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July 6, 2020

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Nunavut Water Board
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Sent via Email: licensing@nwb-oen.ca; derek.donald@nwb-oen.ca

Re: 2019 Annual Geotechnical Inspection Report for the Tailings Impoundment Area Hope Bay Project, Nunavut

Dear Mr. Donald,

In accordance with Part I, Item 9 of Type A Water Licence 2AM-DOH1335, please see Attachment #1 to this correspondence for the results of the Hope Bay Project 2019 Annual Geotechnical Inspection (AGI) of the Doris Tailings Impoundment Area (TIA), conducted by SRK Consulting (Canada) Inc.

TMAC Resources Inc. (TMAC) is pleased to present responses to recommendations made during the AGI for the TIA in Attachment #2.

A secure link to a complete digital and downloadable copy of this full submission, including both attachments, is available at the location listed below.

URL:	https://tmac.exavault.com/share/view/22cub-3x2fe5t6

Should you have any further questions please feel free to contact me at oliver.curran@tmacresources.com.

Sincerely,

Oliver Curran

Vice President, Environmental Affairs, TMAC

Cc:

Licencing (NWB)
John Roesch (KIA)
Kyle Conway (TMAC)
Sarah Warnock (TMAC)
Calum Semple (TMAC)
Adam Grzegorczyk (TMAC)

Attachments:

Attachment 1 - 2019 TIA Annual Geotechnical Inspection Report (SRK, 2020)

Attachment 2 - Recommendations and TMAC Responses – TIA (TMAC, 2020)

Attachment 1

2019 TIA Annual Geotechnical Inspection Report (SRK, 2020)

2019 Annual Geotechnical Inspection
Tailings Impoundment Area
Hope Bay Project, Hope Bay, Nunavut

Prepared for

TMAC Resources Inc.



Prepared by

SRK Consulting (Canada) Inc.
1CT022.038.400
July 2020

2019 Annual Geotechnical Inspection Tailings Impoundment Area Hope Bay Project, Hope Bay, Nunavut

July 2020

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srk consulting

Executive Summary

The Hope Bay Project is a gold mining and milling undertaking of TMAC Resources Inc. The Project comprises three distinct areas of known mineralization, Doris, Madrid (North and South), and Boston. Doris Mine (Phase 1) is currently being operated (as of December 2018) under Nunavut Water Board (NWB) Type A Water License 2AM-DOH1335 - Amendment No.2. This license covers the current Phase 1 and well as the Phase 2 mining developments. TMAC contracted SRK Consulting (Canada) Inc. to conduct an annual geotechnical inspection (AGI) for the Tailings Impoundment Area (TIA) in accordance with all stipulated license conditions.

The TIA currently consists of a water retaining dam, the North Dam, and a tailings retaining dam, the South Dam. A second tailings retaining dam or saddle dam, the West Dam, will be built adjacent to the South Dam when the South Dam is raised. Subaerial tailings are currently retained by the South Dam, and the Reclaim Pond is impounded by the North Dam. The North Dam was constructed during the winters of 2011 and 2012, and Phase 1 of the South Dam was constructed in one season during the winter of the 2017 to 2018 season. In Phase 2, the South Dam will be raised approximately 46m and the West Dam will be constructed. Phase 2 construction is expected to commence around 2022 with the downstream raise of the South Dam. Around the winter of 2023 construction of the West Dam is expected to start. The exact timing of the commencement of the South Dam Phase 2 raise and West Dam construction will be depending on mill processing rates and on-site development activities. An internal dike structure (referred to as the Interim Dike) was previously designed for Phase 2 but is no longer required.

Table A provides a summary of the 2019 AGI inspection components for the TIA, and the primary recommendations stemming from the site inspection and subsequent review of monitoring data. The recommendations from the previous 2018 AGI are included for reference. Based on the results of the 2019 AGI, the North Dam and South Dam are functioning as designed, and no concerns were identified regarding the ongoing performance of these structures. There are however maintenance issues that require attention, and suggestions for improvement of the performance monitoring system. The items in Table A are considered important to the ongoing performance and safety of the TIA and require attention by TMAC prior to the 2020 annual geotechnical inspection. Where appropriate, an update status of certain recommendations is provided in *red* text.

Table A: Summary of 2019 AGI Recommendations

Inspection Item	2018 Recommendations (for reference)	2019 Recommendations
General TIA Management Recommendations		
Third Party Dam Safety Review	• The North Dam hazard classification was revisited and is considered HIGH. This requires an independent third-party Dam Safety Review by 2021.	• Conduct an independent third-party Dam Safety Review for both the North and South Dams in the summer of 2021.
Tailings Operating, Maintenance and Surveillance (OMS) Manual and Emergency Response Plan (ERP)	• Ensure all staff are aware of the OMS Manual and are familiar with its contents. • Review and revise the OMS manual to ensure consistency with the recently amended Water License. • Provide necessary training in accordance with the OMS Manual.	• An update to the OMS manual is in progress by SRK and will be submitted by Q4, 2020. This update is aimed to be a notable improvement to the current OMS. This noted, additional updates are expected in Q3 and Q4 2020. The focus of the OMS updates in Q3 and Q4 will be further refinement of the Trigger Action Response Plans (TARPs). The OMS for this facility will be a 'living' document that is expected to be reviewed annually. • TMAC should ensure all staff are properly informed and trained on the contents of the OMS Manual. • *At the time of writing this report, TMAC was in the process of developing a standalone 'Hope Bay Project Dam Emergency Plan', rather than updates to the ERP, to address dam emergencies. It will incorporate inundation mapping and dam break scenarios. The standalone dam emergency plan will be released upon completion of the OMS update to ensure alignment.* An Emergency Reponses Plan exists for the site; however, this document was lacking sufficient detail for a specific emergency at the TIA, if one were to occur. In 2019 SRK visited site and held a session with site personnel to go over preliminary dam break inundation maps completed by SRK and to provide inputs into what should be included in the site ERP updates to ensure the TIA is properly covered in this document. An update to the ERP is recommended in 2020 to provide additional details for the TIA.
TIA Responsible Parties	• N/A	• TMAC must agree on the roles and responsibilities for the TIA, train and inform personnel of their duties, and operate the facility accordingly. This will be an ongoing recommendation that is expected to be repeated annually. The roles and responsibilities for the TIA will be defined in the OMS update, to be released in 2020.
Monitoring Standard Operating Procedures (SOPs)	• To avoid confusion update SOPs to reflect changes that has been agreed to since the original SOP was developed.	• Update the Monitoring SOP to include South Dam monitoring requirements. SRK is currently preparing a separate SOP for the South Dam, and one already exists for the North Dam. A draft version of the South Dam SOP was submitted to TMAC in June 2020 and a final version is expected in July 2020.

Inspection Item	2018 Recommendations (for reference)	2019 Recommendations
Compliance with Monitoring Requirements	• Improve efforts to conduct monitoring at the frequency described in the SOPs.	• Conduct monitoring in accordance with the Monitoring SOP, paying attention to those areas where conformance is not consistently met.
North Dam Inspection and Review of Monitoring Data		
Ground Temperature Cables (GTCs)	• In accordance with manufacturers recommendations, the dataloggers must be recalibrated as it has been in operation for more than five years. Internal batteries on the dataloggers must also be replaced. • A monitoring well near ND-VTS-130-DS is no longer required. See “Physical Inspection of North Dam”.	• There are no specific recommendations for the installed GTCs. However, TMAC should aim to improve performance tracking of the dataloggers at the South Dam and check to see if cables are being damaged by wildlife after spring melt in order to confirm that current cable protection is adequate.
Thermosyphons	• AFI or another qualified contractor must physically inspect thermosyphon North 2 (at the North Dam) and determine why it is not working. Appropriate repairs must be conducted. • While the contractor is on-site, have them inspect all thermosyphons, and carry out any additional maintenance they recommend.	• The 2018 recommendations were completed in 2019 and Arctic Foundations Canada (AFC) visited the site for an inspection. Additional details are provided in this 2019 AGI (see Appendix A).
CR1000 Datalogger Battery Voltage	• The external datalogger batteries should be tested and recharged or replaced annually.	• The external CR1000 datalogger batteries should continue to be monitored and recharged annually or replaced as needed.
Inclinometers	• No action required.	• The inclinometer and associated readout device should be recalibrated every 3 years as per recommended best practice. SRK was aware that TMAC sent this instrument for recalibration but due to COVID-19, the instrument calibration was unable to be performed and had to be returned from the out of country manufacturers. This recommendation should be revisited before the spring of 2021.
Survey Monitoring Points	• Backfill the erosion around ND−DSP−100.	• Backfill the erosion around survey monitoring point ND−DSP−100 at the North Dam. • Continue to carefully observe the North Dam downstream shell settlement points ND-SSP-080-3 and ND-SSP-110-3 to determine if thaw settlement of the toe is causing undue deformation.
Creep Displacement	• N/A	• None.
Walkover Surveys	• Improve efforts to conduct walkover surveys in accordance with the frequency prescribed in the SOP.	• The required weekly walkover surveys at the North Dam are not being completed in accordance with the SOP. This is an important surveillance activity as defined in the OMS Manual and needs to be complied with.
North Dam Seepage	• Continue to conduct monitoring of the North Dam toe seep in accordance with	• Continue water quality monitoring of North Dam seepage according to the methods

Inspection Item	2018 Recommendations (for reference)	2019 Recommendations
	the recommendations (see Appendix J for the 2018 TIA AGI). This includes: • Field measurements of Electrical Conductivity when Surveillance Network Program (SNP) samples are collected at TL-1; • Weekly sampling and geochemical analysis of North Dam toe seepage when present; • Annual review of North Dam toe seepage water chemistry; • Measurement of active layer thaw depth using a frost probe.	outlined in SRK (2018b) (this was completed in 2019). • Conduct at least one additional frost probe survey along the same transects in early summer and early fall, following the same procedure as in 2018 and 2019. Based on current favourable results, SRK will revisit the requirements for the frost probe surveys as part of the 2020 AGI and determine if further surveys are required beyond 2020.
AGI Physical Inspection	• N/A	• None.
South Dam Inspection and Review of Monitoring Data		
Ground Temperature Cables (GTCs) and D405 Dataloggers	• N/A	• Complete a walk over survey of the South Dam after spring melt and look for any exposed or damaged ground temperature cables. This will allow for preventative maintenance to be done if exposed cables are observed, which will help to limit the potential for damage from wildlife. • SRK to further assess, if repairs are not possible, replacement of Ground Temperature Cables SD-VTS-155-US, SD-VTS-240-US and SD-VTS-240-DS will be required. • Manually download data from each datalogger once annually or as specified by the EOR.
Survey Monitoring Points	• N/A	• None.
Physical Inspection of the South Dam and Walkover Surveys	• N/A	• Start weekly walkover surveys of the South Dam in 2020. This is an important surveillance activity. Additional details will be provided to TMAC in the South Dam SOP.
TIA-Wide Monitoring		
Tailings Deposition System	• No action required.	• TMAC should install the dedicated mine water discharge pipeline to the TIA as soon as possible to allow tailings deposition to recommence from the South Dam. It is critical that tailings deposition from South Dam recommence in order to maintain a beach length of at least 100 m at all times, for all TIA water levels. *UPDATE: this was addressed at the start of 2020 and is now complete. The Roberts Bay Discharge system is now operational.* • Saline mine water may only be discharged together with tailings from, or within, 300 m of the South Dam provided the freezing point depression is less than 0.5ºC (around 4,500 mg/L Cl maximum equivalent). If the

Inspection Item	2018 Recommendations (for reference)	2019 Recommendations
		freezing point depression exceeds 0.5ºC, saline mine water may only be discharged with tailings at other designated tailings discharge points further than 300 m from the South Dam or directly into the Reclaim Pond. The freezing point depression calculation is provided in this AGI and will be incorporated by SRK into the updated OMS Manual (update currently in progress). • The tailings discharge system must be operated in accordance with the designated tailings discharge plan. Primary spigot moves should be expected around, or shortly afterwards, spring melt and again prior to winter freeze up. • Areas along the eastern shoreline of the TIA where tailings discharge has occurred at elevations above 36.5 m need to be carefully monitored to determine if permafrost damage is occurring due to tailings flow and vegetation dieback. Should any damage be noted, appropriate proactive mitigation may be required.
Emergency Dump Catch Basins	• N/A	• Repair the Western Emergency Dump Catch Basin at the earliest opportunity to ensure liner movement does not occur and impact the as-built storage capacity of this Emergency Catch Basin.
Pipelines (Reclaim, Tailings Deposition and TIA Discharge)	• N/A	• TMAC must carefully inspect all pipelines placed directly on the tundra for signs of vegetation dieback and associated flow path channelling. Where this is occurring, the pipeline must be relocated to follow existing all-weather road shoulders, and appropriate remediation needs to be put in place where damage has occurred. Going forward, TMAC should consider abandoning the practice of placing pipelines directly onto the tundra. • The permafrost thermal erosion feature that has developed along the northern shore of the TIA was backfilled by TMAC in 2019. This area should continue to be monitored to ensure that additional thermal erosion does not result in this area.
Shoreline Erosion	• N/A	• None.
TIA Water Balance	• N/A	• It is of paramount importance that the Roberts Bay Discharge System Pipeline be completed during the summer of 2019. Further delay of this may result in reduced operations. *UPDATE: this was addressed at the start of 2020 and is **now complete**. The Roberts Bay Discharge system is now operational.*
Climate Data	• N/A	• None.

Inspection Item	2018 Recommendations (for reference)	2019 Recommendations
TIA Water Quality	• N/A	• No recommendations; however, the following comments are made below. • The water treatment plant for the TIA is required to be maintained in good operational condition so that discharge of supernatant water can occur once the Roberts Bay Discharge System Pipeline is operational, and allow treated water to be discharged in order to maintain water levels in the TIA below the full supply level. *UPDATE: as of the start of 2020 the Roberts Bay Discharge system and the connected water treatment plant is now operational.*
TIA Reclaim Water Pad / 710 Pumphouse Pad	• N/A	• Notable settlement was noted at the TIA Reclaim Jetty Pad (also referred to as the 710 Pumphouse pad). Upon visual inspection and from review of the as-built data, it looks like new ROQ material was placed off the edge of the pad in thick, end dumped lifts in order to widen the pad for the new 710 pumphouse. There are notable stability concerns with this pad as large settlements and notable cracking indicate that a failure of this pad (albeit slow) appears to be occurring. However, it should be noted that the rate of movement could increase suddenly causing a sudden failure, and this risk should not be ignored. Monitoring of this area (at least weekly during winter and daily during months with no ice cover on the lake) should be completed. It is recommended that remediation measures be completed for the pad in order to stabilize the fill and prevent further deformation. This is expected to consist of placing additional fill along the outside of the access road and pad to reduce the overall slope and provide additional confining stress at the toe of the pad (which is currently underwater). Rates of loading must be controlled and slow enough in order to avoid inducing excess pore pressures in the foundation. This means that it may take weeks to build this small additional fill and that the dumping faces should be spread out as much as possible. Material should be end dumped back from the working face and spread with an excavator with the largest reach on site (to limit loading at the crest).

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1 Introduction

1.1 General

The Hope Bay Project is a gold mining and milling undertaking of TMAC Resources Inc. The Project is located 705 km northeast of Yellowknife and 153 km southwest of Cambridge Bay in Nunavut Territory, and is situated east of Bathurst Inlet (Figure 1). The Project comprises three distinct areas of known mineralization, Doris, Madrid (North and South), and Boston.

The Project is being executed in Phases; Phase 1 is currently carried out under an existing Type A Water Licence (Figure 2), while Phase 2 will be carried out under the two Water Licences that were approved in December 2018 (Water License 2AM-DOH1323 and 2AM-DOH1335). Phase 1 includes mining and infrastructure at Doris, while Phase 2 includes mining and infrastructure at Madrid and Boston located approximately 10 and 60 km south from Doris, respectively. The Doris Tailings Impoundment Area (TIA) (Figure 3) will ultimately contain both Phase 1 and 2 tailings.

Construction of Phase 1 infrastructure started in 2007, and underground development commenced in 2010. The North Dam which provides containment for the TIA at its northern perimeter was constructed over two winter seasons, 2011 and 2012 (Figure 3). In the fall of 2012, the Project was placed into Care and Maintenance prior to completing infrastructure development required to allow commercial production. Following an ownership change of the Project, Phase 1 was taken out of Care and Maintenance in 2015 and transitioned into commercial production in 2017. Construction of the South Dam, providing southern TIA containment was carried out between January and June of 2018 (Figure 3).

To fulfill regulatory compliance requirements for an annual geotechnical inspection (AGI) for the TIA containment dams as well as any supplementary infrastructure pertaining to the TIA operations such as pipelines and emergency catch basins, TMAC contracted SRK Consulting (Canada) Inc. to conduct the 2019 inspection. This report provides a summary of the conditions observed, a review of monitoring data, and recommendations to ensure ongoing successful performance of the tailings management system. SRK has conducted each formal AGI of the TIA since 2012 (SRK 2012a, 2013a, 2014a, 2014b, 2016a, 2017a, 2018a, 2019a).

Cam Scott, MSc, PEng, Principal Consultant, and John Kurylo, MSc, PEng, Senior Consultant with SRK, conducted the on-site geotechnical inspection between August 16 and 21, 2019. As of 2019, with the passing of Maritz Rykaart, John Kurylo has taken over the official Engineer-of-Record (EOR) for the North and South Dams (see Appendix O). Weather conditions during the inspection were rainy on August 20, becoming sunny on August 21. The detailed inspection of the dams and supporting infrastructure was carried out on foot, followed by an aerial survey of the TIA using a low altitude helicopter flyover. Kyle Conway, On-Site Environmental Superintendent with TMAC, accompanied Cam and John during the walkover inspections. Photos detailing the inspection conditions are included as photologs, and comprehensive review and analysis of the monitoring data are provided in the appendices. A post inspection meeting was held on site with key personnel from relevant departments, where SRK presented the preliminary inspection findings.

1.2 Inspection Requirements

Phase 1, including the TIA, is licensed by the Nunavut Water Board (NWB) under Type A License 2AM-DOH1323 - Amendment No. 1, dated November 4, 2016. This licence entitles TMAC to use water and dispose of mine waste associated with their operation. The following specific inspection requirements, relevant to the TIA, are stated in Part J, items 16 and 17 of the license:

> *16. The Licensee shall undertake a geotechnical inspection annually between July and September, by a Geotechnical Engineer. The inspection shall be conducted in accordance with the Canadian Dam Safety Guidelines where applicable and take into account all major earthworks, including the following:*
>
> *a. Tailings Impoundment Area North Dam, Interim Dike and South Dam;*
> *b. Geotechnical instrumentation and associated monitoring data;*
> *…*
> *d. Tailings Impoundment Area shoreline and erosion strip survey monitoring results;*
> *…*
>
> *17. The Licensee shall submit to the Board for review, within ninety (90) days of completion of the geotechnical inspection, the Geotechnical Engineer's inspection report. The report shall include a cover letter from the Licensee outlining an implementation plan addressing each of the Geotechnical Engineer's recommendations and shall include the following:*
>
> *a. All quantities in cubic meters of dike seepage from the North and South Dams pumped back into the Tailings Impoundment Area;*
> *b. As-built drawings and a summary of the mitigation works undertaken along the shoreline of the Tailings Impoundment Area in response to erosion, as stipulated in the Shoreline Adaptive Management Plan; and*
> *c. All data and information generated from the monitoring of all project geotechnical instrumentation.*

Additional inspection requirements for other components of Phase 1 are listed within the water license; these conditions are addressed in separate inspection reports which are submitted to the NWB under different covers.

Under the Phase 2 Type A Water License 2AM-DOH1335 - Amendment No. 2, dated December 7, 2018, the specific TIA inspection requirements are stated in Part I, items 9 and 10 of the license:

> *9. The Licensee shall undertake a geotechnical inspection of all surface infrastructure and earthworks, annually between July and September, by a Geotechnical Engineer. The inspection shall be conducted in accordance with applicable best practices including the Canadian Dam Association Guidelines for water and waste containment facilities.*
>
> *10. The Licensee shall submit to the Board for review, within ninety (90) days of completion of the geotechnical inspection, a report in accordance with Part I Item 9 and/or the Annual Report. The report shall include a cover letter from the Licensee outlining an implementation plan addressing each of the Geotechnical Engineer's recommendations and shall include the following:*
>
> *a. All quantities in cubic meters of dike seepage from the North, West, and South Dams pumped back into the Tailings Impoundment Area;*

b. As-built drawings and a summary of the mitigation works undertaken along the shoreline of the Tailings Impoundment Area in response to erosion; and

c. All data and information generated from the monitoring of all project geotechnical instrumentation.

As both water licenses were in effect over the time since the previous inspection, and since the TIA operational strategy changes to some extent between Phase 1 and Phase 2, the 2019 AGI was completed taking into consideration both the Water Licence in effect in August 2018 (2018 Inspection) and the new Water Licence obtained in December 2018.

2 Site Conditions

2.1 Tailings Impoundment Area History

A summary of the TIA permitting, construction, and operations history is provided in Table 1.

Table 1: Summary of TIA Development History

Period	Comments
2003	Doris North Project preliminary economic assessment is completed with Tail Lake designated as the TIA, assuming subaqueous deposition and a maximum tailings quantity of about 0.4 Mt (SRK 2002a).
2002 - 2005	Geotechnical, geophysical, geohydrological and permafrost investigations of dam foundations (North, South and alternate internal locations), TIA shoreline perimeter, and TIA talik (SRK 2002b, 2003 and 2005a, 2005b and 2005c).
2005	Environmental Assessment for the Doris North Project is completed which includes rigorous alternatives assessment confirming Tail Lake as the preferred TIA.
2006	Project Certificate is issued for the Doris North Project.
2006	Application for Schedule 2 listing of Tail Lake as TIA in accordance with the Metal Mining Effluent Regulations (MMER).
2008	Tail Lake MMER Schedule 2 listing obtained.
Winter 2011 and Winter 2012	North Dam constructed (SRK 2012b).
Fall 2012	Project placed into Care and Maintenance before any tailings was ever produced.
2012 – 2015	Project in Care and Maintenance. Water within the TIA is managed in accordance with the Interim Water Management Plan (SRK 2012c) which includes pumping water from the Pollution Control Pond (PCP) to the TIA and discharging TIA water to Doris Creek.
2015 – 2016	TMAC submits application to amend the Water Licence and Project Certificate which amongst other things will result in a change from subaqueous tailings deposition to sub-aerial tailings deposition, increase the TIA capacity to 2.5 Mt, change the South Dam design to a frozen foundation dam, and construction of an Interim Dike. This amendment was approved November 4, 2016.
2017 – 2019	TMAC submits application to amend the Doris Water Licence and Project Certificate, and to obtain a new Water Licence in support of Phase 2 of the Hope Bay Project. Amongst other things, this will result in increasing the TIA capacity to 18 Mt, constructing a South Dam raise, and the Interim Dike would no longer be required. The updated Project Certificate was issued in October 2018, and the amended and new Water Licence issued December 2018.
January 2017	Start of tailings deposition in TIA.
January – June 2018	Completion of Phase 1 South Dam construction.
August 2018	Additional installation of South Dam instrumentation, and cable extensions for the ground temperature cables.
May 2019	Instrumentation upgrades and additional data logger installations at the South Dam.

2.2 Tailings Management Strategy

2.2.1 Phase 1

Phase 1 tailings are subaerially deposited in the TIA (formerly Tail Lake), which was listed on Schedule 2 of the Metal Mining Effluent Regulations (MMER) specifically for use as a tailings

facility. The TIA is located south-east of the Doris mill and mine (Figure 2). Containment for the TIA is provided through a water retaining frozen core dam (North Dam), and a geosynthetic clay liner (GCL) lined frozen foundation tailings dam (South Dam). An Interim Dike near the mid-point of the TIA provides solids containment (Figure 3). Phase 1 tailings solids containment capacity is limited to 2.5 Mt.

2.2.2 Phase 2

Phase 2 tailings management increases the overall tailings solids containment capacity to approximately 18 Mt. The North Dam remains unchanged and is not planned to be raised, but the South Dam gets raised and a new West Dam (also a frozen foundation GCL lined dam) is constructed (Figure 3). Tailings deposition completely covers the Interim Dike if it has been constructed; however, construction of the Interim Dike is currently not planned. Note there is no requirement to construct the Interim Dike to accommodate Phase 2 tailings.

2.3 Tailings Storage Requirements

The planned tailings production rates and associated tailings storage requirements for the Doris TIA are summarized in Table 2. See Appendix N for additional details on the latest tailings deposition modelling analysis.

Table 2: TIA Containment Volume Design Criteria

Description	Value
Tailings Production Rate Allowances	2020 to 2023 → 2,000 tonnes per day (tpd) 2024 → up to 3,500 tpd 2025 to End of Mine Life → up to 4,000 tpd
Tailings Specific Gravity	2.85
Deposited Tailings Dry Density	1.3 t/m^3
Tailings Solids Content	35% solids (by weight) initially, increasing to 65% (somewhat dependent on if mine water inputs continue to TIA or if this water is treated and discharged directly to Roberts Bay before going to the TIA)
Total Tailings Storage Requirement: By Mass By Volume	 20.0 Mt 15.4 Mm^3
Remaining Tailings Storage Requirement: By Mass By Volume	 18.8 Mt 14.5 Mm^3
Ice Entrainment Allowance: Percentage of tailings capacity By volume	 20% 2.4 Mm^3
Tailings Beach Slope:	Between 0.5% and 1.0% (expected variability based on monitoring data and survey data)

2.4 Tailings Impoundment Area Infrastructure

2.4.1 North Dam

The North Dam forms the northern boundary of the Doris TIA within a narrow natural valley, blocking the original Tail Lake outlet to Doris Lake (Figure 3). Complete North Dam geometric design parameters and design criteria are summarized in Table 3 and Table 4 respectively. Figure 4 through Figure 6 depict pertinent details of the North Dam and its instrumentation. Photolog 1 through Photolog 3 from the 2019 inspection show photos of the upstream and downstream slopes, and the installed instrumentation.

The North Dam impounds the Reclaim Pond and was designed as a water retaining structure. The dam has a central frozen core with a secondary upstream GCL. The dam is constructed from local quarry rock and consists of processed fines for the core, 150 mm nominal sized transition material, and a run of quarry (ROQ) outer shell. To ensure maintenance of frozen foundation and frozen core conditions, the key trench of the dam is equipped with 12 horizontal thermosyphon evaporators (SRK 2007, 2012a, 2013a, 2015a).

Construction of the North Dam started in February 2011 and was completed in April 2012, over two distinct winter seasons. Complete as-built details are provided in SRK (2012b).

2.4.2 South Dam

The South Dam is located at the southern end of the former Tail Lake, on the watershed divide to Ogama Lake (Figure 3). The South Dam is designed as a frozen foundation dam consisting of a compacted rock fill dam (sourced from a local quarry) with a GCL keyed into the permafrost overburden and bedrock foundation for seepage control. Complete geometric design parameters and design criteria are summarized in Table 3 and Table 4 respectively, with Figure 7 through Figure 9 presenting pertinent details of the South Dam design. The dam is designed to retain beached tailings as opposed to water. The dam is to be constructed in two phases, incorporating a single downstream raise between Phase 1 and Phase 2.

South Dam construction began in January 2018 and Phase 1 construction was completed in June 2018. The South Dam instrumentation was mostly completed in August 2018. Photolog 4 shows the South Dam Inspection photos.

2.4.3 Interim Dike

The Interim Dike was originally designed as part of Phase 1 and consisted of a homogeneous ROQ rock fill dike, with an upstream filter zone. This was planned to be constructed within the confines of the TIA, directly on the existing lake bed sediment, without dewatering the TIA. The Interim Dike was originally intended to retain tailings solids while allowing for tailings supernatant water to pass unhindered to the Reclaim Pond (SRK 2016). However, the Interim Dike is not required as part of the Phase 2 tailings deposition plan, and since it has not been constructed, it is not expected to be constructed now that the Phase 2 Water Licence has been issued. Going forward, the Interim Dike will be removed from the 2020 AGI.

2.4.4 West Dam

The West Dam has been designed as a frozen foundation dam with a key trench and a GCL liner keyed into permafrost, similar in design to the South Dam. It is intended to retain beached tailings along low-lying ground on the western perimeter of the TIA (Figure 3). Complete geometric design parameters and design criteria are provided in Table 3 and Table 4. This dam will be constructed in a single stage using local quarry rock. This dam has not yet been constructed.

Table 3: TIA Containment Dams Geometric Design Parameters

Description	North Dam	South Dam	West Dam
Structure Type	Frozen core rock fill dam with geomembrane	Frozen foundation rock fill dam with geomembrane	Frozen foundation rock fill dam with geomembrane
Secondary Seepage Barrier	GCL		
GCL Deployment Slope	2.5H:1V	Phase 1 – 3H:1V Phase 2 – 4H:1V	3H:1V
Thermosyphons	12 sloped	None	None
Crest Centerline Length	220 m	515 m	470 m
Maximum Height	11.0 m	Phase 1 – 6.0 m Phase 2 – 14.0 m	5.0 m
Crest Elevation	37.5 masl	Phase 1 – 38.0 masl Phase 2 – 46.0 masl	46.0 masl
Core/GCL Elevation	35.0 masl	Phase 1 – 37.0 masl Phase 2 – 45.0 masl	45.0 masl
Full Supply Level (FSL)	33.5 masl	Phase 1: Water – 33.5 masl Tailings – 36.5 masl Phase 2: Water – 33.5 masl Tailings – 44.5 masl	Water – 33.5 masl Tailings – 44.5 masl
Original Tail Lake Water Level	28.3 masl		
Total Actual Freeboard (Crest to FSL)	4.0 m	Phase 1: Water – 4.5 m Tailings – 1.5 m Phase 2: Water – 12.5 m Tailings – 1.5 m	Water – 12.5 m Tailings – 1.5 m
Total Actual Minimum Freeboard (Core/GCL to FSL)	1.5 m	Phase 1: Water – 3.5 m Tailings – 0.5 m Phase 2: Water – 11.5 m Tailings – 0.5 m	Water – 11.5 m Tailings – 0.5 m
Required Normal Freeboard (CDA 2013)	Wind setup (0.07 m) + Wave runup (1.06 m) = 1.13 m		

Description	North Dam	South Dam	West Dam
Required Minimum Freeboard (CDA 2013)	Wind setup (0.06 m) + Wave runup (1.16 m) = 1.22 m Inflow Design Flood (IDF) = 2.1 m (at end of mine life when Reclaim Pond is at its minimum size)		
Thermal Protection above Frozen Core	2.5 m	n/a	n/a
Crest Width	13 m	10 m	10 m
Upstream Structure Slope	6H:1V	4H:1V	4H:1V
Downstream Structure Slope	4H:1V	2H:1V	2H:1V
Key Trench Depth	Varies (2.0 – 5.0 m)	Varies (2.0 – 4.0 m)	4.0 m
Key Trench Upstream Slope	0.5H:1V	2H:1V	2H:1V
Key Trench Downstream Slope	0.5H:1V	1H:1V	1H:1V

Table 4: TIA Containment Dams Design Criteria

Description	North Dam	South Dam	West Dam
Settlement Allowance Foundation thaw of 1 m (partial thaw) Foundation thaw of 7 m (full thaw)	1.00 m	 0.47 – 0.67 m 2.45 – 3.85 m	 0.40 – 0.60 m 2.03 – 3.43 m
Deformation Allowance (Total Strain due to Creep)	<2%	n/a	n/a
Original Design Life: Active use as water retaining structure Design base as water retaining structure Design base until breach Active use as solids retaining structure Design base as solids retaining structure	 17 years 22 years 30 years	 17 years 25 years	 17 years 25 years
Annual Exceedance Probability (AEP) for Inflow Design Flood Risk Based Standards Based	 1/2,475 (0.0004) 1/3 between 1/1,000 and the PMF(1)		
Static Stability Factor of Safety: Long-term (Drained Conditions)	1.3 during construction 1.5 during operation and closure 1.2 to 1.3 partial or rapid drawdown		
Pseudo-Static Stability Factors of Safety	1.0 during earthquake 1.2 post earthquake		
AEP for Earthquake Design Ground Motion	1/2,500 (0.0004)		
Peak Ground Acceleration (PGA)	0.060g(2)	0.036g	0.043g
Mean Annual Air Temperature Climate Change	+6.8°C up to year 2100		
Thermal Design Freezing Point Depression (Normal Conditions) Tailings Overburden Frozen core	 n/a -8°C -2°C	 0 to -1°C -2°C n/a	 0 to -1°C -2°C n/a

Description	North Dam	South Dam	West Dam
Thermal Design Freezing Point Depression (Upset Conditions) Tailings Overburden Frozen core	 n/a -7°C -1°C	 0 to -1°C -2°C n/a	 0 to -1°C -2°C n/a
Seepage Allowance	78 m^3/day	50 m^3/day	<1 m^3/day

Notes:

1. Value based on experiential engineered judgement.
2. A peak ground acceleration for a ½,475 return period was not available at the time of design of the North Dam, and therefore the PGA of 0.06 g was selected based on published data for Kugluktuk. This is further described in SRK (2007).

2.4.5 Spillway

An operational spillway was originally designed for the TIA at the North Dam due to the freeboard of the North Dam being adjusted to contain the IDF, as defined in Table 4. It has not been constructed. This may be revaluated later in the mine life when the Reclaim Pond diminishes in size requiring more freeboard to contain the IDF.

Additional discussions on the timing for the spillway construction are expected to occur between TMAC and SRK in 2020. Based on the latest deposition modelling for this facility, in excess of 640,000 m^3 is required to be stored for the design storm event. Based on current plans, and assuming the Roberts Bay Discharge system continues to be operational, it is not until around the last four years of the tailings deposition when the available pond storage in the TIA starts to approach the IDF storage volume requirement. At this time, it is expected that lowering the elevation of the TIA's full supply level (FSL) (i.e. operations will need to maintain a very low pond level in the TIA) will be required to help free up as much storage space as possible for the design storm event. To mitigate against the risk of an overtopping failure (specifically at the North Dam) and ensure there is redundancy in the system (i.e. to have a passive outflow in the event pumps break down) an emergency spillway will be required to be constructed. A discharge from the spillway would only occur during an emergency event and is not planned for routine use.

The urgency behind construction of the spillway is linked to the later stages of the mine life, around 2028 or later as indicated by the results of the deposition models. However, this timeline can easily be impacted by unexpected conditions or poor management practices i.e. storing additional water in the TIA or in particular if the Roberts Bay Discharge system was to fail and be offline for an extended period of time (e.g. 6 months or more).

2.4.6 Tailings Deposition System

The tailings discharge system is designed as a single heat-traced and insulated pipeline with end-point (i.e. single spigot) discharge at predetermined locations. The tailings deposition pipeline consists of a combination of 6-inch internal diameter steel and High-Density Polyethylene (HDPE) pipelines with no redundancy. There are no double lined pipeline sections for environmental containment. The pipeline is placed directly on the ground, which consists of either engineered rockfill pads, the all-weather road shoulders, or in some areas directly on the tundra.

Actual tailings deposition started in February 2017 and tailings discharge has occurred from four locations. A plan overview of the tailings deposition history is illustrated in Figure 10. The different tailings discharge locations were in part because of deferral of South Dam construction which prevented earlier tailings deposition. Photos of the tailings deposition are shown in Photologs 5 and 6 attached.

Table 5 summarizes the deposition status as of December 2019. As previously noted, actual tailings deposition is behind what was planned (Table 2); however, increases in deposition rate have been observed over 2019 (Figure 11 and Figure 12). It should be noted that there is no evidence to suggest that there is any significant entrained ice within the deposited tailings at this point in time. The current deposition modelling and storage capacity assessment (see Appendix N) includes a 20% allowance for ice entrainment.

Table 5: Actual Tailings Deposition Between Start-up (February 2017) and December 2019

Period	Percent Solids (by Weight)	Tailings Solids (tpd)	Cumulative Tailings Solids (tonnes)	Cumulative Tailings Solids (m^3)
February 2017	39.0	212	5,936	2,120
March 2017	21.7	351	16,814	6,005
April 2017	32.5	635	35,864	12,809
May 2017	23.0	659	56,293	20,105
June 2017	41.7	662	76,153	27,198
July 2017	15.0	569	93,792	33,497
August 2017	20.8	741	116,778	41,706
September 2017	20.5	555	133,431	47,654
October 2017	19.5	733	156,139	55,764
November 2017	17.3	634	175,159	62,557
December 2017	22.0	841	201,234	71,869
January 2018	34.5	814	226,452	80,876
February 2018	33.0	966	253,489	90,532
March 2018	25.2	1,012	284,864	101,737
April 2018	39.2	1,073	317,066	113,238
May 2018	42.0	893	344,758	123,128
June 2018	16.9	818	369,285	131,888
July 2018	28.3	1,027	401,129	143,260
August 2018	44.6	1,386	444,101	158,607
September 2018	45.7	1,614	492,527	175,902
October 2018	48.6	1,851	549,905	196,395
November 2018	48.0	1,842	605,159	216,128
December 2018	44.0	1,555	653,367	233,345
January 2019	45.0	1,621	703,617	251,292
February 2019	36.7	1,696	751,094	268,248
March 2019	44.0	1,630	801,611	286,290
April 2019	45.0	1,292	840,362	300,129

Period	Percent Solids (by Weight)	Tailings Solids (tpd)	Cumulative Tailings Solids (tonnes)	Cumulative Tailings Solids (m^3)
May 2019	42.8	1,935	900,360	321,557
June 2019	50.0	1,819	954,924	341,044
July 2019	48.0	1,374	997,518	356,256
August 2019	44.0	1,784	1,052,819	376,007
September 2019	47.0	1,838	1,107,969	395,703
October 2019	41.2	1,723	1,161,396	414,784
November 2019	44.5	1,315	1,200,834	428,869
December 2019	28.0	1,091	1,234,664	440,951

2.4.7 Emergency Dump Catch Basins

Two Emergency Dump Catch Basins (EDCBs) have been constructed on either side of Doris Creek (Photolog 7). The EDCBs are lined cells constructed at a topographic low-point along the tailings and reclaim pipeline routes that allow for the pipelines to be drained during prolonged mill shutdowns or power failures to prevent pipeline freeze-up. They were designed to accommodate at least two consecutive shutdowns plus direct precipitation over the basin areas. The EDCBs were constructed in 2017. Table 6 summarizes their design and as-built containment capacities.

Table 6. EDCB Design and As-built Capacities

Component	Western EDCB	Eastern EDCB
Permitted Design Capacity	120 m^3	120 m^3
Required Design Capacity	97 m^3	85 m^3
As-Built Design Capacity	124 m^3	85 m^3

2.4.8 Reclaim Water System

Reclaim water is drawn from the TIA Reclaim Pond for re-use in the Process Plant. Reclaim water is drawn from a submerged suction line feeding a low suction head pump installed in an on-shore enclosure located at the Reclaim Pond (Figure 3). This heat-traced and insulated pipeline follows the TIA Access Road (*aka* Secondary Road) from the Reclaim Pond to the Doris mill and is placed directly on the ground (either tundra, all-weather road shoulder, or the engineered rockfill pads). There are no double-lined sections of this pipeline and there is no redundant pipeline (see attached Photologs 8 and 9).

Table 7 provides a summary of reclaim water volumes drawn from the TIA since tailings production started.

Table 7: Reclaim Water Volumes Between Start-up (February 2017) and November 2018

Date	Reclaim Volume (m^3/month)	Cumulative Reclaim Volume (m^3)
February 2017	94,080	94,080
March 2017	107,880	201,960
April 2017	100,800	302,760

Date	Reclaim Volume (m^3/month)	Cumulative Reclaim Volume (m^3)
May 2017	104,160	406,920
June 2017	100,800	507,720
July 2017	81,721	589,441
August 2017	96,586	686,027
September 2017	92,016	778,043
October 2017	92,181	870,224
November 2017	93,088	963,312
December 2017	93,900	1,057,212
January 2018	82,577	1,139,789
February 2018	69,744	1,209,533
March 2018	78,864	1,288,397
April 2018	74,638	1,363,035
May 2018	76,444	1,439,479
June 2018	69,120	1,508,599
July 2018	66,699	1,575,298
August 2018	71,186	1,646,484
September 2018	65,833	1,712,317
October 2018	64,395	1,776,712
November 2018	66,962	1,843,674
December 2018	65,565	1,909,239
January 2019	64,572	1,973,811
February 2019	57,207	2,031,018
March 2019	69,824	2,100,842
April 2019	60,912	2,161,754
May 2019	61,908	2,223,662
June 2019	57,603	2,281,265
July 2019	69,389	2,350,654
August 2019	79,005	2,429,659
September 2019	84,230	2,513,889
October 2019	82,918	2,596,807
November 2019	77,744	2,674,551
December 2019	76,670	2,751,221

2.4.9 TIA Water Discharge System

TIA water will be discharged to Roberts Bay once the Roberts Bay Ocean Discharge System is operational (note: operation of the system started in February 2020 and will be reported in the 2020 AGI report). The discharge pump is located adjacent to the reclaim pump and will pump water along a pipeline following the same route as the reclaim water pipeline. Historically, prior to

tailings deposition, TIA water was discharged to Doris Creek (compliance monitoring station TL-2) during the open water seasons of 2014 and 2015, as summarized in Table 8.

Table 8: Historic TIA Discharge Water Volumes to Doris Creek (TL-2)

Date	Discharge to TL-2 (m^3/month)	Cumulative Discharge to TL-2 (m^3)
June 2014	104,634	104,634
July 2014	257,778	362,411
August 2014	194,405	556,816
September 2014	118,218	675,034
June 2015	3,095	678,129
July 2015	230,460	908,589
August 2015	233,603	1,142,192
September 2015	164,260	1,306,452

2.5 Tailings Impoundment Area Instrumentation

2.5.1 North Dam

Permanent performance monitoring instrumentation for the North Dam consists of:

- 11 vertical ground temperature cables (GTCs);
- 13 horizontal GTCs;
- 18 surficial survey monitoring points located throughout the downstream face of the dam;
- 14 crest survey monitoring points located along the upstream and downstream crest of the dam;
- 3 deep settlement points;
- 6 inclinometers located within the downstream face; and
- 12 single bead thermistors, measuring thermosyphon contact temperatures.

Figure 4 through Figure 6 illustrates the location of North Dam instrumentation. All GTCs are connected to dataloggers allowing continuous data collection. Slope inclinometers are recorded manually using a slope inclinometer instrument owned by TMAC. Settlement monitoring is done manually by ground survey. The North Dam Standard Operating Procedure (SOP) provides comprehensive details pertaining to this instrumentation (SRK 2018b).

2.5.2 South Dam

The active South Dam permanent performance monitoring instrumentation consists of:

- 9 horizontal GTCs;
- 12 vertical GTCs;
- 1 long GTC parallel to the top crest of the key trench

- 19 surficial survey monitoring points (crest and downstream slope);
- 12 crest survey monitoring points; and
- 3 deep settlement points.

The monitoring instrument locations are shown on Figure 7 through Figure 9.

2.5.3 Interim Dike

No monitoring is undertaken for this structure since it has not been constructed and is no longer required for Phase 2. This structure will be removed from the 2020 AGI reporting.

2.5.4 West Dam

Once constructed, this structure will have a similar monitoring plan to that of the South Dam.

2.5.5 Other TIA Instrumentation and Monitoring

Additional monitoring data collected for the TIA are summarized below:

- The water level in the TIA Reclaim Pond is monitored by an automated pressure transducer-datalogger installed at monitoring point TIA-2. The data is transmitted by a solar-powered iridium satellite transceiver to an online portal where it can be accessed remotely by TMAC and SRK. There is also a back-up datalogger installed to record pond levels should a problem occur with the primary data collection system. The secondary datalogger also records water temperature which is beneficial from a thermal review perspective.
- The primary datalogger is configured to collect a reading every 15 minutes in the summer and every 60 minutes during the winter. The data is transmitted to the online portal daily.
- On at least an annual basis, Environmental Resources Management (ERM) conducts a water level reference survey and bathymetry survey of the TIA basin. Based on communications from ERM and TMAC, the water level constant elevation was adjusted from 27.761 masl (ERM 2017) to 27.71 m on August 15, 2019 at 00:00. This was also reflected / updated in the water level transduce / datalogger readings.

Additional detail of the installed tailings monitoring system is described by ERM (2017) and SRK (2018b):

- Tailings deposition is a continuous operation and the volumes are monitored with a flowmeter and an automated data collection system;
- Reclaim water is measured using a flowmeter with an automated data collection system;
- Mine water is measured by means of a totalizer instrument, recorded manually twice daily; and
- Climate data most directly related to the TIA monitoring includes temperature and precipitation (Appendix J). The ambient air temperature shown is collected at the crest of the North Dam as part of the thermal monitoring system. Precipitation data has historically been collected from several sources including on-site meteorological stations. For the indicative

use in this report, the precipitation data shown in Appendix J is based on precipitation data from Cambridge Bay, adjusted for under catch.

2.6 Water Management

2.6.1 Water Management Plan

The TIA is used as the overall collector for all site contact water, which is either pumped or trucked to the TIA. Saline underground water (i.e., mine water) may also be pumped to the TIA if it is not discharged directly to Roberts Bay. TIA water is stored in the Reclaim Pond which is recycled for processing make-up to the extent possible. Excess water in the TIA will be discharged to Roberts Bay for ocean discharge. Prior to discharge to Roberts Bay, all water must meet MDMER limits (SRK 2017b, TMAC 2017).

There are no non-contact surface water diversions upstream of the TIA. The TIA is in an isolated catchment measuring 461 ha, and the benefits of any diversions are outweighed by the relative cost and complexity of constructing them. A schematic of the TIA water management plan is presented in Figure 13.

2.6.2 Water Balance

A site wide water and load balance, including the TIA, has been developed for the Project (SRK 2017b) and forms the basis for the Water Management Plan (TMAC 2017). A detailed operational TIA water balance has also been developed considering the relevant TIA inflows and outflows. This is used by TMAC to make day-to-day operational decisions pertaining to the TIA. This operational water balance incorporates the most recent available site measurements and then uses historical measurements and direct user inputs to predict future TIA water levels, and water quality. The direct user-inputs allow for the modelling of various scenarios to test future "what if cases". The cases all start with a base case prediction defined as the most likely outcome based on the information known today. The current base case prediction for water levels is presented in Figure 14. TMAC has generated this prediction and it is provided as a representation of current planning. Several assumptions feed into the prediction including:

- All measured data to date (in this case, end of 2019);
- A production rate of 2,000 tpd for the remainder of the model (additional updates to the model are ongoing and this rate will be adjusted based on any changes at site);
- Doris Underground mine water was pumped to the Doris TIA at a rate ramping up from measured flows to the FEIS water load balance values up until February 2020 when it will be discharged to Robert's Bay;
- All process water (including freshwater inputs) are sourced from the Doris TIA and are based on historical usage rates (m^3 water/ tonnes ore processed);
- Sedimentation Control Pond (SCP) water is pumped to the Doris TIA based on historical rates;
- Discharge to Robert's Bay from the Doris TIA commences in January 2020 and each of the following years should occur at a rate of approximately 6,650 m^3/day (after pump availability considerations);

- Sewage treatment plant effluent is directed to the Doris TIA starting in January 2020 based on an average camp size of 300 people at historical usage rates (0.16 m^3/person/day); and
- Average climatic conditions for predicted years.

2.7 Dam Hazard Classification

Dam hazard classifications for the TIA containment dams were made in accordance with the Canadian Dam Safety Guidelines (CDA 2013), as well as the CDA Technical Bulletin on Application of Dam Safety Guidelines to Mining Dams (CDA 2014), as summarized in Table 9. The designated dam hazard classifications assigned to each structure is listed in Table 10 (SRK 2015, 2016b).

Table 9: Dam Hazard Classification (as defined in CDA 2013)

Dam Class	Population at Risk[1]	Incremental losses		
		Loss of Life[2]	Environmental and Cultural Values	Infrastructure and Economics
Low	None	0	• Minimal short-term loss • No long-term loss	Low economic losses; area contains limited infrastructure or services.
Significant	Temporary only	Unspecified	• No significant loss or deterioration of fish or wildlife habitat • Loss of marginal habitat only • Restoration or compensation in kind highly possible	Losses to recreational facilities, seasonal workplaces, and infrequently used transportation routes.
High	Permanent	10 or fewer	• Significant loss or deterioration of *important* fish or wildlife habitat • Restoration or compensation in kind highly possible	High economic losses affection infrastructure, public transportation, and commercial facilities.
Very high	Permanent	100 or fewer	• Significant loss or deterioration of *critical* fish or wildlife habitat • Restoration or compensation in kind possible but impractical	Very high economic losses affecting important infrastructure or services (e.g., highway, industrial facility, storage facilities for dangerous substances).
Extreme	Permanent	More than 100	• Major loss of *critical* fish or wildlife habitat • Restoration or compensation in kind impossible	Extreme losses affecting critical infrastructure or services (e.g., hospital, major industrial complex, major storage facilities for dangerous substances).

Notes:
[1] Definitions for population at risk:
None – There is no identifiable population at risk, so there is no possibility of loss of life other than through unforeseeable misadventure.
Temporary – People are only temporarily in the dam-breach inundation zone (e.g., seasonal cottage use, passing through on transportation routes, participating in recreational activities).
Permanent – The population at risk is ordinarily located in the dam-breach inundation zone (e.g., as permanent residents); three consequence classes (high, very high, extreme) are proposed to allow for more detailed estimates of potential loss of life (to assist in decision-making if the appropriate analysis is carried out).
[2] Implications for loss of life:
Unspecified – The appropriate level of safety required at a dam where people are temporarily at risk depends on the number of people, the exposure time, the nature of their activity, and other conditions. A higher class could be appropriate, depending on the requirements. However, the design flood requirement, for example, might not be higher if the temporary population is not likely to be present during the flood season.

Table 10: Dam Hazard Classification of TIA Containment Structures

Structure	Population at Risk (PAR)	Loss of Life	Environmental and Cultural Values	Infrastructure and Economics	Overall Hazard Classification
North Dam	SIGNIFICANT	SIGNIFICANT	HIGH	LOW	HIGH
South Dam	SIGNIFICANT	SIGNIFICANT	HIGH	LOW	HIGH
Interim Dike (not constructed)	LOW	LOW	LOW	LOW	LOW
West Dam (not constructed)	SIGNIFICANT	SIGNIFICANT	HIGH	LOW	HIGH

A presentation providing a preliminary overview of the dam break inundation maps developed by SRK and site-specific considerations for the next updates of the TMAC Hope Bay Emergency Response Plan (ERP) are provided in Appendix Q.

3 TIA Management System Review Findings

3.1 Third Party Dam Safety Review

In accordance with CDA Dam Safety Guidelines (CDA 2013, 2014), including the CDA Technical Bulletin on Dam Safety Reviews (CDA 2016), independent third-party Dam Safety Reviews (DSRs) should be conducted in accordance with a frequency informed by the hazard classification of the structures. This frequency typically ranges between 5 and 10 years. It is recommended a dam with a HIGH hazard classification, such as the North Dam and South Dam, undergo a Dam Safety Review every seven years. However, the hazard classification should be reviewed periodically to ensure that conditions remain valid.

SRK reviewed the hazard rating as part of the 2019 inspection, and considering tailings deposition has started, SRK agrees that a hazard rating of HIGH is appropriate for the constructed North and South Dams. Some preliminary dam break checks were also done in 2019 to help confirm this hazard rating (Appendix Q).

Therefore, in accordance with CDA guidelines, the North and South Dams should have independent Dam Safety Reviews (DSR) every seven years. The North Dam started impounding water in 2011, which means that a DSR should have been completed in 2018. As is illustrated in Figure 14, the North Dam generally retained about 0.7 m head of water (average water level of 29.0 m) until the summer of 2016. This is about 13% of the full supply level (FSL) head based on the original Tail Lake water level of 28.3 m. After that time the water level has been consistently rising to an elevation in 2018 of 30.7 m, which constitutes a head of 2.4 m, or 46% of the FSL head of 5.2 m. In 2019 the water levels in the TIA rose further up to around 32.0m as of December 2019 which is 71% of the FSL head. This noted the Roberts Bay discharge system is now functional (as of 2020) and the system now has outputs, with overall TIA water levels now being lowered again.

Considering the dam performance to date, as well as the fact that considerable technical reanalysis of the dam was done in 2017 as part of the Phase 2 design, SRK is comfortable at this time, to defer completion of a DSR to 2021, which is 10 years after initial impoundment started.

South Dam construction was completed in 2018, which means a DSR for that structure is due in 2025; however, since a DSR is needed for the North Dam in 2021, it is recommended that the South Dam DSR be completed at the same time.

Recommendations:

- Conduct an independent third-party Dam Safety Review for both the North and South Dams in the summer of 2021.

3.2 Tailings Operating, Maintenance and Surveillance Manual

Phase 1 tailings management is carried out under a Tailings Operation, Maintenance and Surveillance (OMS) Manual prepared in 2016 (TMAC 2016). Because tailings deposition in 2017 was inconsistent and less than the planned deposition rates due to mill commissioning challenges, a thorough review of OMS Manual procedures was not undertaken in 2017, although

a minor update was completed (TMAC 2017). There were however significant operational changes in 2018, including significant personnel changes, and as a result the OMS Manual became outdated. Although the OMS Manual was updated in 2017 (TMAC 2017), that update was centered around changes associated with the Phase 2 project, and the necessary operational and personnel changes were not adequately captured. Furthermore, an updated North Dam Monitoring SOP has been issued (SRK 2018b). In 2019 an update to the OMS manual was started with the involvement of site personnel. The updated OMS is planned to be submitted formally by Q4 2020 and will capture the changes from the Phase 2 project and also the updates to the North Dam and South Dam SOPs. The full document has been rewritten to further improve the usability of the document. This being noted, additional work to refine Trigger Action Response Plans (TARPs) is currently underway and is planned to be completed by Q4 2020. With completion of the construction of the South Dam in 2018, a South Dam Monitoring SOP was also required. A draft version of the South Dam SOP was submitted in June 2020 and a final version of the South Dam SOP is expected in July 2020.

Appendix P provides a presentation that was delivered to site staff in 2019 that provided an overview of the Doris TIA design, upcoming OMS updates and considerations for site staff completing the various inspections and data collection activities at the TIA.

Recommendation:

- An additional update to the OMS manual is in progress by SRK at the time of submitting this report. The updated OMS manual will be submitted by Q4, 2020. This update is aimed to be a notable improvement to the past and current OMS versions. This noted, additional OMS updates are planned (specifically refinement of the TARPs) and will be completed by Q4 2020. The OMS for this facility will be a 'living' document that is expected to be reviewed annually as part of the AGI.
- TMAC should ensure all staff are properly informed and trained on the contents of the OMS Manual.
- An ERP exists for the site; however, this document was lacking sufficient detail for the TIA. In 2019 SRK visited site and held a session with site personnel to review the preliminary dam break inundation maps developed by SRK and to provide inputs into what should be included in the site ERP updates (Appendix Q) to ensure that the TIA is properly covered in the document. It is recommended that the updated ERP be completed in 2020. At the time of writing this report, TMAC was in the process of developing a standalone 'Hope Bay Project Dam Emergency Plan', rather than updates to the ERP, to address dam emergencies. It will incorporate inundation mapping and dam break scenarios. The standalone dam emergency plan will be released upon completion of the OMS update to ensure alignment.

3.3 TIA Roles and Responsibilities

The roles and responsibilities for those involved in managing the TIA are defined in the current OMS Manual. However, due to operational challenges associated with an extended commissioning period, in addition to the South Dam construction activities, the OMS was not updated in 2019. Now that the transition period is complete, and South Dam and fully operational, updates to the 'responsible parties' section outlined in the TIA OMS are recommended. This will

be documented in the next submitted revision of the TIA OMS Manual (for Q4 2020). SRK understands that the primary responsible party for the TIA is the mill, and TMAC has now implemented measures to ensure this responsibility (and associated requirements) are understood on site. This is a notable improvement from 2018.

John Kurylo, MSc, PEng, a licenced professional engineer in Nunavut Territory, and a Senior Consultant with SRK has taken over as the EOR for the TIA from the late Maritz Rykaart. This was based on the EOR succession plan for this facility. John has been heavily involved in the Project and TIA since its construction. This is the current status at the time of completing this report. All monitoring data for the North Dam and South Dam is submitted to the EOR monthly, and the EOR remains in constant communication with site staff regarding the overall operation of the TIA. TMAC has allowed free access to information and resources to allow the EOR to fulfill his duties.

Recommendation:

- The responsible parties' section of the OMS should be updated in the next revision (submitted by SRK to TMAC Q4 2020).

4 TIA Inspection and Monitoring Instrumentation Findings

4.1 Compliance with Monitoring Requirements

The North Dam monitoring frequency requirements were first outlined in the North Dam As-built Report (SRK 2012b) and subsequently finalized in the North Dam Monitoring Standard Operating Procedures (Monitoring SOP) which was updated in 2018 (SRK 2013b, 2018b). The South Dam monitoring requirements are similar to the North Dam, where applicable, and will be included in a revised Monitoring SOP that includes both dams.

Since transitioning to tailings production in 2017, routine monitoring and inspections of the North Dam have been completed by site personnel. The monitoring frequency requirements and actual monitoring frequency for the 2018/2019 monitoring period are summarized in Table 11 for the established instrumentation on the North Dam and within the TIA. The South Dam monitoring program has not yet been finalized as it is still under development at the time of the inspection; however, preliminary monitoring since construction is summarized in Table 12.

Table 11: North Dam Monitoring Requirements for the 2019 Monitoring Year(1)

Element	Item	Method	Resp.	Required Frequency	Conformance with SOP (SRK 2018b)(1)(2)	Comments
Thermal	Ground Temperature Cables	Datalogger	TMAC	Daily (automated)	Yes	• Recorded four times daily
	Thermo-syphons				Yes	• Record four times daily
	Datalogger downloads	Manual		Monthly	Yes	• Data collected monthly
Deformation	Downstream Surface Settlement	Manual	TMAC	Monthly (May to Nov.)	Yes	• Surveys received monthly
	Downstream Deep Settlement				Yes	
	Crest Settlement				Yes	
	Depressions				Yes	• No changes observed
	Inclinometers			Monthly	Yes	• Data collected monthly
Water Balance	Water Level	Datalogger Station	TMAC	Daily (automated)	Yes	• Readings every 15 min and uploaded daily
	Water Level	Manual		Monthly	Yes	• Water Level surveyed during installation of datalogger and must be surveyed once during open water season (2019)
	Seepage			Weekly when seepage is observed	Yes	• Seepage documented at the toe of North Dam during spring 2018
Visual	Walkover Survey	Manual	TMAC	Weekly (below FSL(3))	No	• 51 inspections conducted between Nov. 2018 and Dec. 2019

Element	Item	Method	Resp.	Required Frequency	Conformance with SOP (SRK 2018b)[1][2]	Comments
				Daily (at or above FSL)		• The inspection rate is slightly below the target (60 inspections)
	Annual Geotechnical Inspection		Independent Qualified Licensed Geotechnical Engineer	Annually	Yes	• Aug. 2018 (SRK 2019a) • Aug. 2019 (This report)
Maintenance						
North Dam Thermal Datalogger	Datalogger Primary Batteries	Manually recharge	TMAC	Annually	Yes	• Recharged Jun. 2019
	Datalogger Backup Batteries	Manually replace		5-year cycle	Yes	• Replaced during datalogger recalibration
	Datalogger Recalibration	Manual			Yes	• Completed Jan. 2018
	Desiccant Packs	Manually replace		As required	Not required	• No action required
Water Level Datalogger Station (TIA-2)	Datalogger Transmission Subscription	Online		Annually	Yes	• 22% of the data service plan remains
	Physical Datalogger Station	Manually recalibrate or replace		As required	Not required	• No action required

Note(s):

(1) Data reporting period included in this report was November 1, 2018 to December 31, 2019 which is a continuation of data from the last AGI (SRK 2019a)
(2) This column lists if the monitoring frequency is compliant with the monitoring frequency requirements since the last AGI (SRK 2018a)
(3) FSL: Full Supply Level

Table 12: South Dam Preliminary Monitoring Following Construction[1]

Element	Item	Method	Resp.	Required Frequency	Conformance with Preliminary Needs	Comments
Thermal	Ground Temperature Cables	Datalogger	TMAC	Daily (automated)	No (Acceptable)	• Datalogger systems operating (partially) • Troubleshoot or repair based on recommendations
	Datalogger downloads	Manual		Monthly		
Deformation	Downstream Surface Settlement	Manual	TMAC	Monthly (May – Nov.)		• Survey monitoring points were fully established in the summer of 2019 • Surveys received for August to November
	Downstream Deep Settlement					
	Crest Settlement					
	Depressions					• No issues observed
Water Balance	Seepage	Manual	TMAC	Weekly when seepage is observed	Yes	• No seepage observed

Element	Item	Method	Resp.	Required Frequency	Conformance with Preliminary Needs	Comments
Visual	Walkover Survey	Manual	TMAC	Weekly (below FSL[2]) Daily (at or above FSL)	No (Acceptable during transition period)	• Formal documentation of the South Dam inspections should be completed in a similar fashion to the North Dam
	Annual Geotechnical Inspection		Independent Qualified Licensed Geotechnical Engineer	Annually	Yes	• August 2019 (This report)
Maintenance						
South Dam Thermal Datalogger	Datalogger Primary Batteries	Manually recharge	TMAC	Not yet established	Not applicable during transition period	• The maintenance requirements will be provided in the updated TIA monitoring SOP
	Datalogger Backup Batteries	Manually replace				
	Datalogger Recalibration	Manual				
	Desiccant Packs	Manually replace				

Note(s):

(1) Data reporting period included in this report was November 1, 2018 to December 31, 2019 which is a continuation of data from the last AGI (SRK 2019a)

(2) FSL: Full Supply Level

Recommendations:

- Formalize the South Dam Monitoring SOP with detailed monitoring requirements. The draft version was submitted in June 2020, and the final version will be submitted in July 2020.
- Provide an updated North Dam SOP. This would be done to highlight the change in EOR and review to make sure no additional updates are required.
- Conduct monitoring in accordance with the Monitoring SOP, paying attention to those areas where conformance is not consistently met.

4.2 North Dam Inspection and Monitoring

4.2.1 Ground Temperature Cables

To monitor long-term temperature of the frozen core and the dam foundation, a total of twenty-four GTCs were installed during the North Dam construction (SRK 2012b). Of the twenty-four installed GTCs, twenty-two are still functional. Since September 2012, GTC data for the North Dam is recorded every six hours by two Campbell Scientific CR1000 dataloggers (Photolog 3). Data is downloaded from the dataloggers by TMAC personnel using compact flash memory cards.

The frequency of datalogger downloads and the recorded temperature data is presented in Appendix B. In general, the data logger and GTC system is performing well. Only one isolated error event was observed in the 2018/19 monitoring period on June 12, 2019 as noted in Appendix B. The complete status of all North Dam GTCs is summarized in Table 13.

Table 13: North Dam Ground Temperature Cable Status

GTC ID	Status	Comments
ND-VTS-040-KT	Active	Fully operational, except for recalibration January 1 to March 3, 2018
ND-HTS-040-31.5	Active	Fully operational, except for recalibration January 1 to March 3, 2018
ND-HTS-040-33.5	Active	Cable disconnected from datalogger October 10, 2013 to May 13, 2014
		Connection to datalogger more permanently repaired July 2014
		Disconnected for recalibration January 1 to March 3, 2018
ND-VTS-060-US	Inactive	Irreparably damaged between April 27 and August 8, 2012
ND-VTS-060-DS	Active	Fully operational, except for recalibration January 1 to March 3, 2018
ND-VTS-060-KT	Active	Spliced during construction. Fully operational, except for recalibration January 1 to March 3, 2018
ND-HTS-060-28.8	Active	Bead 7 - No readings February 11, 2012 to December 8, 2013
		Bead 7 - No readings since April 21, 2014
		Bead 7 - Readings between November 1, 2014 and April 19, 2015
		Bead 7 - Readings between October 2015 and April 2016
		Bead 7 - Readings between October 2016 and June 2017
		Bead 7 – Readings between September 2017 and May 2018 (excluding recalibration period), resuming at the end of October 2018. Occasional erratic readings continue (since fall 2016) and are attributed to instrument errors.
		Bead 9 - No readings October 10, 2013 to May 20, 2014 and July 2014 onward
		Disconnected for recalibration January 1 to March 3, 2018
ND-HTS-060-31.0	Active	Fully operational, except for recalibration January 1 to March 3, 2018
ND-HTS-060-33.5	Active	Fully operational, except for recalibration January 1 to March 3, 2018
ND-VTS-085-US	Active	Erratic data at most beads (excluding Beads 3, 6 and 9) between June 2016 and May 2017 with lower amplitude spikes between December 2016 and May 2017
		Erratic data subsided since May 2017
		Disconnected for recalibration January 1 to March 3, 2018
ND-VTS-085-DS	Active	Erratic data at most beads (excluding Beads 3, 6 and 9) between June 2016 and May 2017 with lower amplitude spikes between December 2016 and May 2017
		Erratic data subsided since May 2017
		Disconnected for recalibration January 1 to March 3, 2018
ND-VTS-085-KT	Active	Erratic data at most beads (excluding Beads 3, 6 and 9) between June 2016 and May 2017 with lower amplitude spikes between December 2016 and May 2017
		Erratic data subsided since May 2017
		Disconnected for recalibration January 1 to March 3, 2018
ND-HTS-085-25.3	Active	Fully operational, except for recalibration January 1 to March 3, 2018
ND-HTS-085-29.4	Active	Fully operational, except for recalibration January 1 to March 3, 2018
ND-HTS-085-33.5	Inactive	Irreparably damaged during construction
ND-VTS-130-US	Active	Bead 9 – Readings erratic for periods since June 2016 (temperature dropping randomly to less than -15^{o}C)
		Disconnected for recalibration January 1 to March 3, 2018

GTC ID	Status	Comments
ND-VTS-130-DS	Active	Small magnitude temperature spikes during summer months between 2013 and 2017 (Bead 3, 7, 8, 9, 11), no spikes observed in 2018
		Beads 3 – 8 were offline after the connector at the datalogger housing was damaged on September 24, 2017. Repaired and reconnected on March 11, 2018 following datalogger recalibration
		Disconnected for recalibration January 1 to March 3, 2018. Beads 3 to 8 were disconnected and repaired between September 24, 2017 and March 3, 2018 (due to damaged cable connection)
ND-VTS-130-KT	Active	Fully operational, except for recalibration January 1 to March 3, 2018
ND-HTS-130-28.8	Active	All beads were offline after the connector at the datalogger housing was damaged on September 24, 2017. Repaired and reconnected on March 4, 2018 following datalogger recalibration
		Disconnected for recalibration January 1 to March 3, 2018
		Low temperature spikes and intermittent logging from Bead 2 in Summer 2018 and 2019
ND-HTS-130-31.0	Active	Fully operational, except for recalibration January 1 to March 3, 2018
ND-HTS-130-33.5	Active	Fully operational, except for cable repair and recalibration September 24, 2017 to March 3, 2018
ND-VTS-175-KT	Active	Spliced during construction
		Incorrectly connected to datalogger as ND-HTS-175-33.5 from August 9, 2012 to June 16, 2014
		Beads 9, 10 and 11 - No readings August 9, 2012 to June 16, 2014
		Disconnected for recalibration January 1 to March 3, 2018
ND-HTS-175-32.5	Active	Fully operational, except for recalibration January 1 to March 3, 2018
ND-HTS-175-33.5	Active	Spliced during construction
		Incorrectly connected to datalogger as ND-HTS-175-KT, from August 9, 2012 to June 16, 2014
		Disconnected for recalibration January 1 to March 3, 2018

Source: J:\01_SITES\Hope.Bay\!Project_Data (Not Job Specific)\06_NorthDamMonitoringData\[SiteMonitoringSummary.xlsx]ThermisorStatus

The North Dam GTCs were installed to ensure the dam core and key foundation section remain below the design temperatures of −2˚C and −8˚C, respectively under normal operating conditions. Under upset conditions these temperatures increase to −1˚C and −7˚C. In addition, ground temperature data along with thermosyphon monitoring data can be used to determine if the thermosyphons are functioning correctly. Observations related to a review of the data presented in Appendix B are summarized in Table 14.

Table 14: Summary of Core and Key Trench Ground Temperature Cable Observations

Zone	Horizontal GTCs	Vertical GTCs	Observation
Design Temperature	**−2˚C**	**−8˚C**	• **The minimum criteria required to ensure Dam is performing in accordance with design specifications**
Station 0+040	Meets	Meets	• Performing as expected with substantive safety buffer and slight trend suggesting ongoing cooling
Station 0+060	Meets	Meets	• Performing as expected with substantive safety buffer and slight trend suggesting ongoing cooling • In conjunction with the 2019 seepage review (SRK 2020), no evidence of seepage was noted at this station
Station 0+085	Meets	Meets	• Generally performing as expected with substantive safety buffer and slight trend suggesting ongoing cooling in the core, foundation and downstream portions of the dam • A rise in the temperature of the upstream-most beads of ND-HTS-085-29.4 (Bead 7, 8, 9, 10) and ND-HTS-085-25.3 (Bead 9 to 15) was observed. This is attributed to the elevated RCP water levels in 2019 and are in line with the expected thermal response. • Seasonal variability in temperature continues to be observed and the temperatures remain below 0C. Ground warming is expected in this area. • In conjunction with the 2019 seepage review (SRK 2020), no evidence of seepage was noted at this station
Station 0+130	Meets	Meets	• Generally performing as expected with substantive safety buffer and stable or a slight cooling trend • Short term temperature spikes are noted for all but the uppermost 2 beads of ND−VTS−130−DS in 2017 (and every year prior). In 2018, no temperature spikes were noted. Between 2013 and 2017, the temperature spikes were observed between May and November with the largest amplitudes in 2013 and 2016 (Appendix B.13) • Erratic reading attributed to instrumentation error are noted in both ND-HTS-130-28.8 (Bead 2) and ND-VTS-130-US (Bead 9) in 2018. Previously erratic readings were only observed in ND-VTS-130-US • A slight rise in the upstream-most beads of ND-HTS-130-28.8 (Bead 10) and ND-HTS-130-31.0 (Bead 8) was observed. This is attributed to the elevated RCP water levels in 2019 and in line with the expected thermal response. • In conjunction with the 2019 seepage review (SRK 2020), no evidence of seepage was noted at this station
Station 0+175	Meets	Meets	• Generally performing as expected with substantive safety buffer and stable or a slight cooling trend • The annual maximum of the uppermost two beads remain slightly above the design temperature at -7˚C

Recommendations

- None.

4.2.2 Thermosyphons

Passive thermosyphons assist in cooling the North Dam key trench foundation. They function when the ambient air temperature is colder than the ground temperature where the thermosyphon is located. This happens because of phase change of the carbon dioxide gas with which the

thermosyphon is filled. Therefore, during the winter months the cold ambient air temperature is used to draw heat from the foundation, but during the summer period the thermosyphons remain dormant.

Thermosyphon temperature monitoring for the North Dam has been automated. Single bead thermistors connected to the datalogger system are attached to each thermosyphon evaporator pipe below the ground surface, and insulation has been placed around the thermistor beads to ensure the evaporator pipe temperature, and not the ambient air temperature, is measured (SRK 2012b). Additionally, air temperatures are recorded at the dataloggers every six hours. This data is downloaded as part of the monthly thermal datalogger downloads.

To monitor the performance of the thermosyphons, thermosyphon evaporator pipe contact temperatures and air temperatures are plotted against time. During the winter months, when the thermosyphons are working, the thermosyphon pipe temperature should be roughly 5˚C warmer than the air temperature. If the thermosyphon pipe temperature during the winter months is approximately the same as the air temperature, it indicates that the thermosyphon is not working correctly.

Thermistor data indicates all the south and north thermosyphons are functioning except for North 2 (Appendix C). Since 2012, the measured pipe temperature of North 2 was only slightly higher than the measured air temperature, which indicates a malfunction. Ground temperature readings near the North 2 thermosyphon pipe support the conclusion that the North 2 thermosyphon is not working correctly.

During the 2014 North Dam AGI, thermosyphon North 2 was inspected in detail to determine the cause of the elevated temperature readings. No damage or reason for the malfunction was observed (SRK 2014b). Previously, SRK recommended that Arctic Foundations of Canada Inc. (AFC) be contracted to investigate further and repair the thermosyphon. An initial inspection was conducted by AFC on April 10 and 11, 2017. No issues were identified at the time; however, monitoring data indicated North 2 continued to malfunction.

To address the issue, the best course of action was decided to discharge and recharge the thermosyphon. To do so in the most efficient manner, Mike Watt (AFC) travelled to site to inspect and discharge the North 2 thermosyphon on June 5 and 6, 2019 after the thermosyphon had gone dormant. The recharge and testing were completed between November 19 and 21, 2019. During this time AFC conducted testing and recharged the North 2 thermosyphon. After recharge, AFC periodically tested the system but North 2 was not observed to be operating correctly. The thermosyphon was partially discharged to reinitiate function in a blocked thermosyphon evaporator scenario (Appendix A).

Following the recharge, initial inspection of the thermosyphons and monitoring data indicate North 2 continues to remain essentially dormant (Appendix C). TMAC has exhausted the practical repair options for the thermosyphon at this point, and performance monitoring will continue. AFC recommended re-modelling the North Dam, taking into account the non-functional North 2 thermosyphon. This was already completed as part of past studies on extending the life of the North Dam. The result of this modelling shows that under conservative boundary conditions (typically higher thermal inputs or temperatures), the North Dam performance will not be

adversely impacted by a non-functional North 2 thermosyphon; however, the design redundancy is slightly reduced. Based on these checks there is no major concerns at this time from the loss of the North 2 thermosyphon.

Any additional measures will be taken as necessary based on the observed performance of the overall dam.

The thermosyphon radiator steel foundations are in good condition. The thermosyphons themselves do not show any physical damage; however, there is rust and peeling paint at the weld between the evaporator pipe and the twin radiators on most of the thermosyphons. AFC was not concerned about this surface rust during their inspection.

Recommendations:

- None

4.2.3 CR1000 External Datalogger Battery Voltage

Each CR1000 data logger is powered by an external lead acid battery. Battery voltage is an important indicator of datalogger performance. If the battery voltage drops below 12 V, it is operating outside of the optimal range. At or below 9.6 V, voltage is outside of the operating range and the recorded readings could be incorrect, or the datalogger will shut down and readings would not be recorded at all. The dataloggers record the minimum battery voltage four times daily. A graph of battery voltage versus time is provided in Appendix D.

The batteries have been recharged on multiple occasions since the North Dam was commissioned. At no time has the voltage dropped low enough to cause any concerns with data integrity. The batteries should continue to be monitored to ensure they maintain their charge through the winter months.

Recommendations:

- The external CR1000 datalogger batteries should continue to be monitored and recharged annually or replaced as needed.

4.2.4 Inclinometers

Six inclinometers were installed within the downstream face of the North Dam. These inclinometers are used along with the survey monitoring points to monitor deformation within the dam and dam foundation. Inclinometer readings are taken by TMAC site personnel. As discussed in Section 3.1, inclinometer readings were collected intermittently prior to May 2014. Readings were collected monthly during the 2018/2019 monitoring period.

Inclinometer measurements are provided in Appendix E. Data quality for the surveys has generally been good. The inclinometer profiles show only negligible displacements in the dam foundation, and small displacements over the portion of the inclinometer above the natural ground surface as summarized in Table 15. Inclinometer ND-IN-120-3 is the only inclinometer that suggests a trend of downslope movement. All other inclinometers are showing virtually no movement, or the movement is oscillating seasonally which likely means there is some

movement of the inclinometer tube itself, as opposed to actual deformation of the dam or foundation.

Table 15: Summary of Inclinometer Measurement Observations (Sep. 2012 through Dec. 2019)

Inclinometer	Maximum Overall Deformation			Maximum Foundation Deformation (m)	Observations
	Magnitude (m)	Location – Depth Below Dam Shell (m)	Location – Height Above Foundation (m)		
ND-IN-070-1	0.025	1.0	8.5	0.002	• Deformation essentially constant since 2015
ND-IN-070-2	0.029	2.5	6.5	0.019	• Seasonal oscillation, and overall trend suggest slight increase in deformation over time
ND-IN-070-3	0.013	4	3.5	0.013	• Deformation essentially constant since 2015
ND-IN-120-1	0.012	0.5	6.5	0.004	• Deformation essentially constant since May 2016
ND-IN-120-2	0.008	0.5	5.5	0.005	• Deformation essentially constant since November 2017. Upper deformation oscillating somewhat
ND-IN-120-3	0.021	1.0	2.2	0.002	• General trend of movement towards the south and downstream of the dam

Previous recommendations were made to send the inclinometer for re-calibration every three years. Although these do not have specified re-calibration intervals, the instruments are sensitive, and issues identified in February 2019 indicate one reason for this. TMAC sent the instrument to the manufacturer, in the United States, for recalibration in March 2020. Unfortunately, due to the global COVID-19 pandemic, this calibration was unable to be performed and was sent back to site for use in the spring and summer 2020 monitoring program.

Recommendations:

- Inclinometer re-calibration should be re-attempted before spring 2021.

4.2.5 Survey Monitoring Points

A series of 14 crest survey monitoring points, 3 deep survey monitoring points, and 18 surficial survey points were installed in the North Dam upon completion. These survey monitoring points were installed to monitor for any surface movement of the downstream face and deep settlement of the downstream foundation of the dam.

Survey monitoring of the North Dam occurred for all eight of eight occurrences between November 2018 and December 2019. The survey data should be collected monthly between May and November. Complete survey data is presented in Appendix F.

The overall vertical and horizontal displacement since completion of construction based on these readings are summarized in Table 16. Deep settlement and crest displacement have been very small and of similar magnitude, and has essentially been unchanged since September 2013, confirming that the measured displacement to date is all directly related to the period immediately following construction.

Downstream dam shell settlement follows the same general trends as the deep and crest settlement points; however, the total displacement magnitude is about twice as much. There is also an increasing trend in displacement in two points (ND-SSP-155-2 and ND-SSP-110-3) since June 2016. The measured vertical displacement of these points suggests no displacement change, but the horizontal displacement is increasing, which results in the overall increased displacement trend. Both these points are located near the downstream toe of the dam, and this increased displacement is likely a result of increased active layer thaw beneath the shallow rockfill toe of the dam. The displacement is not of immediate concern, but it should be carefully monitored going forward.

Table 16. Summary of Survey Monitoring Observations (May 2012 through December 2019)

Location	No. of Stations	Vertical Displacement (m)			Horizontal Displacement (m)		
		Min.	Max.	Avg.	Min.	Max.	Avg.
Deep settlement points (DSP)	3	0.02	0.04	0.03	0.01	0.08	0.05
Crest settlement points (SMP)	14	0.03	0.08	0.05	0.02	0.10	0.05
Downstream dam shell settlement points (SSP)	18	0.03	0.22	0.11	0.0	0.29	0.07

Recommendations:

- Continue to carefully monitor the downstream dam shell settlement points ND-SSP-080-3 and ND-SSP-110-3 to further assess if thaw settlement of the toe is causing undue deformation.
- Continue to watch for ongoing erosion around settlement monitoring point ND-DSP-100.

4.2.6 Creep Displacement

North Dam displacements as recorded by the inclinometers and survey points are expected to be caused primarily because of creep of the saline ice-rich permafrost foundation soils. Table 17 summarizes the predicted deformation as determined through rigorous numerical creep deformation modeling (SRK 2017c), as well as the allowable design values. Figure 15 presents a plot comparing predicted vertical displacement against measured vertical displacement along the crest of the dam near Station 1+20. This graph clearly demonstrates that the current displacement is less than predicted.

Table 17. Predicted North Dam Deformation Displacement

Period	Location	Max. Shear Strain Rate (year-1)	Max. Shear Strain (m/m)	Displacement (m)	
				Max. Horizontal	Max. Vertical
Overall allowable design values	**Core**	**3.2E+02**	**2%**	**-**	**1.0**
10 years post construction	Core crest	-	-	-	0.2
	Core	5.0E-08	5.0E-02	0.4	0.6
	Foundation	1.0E-07	~1.0E-01	0.4	0.6
30 years post construction	Core crest	-	-	-	1.0
	Core	2.0E-08	1.0E-01	0.8	1.0
	Foundation	4.0E-08	~2.0E-02	0.6	1.0

Recommendations:

- None.

4.2.7 Walkover Surveys

Walkover surveys of the North Dam are required weekly when tailings deposition is occurring, and when the TIA water level is below the FSL. During the 2018/2019 monitoring period between November 2018 and December 2019, 51 walkover surveys were completed, and the associated reports and photos are included in Appendix G.

The walkover survey reports and tracks all changes to the dam surface, visible damage to instrumentation, signs of erosion or seepage, or any other surface anomalies. To date, the primary observations of note from the walkover surveys include:

- Surface depressions in the upstream and downstream slopes of the dam;
- Minor cracking on the turn-around pad on the upstream side;
- Rust on the thermosyphons (Section 4.2.2);
- Erosion near the thermosyphons (Section 4.2.2); and
- Ponded or flowing water at the downstream toe of the dam (Section 4.2.8).

The surface depressions are located on the upstream and downstream faces of the dam. Six depressions have historically been classified as significant depressions requiring monitoring (D1, D2, D3, U1, U2 and U3), as illustrated in Appendix H. The Monitoring SOP requires a GPS location, photographs and estimated dimensions/extents of these large surface depressions on a continuous basis to track if they are increasing in size. No monitoring of the depressions was completed during this monitoring year. Based on the AGI physical inspection (see Photolog 1 and 2), SRK is satisfied that there were no substantial changes to these surface depressions since the 2017 AGI, and this observation is confirmed by the settlement data.

Some surficial cracking has been noted in past walk over inspections (more in 2018) near the upstream face of the North Dam (now below the water level in the TIA). A review of this area was completed and determined that this cracking was primarily on additional fill that was placed over steepened during care and maintenance to access temporary pumps. This fill was placed on top of the North Dam upstream slope and is not expected to be reflective of the underlying dam conditions. In addition, this temporary access route is no longer being used on site and is currently decommissioned. Review of the thermal monitoring data also confirms that any upstream foundation thawing rates are still below the original design criteria and predictions.

Recommendations:

- Ensure that the required weekly walkover surveys are being completed in accordance with the SOP. This is an important surveillance activity as defined in the OMS Manual and needs to be complied with. In 2019 notable improvements were made in the frequency of the walk over surveys completed, however there are still room for additional improvement on frequency and documentation. SRK and TMAC to continue to work together on this and South Dam walkover surveys to be included in 2020.

4.2.8 North Dam Seepage

Since completion of the North Dam construction there has been evidence of surface water flow along the downstream toe of the dam. This flow has historically been reviewed by SRK, and a rigorous thermal assessment and water quality review was conducted in 2017 to establish whether the flow was in any way indicative of North Dam seepage (SRK 2018a). The evaluation concluded that North Dam seepage was unlikely but could not be definitively excluded. It was recommended that flow measurements be obtained, systematic water quality sampling be undertaken, and frost probe data be collected.

A V-notch weir was installed at this location in July 2017, as illustrated in Figure 4 and flow and water quality sampling were carried out in accordance with the newly established Monitoring SOP (SRK 2018b). SRK's review of the 2019 seepage water quality data (Appendix K) confirms that currently there is strong evidence to suggest that the origin of the seepage water is not from the TIA. Although this 'seepage' is not expected to be from the TIA impoundment, additional data collection could allow for a more rigorous determination going forward if things were to change. Based on this the implemented seepage monitoring program is planned to be continued on site.

As part of the seepage monitoring, flow through the V-notch weir varied between 0 and 2.5 l/s and was only present between late June and September (approximately 85 days). The flow was variable, and generally correlates with rainfall which suggests that a consistent baseflow seepage from the TIA is unlikely.

Two frost probe surveys were conducted along seven transects downstream of the North Dam. The data collected identifies variation in the seasonal active layer thaw depth between July and November, typically varying by 0.2 – 0.6 m. The greatest variation was observed near the previously identified flow path locations along the NE downstream toe where the maximum thaw depth was 0.7 m. This data is consistent with the settlement data indicating maximum dam deformation at the toe of the dam.

Based on all data reviewed in relation to the North Dam seep, there is currently no anomalous data to suggest that TIA water is seeping from the North Dam.

Recommendations:

- Continue water quality and flow monitoring of North Dam seepage according to the methods outlined in SRK (2018b).
- Conduct at least one additional frost probe survey along the same transects in early summer to early fall 2020, following the same procedure as in 2019. Data from this frost probe survey should be reviewed in 2020 to determine if these surveys are required beyond 2020.

4.2.9 Physical Inspection of the North Dam

As part of the 2019 AGI a walkover survey of the North Dam was completed. No general issues of concern were observed. The attached Photolog (Photolog 1 to 3) provides a general overview of conditions on the North Dam.

Recommendations:

- None.

4.3 South Dam Inspection and Monitoring

4.3.1 Ground Temperature Cables

To monitor long-term temperature of the frozen foundation dam, a total of twenty-seven GTCs were installed during South Dam construction (SRK 2018c). The GTCs are connected to Beaded Stream Dataloggers (D405) to allow continuous data capture; however, some issues in data capture and transmission have been encountered and required SRK to undergo detailed review and ongoing monitoring by SRK and TMAC site staff. Due to these commissioning challenges, a detailed review of monitoring data is provided in Appendix L, in additional to the plots seen in Appendix B. Table 18 provides a summary of the GTC status during the 2019 AGI inspection. Note that not all of the installed cables are operational (due to various issues typically linked to cable damage from construction and/or wildlife). Wherever possible, repairs were completed on site by the mill instrumentation electrician to bring as many cables as possible back online, and additional measures were put in place to improve protection of the cables.

The design criteria for the dam requires a ground temperature of less than -2^{o}C at the upstream base of the key trench (Figure 9). Based on the data review, the ground temperatures generally meet the design requirements and the dam is performing as expected.

Table 18: South Dam Ground Temperature Cable Status Summary

GTC ID	Station ID	Status	# of Sensors (Functional / As-built)	Comment
SD-VTS-065-KT	0+65	Active	11 / 11	• Damaged following construction (repaired)
SD-HTS-065-US	0+65	Active	5 / 5	• Damaged following construction (repaired)
SD-VTS-155-KT	1+55	Active	11 / 11	
SD-HTS-155-US	1+55	Active	5 / 5	
SD-VTS-155-US	1+55	Inactive	1 / 11	• Sensor 1 functional, ended on 11/8/2019
SD-VTS-155-DS	1+55	Active	11 / 11	
SD-HTS-155-KT	1+55	Inactive	0 / 11	• Damaged during construction (irreparable)
SD-HTS-240-KT	2+40	Active	11 / 11	
SD-VTS-240-KT	2+40	Active	11 / 11	
SD-HTS-240-US	2+40	Active	7 / 7	
SD-VTS-240-US	2+40	Inactive	0 / 11	• Measurements ended on 10/10/2019
SD-VTS-240-DS	2+40	Inactive	0 / 11	• Measurements ended on 10/22/2019
SD-VTS-365-KT	3+65	Inactive	0 / 11	• Damaged following construction (irreparable)
SD-HTS-365-KT	3+65	Active	11 / 11	• Damaged following construction (repaired)
SD-HTS-365-US	3+65	Active	11 / 11	
SD-VTS-365-US	3+65	Active	11 / 11	
SD-VTS-365-DS	3+65	Active	11 / 11	
SD-VTS-US1	3+65	Active	2 / 13	• Installed in suspected ground ice wedge near upstream toe • Sensors 1 and 2 active
SD-VTS-US2	3+65	Active	1 / 15	• Installed in suspected ground ice wedge near upstream toe • Sensor 1 active
SD-VTS-460-KT	4+60	Active	11 / 11	
SD-HTS-460-KT	4+60	Active	11 / 11	
SD-VTS-460-US	4+60	Active	11 / 11	• Damaged following construction (repaired)
SD-VTS-460-DS	4+60	Active	11 / 11	
SD-HTS-460-US	4+60	Inactive	0 / 5	• Damaged following construction (irreparable)
SD-VTS-510-KT	5+10	Active	11 / 11	
SD-HTS-510-US	5+10	Active	5 / 5	• Damaged following construction (repaired)
SD-HTS-B1-KT	NA	Active	20 / 20	

Notes:

1. Number of functional GTC sensors on 3/1/2020

GTCs provide thermal monitoring of the dam to ensure conditions remain within the intended design for safe operation and containment. SRK is currently assessing if replacement of the following GTCs will be required to ensure the monitoring system integrity is upheld; SD-VTS-155-US; SD-VTS-240-US; SD-VTS-240-DS. Prior to any GTC replacement, the surface cable lead and connection with the data loggers should be inspected for damage and repaired, where possible. The upstream toe at section 2+40 is currently outside of the tailings beach which would allow for replacement of SD-VTS-240-US prior to being covered by tailings.

Recommendations:

- Inspect the surface cable lead and connection with the data loggers for damage or similar issues and repair where possible. SRK to further assess, if the repairs are not possible, replacement of SD-VTS-155-US, SD-VTS-240-US and SD-VTS-240-DS will be required.
- Manually download data from each datalogger once annually or as specified by the EOR.

4.3.2 Survey Monitoring Points

A series of 12 crest survey monitoring points, 3 deep settlement points, and 26 surficial survey monitoring points are proposed for the South Dam. Survey monitoring points were installed in August 2019 and monitoring surveys occurred in August through November. Going forward, survey data should be collected monthly between May and November. Complete survey data is presented in Appendix F.

The overall vertical and horizontal displacement since August 2019 indicates limited displacements. In all instruments, vertical displacements were less than 0.05 m and horizontal displacements less than 0.05 m except for SD-FMP-04 (0.13 m). Continued monitoring will provide a greater understanding of the dam's performance. At this point the limited displacements observed are not of concern.

Recommendation:

- Complete survey monitoring monthly from May to November.

4.3.3 Physical Inspection of the South Dam

As part of the AGI a walkover survey of the South Dam was completed. As dam construction had just been completed, there were no issues of concern to note. Photolog 4 provides a general overview of the South Dam conditions at the time of the AGI.

Recommendations:

- None.

4.4 Tailings Deposition System

Table 5, Figure 10, and Figure 11 provide a summary of tailings deposition in the TIA to date. Generally, the tailings deposition rates to date have been lower than the original planned tonnages. The solids content during this time has also been variable. There has generally been a constant increase from about 15% solids by weight in July 2017 to approximately 48% solids by

weight by November 2018. In 2019 tailings solids contents were typically between 40 and 50% (except for February and December 2019 where solids contents were lower).

Tailings deposition has occurred as single point discharge from approximately 5 separate locations in 2019; two locations along the eastern shoreline of the TIA, two locations from the South Dam, and one winter location just downstream of the developing South Dam tailings beach. At the time of the 2019 AGI tailings discharge from the South Dam was underway and beach development had pushed supernatant water greater than the specified 100m offset from the upstream dam crest. Tailings deposition will need to continue from the South Dam in accordance with the tailings deposition plan (Figure 12 and Appendix N).

In accordance with the site water management plan, saline mine water can be discharged directly to Roberts Bay, or directed to the TIA via a dedicated pipeline. The marine outfall pipeline was constructed in 2019 but was not commissioned until Q1 2020. SRK has advised against discharging saline mine water with tailings into the TIA, especially when beaching from the South Dam, because the saline pore water will depress the freezing point of the tailings. This could compromise the performance of the South Dam or the long-term freeze-back of the tailings. Based on this risk, saline water should be directed away from the TIA whenever possible. This noted, if saline water must be directed to the TIA then it should be done at a spigot location that is at least 300 m away from the South Dam crest so that the freeze back of the tailings at the South Dam beach is not impacted.

In 2019, tailings samples were collected from the South Dam beach and geochemical laboratory testing was completed to assess the pore water salinity. A review of the tailings pore water salinity and freezing point depression analysis is presented in Appendix M.

As noted in the 2018 AGI, TMAC has advised that, on occasion, they may dispose of propylene glycol from aircraft de-icing activities into the TIA. Small volumes of glycol will not affect the TIA water chemistry, but glycol does have a depressed freezing point and therefore discharging glycol with the tailings solids can only be done under the following conditions:

- Glycol must be discharged directly into the Reclaim Pond, at least 300 m away from any dams, and at least 10 m from any exposed shoreline;
- The maximum discharge rate of glycol is 30 m^3 per 6 months;
- All glycol disposal into the TIA must be recorded with the product details, disposal volume, location of discharge and date; and
- The EOR must be informed of all glycol discharges to the TIA.

Recommendations:

- TMAC should install the dedicated mine water discharge pipeline to the TIA as soon as possible to allow tailings deposition to recommence from the South Dam. It is critical that tailings deposition from the South Dam occur in order to maintain a beach of at least 100 m at all times, for all TIA water levels. *UPDATE: this was addressed at the start of 2020 and is now complete. The Roberts Bay Discharge system is now operational.*

- Saline mine water may only be discharged together with tailings from, or within, 300 m of the South Dam provided the freezing point depression is less than 0.5^{o}C (around 4,500 mg/L Cl maximum equivalent). If the freezing point depression exceeds 0.5^{o}C, saline mine water may be discharged with tailings at other designated tailings discharge points or directly into the Reclaim Pond. The freezing point depression calculation provided in this AGI (Appendix M) will be incorporated by SRK into the updated OMS Manual (update currently in progress).
- Tailings discharge must be done in accordance with the designated tailings discharge plan. Primary spigot moves should be expected around or immediately after spring melt and again prior to winter freeze up. This approach will help to achieve the required beach development, promote beach freeze back, and minimize ice entrainment in the tailings.
- Areas along the eastern shoreline of the TIA where tailings discharge has occurred at elevations above 36.5 m, although mainly over exposed bedrock, should be carefully monitored to determine if permafrost damage is occurring due to vegetation dieback. Should any damage be noted, appropriate proactive mitigation may be required.

4.5 Emergency Dump Catch Basins

The Eastern Dump Catch Basin is in good condition as shown in Photolog 7. The Western Dump Catch Basin was however not constructed in accordance with the Design Drawings and Technical Specifications and may not perform as intended. Currently it looks like this structure has the required containment volume, but some liner slippage has been noted and repairs are suggested. SRK has therefore advised that this structure be repaired at the earliest opportunity. TMAC has agreed to do this reconstruction at the earliest opportunity on site / when practical.

Recommendations:

- Repair the Western Emergency Dump Catch Basin at the earliest opportunity.

4.6 Pipelines (Reclaim, Tailings Deposition and TIA Discharge)

Pipelines are placed directly on the ground, which could be either rockfill pads, road shoulders or directly on the tundra. There are signs of vegetation dieback because of pipelines placed directly on the tundra along the northern shore of the TIA upstream of the Reclaim Pump Station. This is becoming a preferred flow path for surface runoff which could ultimately lead to rapid surface erosion and subsequent thermal erosion of permafrost.

Notable settlement was noted at the TIA Reclaim Jetty Pad (also referred to as the 710 Pumphouse pad). Upon visual inspection and from review of the as-built data it looks like new ROQ material was placed off the edge of the pad in thick, end dumped lifts in order to widen the pad for the new 710 pumphouse. There are notable stability concerns with this pad as large settlements and notable cracking indicate that a failure of this pad (albeit slow) appears to be occurring. However, it should be noted that the rate of movement could increase suddenly, causing a sudden failure, and this risk should not be ignored. Monitoring of this area (at least weekly during winter and daily during months with no ice cover on the lake) should be completed. It is recommended that remediation measures be completed for the pad area in order to stabilize the fill and prevent further deformation. This is expected to consist of placing additional fill along the outside of the access road and pad to reduce the overall slope and provide additional

confining stress at the toe of the pad (which is currently underwater). Rates of loading must be controlled and slow enough to avoid inducing excess pore pressures in the foundation. This means that it may take weeks to build this small additional fill and that the dumping faces should be spread out as much as possible. Material should be end dumped back from the working face and spread with an excavator with the largest reach on site (to limit loading at the crest).

Recommendations:

- TMAC must carefully inspect all pipelines placed directly on the tundra for signs of vegetation dieback and associated development of erosion and channeling. Where this is occurring, the pipeline must be relocated to follow existing all-weather road shoulders, and appropriate remediation needs to be put in place where damage has occurred. Although SRK previously approved the placement of insulated pipelines directly on the tundra, inspection observations suggest TMAC should avoid placement of any pipelines on the tundra where possible and relocate any un-insulated pipes on the tundra.
- The thermal erosion feature that was backfilled in 2019 should continue to be monitored to ensure that ongoing thermal erosion of this area does not occur and to confirm that the thermal erosion has slowed.
- Monitoring instruments should be installed at the TIA Reclaim Jetty Pad (710 Pumphouse pad) and additional safety considerations put into place when personnel are working at or around this area. *UPDATE: since the time of the 2019 inspection these measures have been installed on site (installed start of Q2 2020).*
- Remediation construction activities should be carried out on the TIA Reclaim Jetty Pad in 2020 to improve the stability of this pad, specifically on the most recently constructed, most northern portion of the pad (where additional fill was placed in 2019).

4.7 Shoreline Erosion

The pre-mining water level in the pond is 28.3 m. Since the start of commercial production, the water level has risen to 30.7 m, which is 2.4 m above the original lake water level. Therefore, a large section of shoreline has been flooded which has resulted in vegetation stress. At this time, there are no visible signs of shoreline erosion, and therefore no additional monitoring is required.

Recommendations:

- None.

4.8 TIA Operational Water Level Targets

The TIA operational water balance can be used to predict water levels in the TIA going forward. The Roberts Bay Discharge System began discharging from the TIA to Roberts Bay in February 2020. As a result, the Reclaim Pond water levels decreased from 32.0 m (around January 2020) down to 31.1 m in May 2020, which is near the target level for this stage of the operation. SRK has previously provided recommendations on target maximum operational water levels in the TIA (SRK 2019). These same recommendations currently hold. The current recommendation is tied to two key time periods:

- May 31, 2020 (Pre-freshet): 31.5 masl
- September 30, 2020 (Pre-freeze-up): 31.0 masl

In addition to the Reclaim Pond water level targets, the South Dam beach length must be maintained to a minimum of 100 m. See the 2019 TIA target water levels memo (provided in Appendix I) for additional details.

Recommendations:

- Continue pumping to reduce the water levels in the pond to at or below the target maximum elevations.
- Continue to monitor the South Dam beach length to maintain at least 100 meters separation between the Dam and Reclaim Pond.

4.9 Climate Data

For reference, precipitation and temperature data, as described in Section 2.5.5, is provided in Appendix J.

Recommendations:

- None.

4.10 TIA Water Quality

TIA Water quality is monitored at compliance station TL-1 at the Reclaim Water pump station. Ongoing review of water quality trends and a comparison to MDMER limits has been completed each year. To date, the only parameter that has exceeded MDMER limits is total suspended solids (TSS) for both the maximum authorized monthly mean concentration and the maximum authorized concentration in a grab sample.

A comprehensive analysis of the reasons for the high TSS concentrations has been completed (SRK 2019). The high TSS is a result of an algae bloom event that typically occurs each year during the summer months. In order to maintain operational flexibility and continue to discharge water to Robert's Bay during the summer, it has been concluded that a water treatment plant is required to remove TSS prior to discharge.

Recommendations:

- TMAC must commission a water treatment plant to be able to treat for TSS and provide flexibility for water discharge during the annual anticipated algae bloom. If the plant is not constructed ahead of the anticipated algae bloom in 2020, no discharge will occur when elevated TSS is measured in the TIA.

5 Recommendations and Conclusions

Based on the results of the 2019 AGI, the Doris TIA and associated structures (primarily the North Dam and South Dam) are functioning as designed. Some issues were observed during the physical inspection and some anomalies were identified during the monitoring data review; however, these are either within expected performance or determined to be of no concern to dam performance. Improvements to the overall tailings management system (e.g. SOP and OMS Manual updates) were also identified, and these are currently being actioned by TMAC with support from SRK where required. Table 19 presents a summary of the recommendations listed throughout this report.

Table 19: Summary of Recommendations

Inspection Item	2018 Recommendations (for reference)	2019 Recommendations
General TIA Management Recommendations		
Third Party Dam Safety Review	• The North Dam hazard classification was revisited and is considered HIGH. This requires an independent third-party Dam Safety Review by 2021.	• Conduct an independent third-party Dam Safety Review for both the North and South Dams in the summer of 2021.
Tailings Operating, Maintenance and Surveillance (OMS) Manual and Emergency Response Plan (ERP)	• Ensure all staff are aware of the OMS Manual and are familiar with its contents. • Review and revise the OMS manual to ensure consistency with the recently amended Water License. • Provide necessary training in accordance with the OMS Manual.	• An update to the OMS manual is in progress by SRK and will be submitted by Q4, 2020. This update is aimed to be a notable improvement to the current OMS. This noted, additional updates are expected in Q3 and Q4 2020. The focus of the OMS updates in Q3 and Q4 will be further refinement of the Trigger Action Response Plans (TARPs). The OMS for this facility will be a 'living' document that is expected to be reviewed annually. • TMAC should ensure all staff are properly informed and trained on the contents of the OMS Manual. • *At the time of writing this report, TMAC was in the process of developing a standalone 'Hope Bay Project Dam Emergency Plan', rather than updates to the ERP, to address dam emergencies. It will incorporate inundation mapping and dam break scenarios. The standalone dam emergency plan will be released upon completion of the OMS update to ensure alignment.* An Emergency Reponses Plan exists for the site; however, this document was lacking sufficient detail for an emergency at the TIA. In 2019 SRK visited site and held a session with site personnel to go over preliminary dam break inundation maps completed by SRK and to provide inputs into what should be included in the site ERP updates to ensure the TIA is properly covered in this document. An update to the ERP is recommended in 2020 to provide additional details for the TIA.
TIA Responsible Parties	• N/A	• TMAC must agree on the roles and responsibilities for the TIA, train and inform personnel of their duties, and operate the

Inspection Item	2018 Recommendations (for reference)	2019 Recommendations
		facility accordingly. This will be an ongoing recommendation that is expected to be repeated annually. The roles and responsibilities for the TIA will be defined in the OMS update, to be released in 2020.
Monitoring Standard Operating Procedures (SOPs)	• To avoid confusion update SOPs to reflect changes that has been agreed to since the original SOP was developed.	• Update the Monitoring SOP to include South Dam monitoring requirements. SRK is currently preparing a separate SOP for the South Dam, and one already exists for the North Dam. A draft version of the South Dam SOP was submitted to TMAC in June 2020 and a final version is expected in July 2020.
Compliance with Monitoring Requirements	• Improve efforts to conduct monitoring at the frequency described in the SOPs.	• Conduct monitoring in accordance with the Monitoring SOP, paying attention to those areas where conformance is not consistently met.
North Dam Inspection and Review of Monitoring Data		
Ground Temperature Cables (GTCs)	• In accordance with manufacturers recommendations, the dataloggers must be recalibrated as it has been in operation for more than five years. Internal batteries on the dataloggers must also be replaced. • A monitoring well near ND-VTS-130-DS is no longer required. See “Physical Inspection of North Dam”.	• There are no specific recommendations for the installed GTCs. However, TMAC should aim to improve performance tracking of the dataloggers at the South Dam and check to see if cables are being damaged by wildlife after spring melt in order to confirm that current cable protection is adequate.
Thermosyphons	• AFI or another qualified contractor must physically inspect thermosyphon North 2 (at the North Dam) and determine why it is not working. Appropriate repairs must be conducted. • While the contractor is on-site, have them inspect all thermosyphons, and carry out any additional maintenance they recommend.	• The 2018 recommendations were completed in 2019 and Arctic Foundations Canada (AFC) visited the site for an inspection. Additional details are provided in this 2019 AGI (see Appendix A).
CR1000 Datalogger Battery Voltage	• The external datalogger batteries should be tested and recharged or replaced annually.	• The external CR1000 datalogger batteries should continue to be monitored and recharged annually or replaced as needed.
Inclinometers	• No action required.	• The inclinometer and associated readout device should be recalibrated every 3 years as per recommended best practice. SRK was aware that TMAC sent this instrument for recalibration but due to COVID-19, the instrument calibration was unable to be performed and had to be returned from the out of country manufacturers. This recommendation should be revisited before the spring of 2021.
Survey Monitoring Points	• Backfill the erosion around ND−DSP−100.	• Backfill the erosion around survey monitoring point ND−DSP−100 at the North Dam. • Continue to carefully observe the North Dam downstream shell settlement points ND-SSP-080-3 and ND-SSP-110-3 to

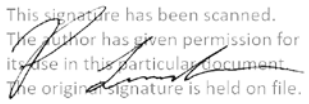
Inspection Item	2018 Recommendations (for reference)	2019 Recommendations
		determine if thaw settlement of the toe is causing undue deformation.
Creep Displacement	• N/A	• None.
Walkover Surveys	• Improve efforts to conduct walkover surveys in accordance with the frequency prescribed in the SOP.	• The required weekly walkover surveys at the North Dam are not being completed in accordance with the SOP. This is an important surveillance activity as defined in the OMS Manual and needs to be complied with.
North Dam Seepage	• Continue to conduct monitoring of the North Dam toe seep in accordance with the recommendations (see Appendix J for the 2018 TIA AGI). This includes: • Field measurements of Electrical Conductivity when Surveillance Network Program (SNP) samples are collected at TL-1; • Weekly sampling and geochemical analysis of North Dam toe seepage when present; • Annual review of North Dam toe seepage water chemistry; • Measurement of active layer thaw depth using a frost probe.	• Continue water quality monitoring of North Dam seepage according to the methods outlined in SRK (2018b) (this was completed in 2019). • Conduct at least one additional frost probe survey along the same transects in early summer and early fall, following the same procedure as in 2018 and 2019. Based on current favourable results, SRK will revisit the requirements for the frost probe surveys as part of the 2020 AGI and determine if further surveys are required beyond 2020.
AGI Physical Inspection	• N/A	• None.
South Dam Inspection and Review of Monitoring Data		
Ground Temperature Cables (GTCs) and D405 Dataloggers	• N/A	• Complete a walk over survey of the South Dam after spring melt and look for any exposed or damaged ground temperature cables. This will allow for preventative maintenance to be done if exposed cables are observed, which will help to limit the potential for damage from wildlife. • SRK to further assess, if repairs are not possible, if replacement of Ground Temperature Cables SD-VTS-155-US, SD-VTS-240-US and SD-VTS-240-DS will be required. • Manually download data from each datalogger once annually or as specified by the EOR.
Survey Monitoring Points	• N/A	• None.
Physical Inspection of the South Dam and Walkover Surveys	• N/A	• Start weekly walkover surveys of the South Dam in 2020. This is an important surveillance activity. Additional details will be provided to TMAC in the South Dam SOP.
TIA-Wide Monitoring		
Tailings Deposition System	• No action required.	• TMAC should install the dedicated mine water discharge pipeline to the TIA as soon as possible to allow tailings deposition to recommence from the South Dam. It is critical that tailings deposition from South

Inspection Item	2018 Recommendations (for reference)	2019 Recommendations
		Dam recommence in order to maintain a beach length of at least 100 m at all times, for all TIA water levels. *UPDATE: this was addressed at the start of 2020 and is now complete. The Roberts Bay Discharge system is now operational.* • Saline mine water may only be discharged together with tailings from, or within, 300 m of the South Dam provided the freezing point depression is less than 0.5ºC (around 4,500 mg/L Cl maximum equivalent). If the freezing point depression exceeds 0.5ºC, saline mine water may only be discharged with tailings at other designated tailings discharge points further than 300 m from the South Dam or directly into the Reclaim Pond. The freezing point depression calculation is provided in this AGI and will be incorporated by SRK into the updated OMS Manual (update currently in progress). • The tailings discharge system must be operated in accordance with the designated tailings discharge plan. Primary spigot moves should be expected around, or shortly afterwards, spring melt and again prior to winter freeze up. • Areas along the eastern shoreline of the TIA where tailings discharge has occurred at elevations above 36.5 m need to be carefully monitored to determine if permafrost damage is occurring due to tailings flow and vegetation dieback. Should any damage be noted, appropriate proactive mitigation may be required.
Emergency Dump Catch Basins	• N/A	• Repair the Western Emergency Dump Catch Basin at the earliest opportunity to ensure liner movement does not occur and impact the as-built storage capacity of this Emergency Catch Basin.
Pipelines (Reclaim, Tailings Deposition and TIA Discharge)	• N/A	• TMAC must carefully inspect all pipelines placed directly on the tundra for signs of vegetation dieback and associated flow path channelling. Where this is occurring, the pipeline must be relocated to follow existing all-weather road shoulders, and appropriate remediation needs to be put in place where damage has occurred. Going forward, TMAC should consider abandoning the practice of placing pipelines directly onto the tundra. • The permafrost thermal erosion feature that has developed along the northern shore of the TIA was backfilled by TMAC in 2019. This area should continue to be monitored to ensure that additional thermal erosion does not result in this area.
Shoreline Erosion	• N/A	• None.

Inspection Item	2018 Recommendations (for reference)	2019 Recommendations
TIA Water Balance	• N/A	• It is of paramount importance that the Roberts Bay Discharge System Pipeline be completed during the summer of 2019. Further delay of this may result in reduced operations. *UPDATE: this was addressed at the start of 2020 and is **now complete**. The Roberts Bay Discharge system is now operational.*
Climate Data	• N/A	• None.
TIA Water Quality	• N/A	• No recommendations; however, the following comments are made below. • The water treatment plant for the TIA is required to be maintained in good operational condition so that discharge of supernatant water can occur once the Roberts Bay Discharge System Pipeline is operational, and allow treated water to be discharged in order to maintain water levels in the TIA below the full supply level. *UPDATE: as of the start of 2020 the Roberts Bay Discharge system and the connected water treatment plant is now operational.*
TIA Reclaim Water Pad / 710 Pumphouse Pad	• N/A	• Notable settlement was noted at the TIA Reclaim Jetty Pad (also referred to as the 710 Pumphouse pad). Upon visual inspection and from review of the as-built data, it looks like new ROQ material was placed off the edge of the pad in thick, end dumped lifts in order to widen the pad for the new 710 pumphouse. There are notable stability concerns with this pad as large settlements and notable cracking indicate that a failure of this pad (albeit slow) appears to be occurring. However, it should be noted that the rate of movement could increase suddenly causing a sudden failure, and this risk should not be ignored. Monitoring of this area (at least weekly during winter and daily during months with no ice cover on the lake) should be completed. It is recommended that remediation measures be completed for the pad in order to stabilize the fill and prevent further deformation. This is expected to consist of placing additional fill along the outside of the access road and pad to reduce the overall slope and provide additional confining stress at the toe of the pad (which is currently underwater). Rates of loading must be controlled and slow enough in order to avoid inducing excess pore pressures in the foundation. This means that it may take weeks to build this small additional fill and that the dumping faces should be spread out as much as possible. Material should be end dumped back from the working face and spread with

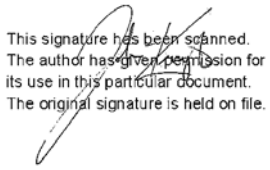
Inspection Item	2018 Recommendations (for reference)	2019 Recommendations
		an excavator with the largest reach on site (to limit loading at the crest).

This final report, 2019 Annual Geotechnical Inspection, Tailings Impoundment Area, Hope Bay Project, Hope Bay, Nunavut was prepared by:



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Consultant

and reviewed by



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Senior Consultant

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

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

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Figures

Figure 1: Project Location Map

Figure 2: Doris Site Layout

Figure 3: Doris TIA General Arrangement

Figure 4: North Dam General Arrangement and Instrumentation

Figure 5: North Dam Foundation Conditions and Typical As-Built Section

Figure 6: North Dam Instrumentation Cross Sections

Figure 7: South Dam General Arrangement and Instrumentation

Figure 8: South Dam Foundation Conditions and Typical As-Built Section

Figure 9: South Dam Instrumentation Cross Sections

Figure 10: Actual Tailings Deposition History

Figure 11: Actual Tailings Deposition Values (Design vs Actual)

Figure 12: Phase 1 Planned Tailings Deposition (Phase 1 and Phase 2) - End Of Mine

Figure 13: Schematic of TIA Water Management

Figure 14: Actual and Predicted Water Level in TIA

Figure 15: Measured versus Modelled Vertical Displacement at Station 1+20 (North Dam)

Photologs

Photolog 1: North Dam Upstream Face

Photolog 2: North Dam Downstream Face

Photolog 3: North Dam Instrumentation and Thermosyphons

Photolog 4: South Dam Inspection

Photolog 5: South Dam Instrumentation

Photolog 6: Reclaim Pond Access and Pump House

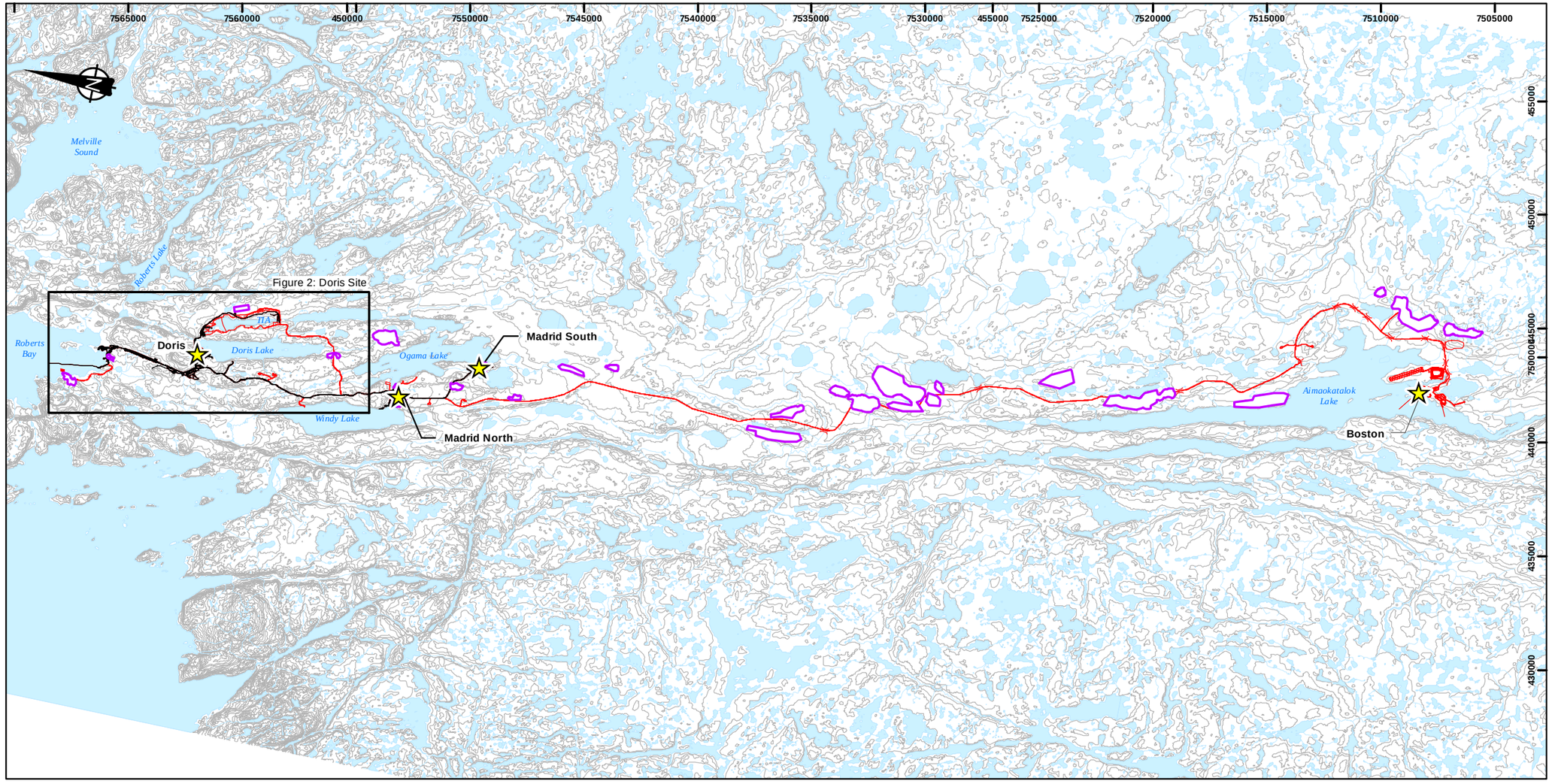
Photolog 7: TIA Shoreline and Tailings Discharge (South End)

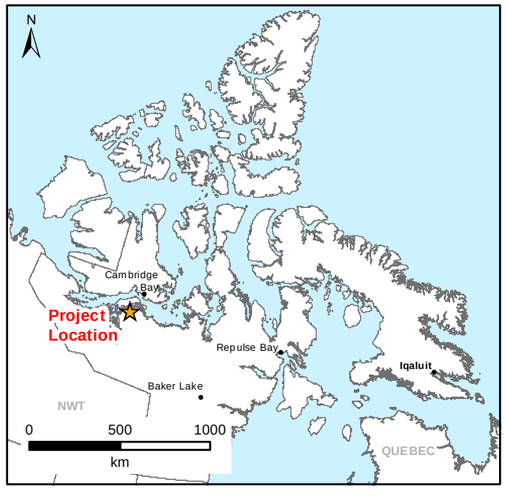
Photolog 8: Emergency Dump Catch Basins

Photolog 9: Tailings Discharge and Reclaim Pipelines (Near TIA)

Photolog 10: Tailings / Reclaim Pipelines and Sumps (Near Doris Camp)

Figures





LEGEND

- Underground Mine Portal
- Existing/Permitted Infrastructure
- Proposed Infrastructure
- Contours
- Stream
- Future Quarries

NOTES

1. Contours shown at 10m intervals.
2. Coordinate System: NAD 1983 UTM Zone 13N.

REFERENCES

1. Base Topo Data: CanVec, Natural Resources Canada

0 2000 4000 6000 8000 10000
Meters

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2019 Annual Geotechnical Inspection

Project Location Map

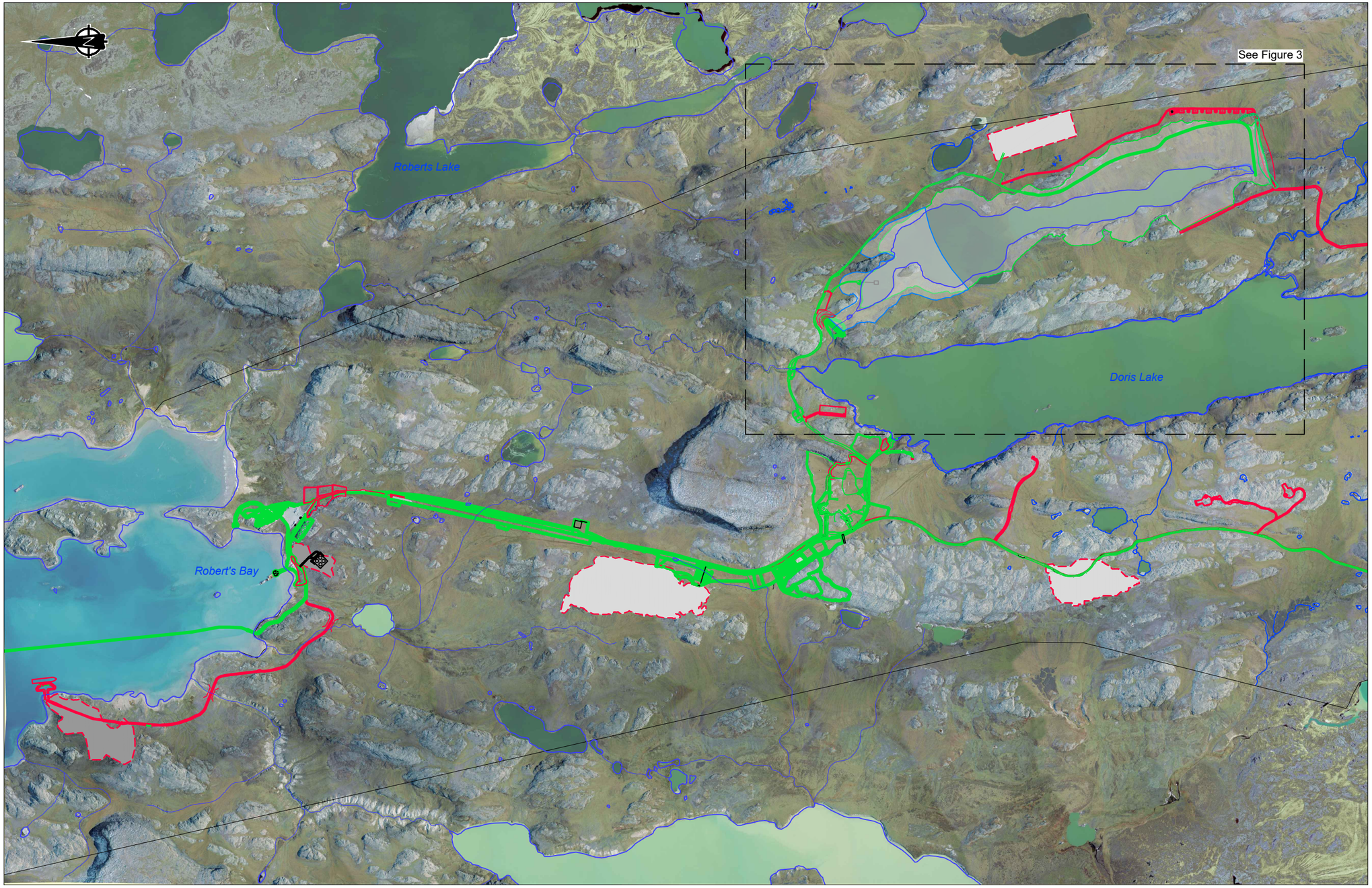
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Doris TIA

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LEGEND

- As-Built Infrastructure
- Proposed Infrastructure
- Quarries

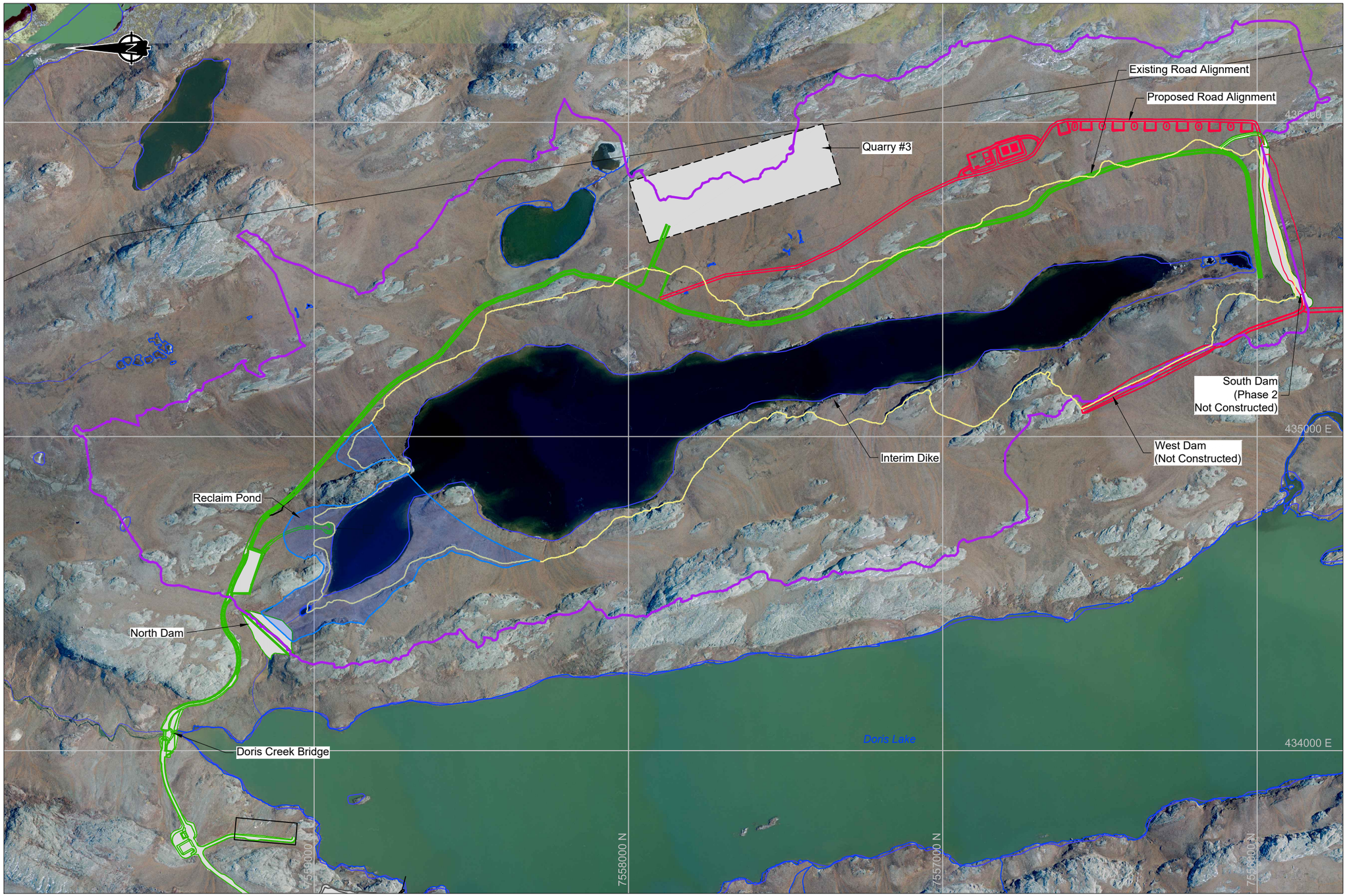
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NAD83 UTM Zone 13.
Aerial image captured in 2007, provided by client.

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FILE NAME: 1CT022.038 - PLM.dwg		DATE: June 2020 / APPROVED: PDL / FIGURE: 2

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LEGEND

- Existing Infrastructure
- Proposed Road Realignment
- Ultimate Tailings Extent
- Dam / Dike
- Reclaim Pond
- Watershed Boundary
- Quarry

REFERENCE

NAD83 UTM Zone 13.
Aerial image captured in 2007, provided by client.

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2019 Annual Geotechnical Inspection

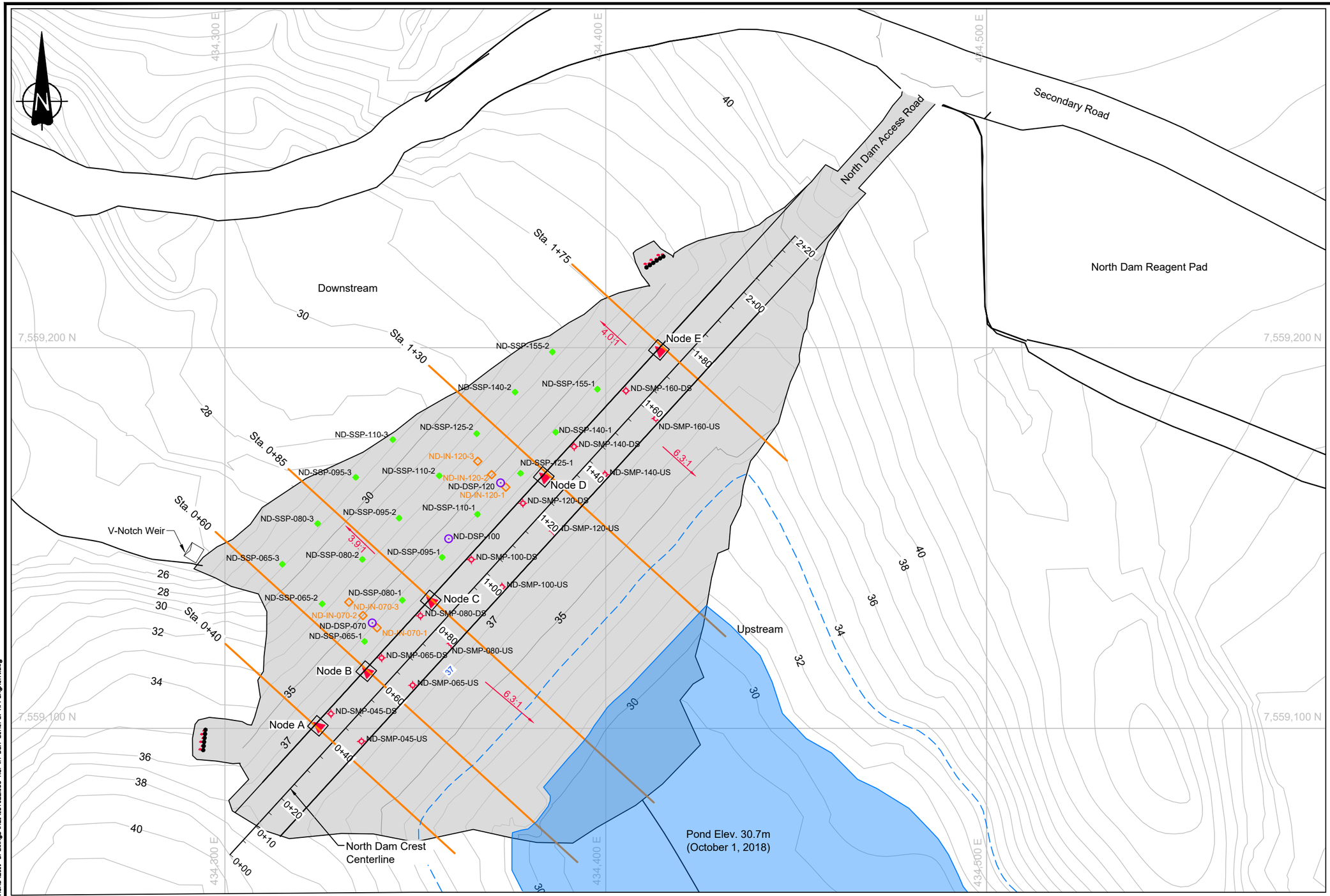
Doris TIA General Arrangement

SRK JOB NO.:	1CT022.038
FILE NAME:	1CT022.038 - Doris TIA.dwg

Doris TIA

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March 2020	PDL	3

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LEGEND

- Survey Monitoring Point (Crest)
- Deep Settlement Point
- Surficial Survey Point
- Inclinometer Location
- Major Contour
- Final Surface Extents
- Full Supply Level (Elev. 33.5m)
- Thermosyphon Radiator Datalogger Node

NOTES

1. Topographic contour data was provided by the Client. As-Built contour data for the terrain model was provided by the Contractor.
2. Contours shown at 1.0m intervals.

REFERENCE

NAD83 UTM Zone 13.

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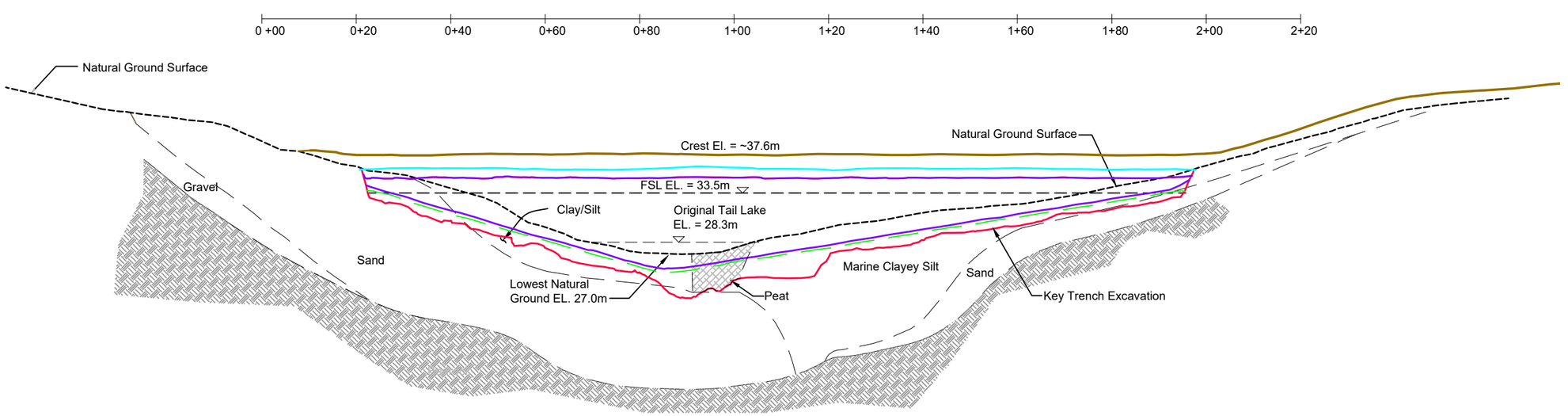
Doris TIA

2019 Annual Geotechnical Inspection

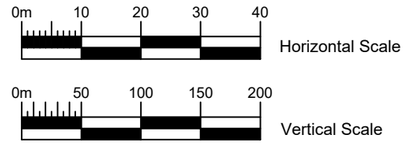
North Dam General Arrangement and Instrumentation

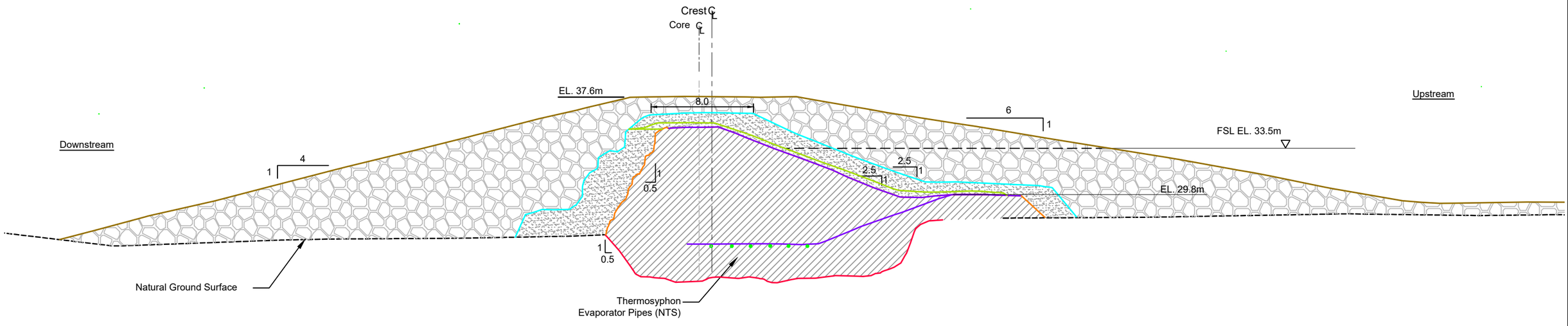
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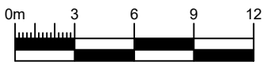


SECTION ALONG
NORTH DAM CREST CENTERLINE





NORTH DAM TYPICAL SECTION



LEGEND

- Natural Ground
- Stratigraphic Boundary
- Core Material
- Transition Material
- Run of Quarry (ROQ)
- Surfacing Material
- Bedrock
- Peat
- Thermosyphon Evaporator Pipe (NTS)
- Geosynthetic Clay Liner (GCL)
- Core Material
- Key Trench
- GCL Cover Material
- Transition Material
- ROQ Material
- Thermosyphon Evaporator Pipes
- Thermosyphon Evaporator Pipes

NOTES

1. The subsurface geology has been extrapolated from a series of geotechnical investigations consisting of drill holes, auger holes and shallow test pits. Bedrock contact and geological unit contacts are therefore likely to vary somewhat.

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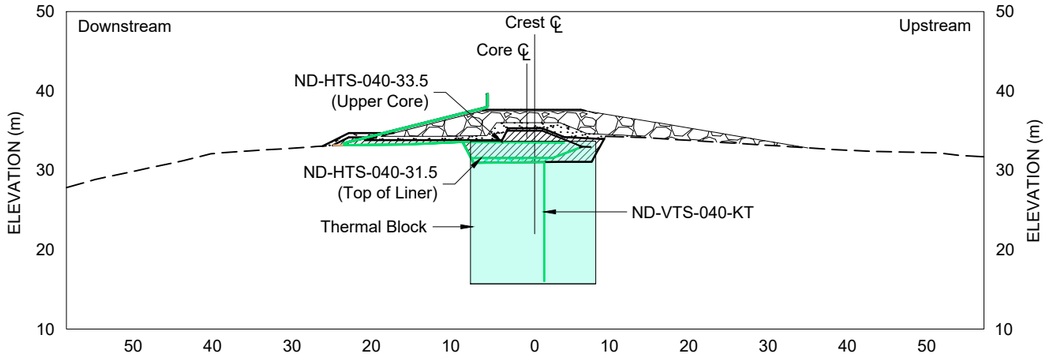
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Doris TIA

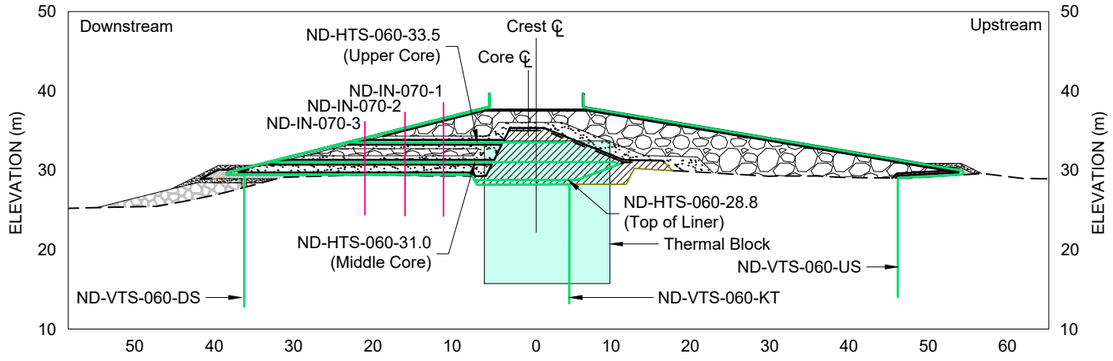
2019 Annual Geotechnical Inspection

North Dam Foundation Conditions and Typical As-Built Section

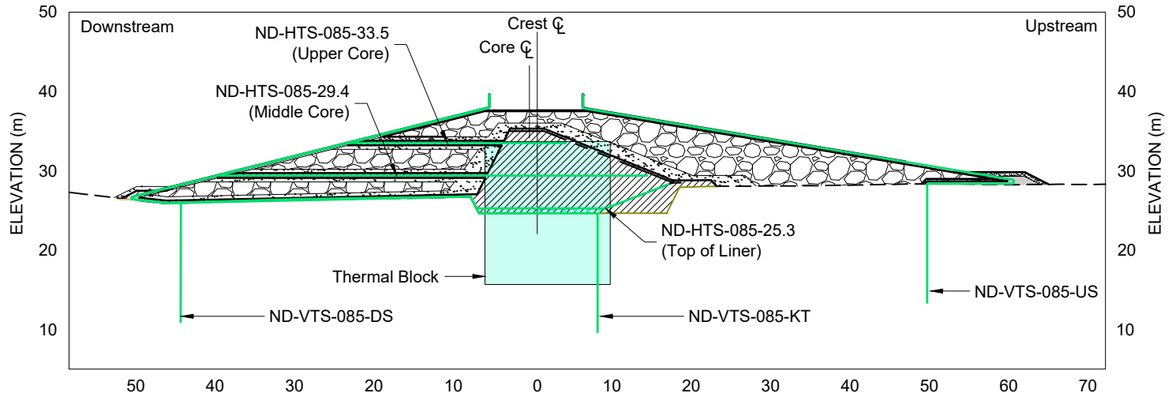
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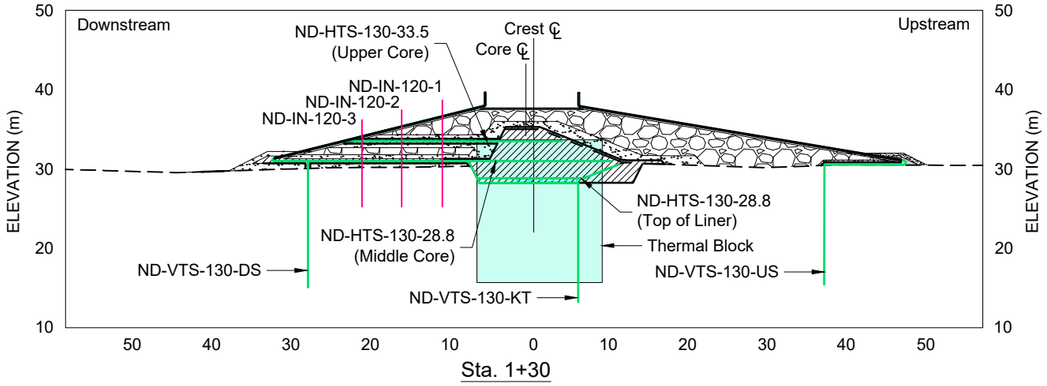
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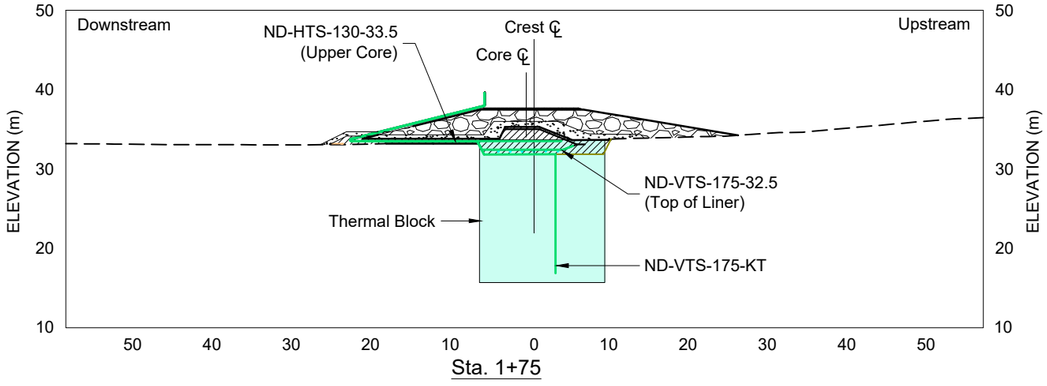
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Sta. 0+85



Sta. 1+30



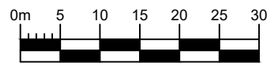
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LEGEND

- Ground Temperature Cable
- Core Material
- Thermal Block
- Transition Material
- Run of Quarry (ROQ) Material
- Surfacing Material

NOTES

1. Topographic and as-built contour data from the terrain model was provided by the Client (TMAC).
2. All units shown are in meters unless otherwise stated.



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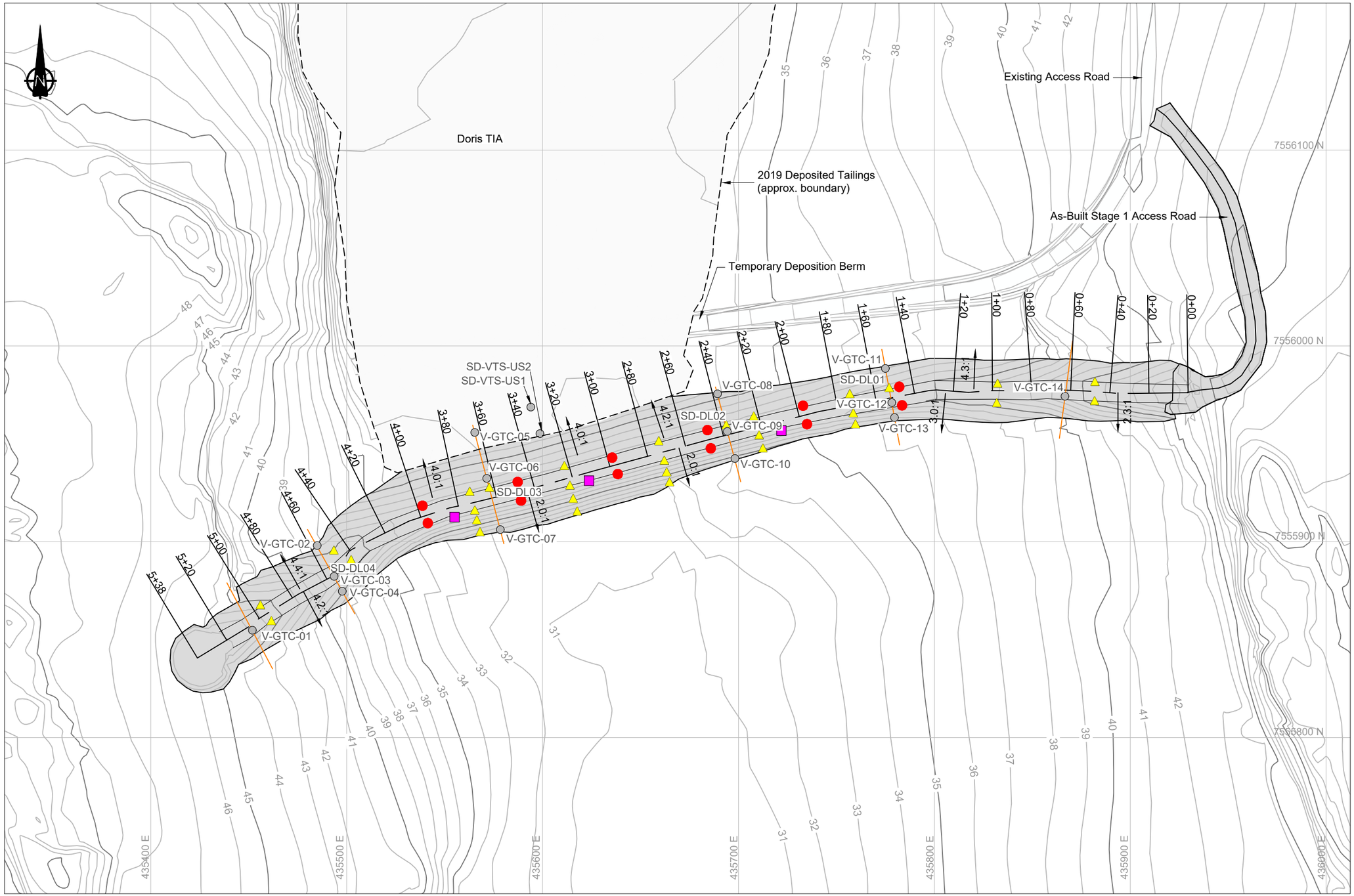
Doris TIA

2019 Annual Geotechnical Inspection

North Dam Instrumentation Cross Sections

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LEGEND

- As-Built Survey Monitoring Point
- Design Surface Monitoring Point
- Design Deep Settlement Point
- Datalogger Location
- Vertical Ground Temperature Cable

NOTES

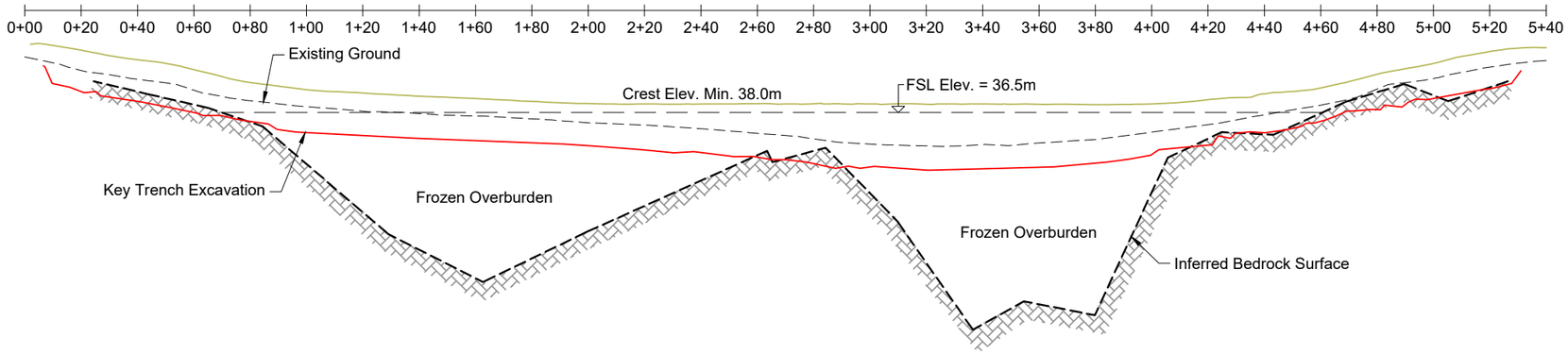
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2. Contours shown at 1.0m interval.
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REFERENCES

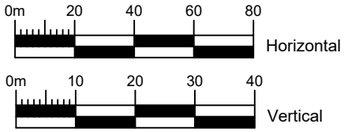
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srk consulting	TMAC RESOURCES	2019 Annual Geotechnical Inspection
SRK JOB NO.: 1CT022.038	Doris TIA	South Dam General Arrangement and Instrumentation
FILE NAME: 1CT022.038 - Instrumentation Plan.dwg		DATE: April 2020 / APPROVED: PDL / FIGURE: 7

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SECTION ALONG
SOUTH DAM CREST CENTERLINE

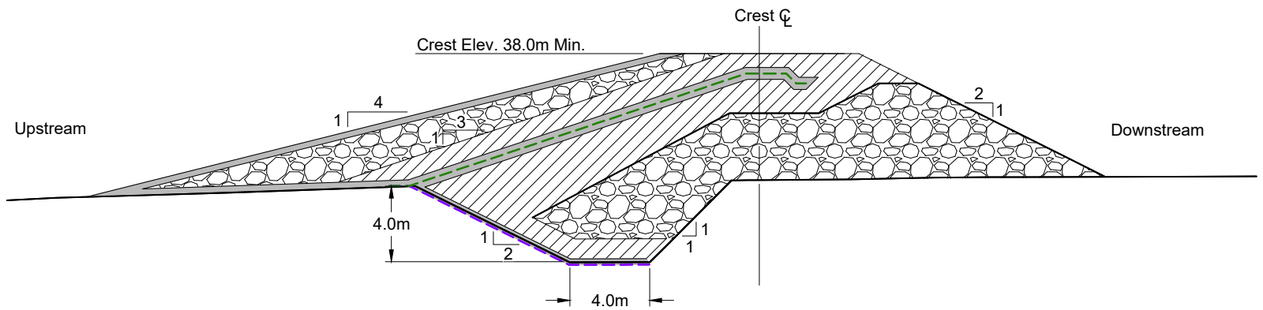


LEGEND

- Thermistor Bead Location
- Lower GCL Liner
- Upper GCL Liner
- Bedding Material
- Transition Material
- Run of Quarry Backfill

NOTES

1. Topographic and as-built contour data from the terrain model was provided by the Client (TMAC).
2. All units shown are in meters unless otherwise stated.



SOUTH DAM TYPICAL SECTION



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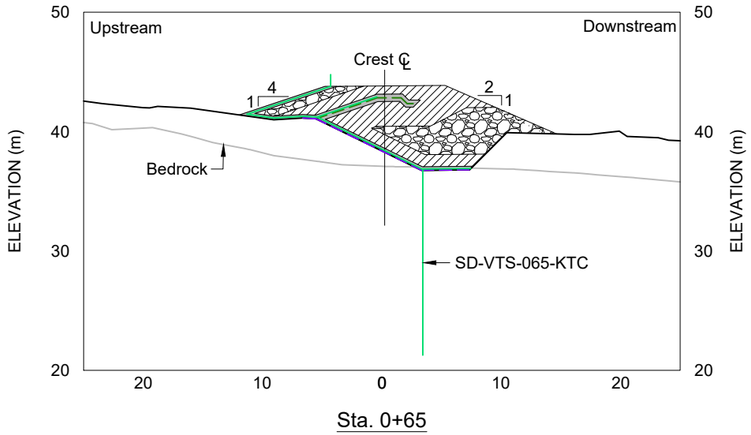
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Doris TIA

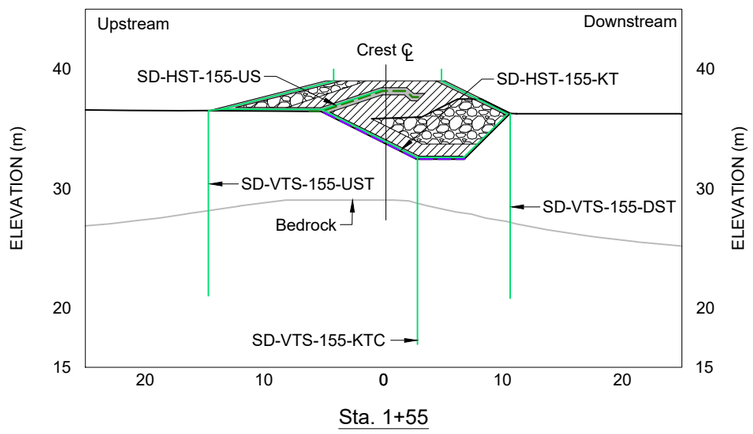
2019 Annual Geotechnical Inspection

South Dam Foundation Conditions and Typical As-Built Section

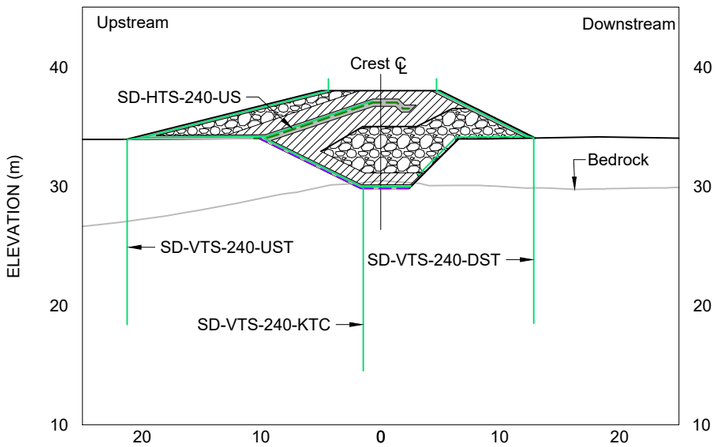
DATE:	APPROVED:	FIGURE:
March 2020	PDL	8



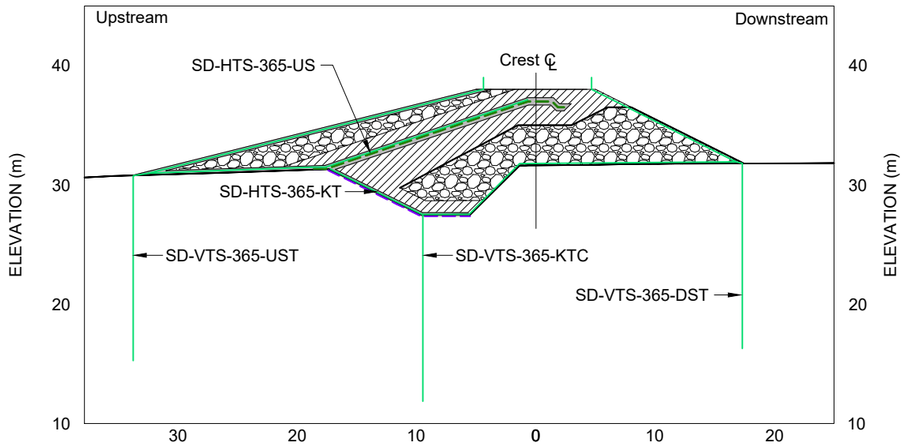
Sta. 0+65



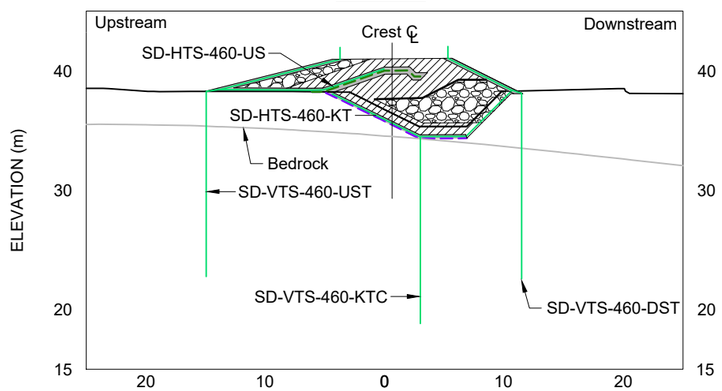
Sta. 1+55



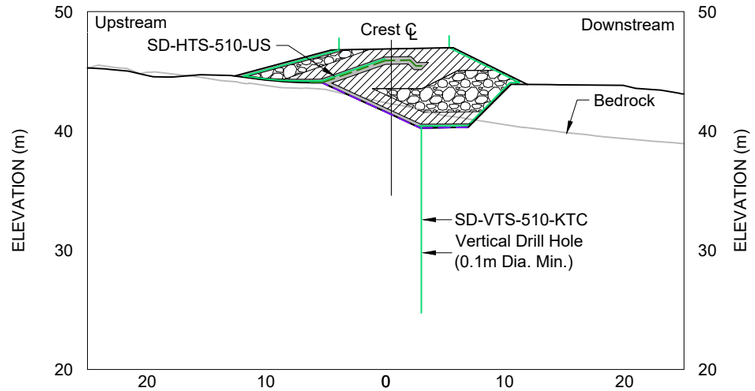
Sta. 2+40



Sta. 3+65



Sta. 4+60



Sta. 5+10

LEGEND

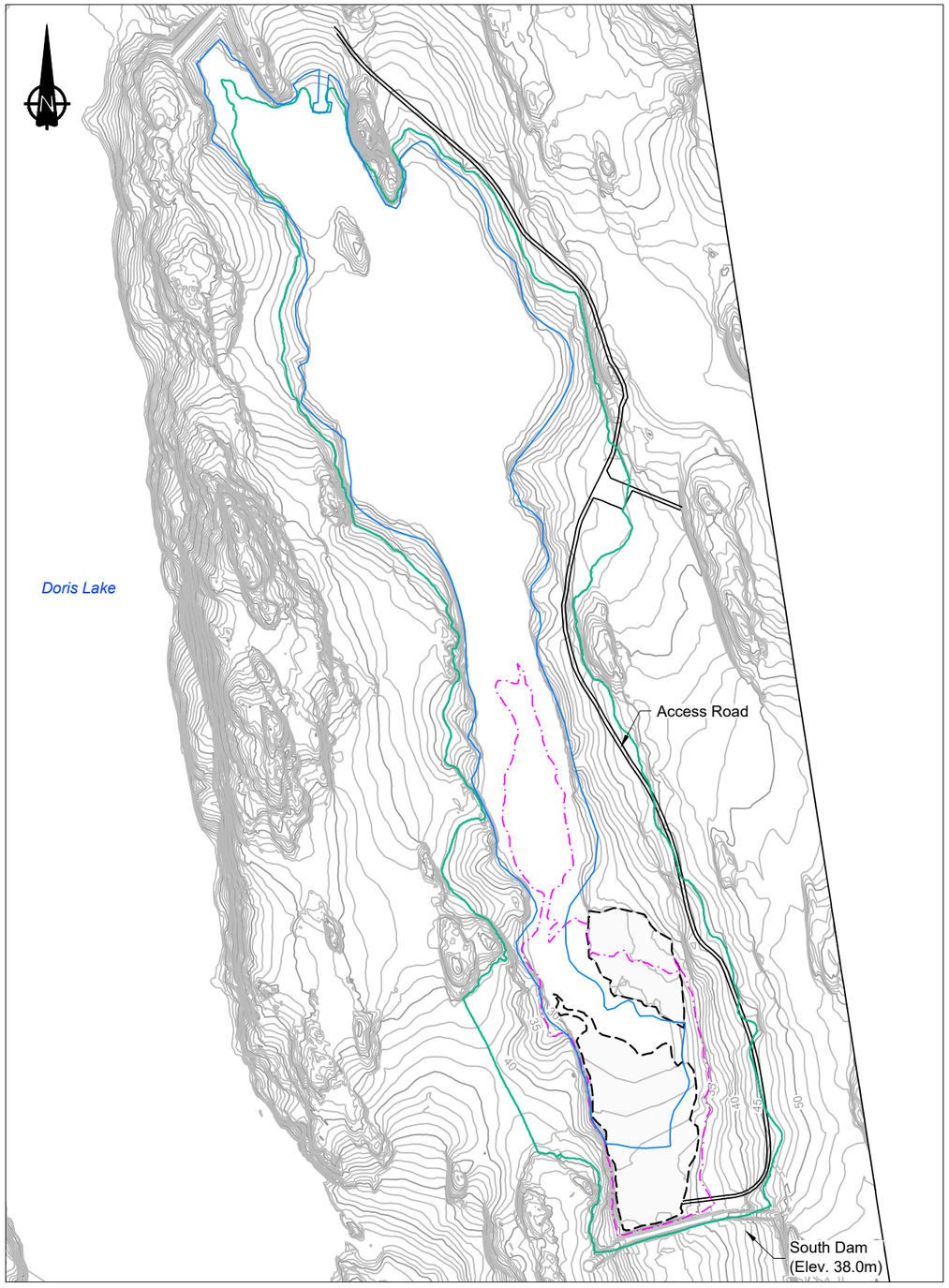
- Ground Temperature Cable
- Lower GCL Liner
- Upper GCL Liner
- Bedding Material
- Transition Material
- Run of Quarry Backfill

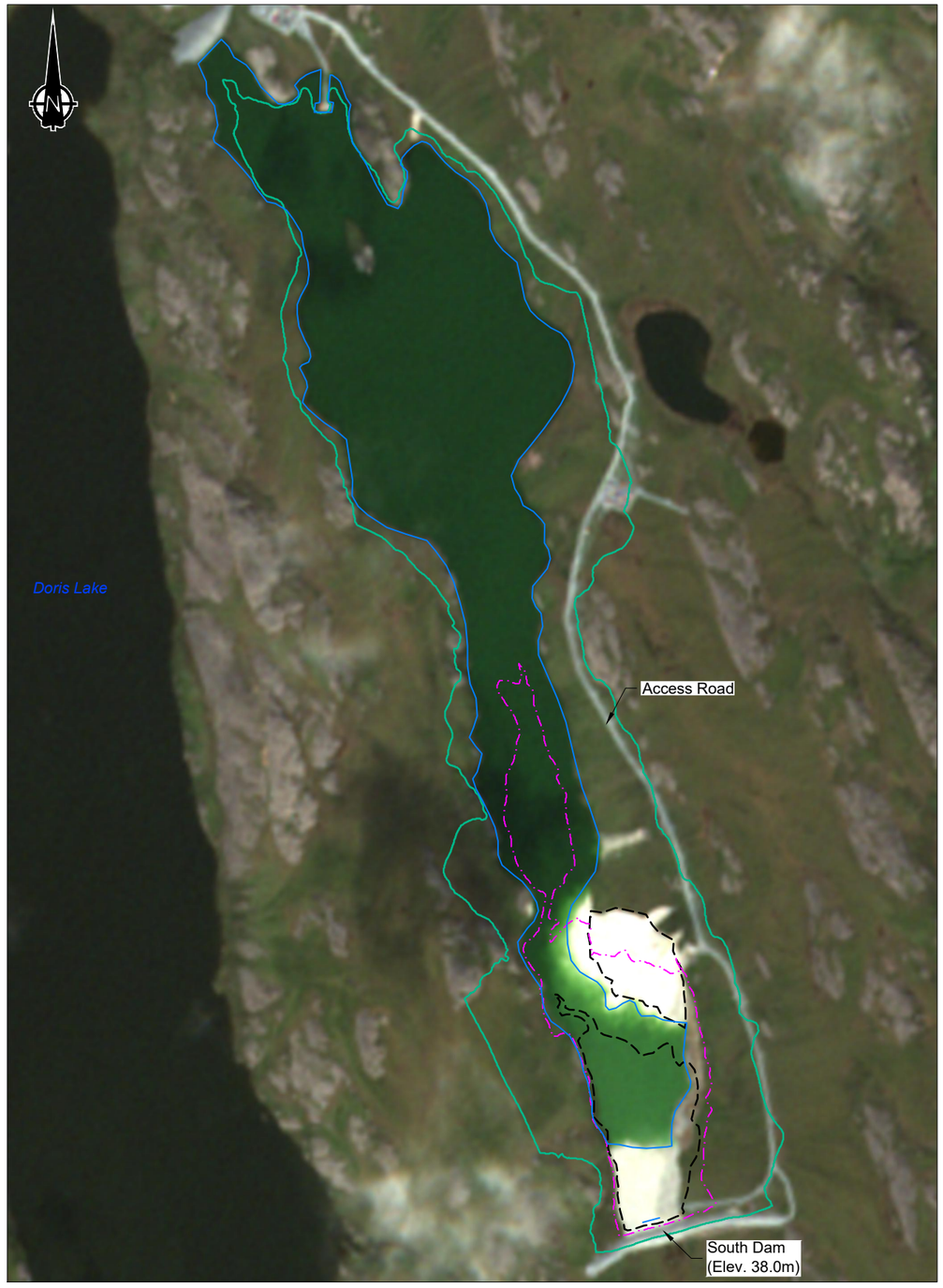
NOTES

1. Topographic and as-built contour data from the terrain model was provided by the Client (TMAC).
2. All units shown are in meters unless otherwise stated.

srk consulting	TMAC RESOURCES	2019 Annual Geotechnical Inspection	
SRK JOB NO.: 1CT022.038	Doris TIA	South Dam Instrumentation Cross Sections	
FILE NAME: 1CT022.038 - Instrumentation Plan.dwg		DATE: March 2020	APPROVED: PDL / FIGURE: 9

P:\Projects\01_SITES\Hope Bay\ACAD\2019 Drawings\AG\1CT022.038 - Instrumentation Plan.dwg





LEGEND

- Major Contour (5m)
- Minor Contour (1m)
- 2020 Projected Tailings Limit
- Ultimate Tailings Extent
- Surveyed Tailings Beach (See Reference 2)

NOTES

1. Topographic and As-built data was provided by the client.
2. Contours shown at 1.0m intervals.
3. All units shown are in meters unless otherwise stated.

REFERENCE

1. Sentinel 2 Satellite imagery captured August 11, 2019.
2. Tailings surveys dated December 22 and 25, 2019.

0m 50 100 150 200

srk consulting

SRK JOB NO.: 1CT022.038

FILE NAME: 1CT022.038 - 2019 Deposition History.dwg

TMAC RESOURCES

Doris TIA

2019 Annual Geotechnical Inspection

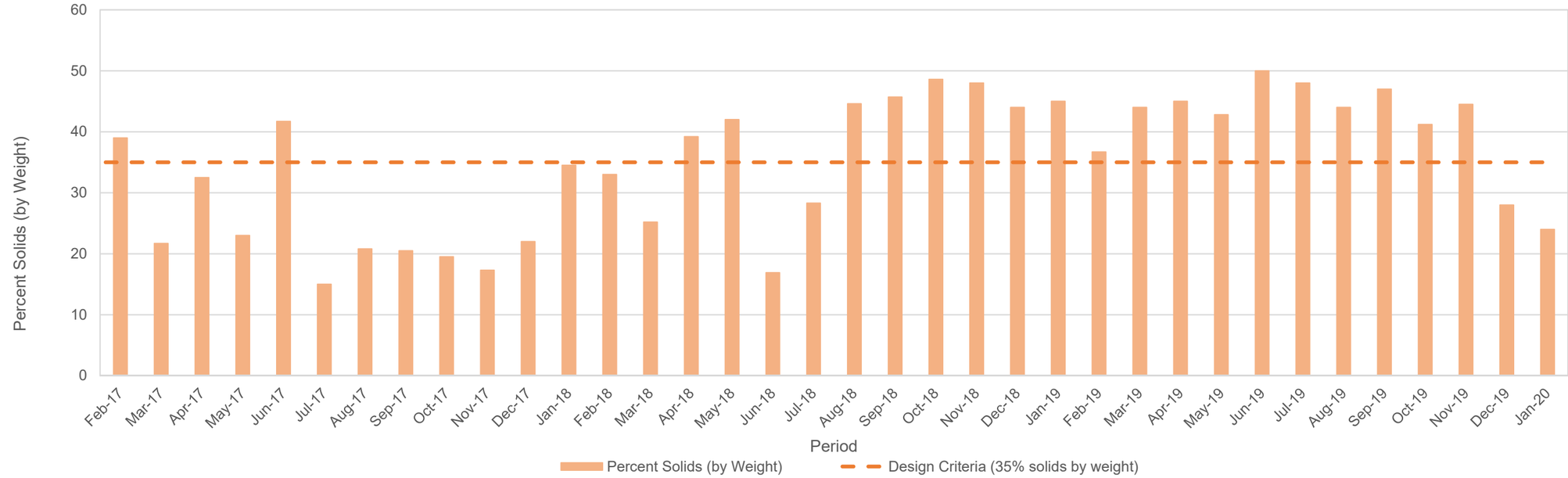
Actual Tailings Deposition History

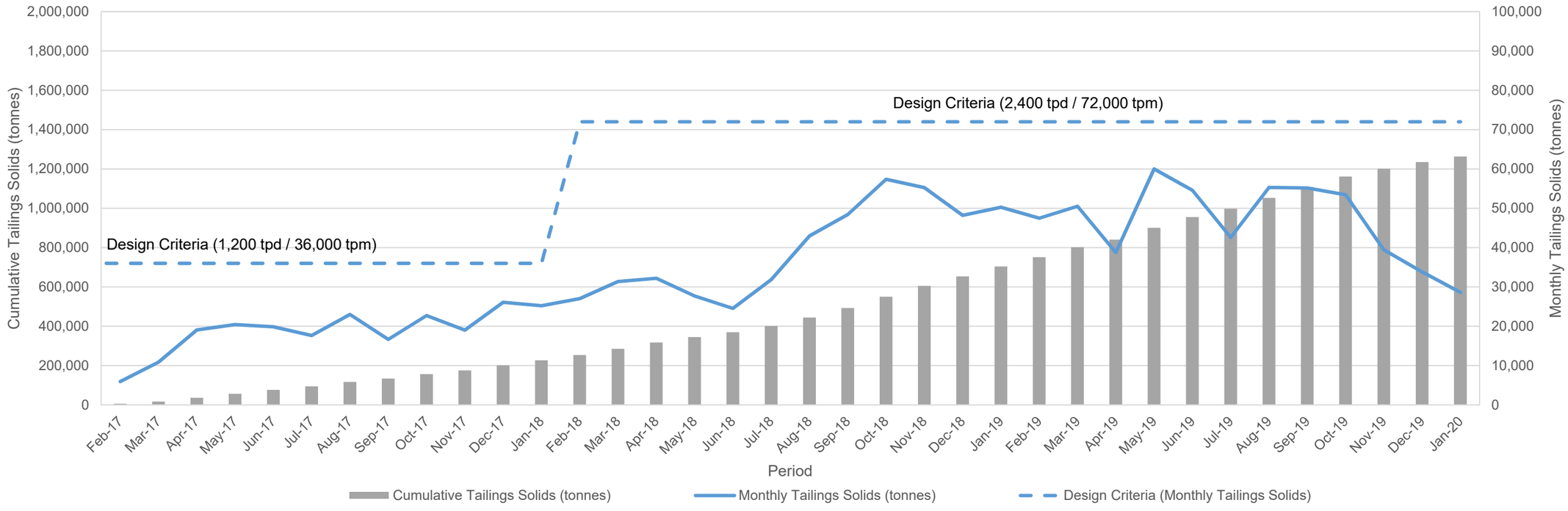
DATE: April 2020

APPROVED: PDL

FIGURE: 10

P:\Projects\01_SITES\Hope Bay\ACAD\2019 Drawings\AGI\1CT022.038 - 2019 Deposition History.dwg





srk consulting

MAC RESOURCES

Job No: 1CT022.038

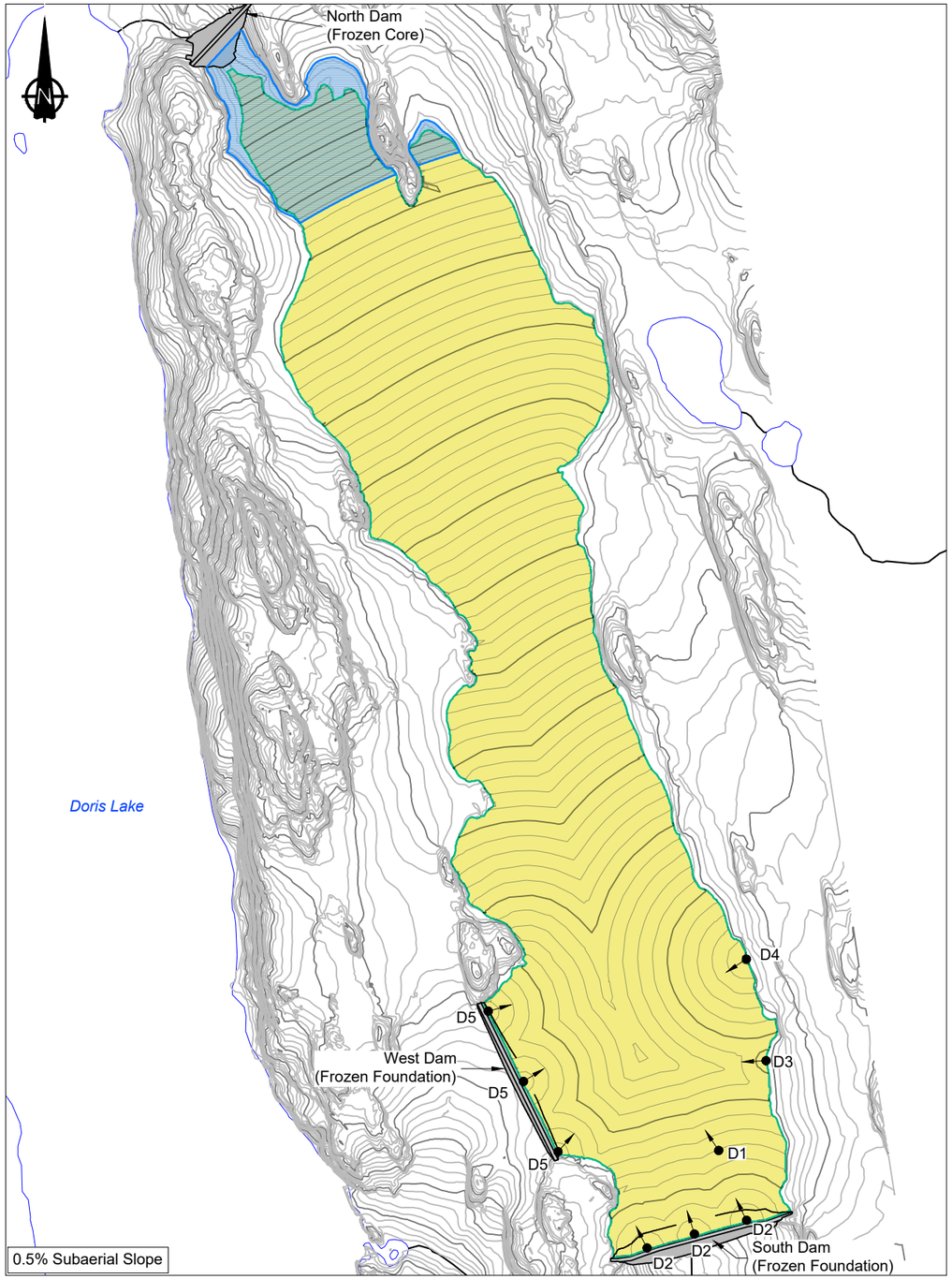
Filename: 11_TailingsDepositionHistory_20200313.pptx

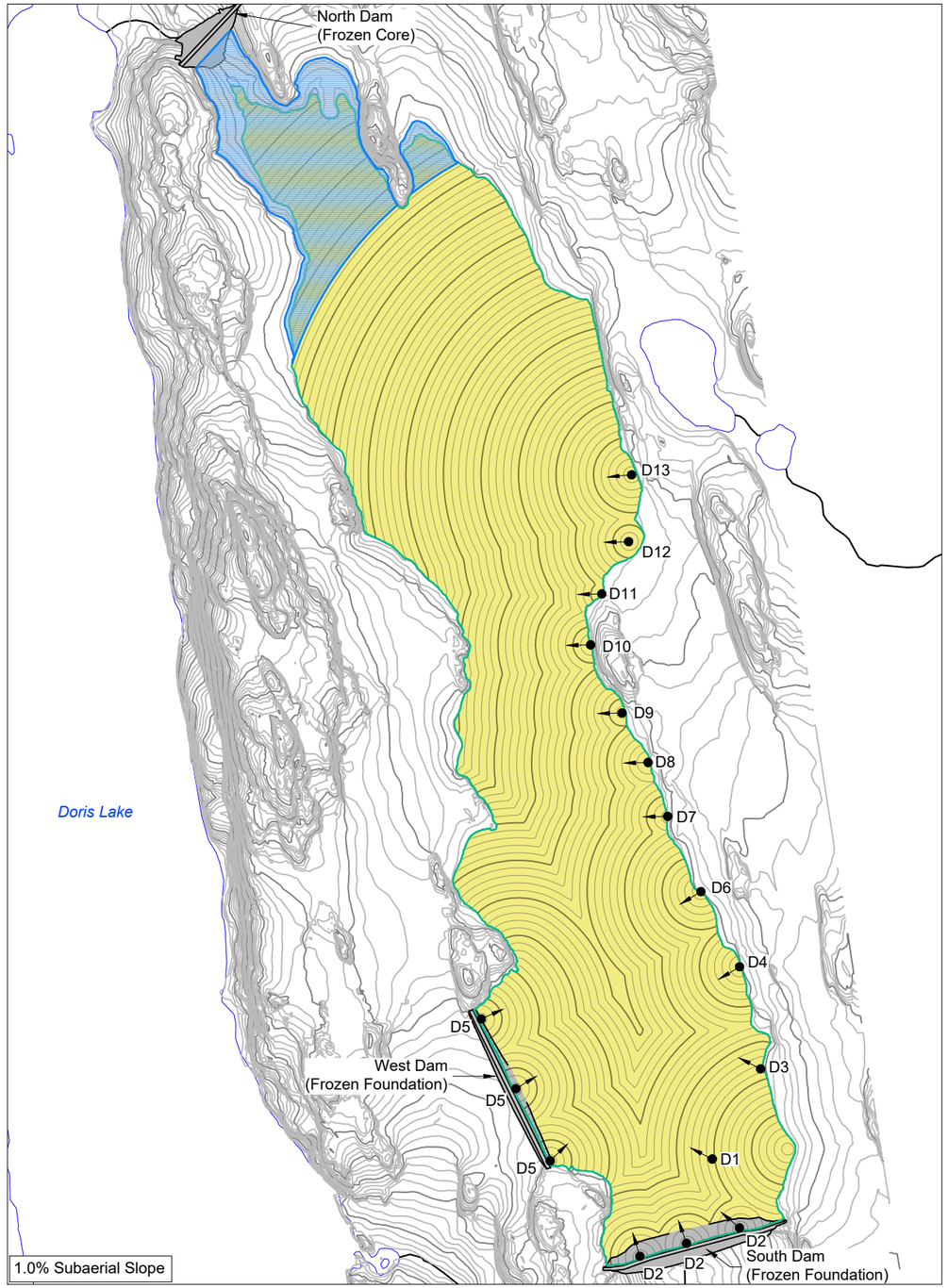
Doris TIA

2019 Annual Geotechnical Inspection

Actual Tailings Deposition Values (Design / Actual)

Date:	Approved:	Figure:
Mar 2020	PL	**11**





LEGEND

- Spigot Location
- Deposited Tailings

NOTES

1. Deposition durations are approximate and were based on the Mine Plan average production rates provided by TMAC Resources.
2. A deposited tailings dry density of 1.3t/m³ was used.
3. All tailings volumes presented include ice entrainment at 20% of production.
4. Dam elevations shown were assumed constant throughout deposition.
5. Total storage requirements includes Madrid and Boston Tailings (Tailings 11.6Mm³ + Ice Entrainment 2.3Mm³).

REFERENCE

NAD83 UTM Zone 13.

0m 3 6 9 12

Note:
Final tailings beach slope will be based on operation. Tailings beach will be somewhere between 0.5% and 1% slope; based on latest as-built survey and operations data (as of December 2019).

srk consulting

SRK JOB NO.: 1CT022.038
FILE NAME: 1CT022.038 - Planned Tailings.dwg

TMAC RESOURCES

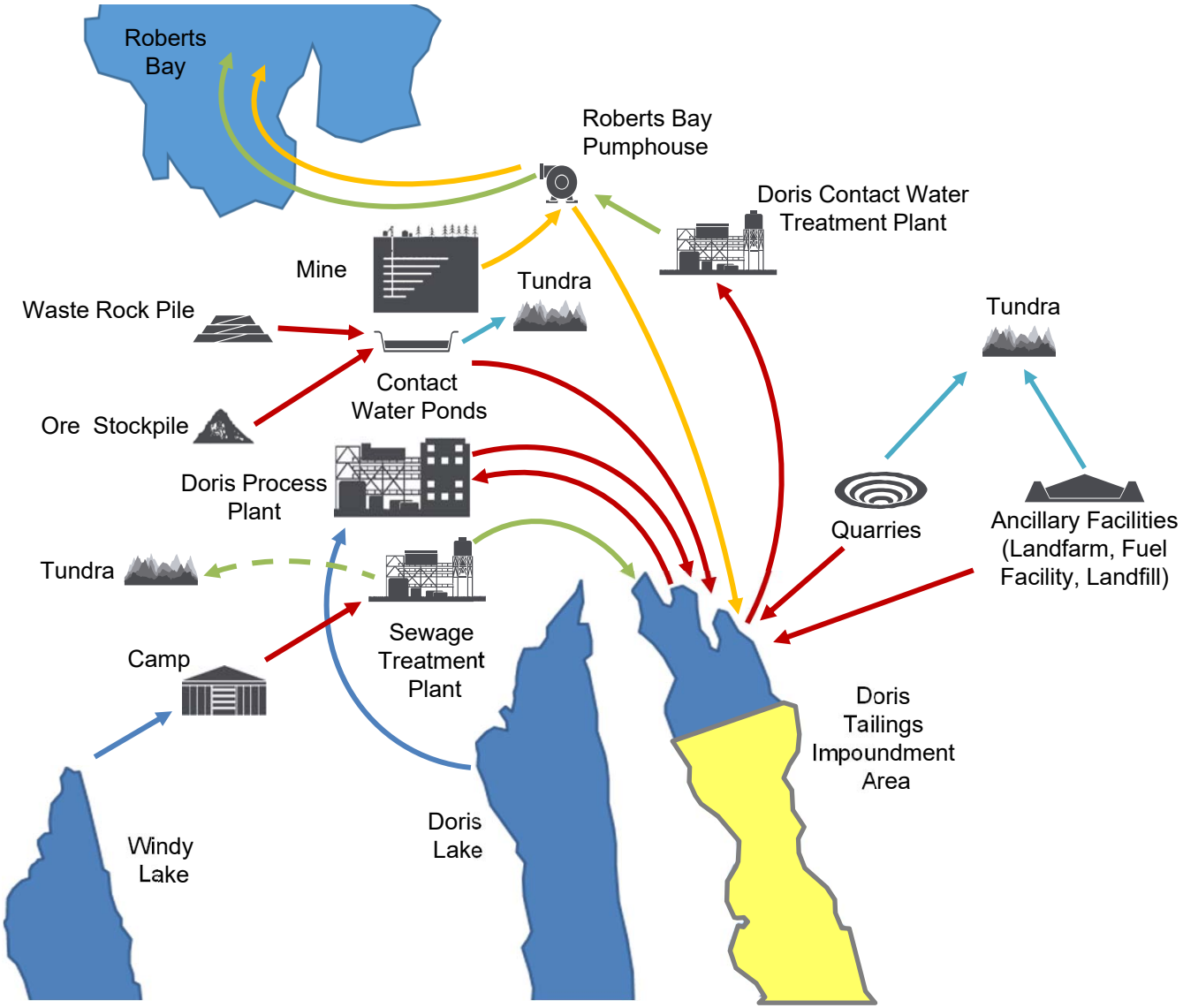
Doris TIA

2019 Annual Geotechnical Inspection

Planned Tailings Deposition (Phase 1 & Phase 2) - End of Mine

DATE:	APPROVED:	FIGURE:
April 2020	PDL	12

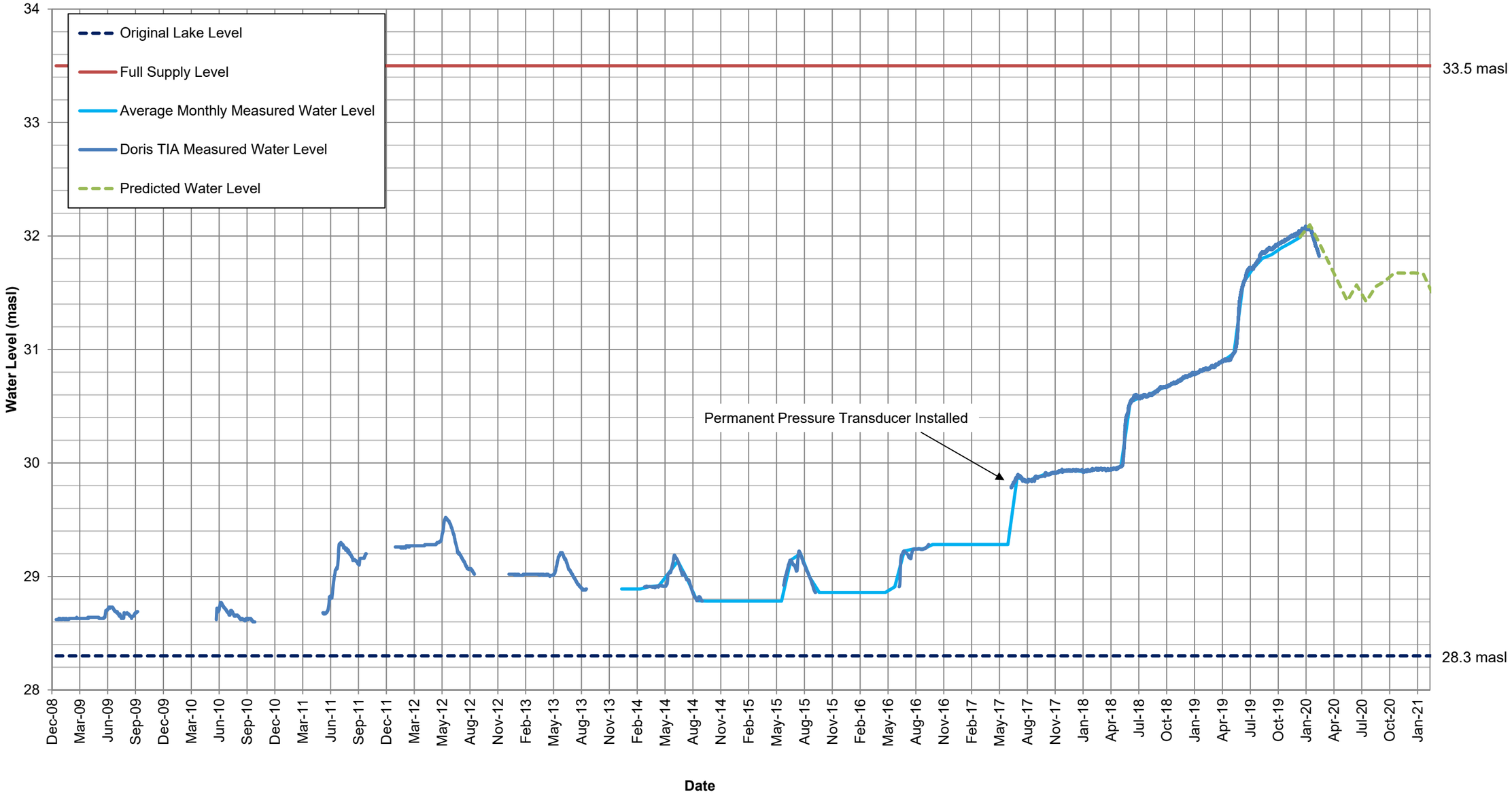
P:\Projects\01_SITES\Hope Bay\ACAD\2019 Drawings\AGI\1CT022.038 - Planned Tailings.dwg



Legend

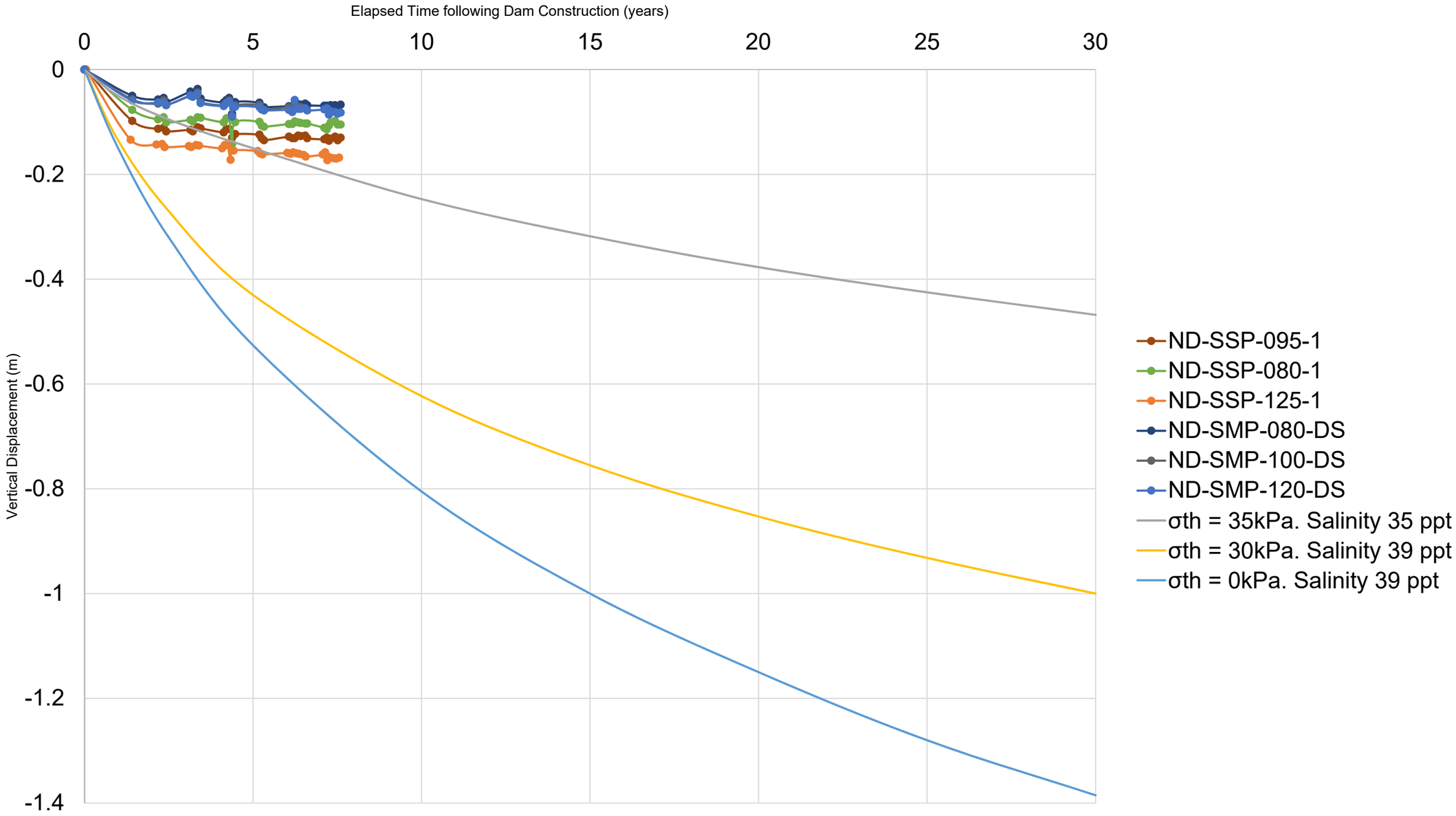
- Treated Water (Operations)
- Non-contact Water
- Freshwater
- Contact Water
- Mine Water
- Treated Water (Closure and Construction

srk consulting	TMAC RESOURCES	2019 Annual Geotechnical Inspection
		Schematic of TIA Water Management
Job No: 1CT022.038 Filename: DorisTIA_WaterMgmtSchematic_1CT022.038.pptx	Doris TIA	Date: Mar. 2020 | Approved: PDL | Figure: **13**



Notes:
The predicted water level presented here is based on the current detailed operational TIA water balance as discussed in the report

srk consulting	TMAC RESOURCES	2019 Annual Geotechnical Inspection
		Actual and Predicted Water Level in TIA
Job No: 1CT022.038 Filename: 16_ActualsPredWaterLevel_20200313.pptx	Doris TIA	Date: Mar. 2020 / Approved: PDL / Figure: **14**



srk consulting	MAC RESOURCES	2019 Annual Geotechnical Inspection
		Measured vs. Modelled Vertical Displacement at Station 1+20 (North Dam)
Job No: 1CT022.038 Filename: 17_CreepDisp_20190316.pptx	Doris TIA	Date: Mar. 2020 / Approved: PL / Figure: **15**

Photolog





1



2



3



Photos:
Top: Aerial photos of the North Dam (2018 left, and 2019 right image)
Photo 1: View of additional fill material previously placed over upstream dam shell for access.
Photo 2: View of the cracking observed on the upstream face pumping pad, looking east.
Photo 3: View looking East down the top dam crest.

Note:
All photos from 2019 unless specifically noted

srk consulting	MAC RESOURCES	2019 Annual Geotechnical Inspection
		North Dam Upstream Face
Job No: 1CT022.038 Filename: 2019NDGeotechInsp_Rev1_sw.pptx	Doris TIA	Date: March 2020 / Approved: PL / JK / Photolog: **1**

1



2



3





4



Photos:
Photo 1: View of the North Dam crest, looking east-northeast
Photo 2: Light green, thicker vegetation at downstream toe of North Dam.
Photo 3: Close-up view of fixed survey monitoring point on the downstream shell.
Photo 4: Close-up of the V-notch weir installed at the downstream toe
Middle: Aerial photo of the North Dam (from 2018 – selected to show photo locations)

Note:
All photos from 2019 unless specifically noted

srk consulting	MAC RESOURCES	2019 Annual Geotechnical Inspection
		North Dam Downstream Face
Job No: 1CT022.038 Filename: 2019NDGeotechInsp_Rev1_sw.pptx	Doris TIA	Date: March 2020 / Approved: PL / JK / Photolog: **2**

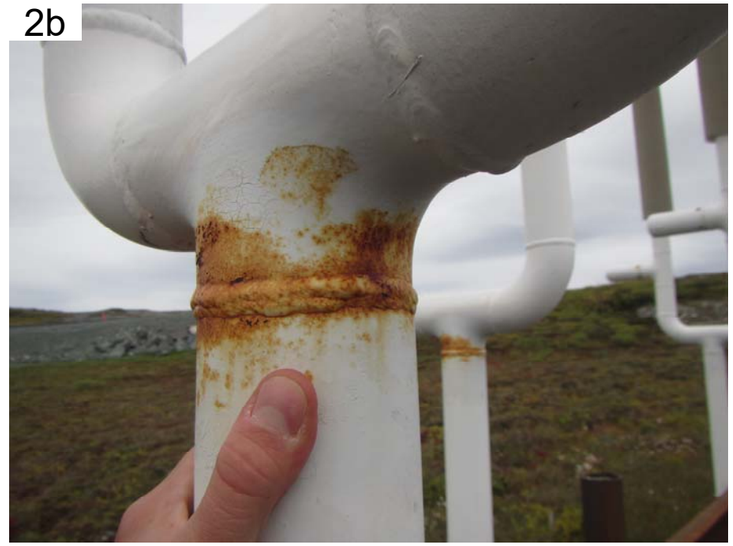
1



2a



2b





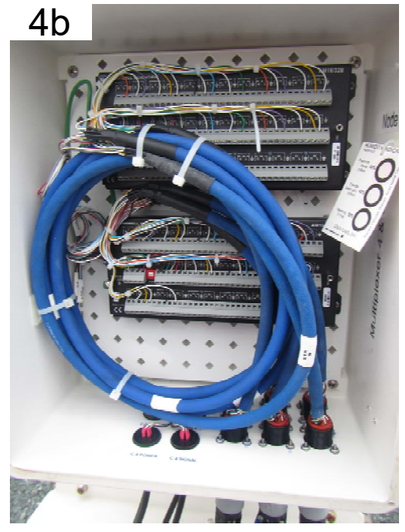
3



4a



4b



Photos:
Photo 1: North view of east thermosyphon risers and radiators
Photo 2a: Approx. north-north east view of west thermosyphon radiators and risers
Bottom Left: Overview photo (south-southwest view) of North Dam. Photo locations shown on overview.
Photo 3: Set of instrumentation on / through downstream dam slope.
Photo 4a and 4b: Example of ground temperature cable datalogger housing and wiring.

srk consulting	MAC RESOURCES	2019 Annual Geotechnical Inspection
		North Dam Instrumentation and Thermosyphons
Job No: 1CT022.038 Filename: 2019NDGeotechInsp_Rev1_sw.pptx	Doris TIA	Date: March 2020 / Approved: PL / JK / Photolog: 3

1



2



3



4



5



6



Photos:
Photo 1: Aerial photo of the South Dam, looking north-northeast
Photo 2: Aerial photo of the East central tailings beach, looking west
Photo 3: Aerial photo of the South Dam, looking east
Photo 4: The upstream face of the South Dam, looking west
Photo 5: The downstream face of the South Dam, looking west
Photo 6: Active tailings deposition off the South Dam crest.

srk consulting	TMAC RESOURCES	2019 Annual Geotechnical Inspection
		South Dam Inspection
Job No: 1CT022.038 Filename: 2019NDGeotechInsp_Rev1_sw.pptx	Doris TIA	Date: March 2020 / Approved: PL / JK / Photolog: **4**

1



2



3



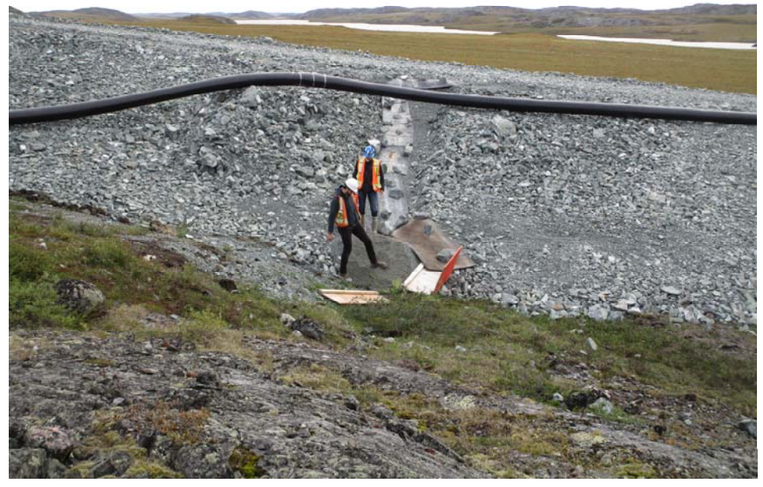
4



5



6



Photos:
Photo 1: Aerial photo of the South Dam, looking east
Photo 2: One of the data logger nodes on the upstream crest. Plywood casing is used to prevent animal damage.
Photo 3: Close-up of the BeadedStream DL505 datalogger and solar panel units
Photo 4: Photo along the crest showing the tailings discharges and monitoring instrumentation
Photo 5: Example fixed settlement monitoring point along the crest
Photo 6: One of the locations where a GTC has been repaired and will be further backfilled / covered (done post inspection)

srk consulting	MAC RESOURCES	2019 Annual Geotechnical Inspection
		South Dam Instrumentation
Job No: 1CT022.038 Filename: 2019NDGeotechInsp_Rev1_sw.pptx	Doris TIA	Date: March 2020 / Approved: PL / JK / Photolog: **5**

1a



1b



4



2



3



5



Photos:
Photo 1a: Permafrost degradation near the reclaim pond access road (partially backfilled with tailings). Location noted in past / earlier year inspections.
Photo 1b: Second view of the permafrost degradation near the reclaim pond access road
Photo 2: Aerial photo of the Reclaim Pond Pumphouse and northeastern shore of the TIA
Photo 3: The historic discharge pipelines over the tundra, with the pumphouse in the background
Photo 4: West-southwest view of the reclaim pumphouse.
Photo 5: Tension cracking on reclaim pad on the north side of the 710 pumphouse.

srk consulting	TMAC RESOURCES	2019 Annual Geotechnical Inspection
		Reclaim Pond Access and Pump House
Job No: 1CT022.038 Filename: 2019NDGeotechInsp_Rev1_sw.pptx	Doris TIA	Date: March 2020 / Approved: PL / JK / Photolog: **6**

1



2



3



4



5



Photos:
Photo 1: Photo of the east side of the TIA with the primary spigot points and the overburden dump along the shoreline
Photo 2: East shoreline of the TIA, showing the northern-most historic spigot point (not active)
Photo 3: The South Dam and beach looking south east
Photo 4: The South Dam in August 2018 showing the tailings beach extents one year prior (looking north)
Photo 5: The South Dam in August 2019 showing the tailings beach extents (looking north-northwest)

Note:
All photos from 2019 unless specifically noted

srk consulting	MAC RESOURCES	2019 Annual Geotechnical Inspection
		TIA Shoreline and Tailings Deposition (South End)
Job No: 1CT022.038 Filename: 2019NDGeotechInsp_Rev1_sw.pptx	Doris TIA	Date: March 2020 / Approved: PL / JK / Photolog: 7

1



2



3



4



Photos:
Photo 1: The Western EDCB looking south
Photo 2: The Western EDCB looking northwest
Photo 3: The Eastern EDCB looking north-northwest (panoramic view)
Photo 4: Approx. east aerial view of Emergency Dump Catch Basins.

srk consulting	MAC RESOURCES	2019 Annual Geotechnical Inspection
		Emergency Dump Catch Basins
Job No: 1CT022.038 Filename: 2019NDGeotechInsp_Rev1_sw.pptx	Doris TIA	Date: March 2020 / Approved: PL / JK / Photolog: **8**

1



2



3



4



5



6



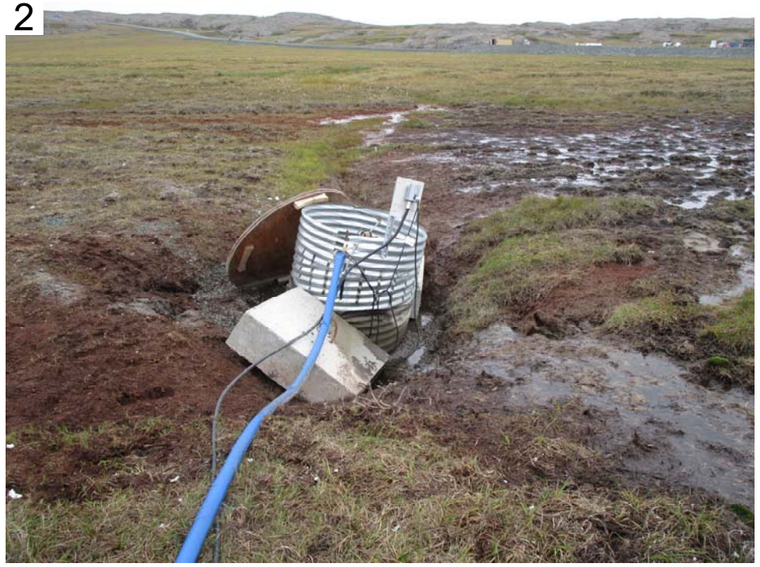
Photos:
Photo 1: Doris Creek Bridge (East Abutment) showing the electrical line, tailings pipelines and racking, looking south
Photo 2: Doris Creek Bridge (West Abutment) showing the electrical line, tailings pipelines and racking, looking south
Photo 3: Reclaim pipeline over the south pipe racking on the Doris Creek Bridge, looking east
Photo 4: Reclaim pipeline over the south pipe racking on the Doris Creek Bridge, looking west
Photo 5: Tailings pipeline over the north pipe racking on the Doris Creek Bridge, looking west
Photo 6: Tailings pipeline over the north pipe racking on the Doris Creek Bridge, looking east.
The small grey box shows the top of the DCB West GTC.

srk consulting	TMAC RESOURCES	2019 Annual Geotechnical Inspection
		Tailings Discharge and Reclaim Pipeline (Near TIA)
Job No: 1CT022.038 Filename: 2019NDGeotechInsp_Rev1_sw.pptx	Doris TIA	Date: March 2020 / Approved: PL / JK / Photolog: **9**

1



2



3



4



5



6



Photos:
Photo 1: Sump #3 area and associated tundra / permafrost degradation visible. Looking approx. west toward Doris Mill Area
Photo 2: A different view of the same sump, looking south, the deformation and sunken blocks due to permafrost degradation.
Photo 3: Reclaim pipelines leading toward the TIA from the Doris Creek Bridge, looking southeast
Photo 4 through 6: Sumps (#1 and 2) with pipelines showing pipelines directly on tundra. Near Doris Camp.

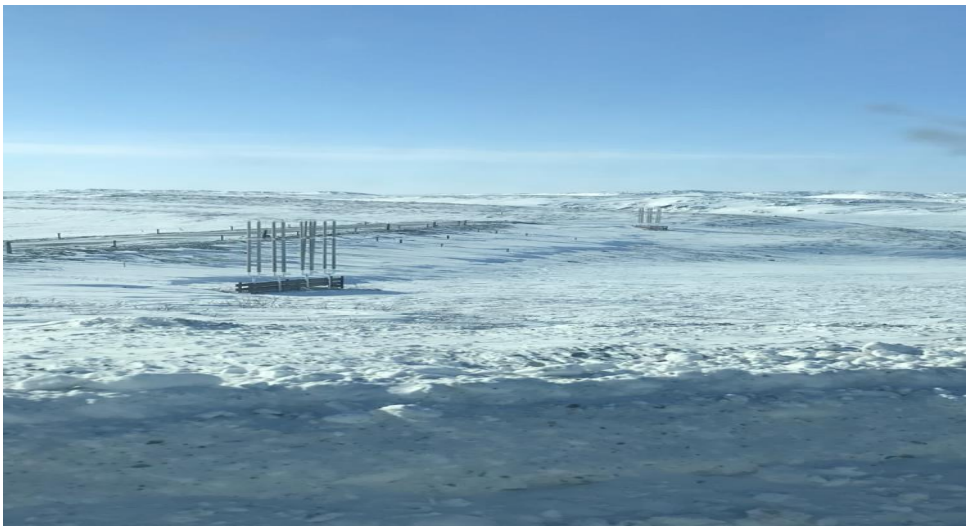
srk consulting	MAC RESOURCES	2019 Annual Geotechnical Inspection
		Tailings / Reclaim Pipelines and Sumps (Near Doris Camp)
Job No: 1CT022.038 Filename: 2019NDGeotechInsp_Rev1_sw.pptx	Doris TIA	Date: March 2020 / Approved: PL / JK / Photolog: **10**

Appendix A – Arctic Foundations of Canada Inspection Report

Arctic Foundations of Canada

Doris North Dam – North Thermosyphon #2

Discharge and Recharge of Thermosyphon June 4-6 / November 19-21 2019



1.0 Background Summary

In 2018 AFC was contracted to attend site to complete an inspection of the Thermosyphon system on Doris North Dam. During SRK Consulting's ground temperature sensor monitoring, a concern was brought forth that North #2 showed deviation from the other units and my not be operational.

April 10-11 AFC personnel attended site and found that all units were pressurized, in good condition and appeared to be functioning as designed. It is important to note that due to the timing of the 2018 inspection, the Thermosyphons were transitioning into their dormant stage. Although difficult to achieve, a thermal heat signature was captured from all 12 units

15 ELIE ST E ELIE, MB
T (204) 353 2510 U WWW.ARCTICFOUNDATIONS.CA

2.0 Further Monitoring

Continued monitoring of the ground temperature sensors through the winter of 2018-2019 by SRK showed data similar to previous years. After much analyzing and discussions, TMAC contracted AFC to attend site to complete a controlled discharge and recharge of North #2. It was decided to complete these works in two separate trips. The first trip would be in the spring of 2019 after the Thermosyphons had entered their dormant stage. The second trip was planned for fall of 2019 when the Thermosyphons had transitioned into passive heat transfer stage. There were two main reasons for these works to be split into separate trips. The first, to allow for a slow, controlled discharge over a long period of time to ensure dry ice was not formed inside the evaporator. The second reason was to monitor the ground temperature data during the discharge process to see if any super-cooling of the material around the evaporator was produced.

3.0 Discharge

June 4-6 2019 One technician attended site to complete the discharge on North#2. Before the discharge, the protective valve cap, o ring and charge valve were in place, intact, and showed no signs of wear or damage. The unit was fully charged with refrigerant and showed no signs to indicate it should not be fully functional. The unit was discharged as planned and took many hours to completely depressurize.



4.0 Recharge

Nov. 19-21 2019 Two technicians attended site to recharge the previously discharged North #2 Thermosyphon. This unit was placed under a vacuum late morning. It drew down to the target vacuum within a few hours as expected. Upon completion of recharge, North#2 did not activate as anticipated. Nov. 20 it was found to be non-operational in the morning. During the course of the day, the charge rate was gradually decreased repeatedly. Despite numerous attempts, the technicians were unable to get the unit to operate.

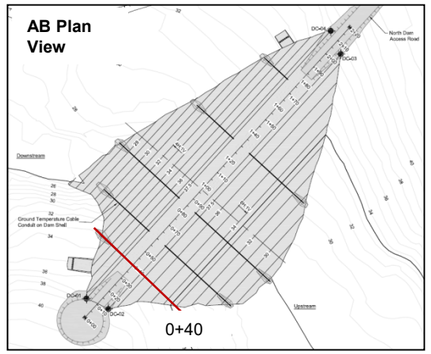
5.0 Conclusions

It appears that the subgrade evaporator section of North #2 has a blockage that is not allowing vapor to rise into the radiator section. It is possible that during the backfill process at the time of construction, the pipe was pinched or deviated to cause a liquid trap. AFC is of the opinion that this deviation or pinch is close to the radiator section of the system. If the blocked section of evaporator was closer to the end of the evaporator, the unit should have operated at a reduced capacity. It should have then started to operate more efficiently once the overall refrigerant charge was reduced. If this were the case, the unit would "short circuit" but still function. At no time did North #2 show any signs of functioning. This would indicate an obstruction close to the radiator section of the system. AFC estimates that the overall refrigerant remaining in the system is approximately 25% of the original charge volume.

5.0 Recommendations

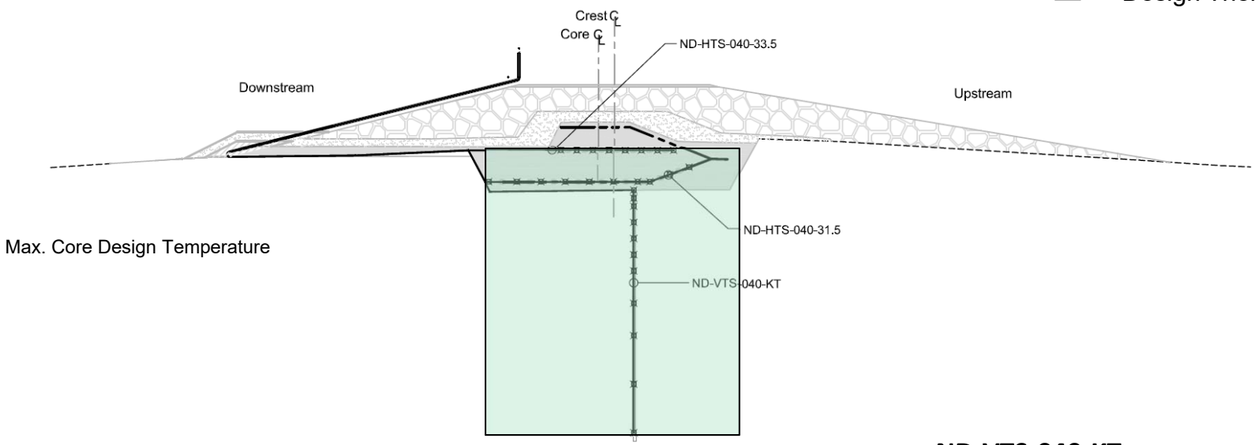
AFC recommends further monitoring of the subgrade temperatures to ensure the key-trench temperatures remain within the original design parameters. While original design parameters allowed for redundancy within the system, it is suggested that thermal modeling of the North side of the dam be completed using the five fully functional thermosyphons to ensure continued adequate sub-grade temperatures throughout the life of the project.

Appendix B – Ground Temperature Cables

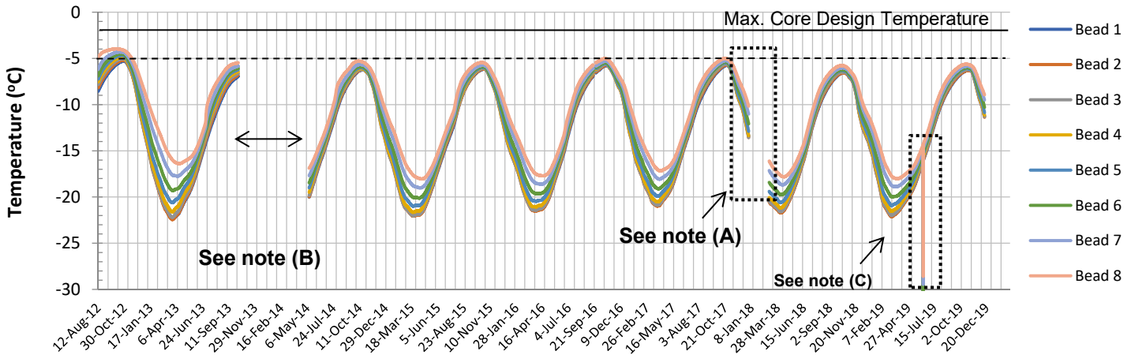


Legend:

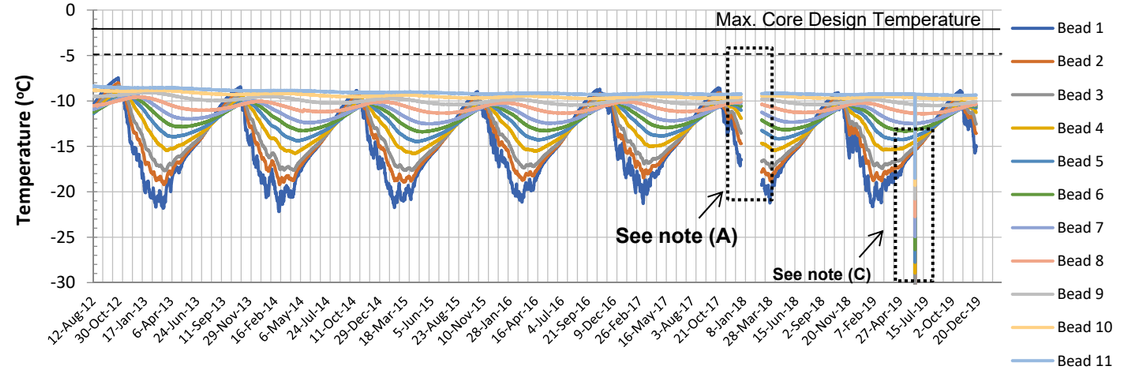
- GTC Status: Cable irreparably damaged
- GTC Status: Bead damaged or data missing
- Design Thermal Block



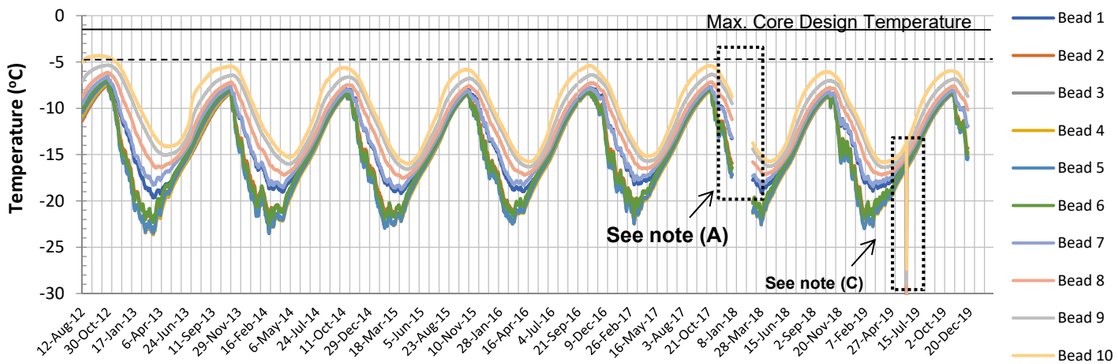
ND-HTS-040-33.5



ND-VTS-040-KT



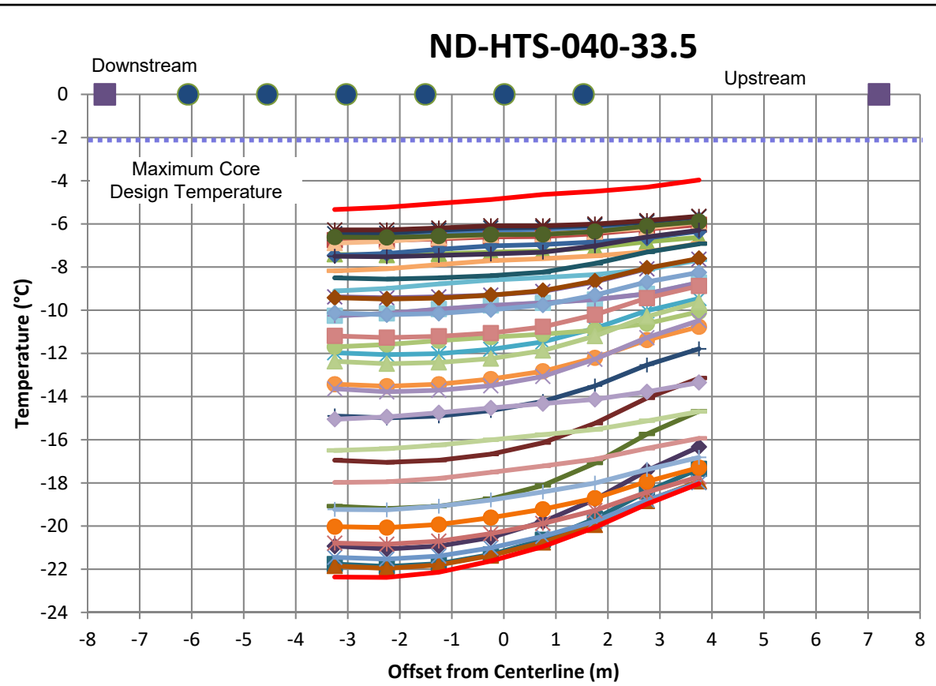
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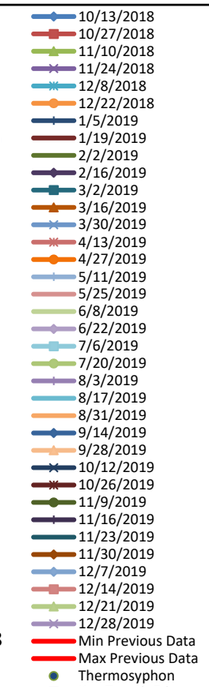


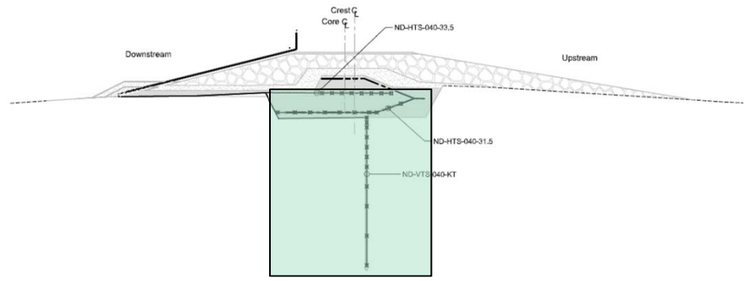
Notes:

- Bead numbers increase from downstream to upstream (horizontal) and top to bottom (vertical)
- **(A)** Data logger was disconnected from January 1, 2018 to March 3, 2018 for recalibration
- **(B)** GTC was disconnected from datalogger
- **(C)** A low temperature spike for all beads was observed for a single reading on June 12, 2019 and is attributed to an instrumentation error.

srk consulting	MAC RESOURCES	2019 AGI - North Dam
		Station 0+40 Ground Temperature Cable Temperature Vs. Time
Job No: 1CT022.038 Filename: AppB_1CT022.038_ND_GTC	**DORIS TIA**	Date: Feb. 2020 / Approved: AB / Figure: **B.1**

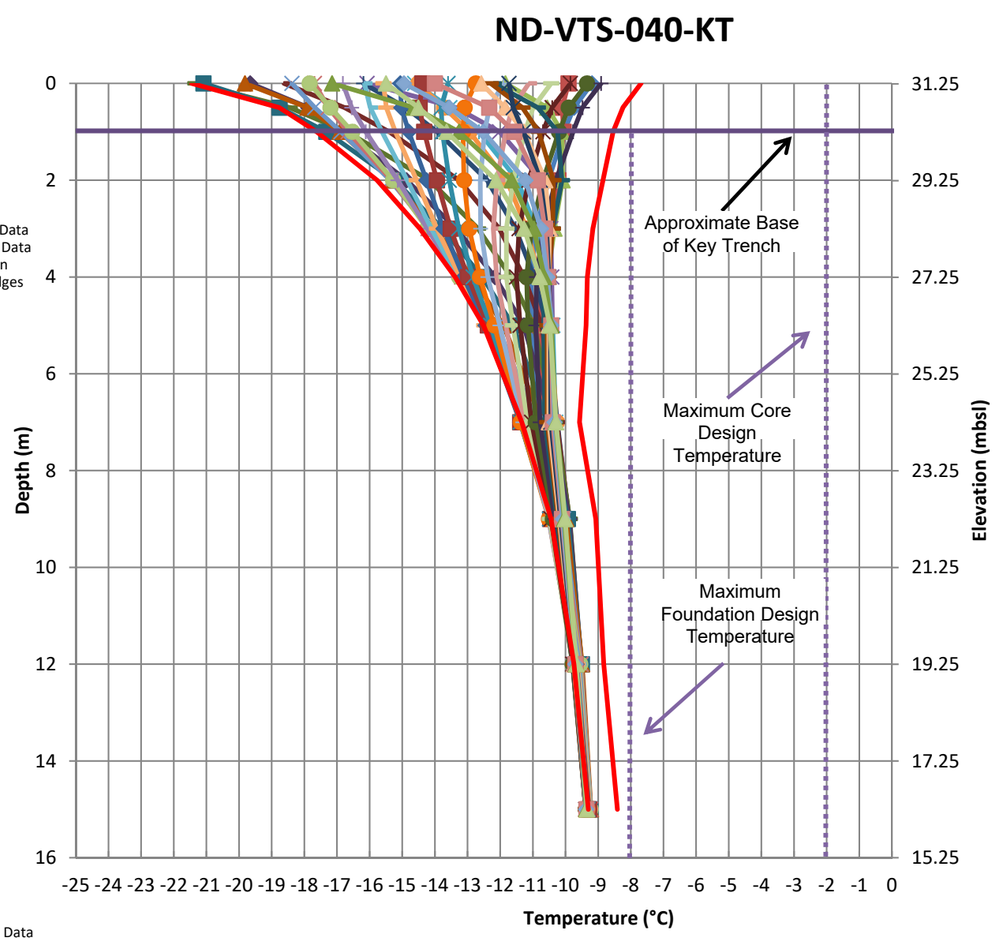


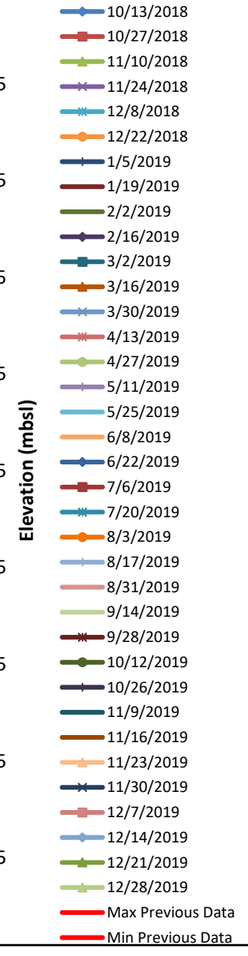


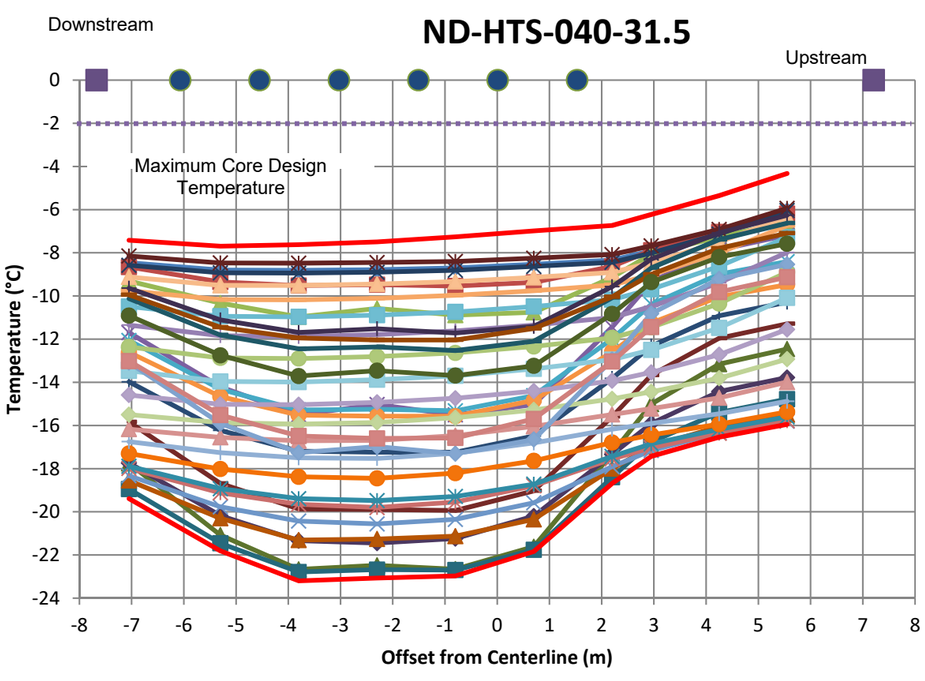


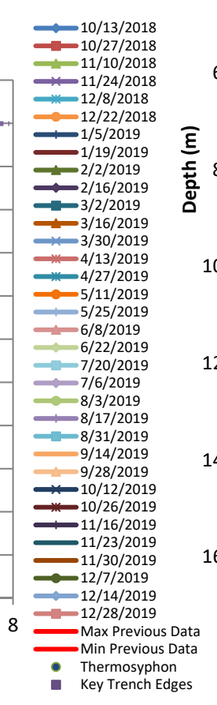
Legend:

- GTC Status: Cable irreparably damaged
- GTC Status: Bead damaged or data missing
- Design Thermal Block





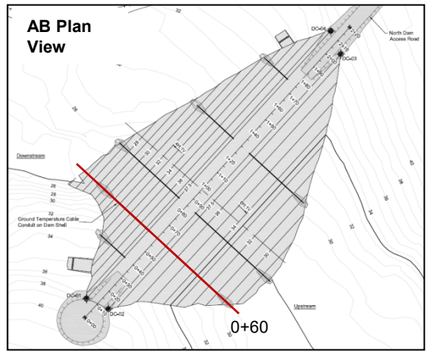


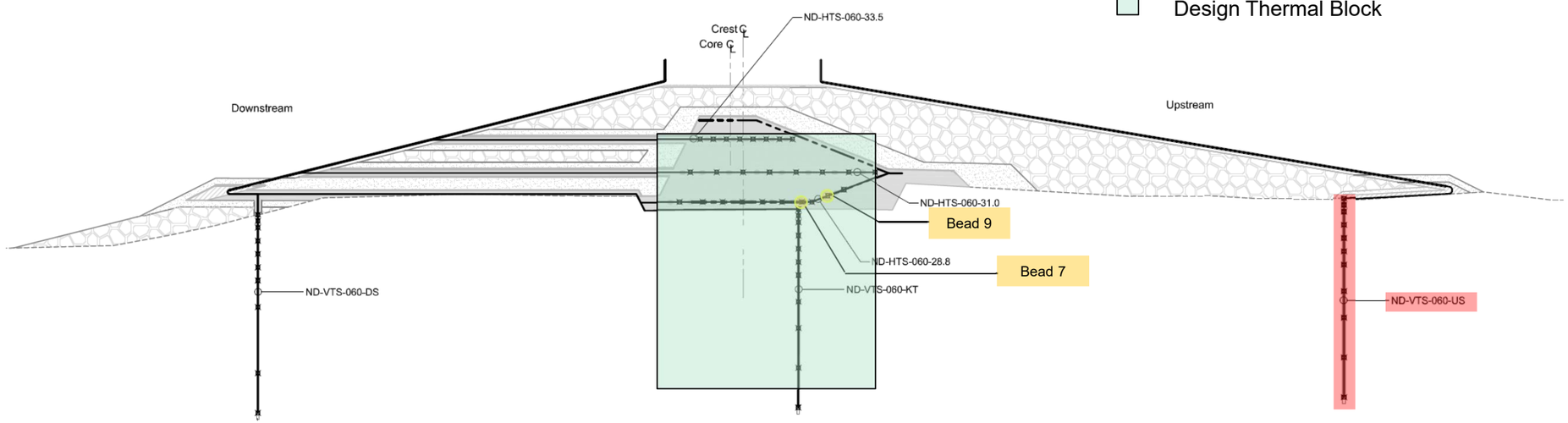


Note:

- Previous Data was recorded between August 2012 and September 2018

srk consulting	MAC RESOURCES	2019 AGI - North Dam
		Station 0+40 Ground Temperature Cable Readings by Location
Job No: 1CT022.038 Filename: AppB_1CT057.038_ND_GTC	**DORIS TIA**	Date: Feb. 2020 / Approved: PL / Figure: **B.2**

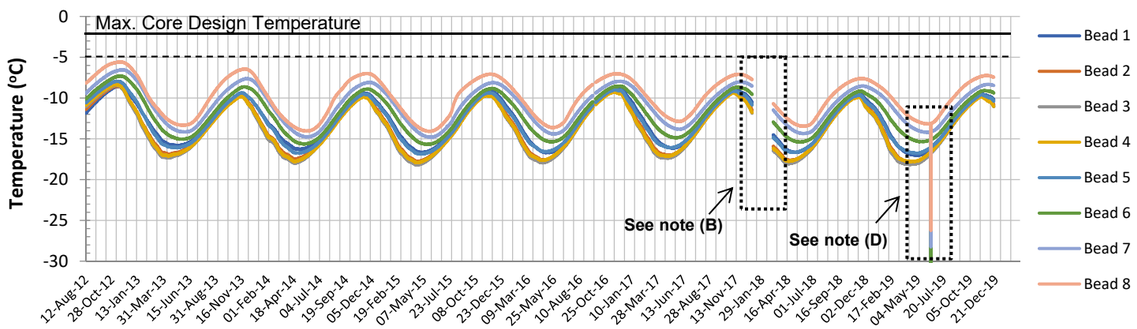




ND-HTS-060-33.5

ND-HTS-060-28.8

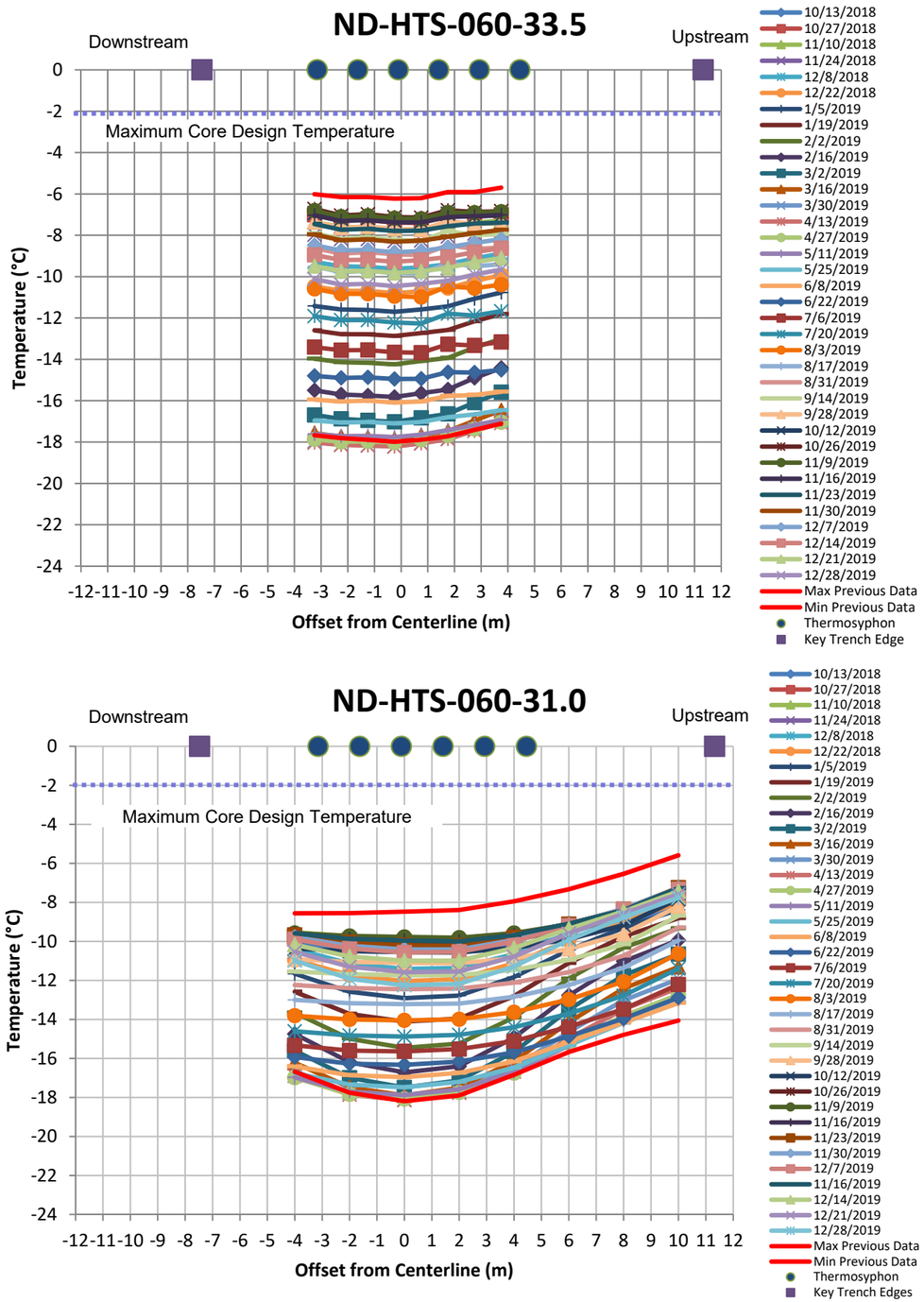
ND-HTS-060-31.0

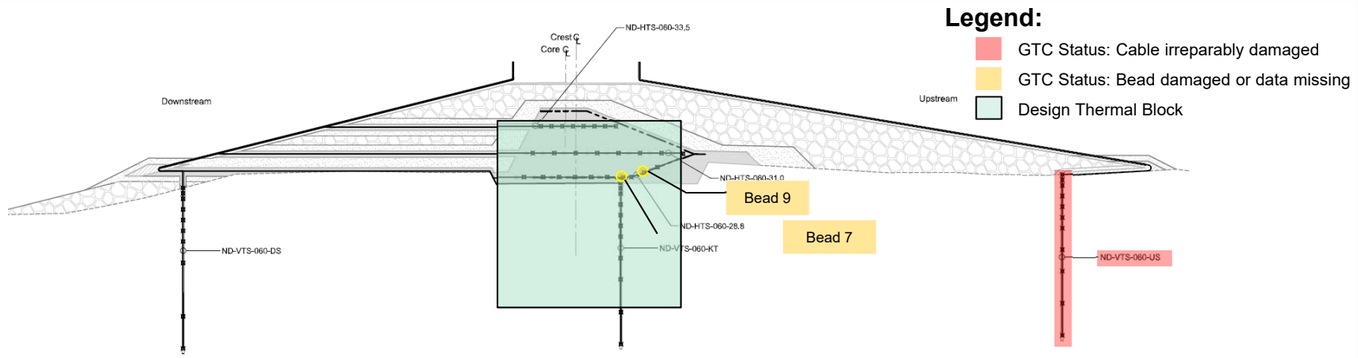


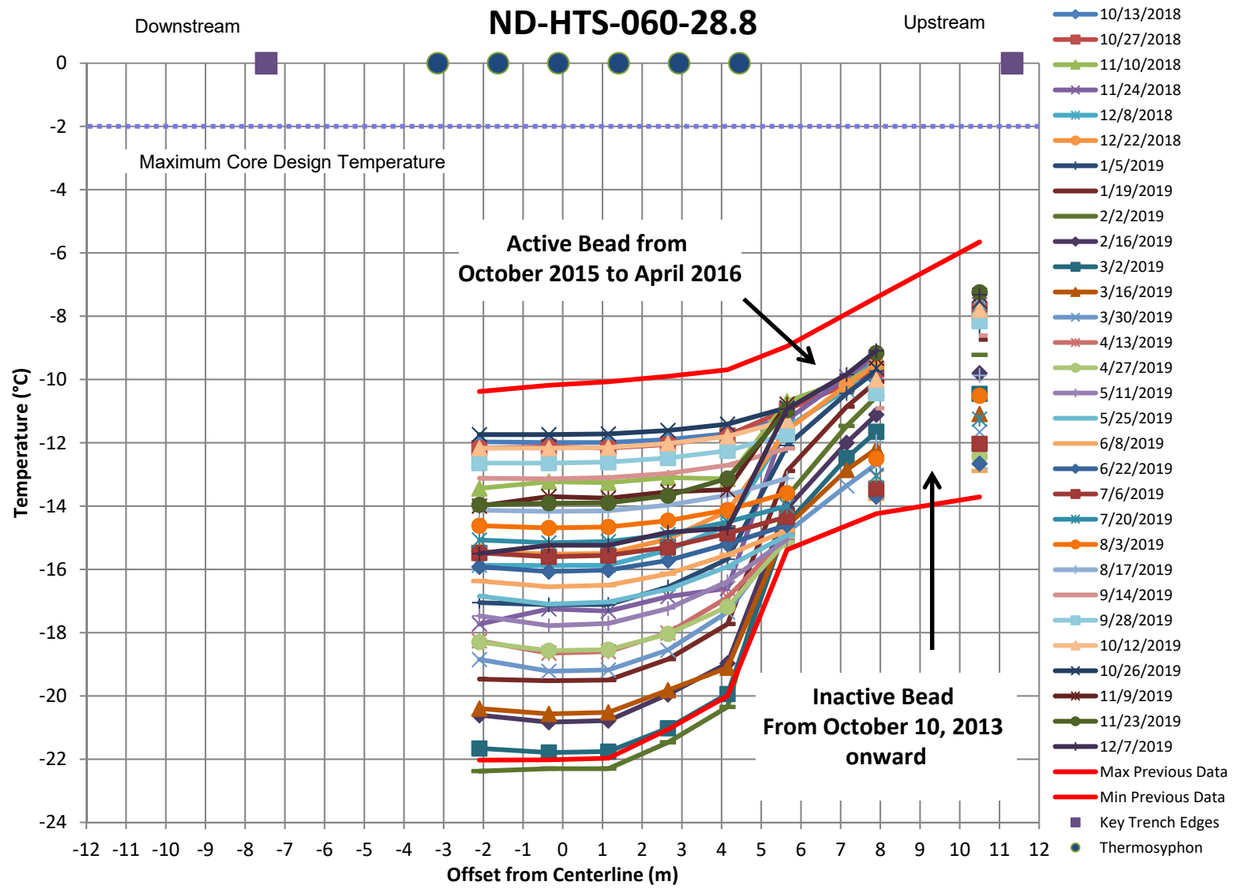
Notes:

- Bead numbers increase from downstream to upstream (horizontal) and top to bottom (vertical)
- **(A)** Variation in Ground Temperature Cable readings during winter months due to close proximity of Ground Temperature Cable beads to thermosyphon pipes.
- **(B)** Data logger was disconnected from January 1, 2018 to March 3, 2018 for recalibration
- **(C)** No readings from Bead 7
- **(D)** A low temperature spike for all beads was observed for a single reading on June 12, 2019 and is attributed to an instrumentation error.

srk consulting	TMAC RESOURCES	2019 AGI - North Dam
Job No: 1CT022.038 Filename: AppB_1CT022.038_ND_GTC	DORIS TIA	**Station 0+60** **Horizontal Ground Temperature Cable Temperature Vs. Time**
		Date: Feb. 2020 / Approved: AB / Figure: **B.3**



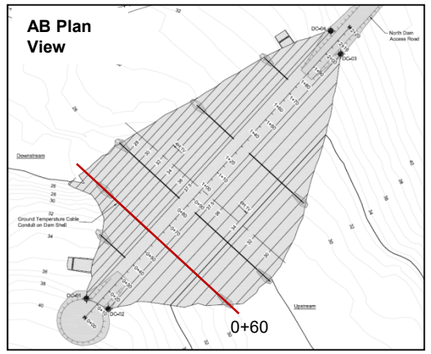


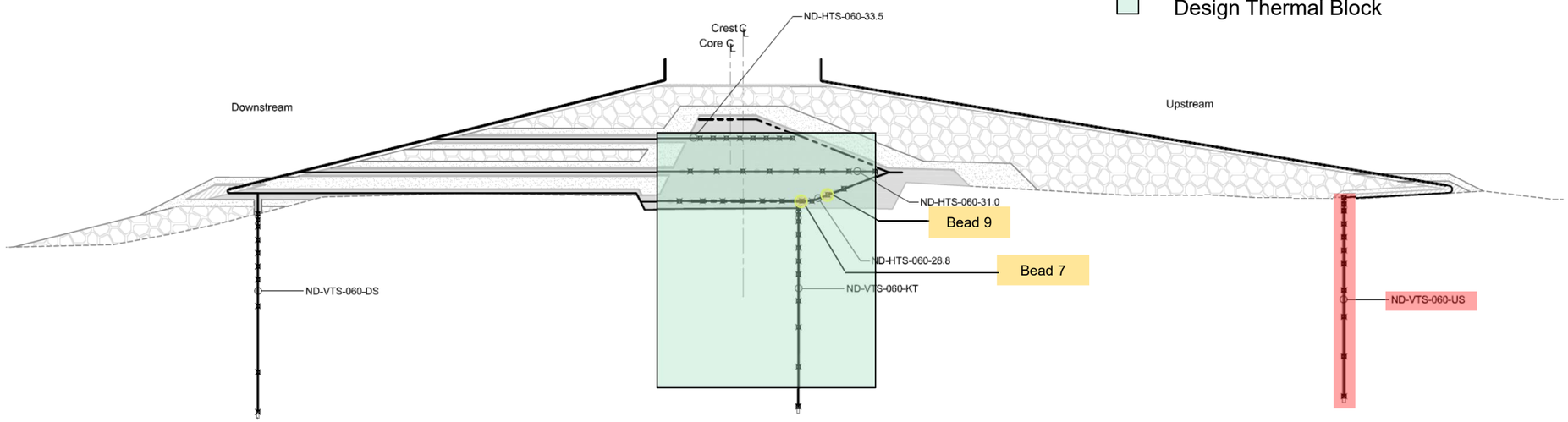


Note:

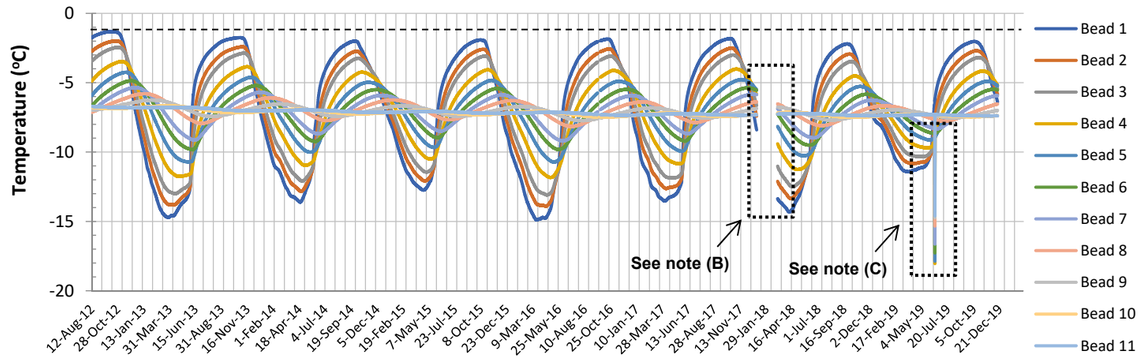
- Previous Data was recorded between August 2012 and September 2018

srk consulting	MAC RESOURCES	2019 AGI - North Dam
		Station 0+60 Horizontal Ground Temperature Cable Readings by Location
Job No: 1CT022.038 Filename: AppB_1CT057.038_ND_GTC	**DORIS TIA**	Date: Feb. 2020 · Approved: PL · Figure: **B.4**

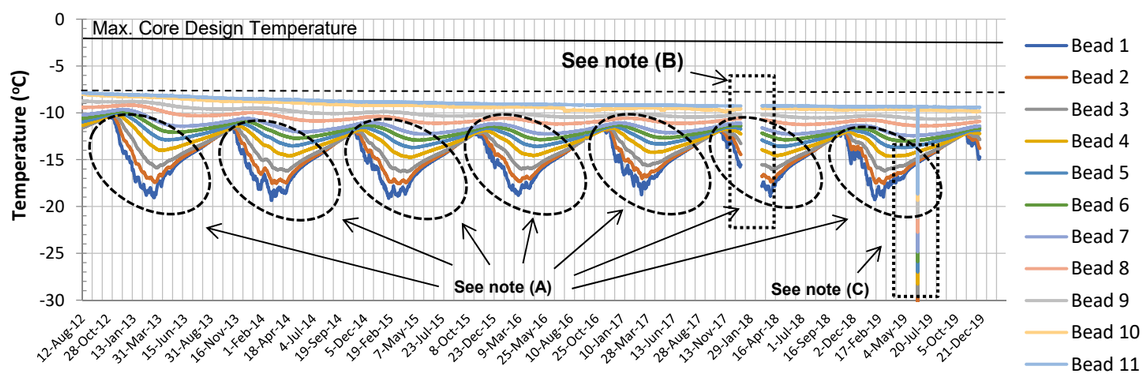




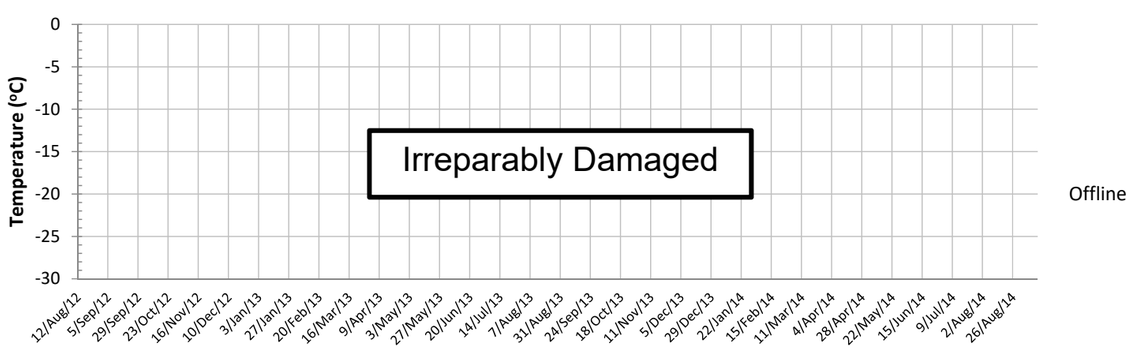
ND-VTS-060-DS



ND-VTS-060-KT



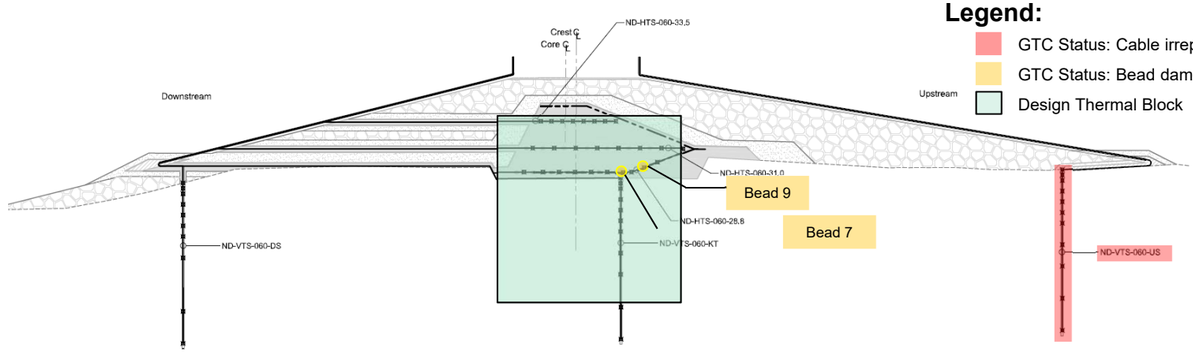
ND-VTS-060-US

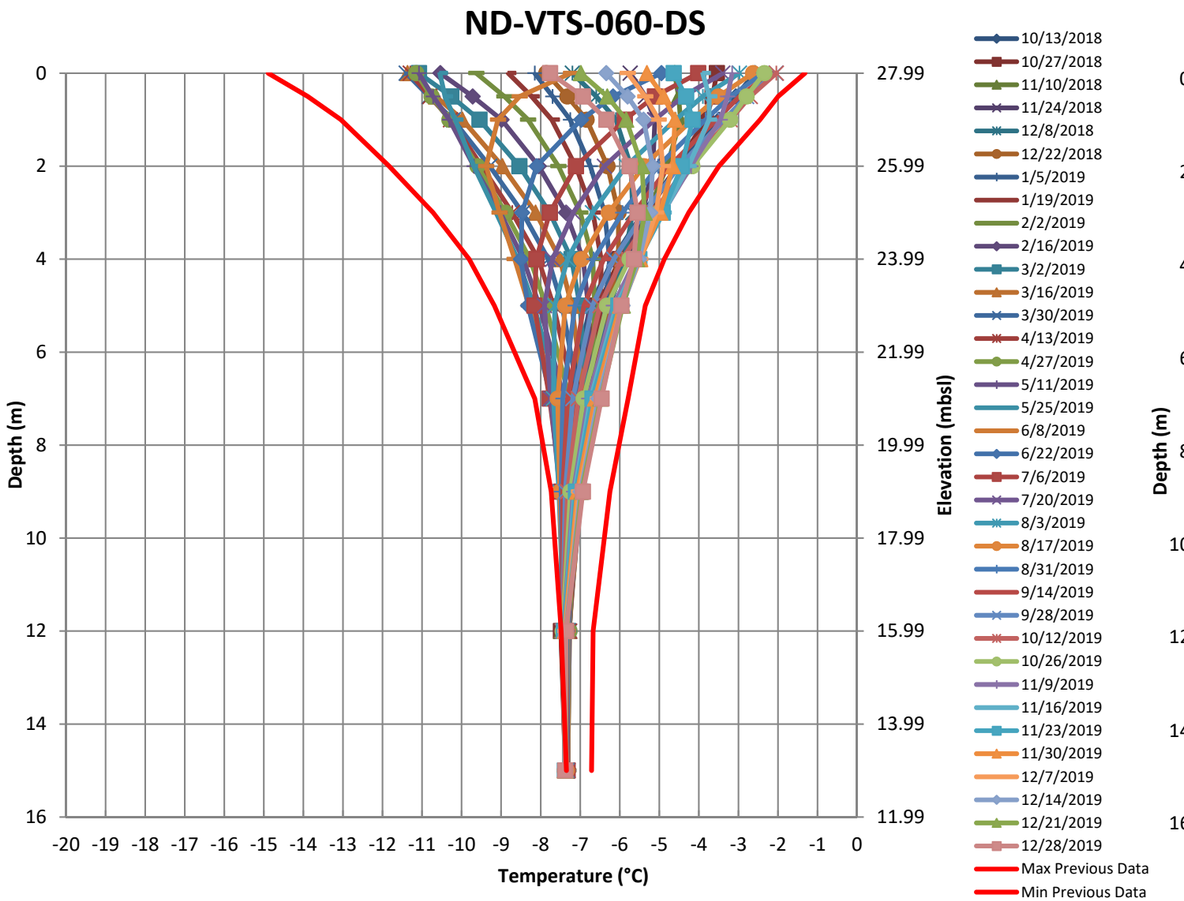


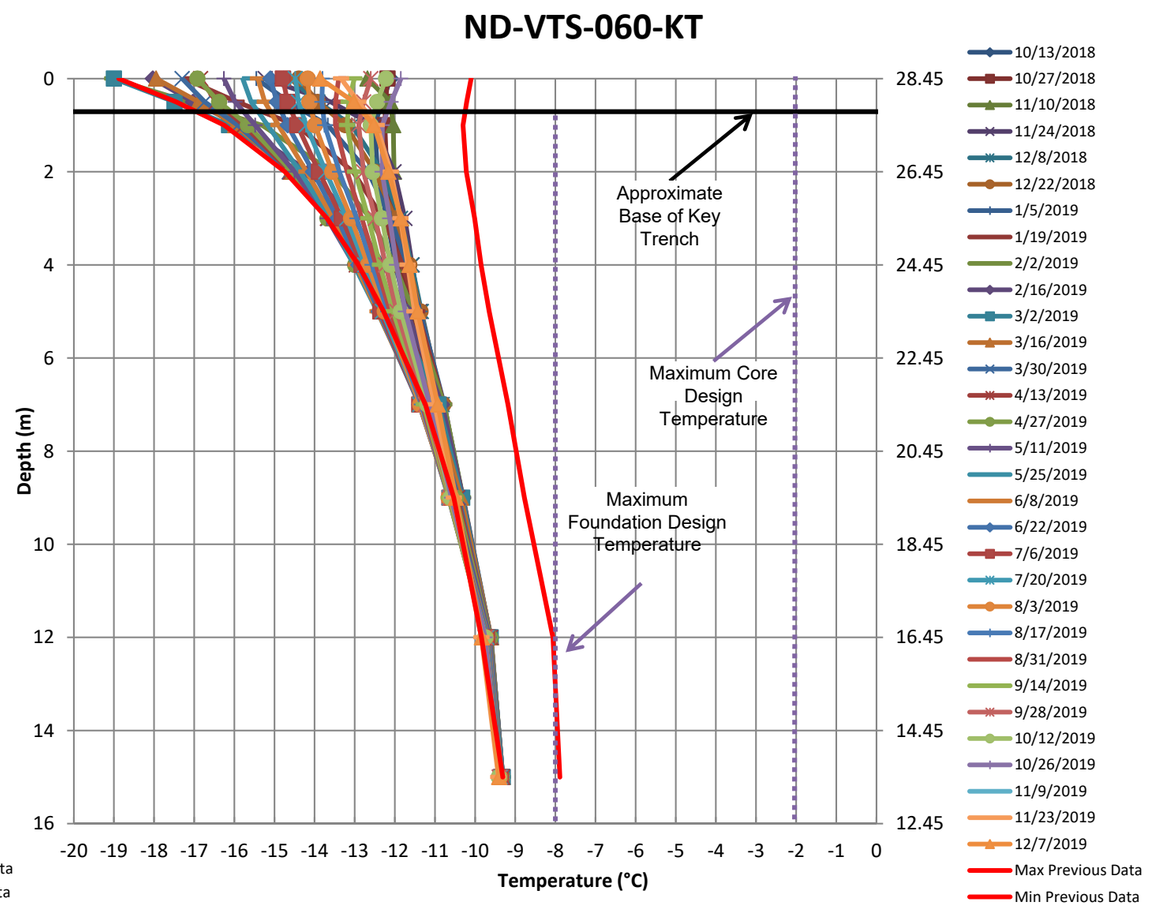
Notes:

- Bead numbers increase from downstream to upstream (horizontal) and top to bottom (vertical)
- **(A)** Variation in Ground Temperature Cable readings during winter months due to close proximity of Ground Temperature Cable beads to thermosyphon pipes.
- **(B)** Data logger was disconnected from January 1, 2018 to March 3, 2018 for recalibration
- **(C)** A low temperature spike for all beads was observed for a single reading on June 12, 2019 and is attributed to an instrumentation error

srk consulting	MAC RESOURCES	2019 AGI - North Dam
Job No: 1CT022.038 Filename: AppB_1CT022.038_ND_GTC	DORIS TIA	**Station 0+60** **Vertical Ground Temperature Cable Temperature Vs. Time**
		Date: Feb. 2020 / Approved: AB / Figure: **B.5**



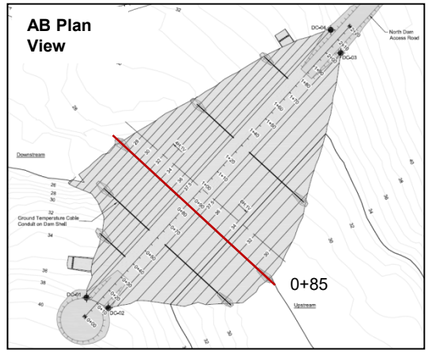


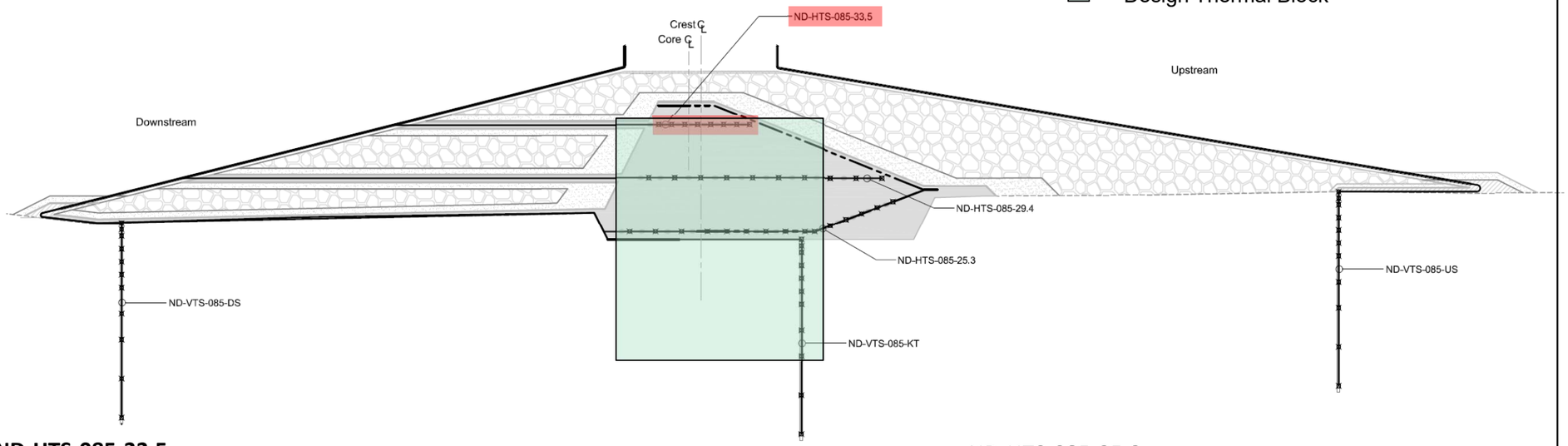


Note:

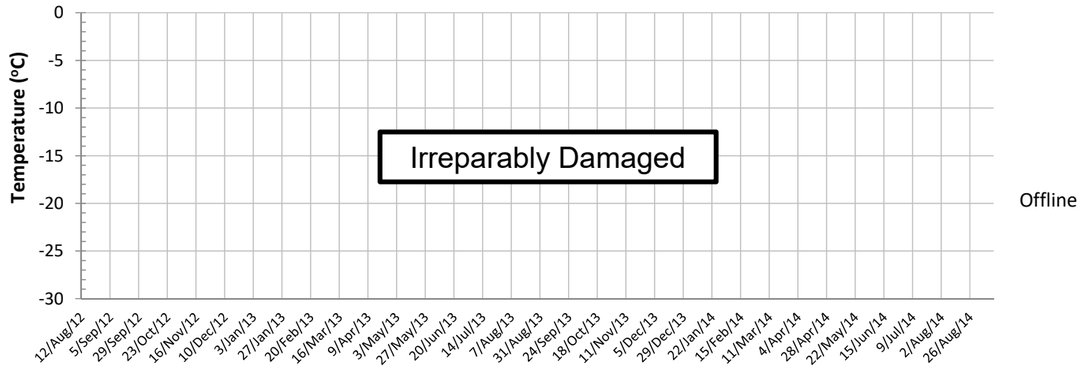
- Previous Data was recorded between August 2012 and September 2018

srk consulting	TMAC RESOURCES	2019 AGI - North Dam
		Station 0+60 Vertical Ground Temperature Cable Readings by Location
Job No: 1CT022.038 Filename: AppB_1CT057.038_ND_GTC	**DORIS TIA**	Date: Feb. 2020 / Approved: PL / Figure: **B.6**

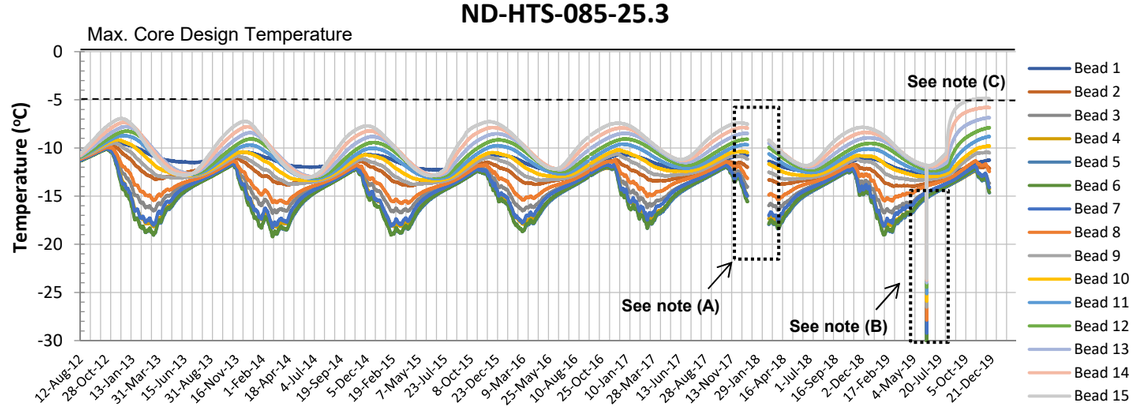




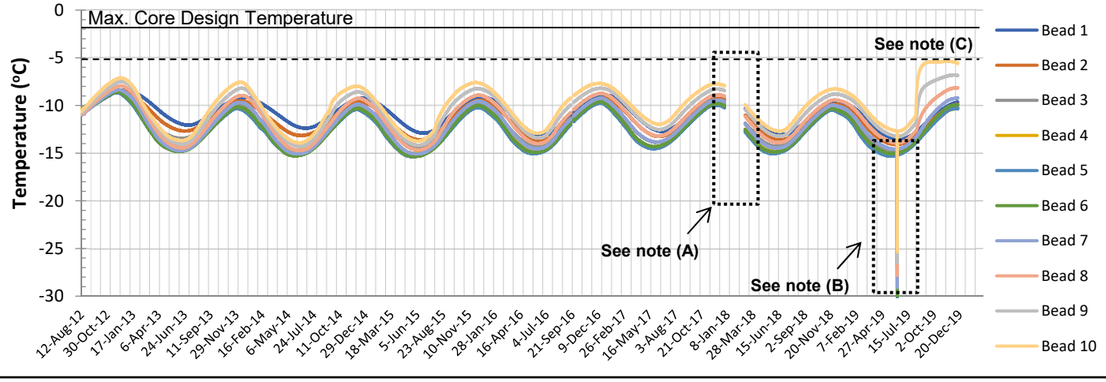
ND-HTS-085-33.5



ND-HTS-085-25.3



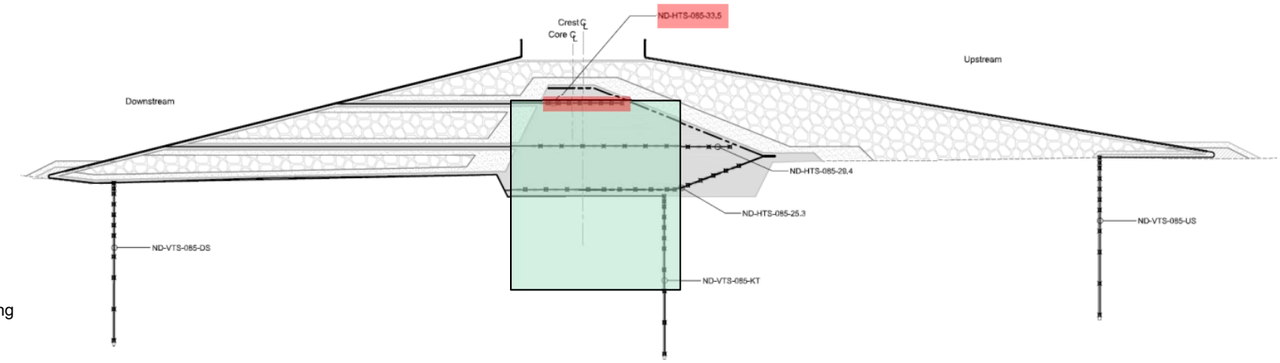
ND-HTS-085-29.4



Notes:

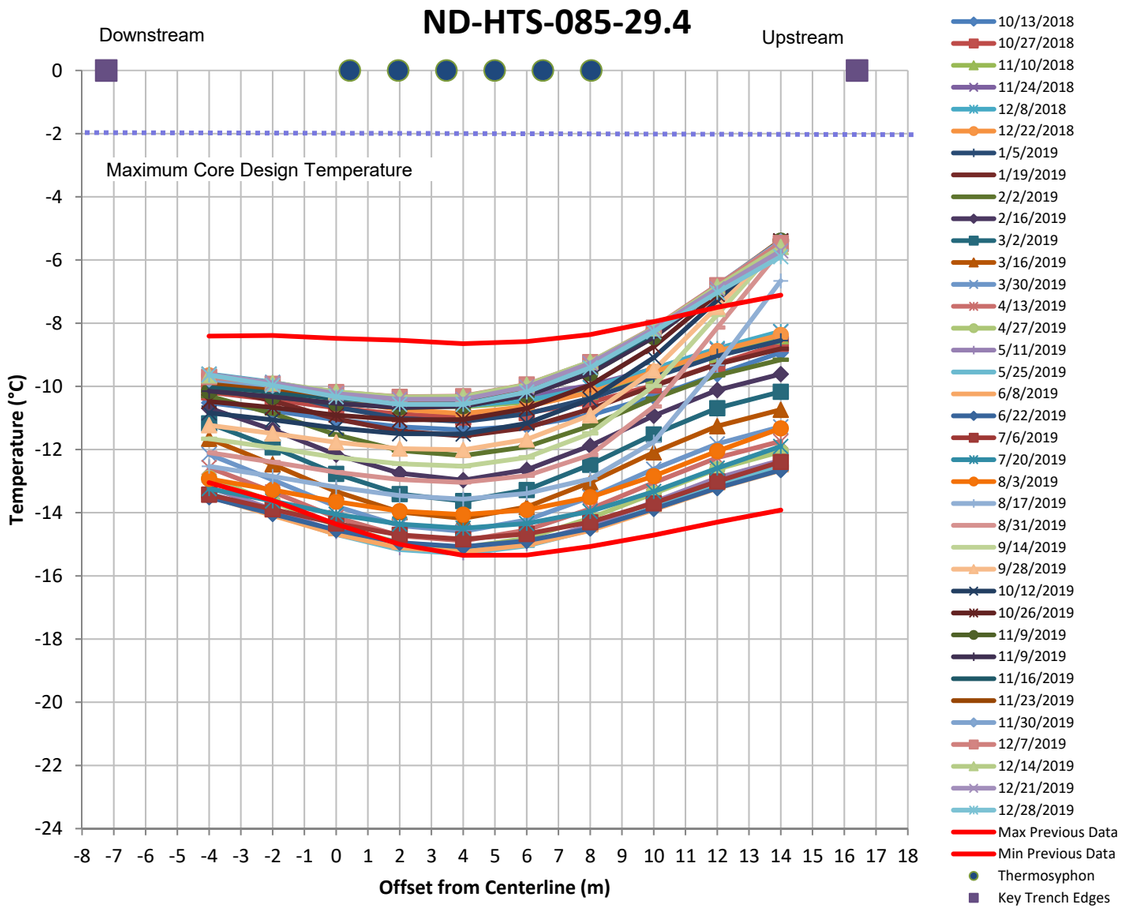
- Bead numbers increase from downstream to upstream (horizontal) and top to bottom (vertical)
- **(A)** Data logger was disconnected from January 1, 2018 to March 3, 2018 for recalibration
- **(B)** A low temperature spike for all beads was observed for a single reading on June 12, 2019 and is attributed to an instrumentation error
- **(C)** Temperature rise is expected to be a result of the rise in the reclaim pond water level.

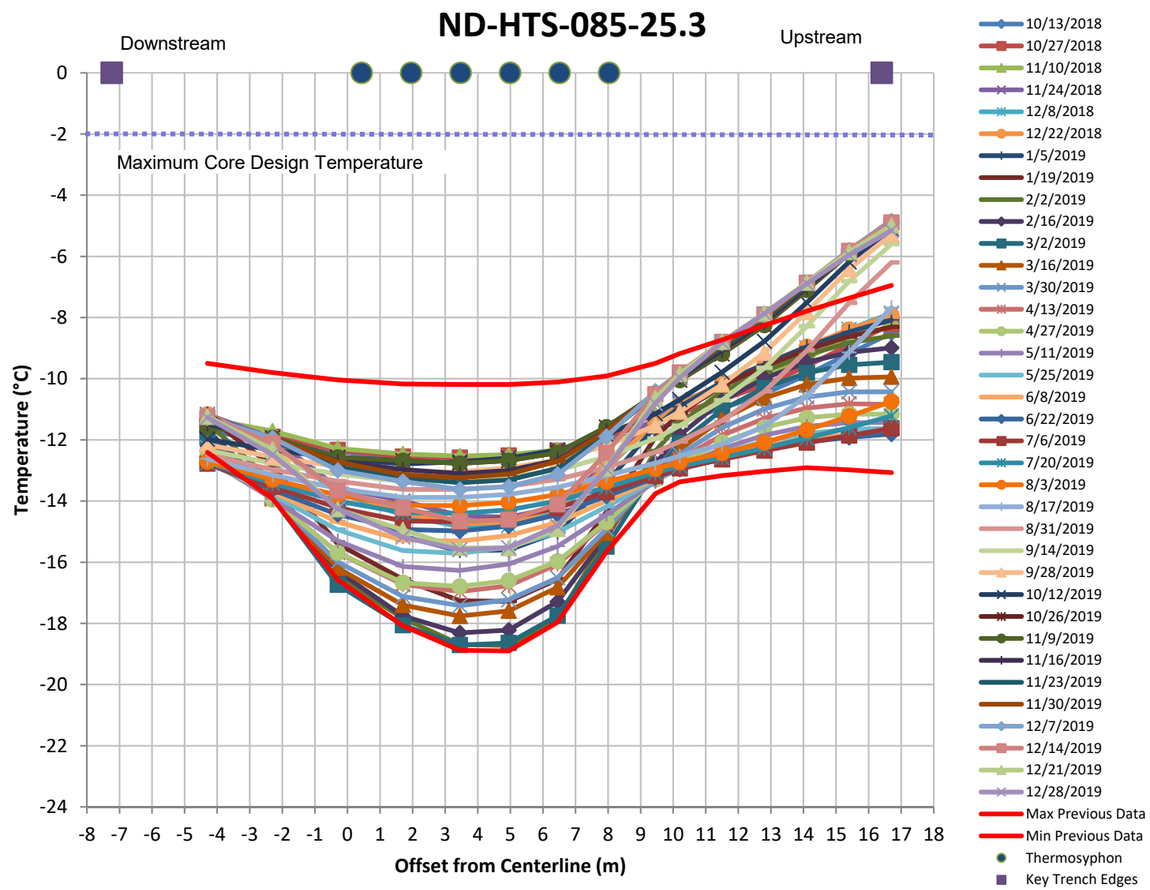
srk consulting	MAC RESOURCES	2019 AGI - North Dam
Job No: 1CT022.038 Filename: AppB_1CT022.038_ND_GTC	DORIS TIA	**Station 0+85** **Horizontal Ground Temperature Cable Temperature Vs. Time**
		Date: Feb. 2020 / Approved: AB / Figure: **B.7**



Legend:

- GTC Status: Cable irreparably damaged
- GTC Status: Bead damaged or data missing
- Design Thermal Block

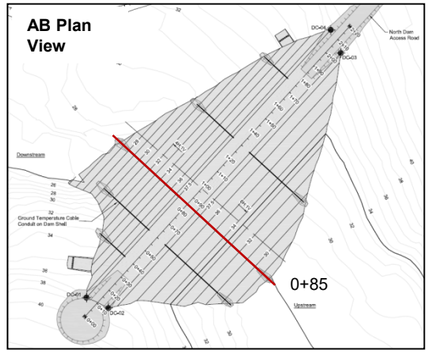


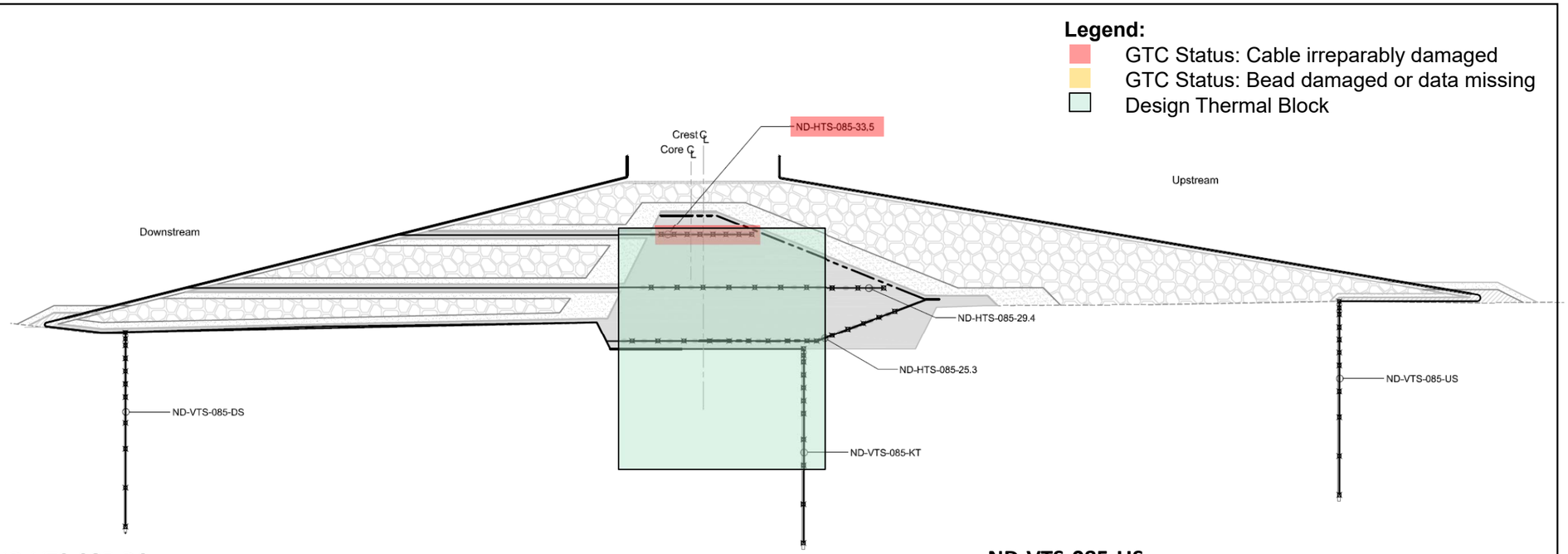


Note:

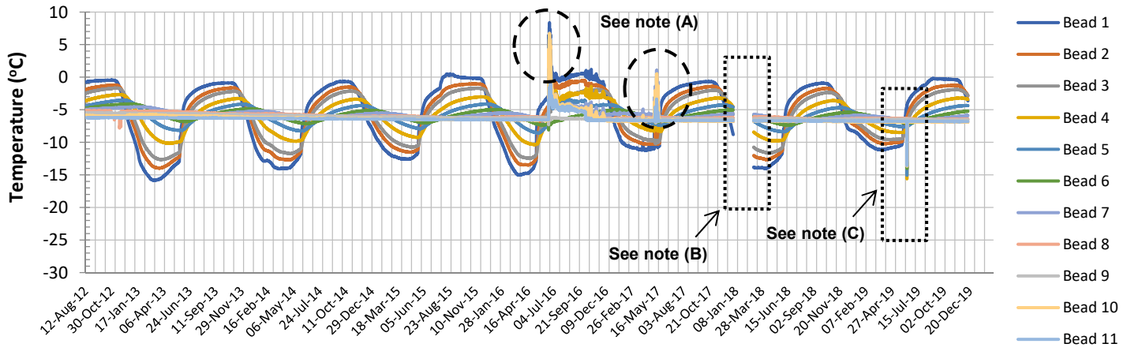
- Previous Data was recorded between August 2012 and September 2018

srk consulting	MAC RESOURCES	2019 AGI - North Dam
		Station 0+85 Horizontal Ground Temperature Cable Readings by Location
Job No: 1CT022.038 Filename: AppB_1CT057.038_ND_GTC	**DORIS TIA**	Date: Feb. 2020 / Approved: PL / Figure: **B.8**



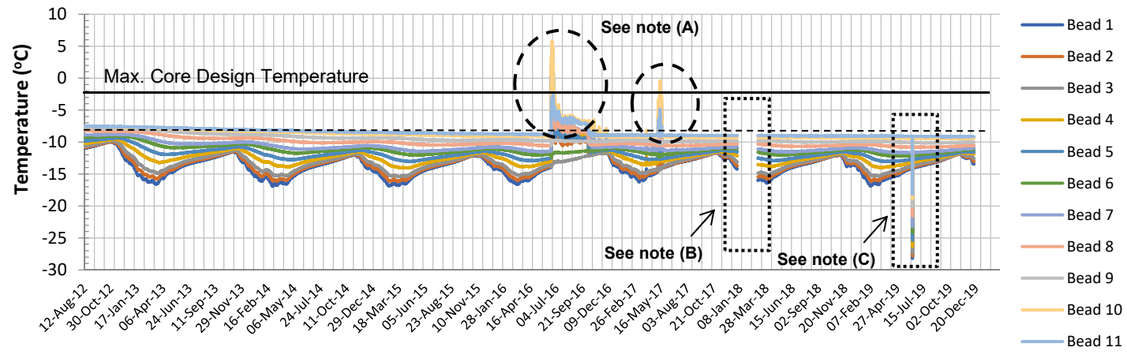


ND-VTS-085-DS



ND-VTS-085-US

ND-VTS-085-KT

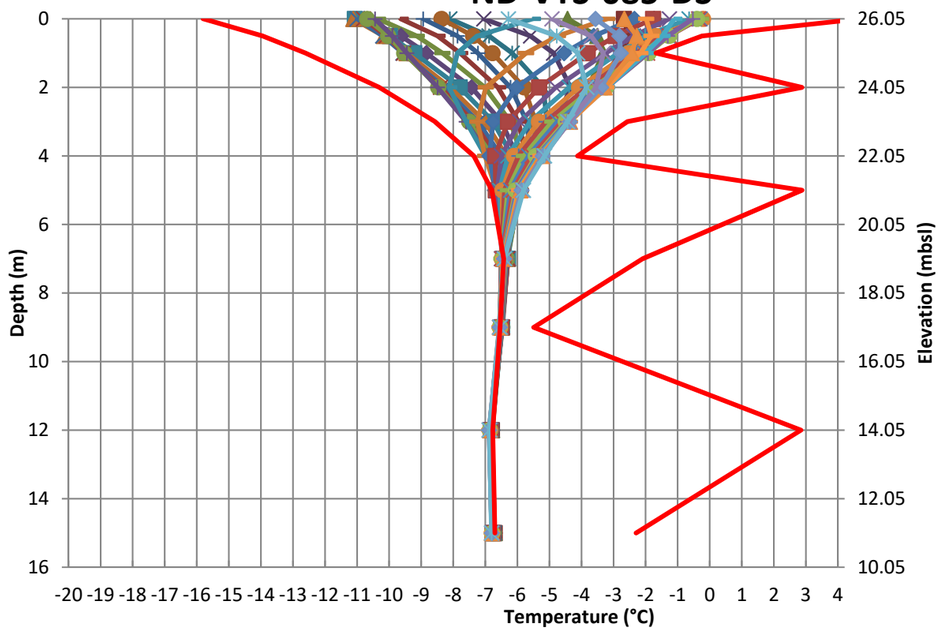


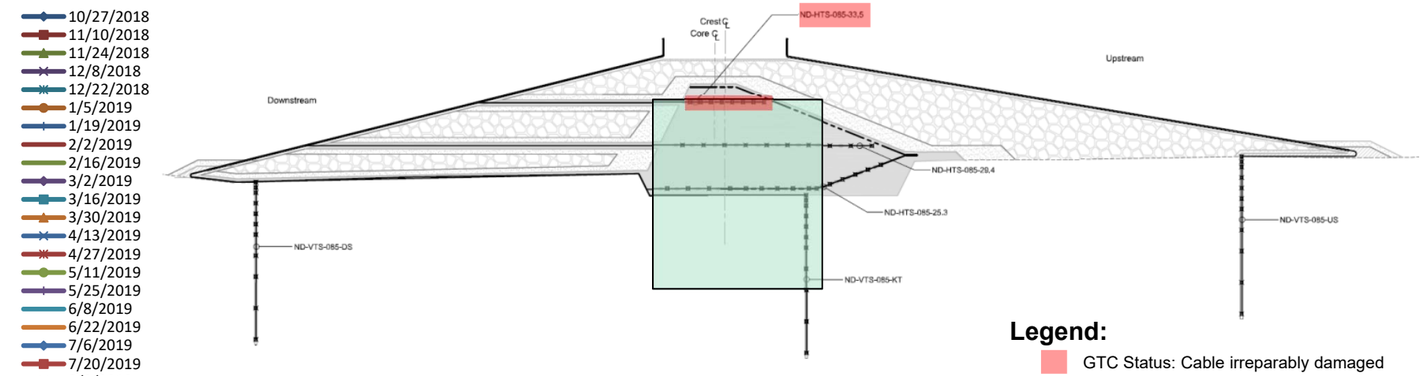
Notes:

- Bead numbers increase from downstream to upstream (horizontal) and top to bottom (vertical)
- **(A)** Temperature in Bead 1, 2, 4, 5, 7, 8, 10, 11 spiked in the Spring of 2016 and 2017. Erratic readings in some elevations suggest a data logger issue. During the current monitoring period, the readings at ND-VTS-085-DS and ND-VTS-085-KT returned to normal. Along a similar timeline, the temperatures of ND-VTS-085-KT has risen to between 0 and -7 degrees from Bead 1 to Bead 11. The temperature rise is expected to be a result of the rise in the reclaim pond water level.
- **(B)** Data logger was disconnected from January 1, 2018 to March 3, 2018 for recalibration.
- **(C)** A low temperature spike for all beads was observed for a single reading on June 12, 2019 and is attributed to an instrumentation error.

srk consulting	MAC RESOURCES	2019 AGI - North Dam
		Station 0+85 **Vertical Ground Temperature Cable Temperature Vs. Time**
Job No: 1CT022.038 Filename: AppB_1CT022.038_ND_GTC	**DORIS TIA**	Date: Feb. 2020 · Approved: AB · Figure: **B.9**

ND-VTS-085-DS

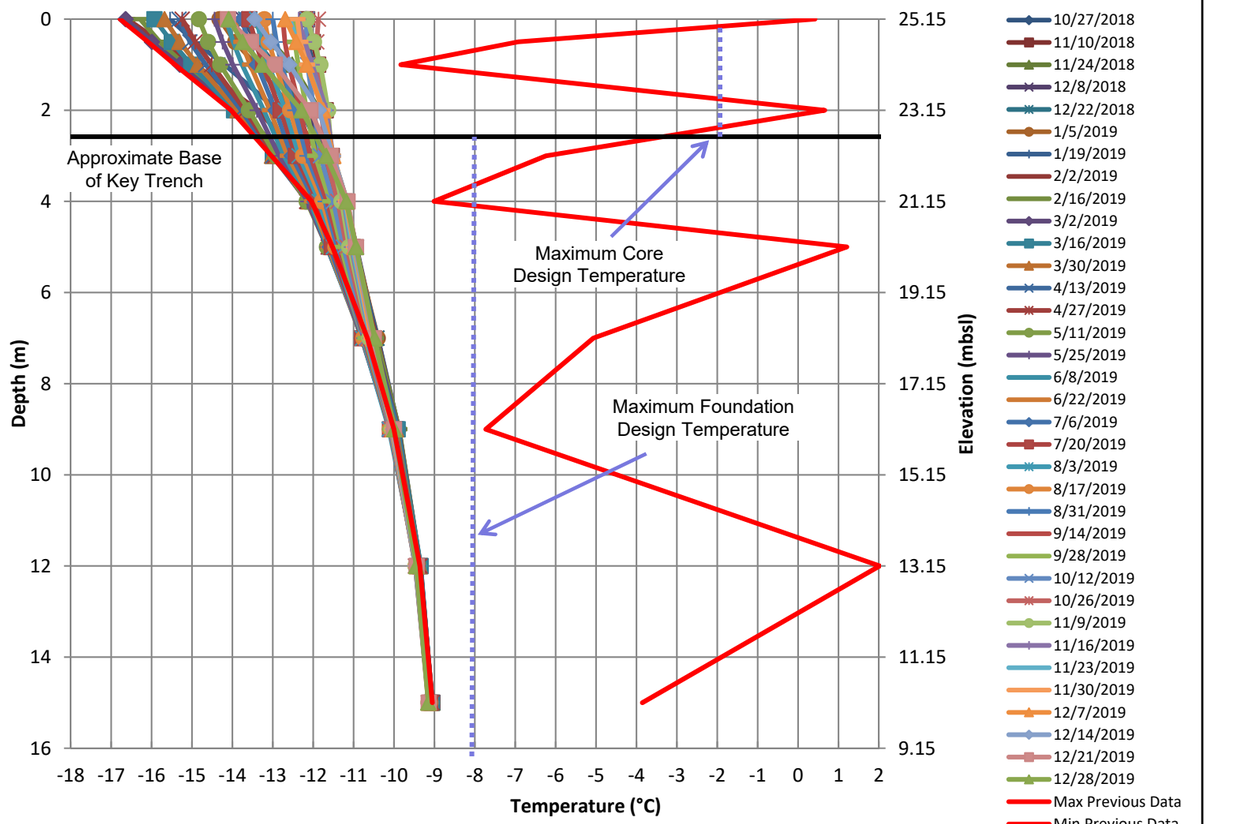




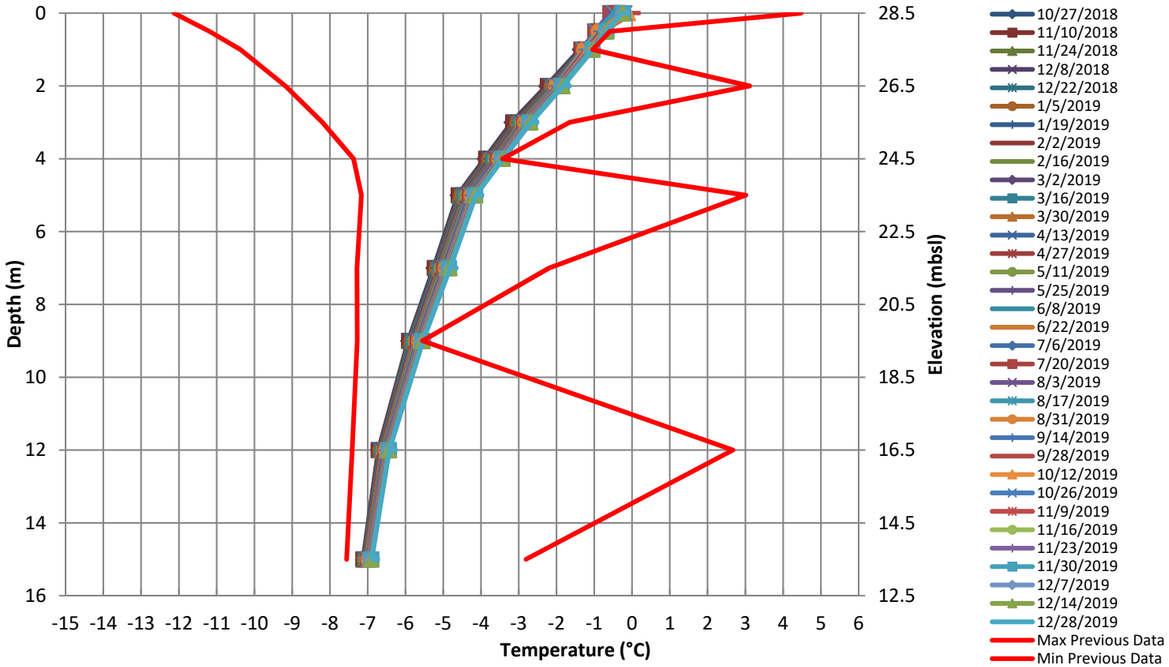
Legend:

- GTC Status: Cable irreparably damaged
- GTC Status: Bead damaged or data missing
- Design Thermal Block

ND-VTS-085-KT



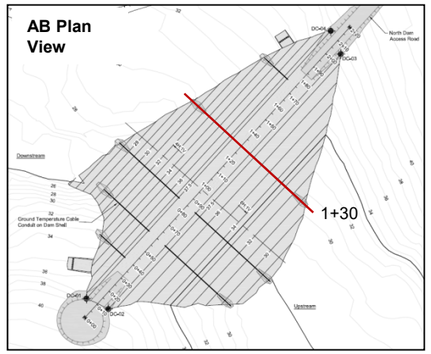
ND-VTS-085-US



Note:

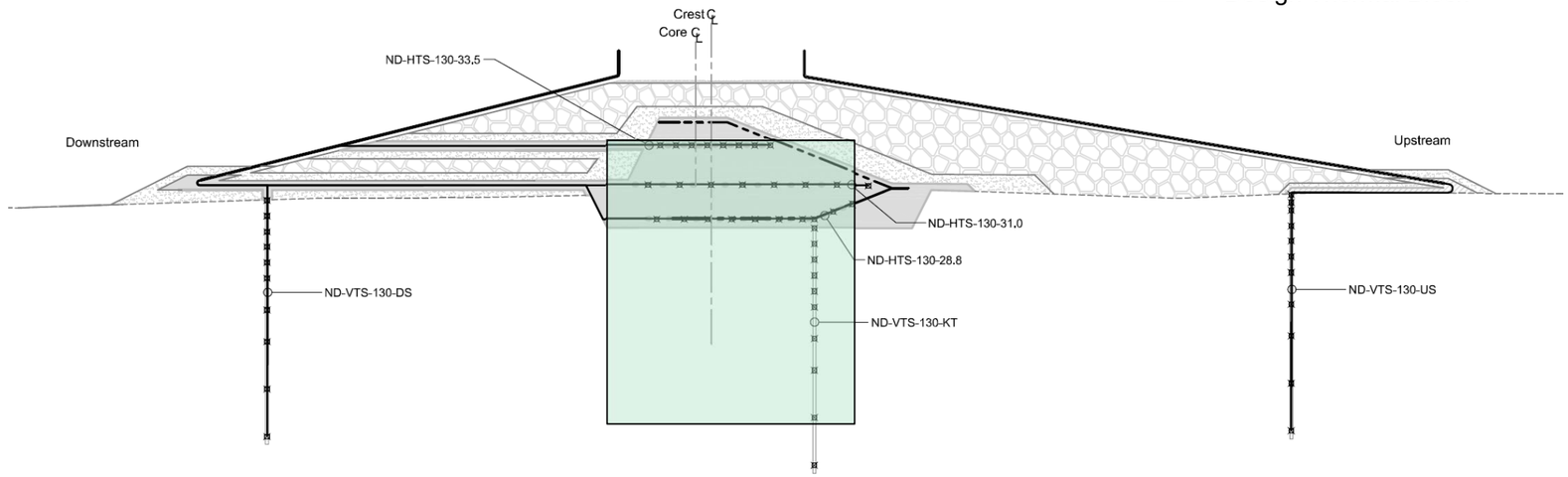
- Previous Data was recorded between August 2012 and September 2018

srk consulting	MAC RESOURCES	2019 AGI - North Dam
Job No: 1CT022.038 Filename: AppB_1CT057.038_ND_GTC	DORIS TIA	**Station 0+85** **Vertical Ground Temperature Cable Readings by Location**
		Date: Feb. 2020 / Approved: PL / Figure: **B.10**

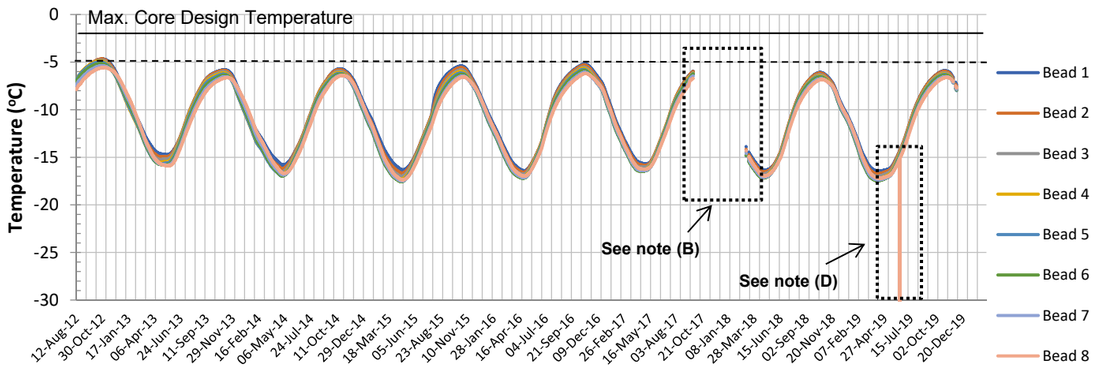


Legend:

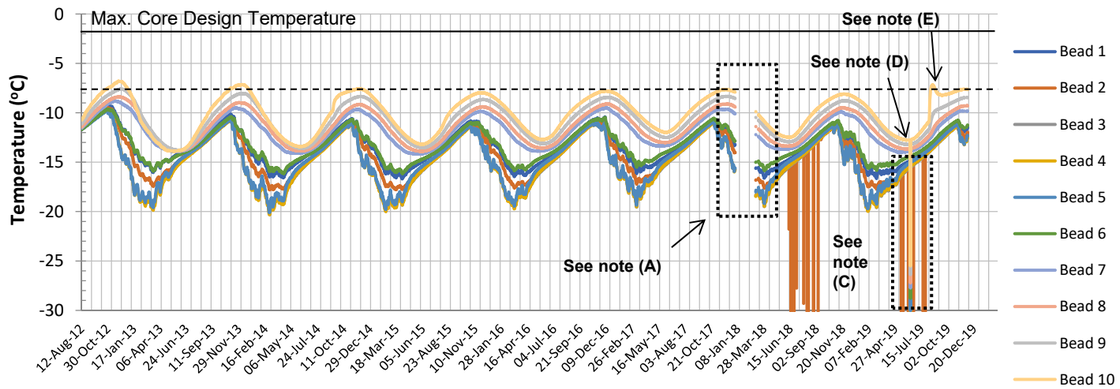
- GTC Status: Cable irreparably damaged
- GTC Status: Bead damaged or data missing
- Design Thermal Block



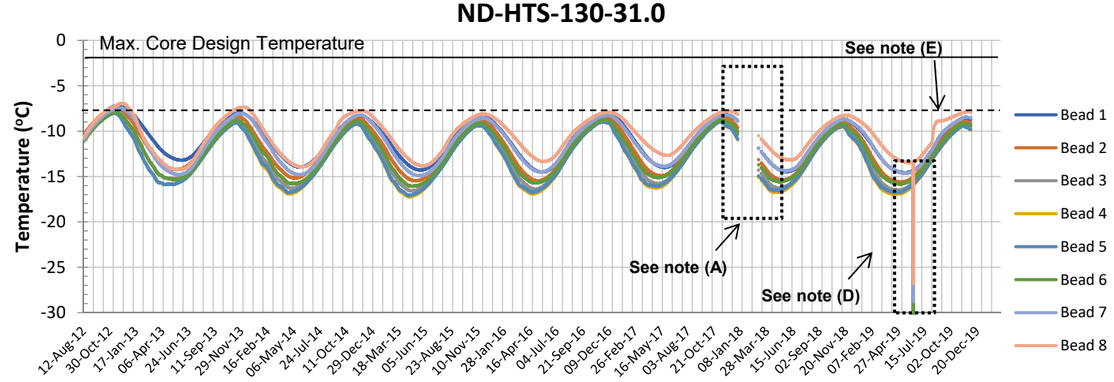
ND-HTS-130-33.5



ND-HTS-130-28.8



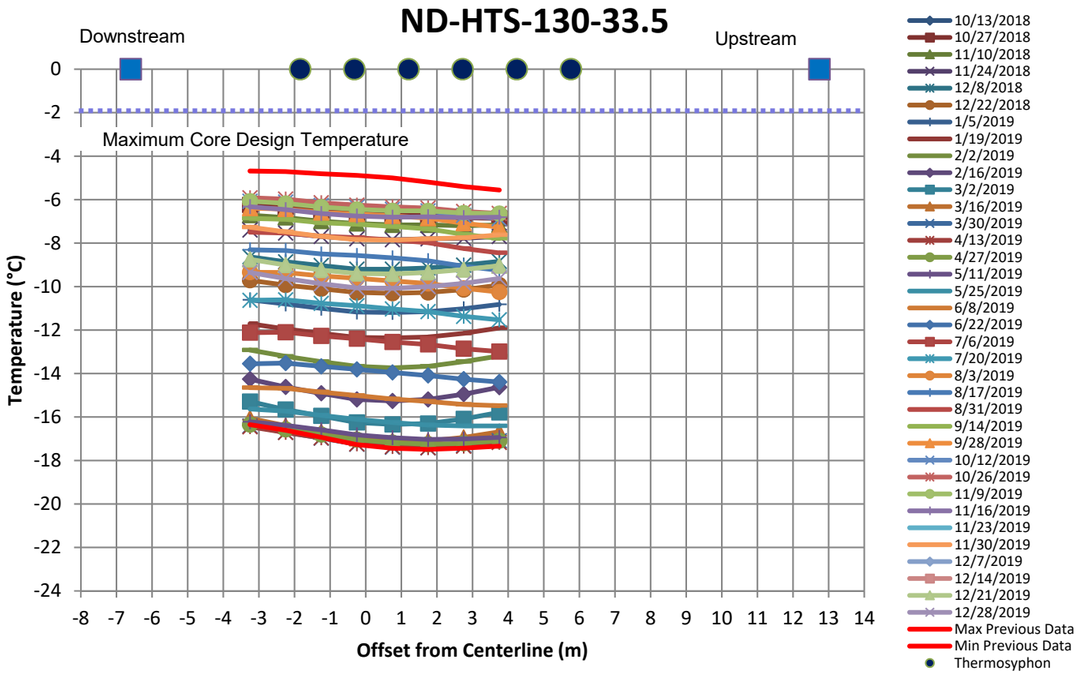
ND-HTS-130-31.0

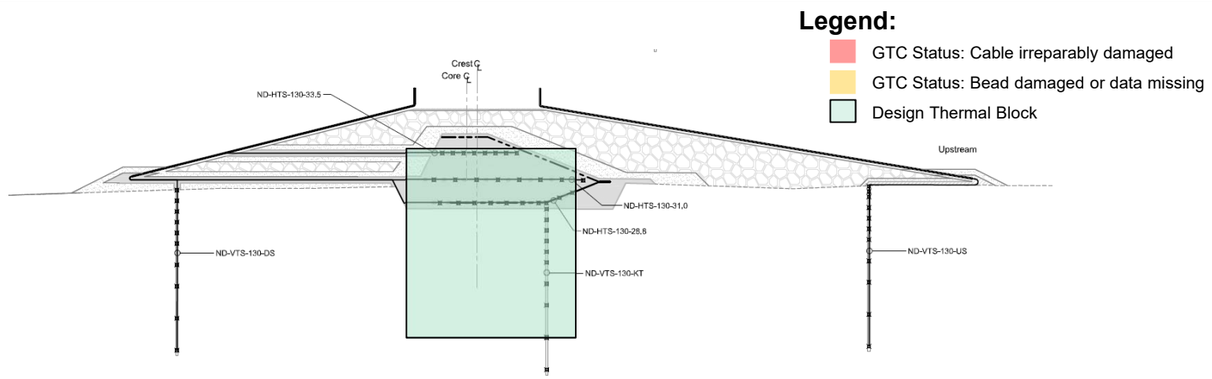


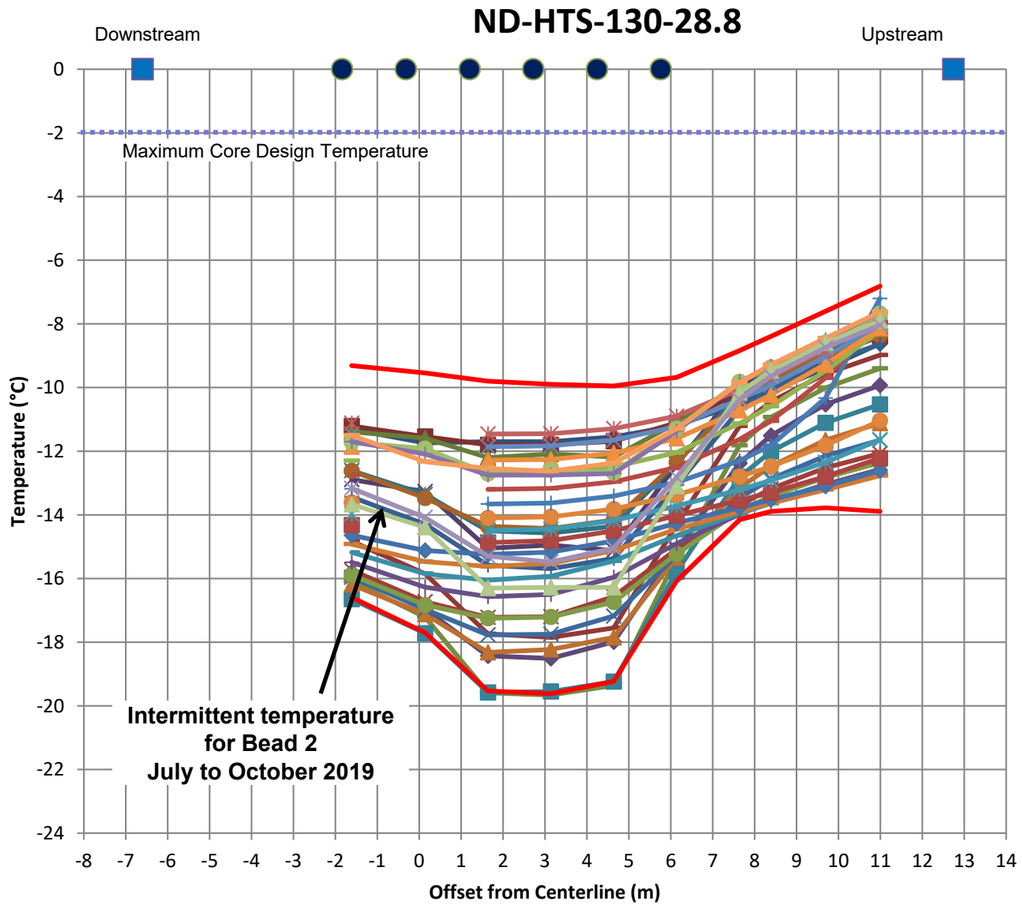
Notes:

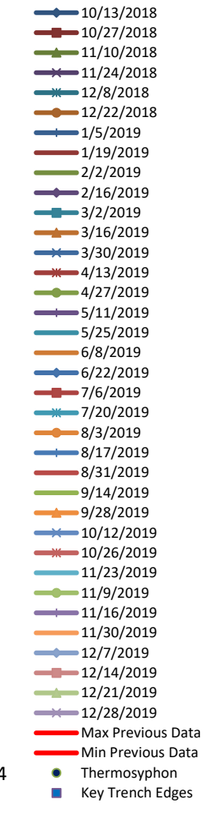
- Bead numbers increase from downstream to upstream (horizontal) and top to bottom (vertical)
- **(A)** Data logger was disconnected from January 1, 2018 to March 3, 2018 for recalibration
- **(B)** ND-HTS-130-33.5 was disconnected from September 24, 2018 to March 3, 2018 due to damage of the cable lead at the datalogger housing. The lead was repaired prior to the reconnection of the datalogger.
- **(C)** Low temperature spikes and intermittent data logging from Bead 2 of ND-HTS-130-28.8 were observed in the Summer of 2018 and 2019. Likely a data logger issue, these spikes will be monitored.
- **(D)** A low temperature spike for all beads was observed for a single reading on June 12, 2019 and is attributed to an instrumentation error.
- **(E)** Temperature increase at the upstream most bead, this is related to the rise in reclaim pond water levels

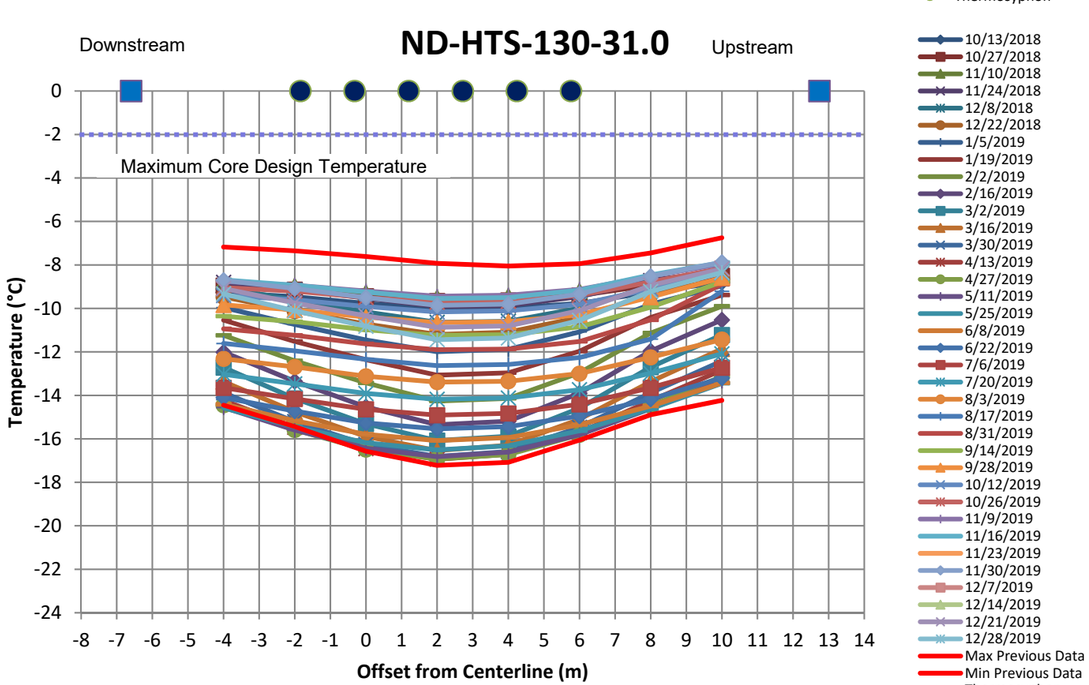
srk consulting	TMAC RESOURCES	2019 AGI - North Dam
Job No: 1CT022.038 Filename: AppB_1CT022.038_ND_GTC	DORIS TIA	**Station 1+30** **Horizontal Ground Temperature Cable Temperature Vs. Time**
		Date: Feb. 2020 / Approved: AB / Figure: **B.11**







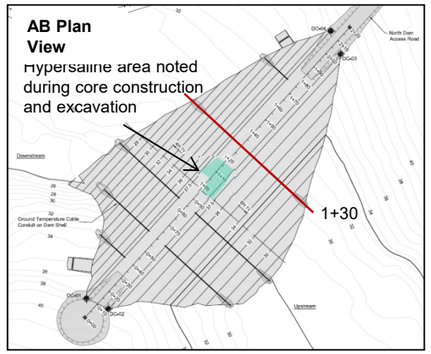




Note:

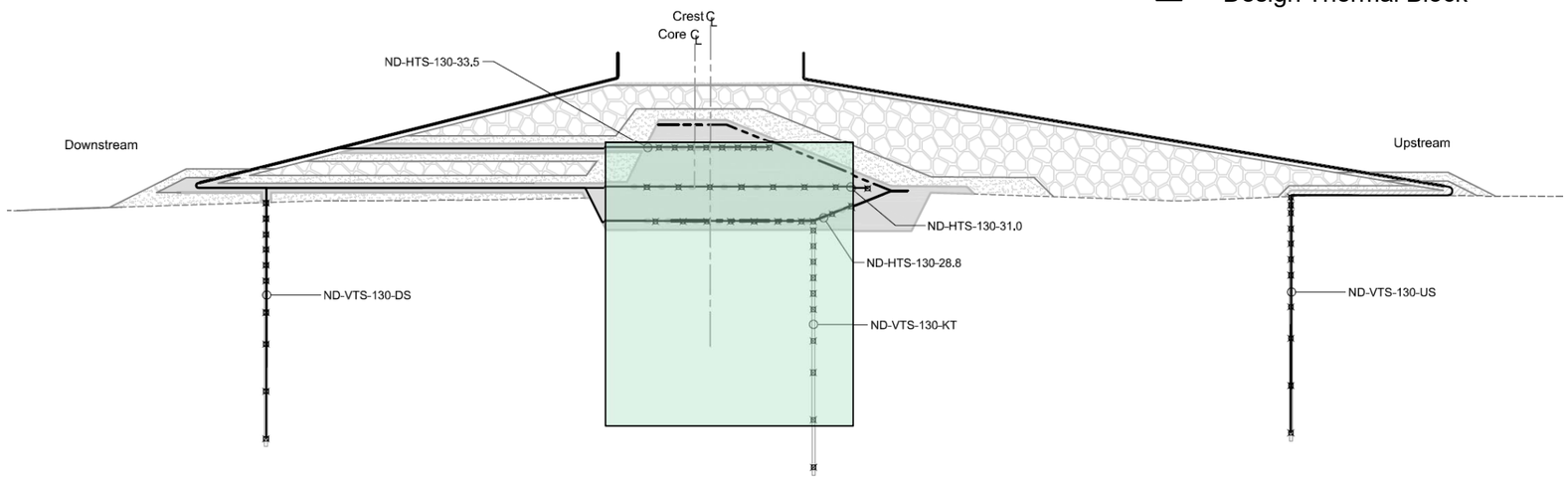
- Previous Data was recorded between August 2012 and September 2018

srk consulting	MAC RESOURCES	2019 AGI - North Dam
		Station 1+30 Horizontal Ground Temperature Cable Readings by Location
Job No: 1CT022.038 Filename: AppB_1CT057.038_ND_GTC	**DORIS TIA**	Date: Feb. 2020 / Approved: PL / Figure: **B.12**

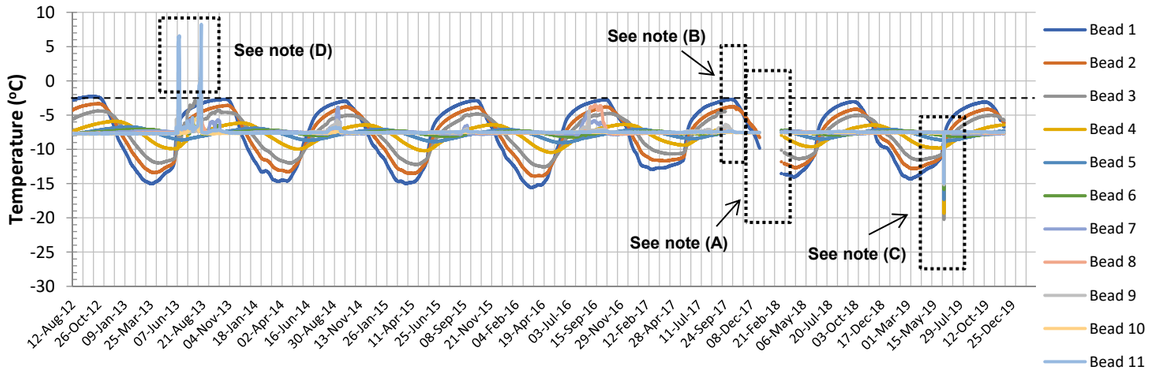


Legend:

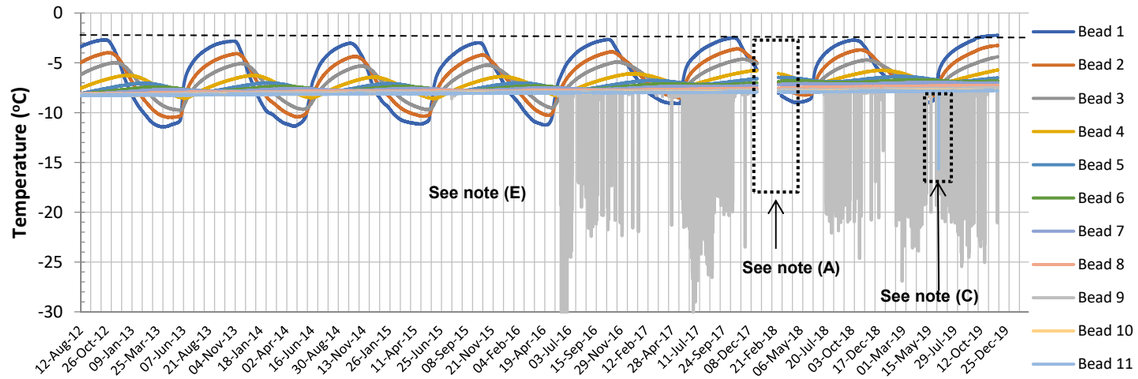
- GTC Status: Cable irreparably damaged
- GTC Status: Bead damaged or data missing
- Design Thermal Block



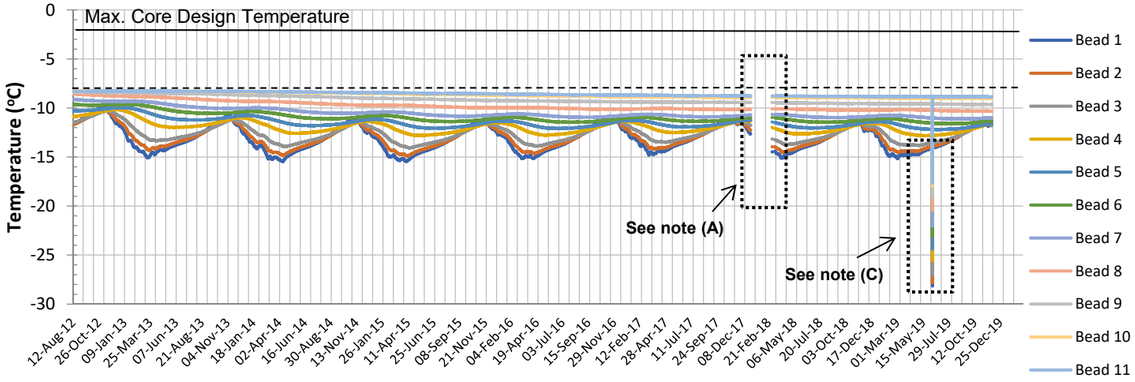
ND-VTS-130-DS



ND-VTS-130-US



ND-VTS-130-KT

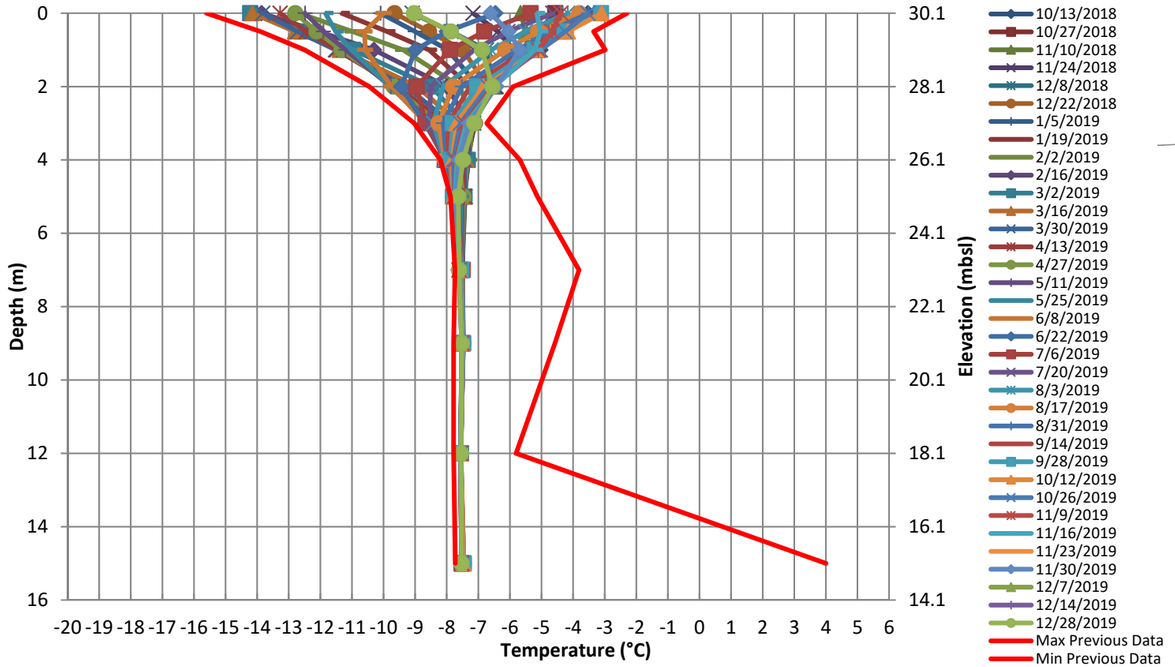


Notes:

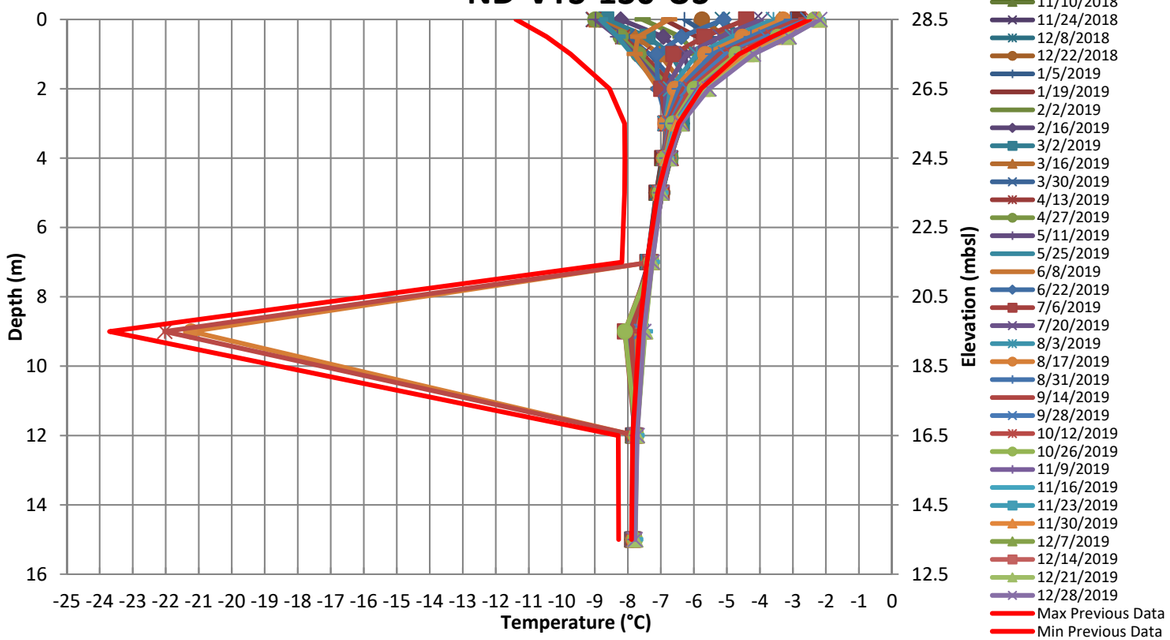
- Bead numbers increase from downstream to upstream (horizontal) and top to bottom (vertical)
- **(A)** Data logger was disconnected from January 1, 2018 to March 3, 2018 for recalibration
- **(B)** Beads 3 to 8 of ND-VTS-130-DS were disconnected from September 24, 2018 to March 3, 2018 due to damage of the cable lead at the datalogger housing. The lead was repaired prior to the reconnection of the datalogger.
- **(C)** A low temperature spike for all beads was observed for a single reading on June 12, 2019 and is attributed to an instrumentation error.
- **(D)** Temperature spike is attributed to an instrumentation error rather than a change in the ground temperature.
- **(E)** Reoccurring low temperature spikes in Bead 9 of ND-VTS-130-US began June 2016, around the same period when the Station 0+085 readings began to spike. These are expected to be an instrumentation issue rather than a change in the ground temperature regime.

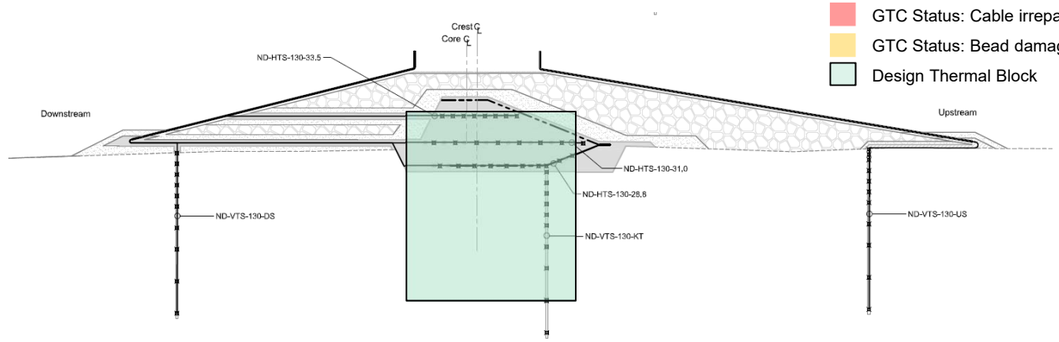
srk consulting	TMAC RESOURCES	2019 AGI - North Dam
		Station 1+30 **Vertical Ground Temperature Cable** **Temperature Vs. Time**
Job No: 1CT022.038 Filename: AppB_1CT022.038_ND_GTC	**DORIS TIA**	Date: Feb. 2020 / Approved: AB / Figure: **B.13**

ND-VTS-130-DS



ND-VTS-130-US

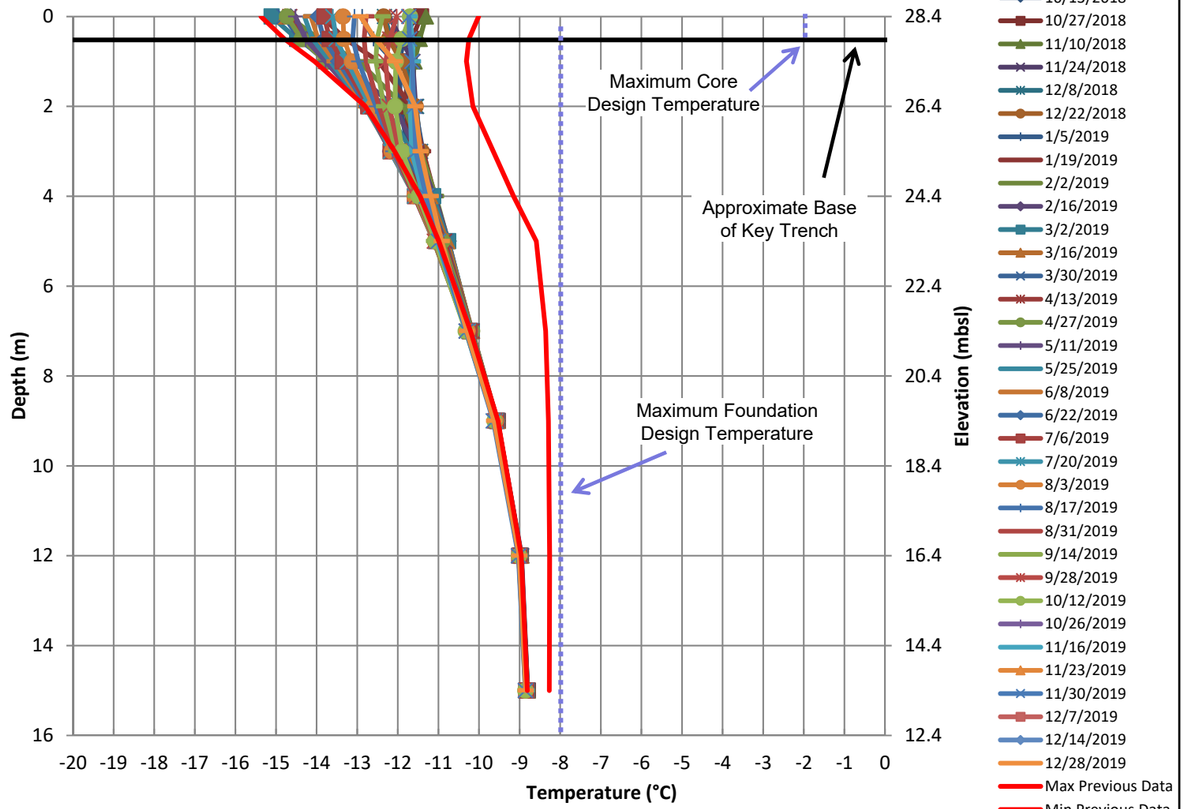




Legend:

- GTC Status: Cable irreparably damaged
- GTC Status: Bead damaged or data missing
- Design Thermal Block

ND-VTS-130-KT



10/13/2018
10/27/2018
11/10/2018
11/24/2018
12/8/2018
12/22/2018
1/5/2019
1/19/2019
2/2/2019
2/16/2019
3/2/2019
3/16/2019
3/30/2019
4/13/2019
4/27/2019
5/11/2019
5/25/2019
6/8/2019
6/22/2019
7/6/2019
7/20/2019
8/3/2019
8/17/2019
8/31/2019
9/14/2019
9/28/2019
10/12/2019
10/26/2019
11/9/2019
11/16/2019
11/23/2019
11/30/2019
12/7/2019
12/14/2019
12/21/2019
12/28/2019
Max Previous Data
Min Previous Data

Note:

- Previous Data was recorded between August 2012 and September 2018

srk consulting

Job No: 1CT022.038
Filename: AppB_1CT057.038_ND_GTC

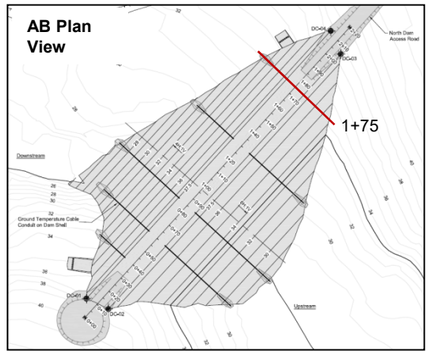
MAC RESOURCES

DORIS TIA

2019 AGI - North Dam

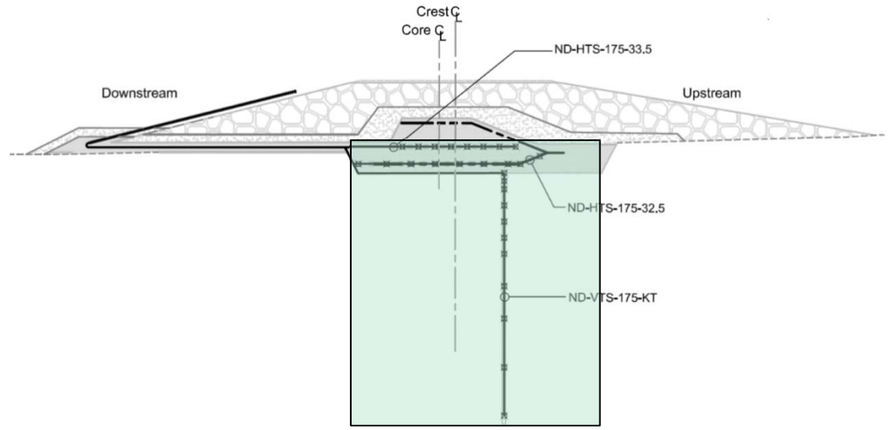
Station 1+30
Vertical Ground Temperature Cable Readings by Location

Date: Feb. 2020 | Approved: PL | Figure: **B.14**

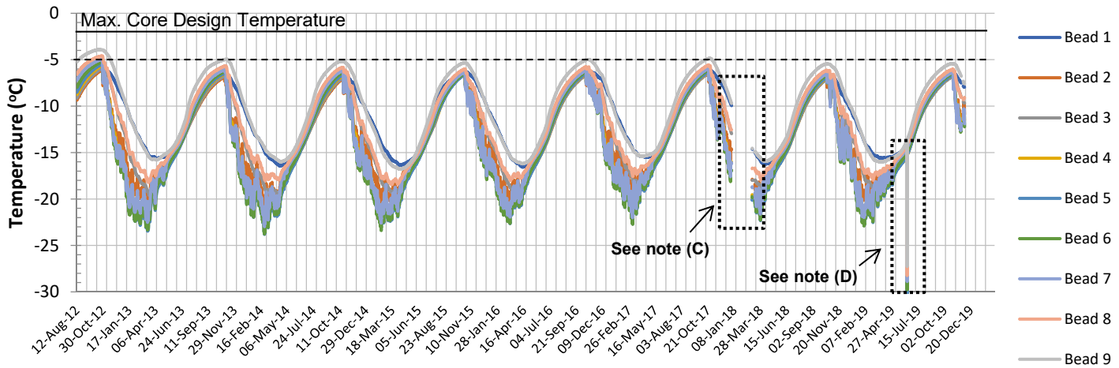


Legend:

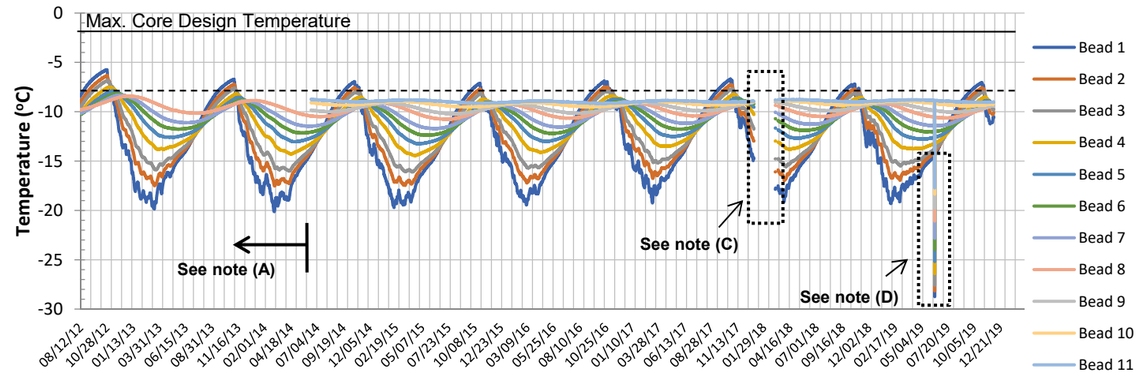
- GTC Status: Cable irreparably damaged
- GTC Status: Bead damaged or data missing
- Design Thermal Block



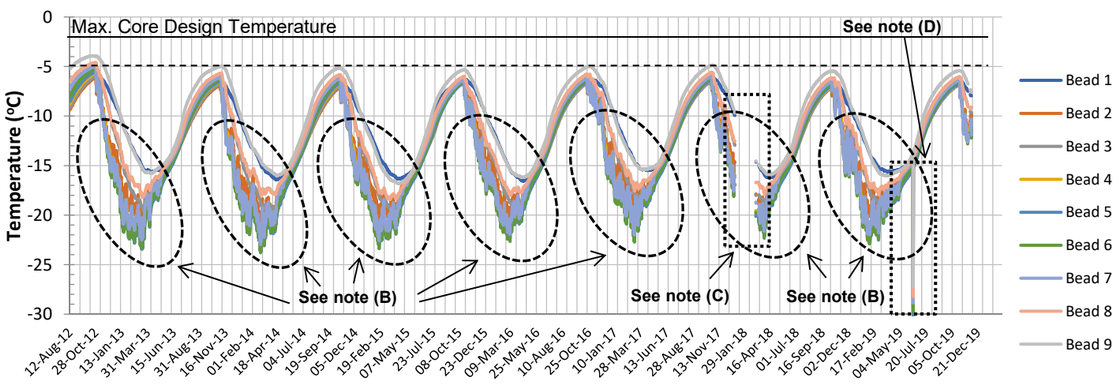
ND-HTS-175-33.5



ND-VTS-175-KT



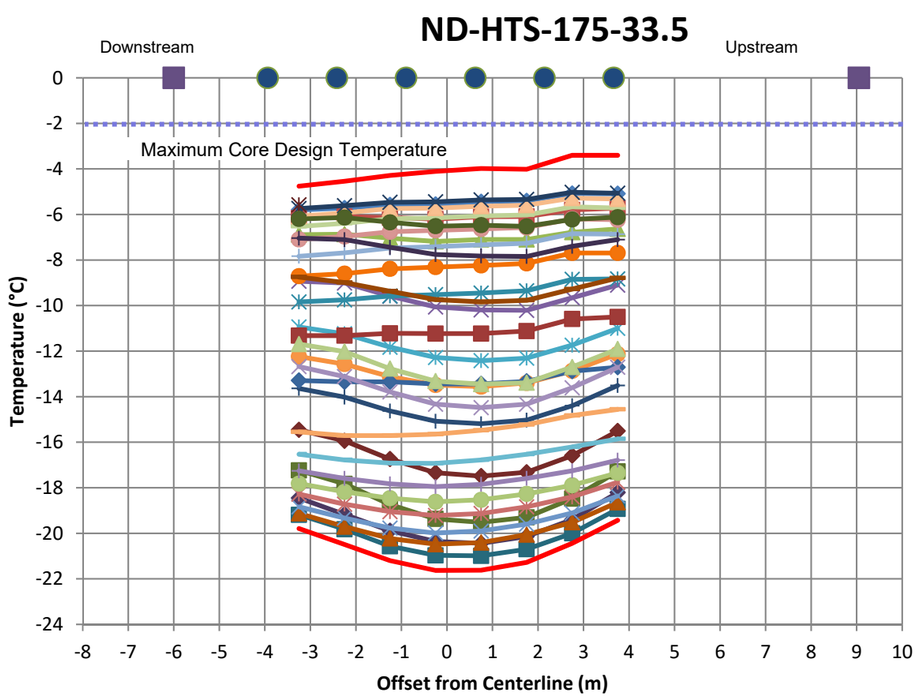
ND-HTS-175-32.5

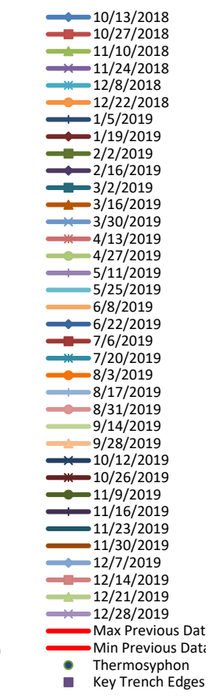


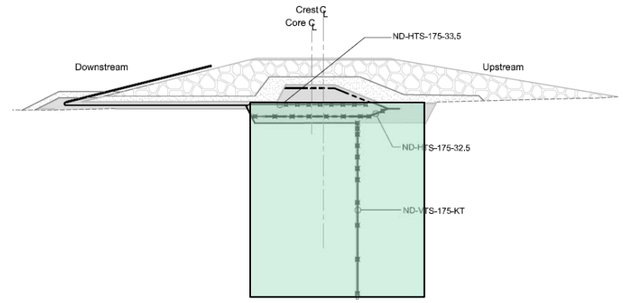
Notes:

- Bead numbers increase from downstream to upstream (horizontal) and top to bottom (vertical)
- **(A)** Incorrectly connected to datalogger at ND-HTS-175-33.5; therefore, no readings for beads 9, 10 and 11.
- **(B)** Variation in Ground Temperature Cable readings during winter months due to close proximity of Ground Temperature Cable beads to thermosyphon pipes.
- **(C)** Data logger was disconnected from January 1, 2018 to March 3, 2018 for recalibration
- **(D)** A low temperature spike for all beads was observed for a single reading on June 12, 2019 and is attributed to an instrumentation error.

srk consulting	MAC RESOURCES	2019 AGI - North Dam
Job No: 1CT022.038 Filename: AppB_1CT022.038_ND_GTC	DORIS TIA	**Station 1+75** **Ground Temperature Cable** **Temperature Vs. Time**
		Date: Feb. 2020 / Approved: AB / Figure: **B.15**

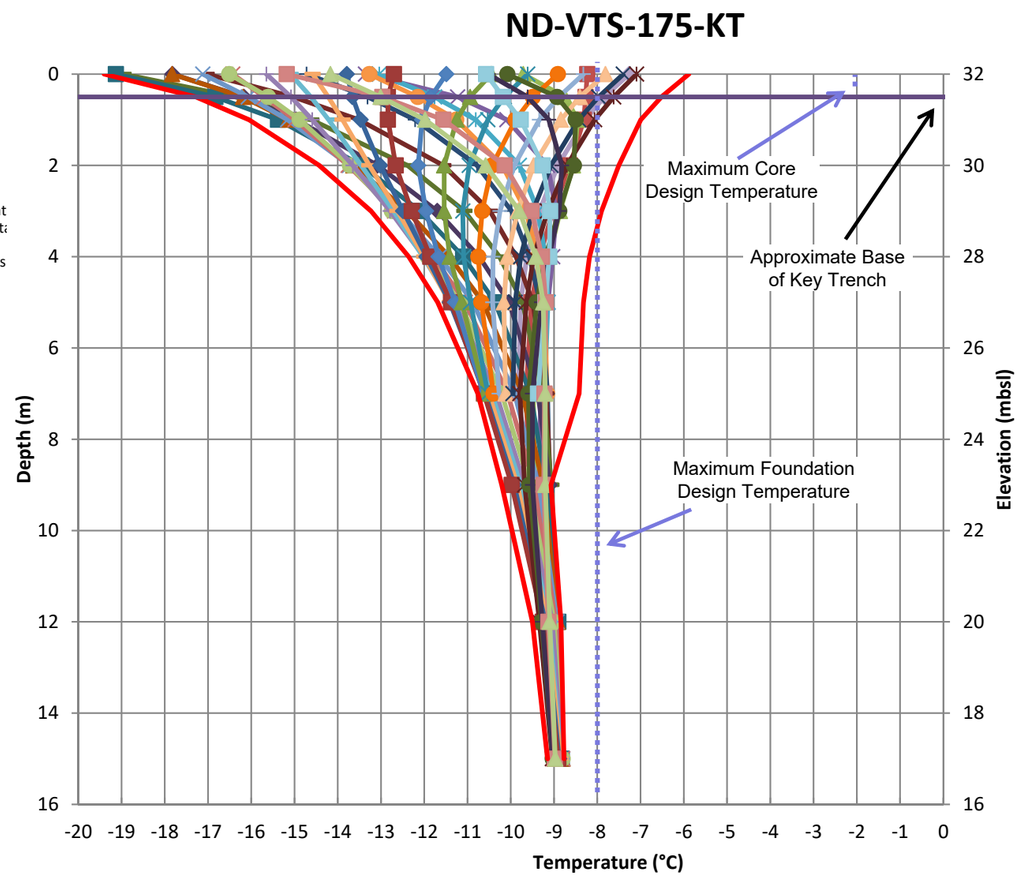


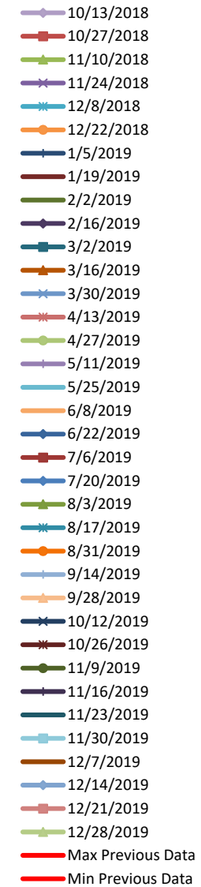


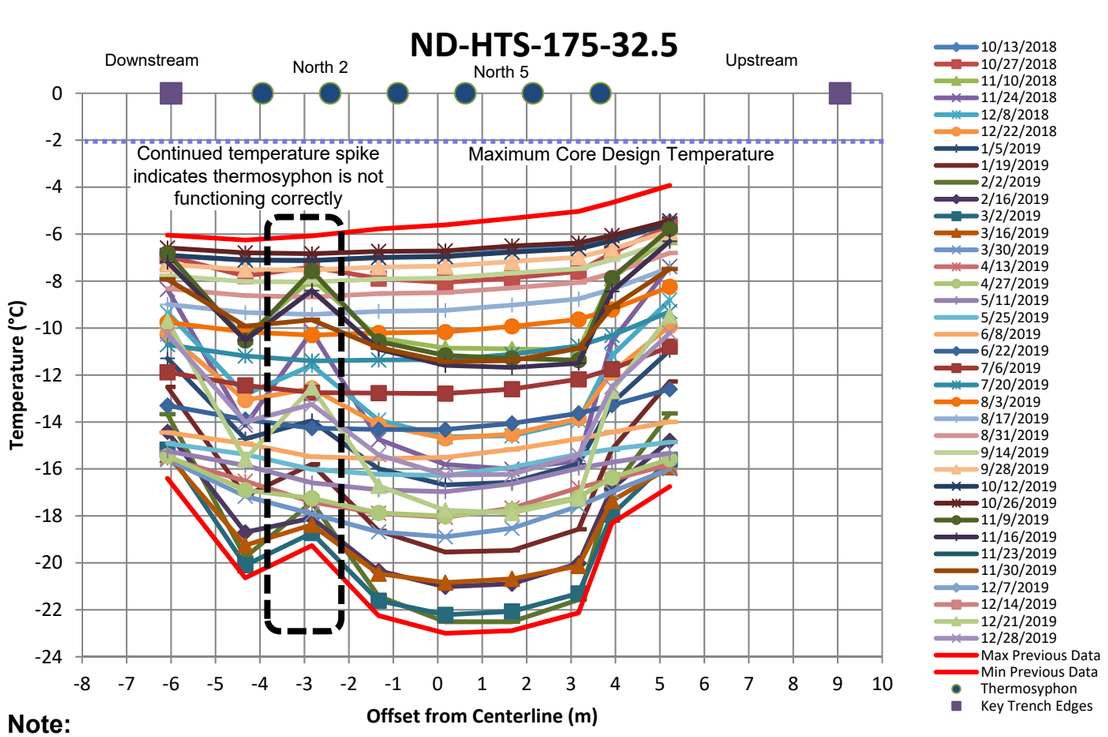


Legend:

- GTC Status: Cable irreparably damaged
- GTC Status: Bead damaged or data missing
- Design Thermal Block







Note:

- Previous Data was recorded between August 2012 and September 2018

srk consulting

Job No: 1CT022.038
Filename: AppB_1CT057.038_ND_GTC

TMAC RESOURCES

DORIS TIA

2019 AGI - North Dam

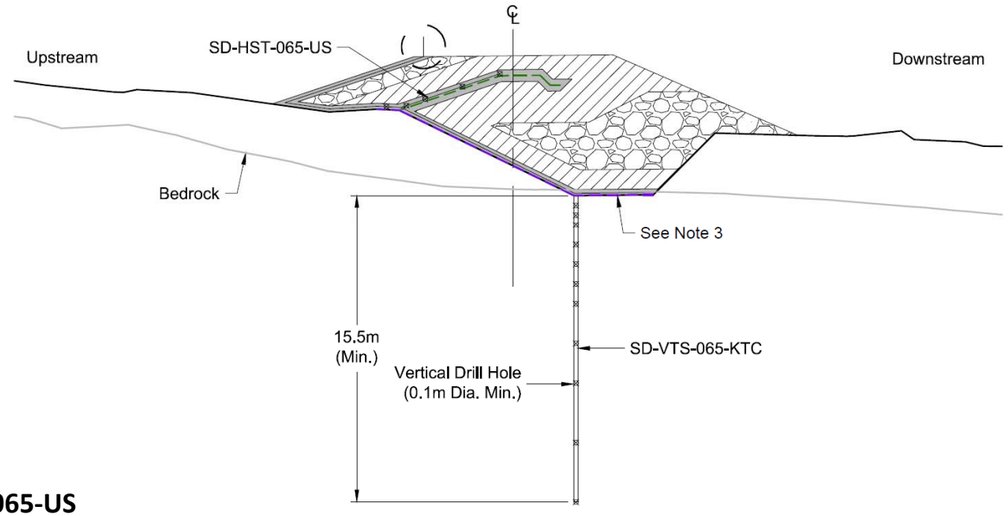
Station 1+75
Ground Temperature Cable Readings by Location

Date: Feb. 2020 | Approved: PL | Figure: **B.16**

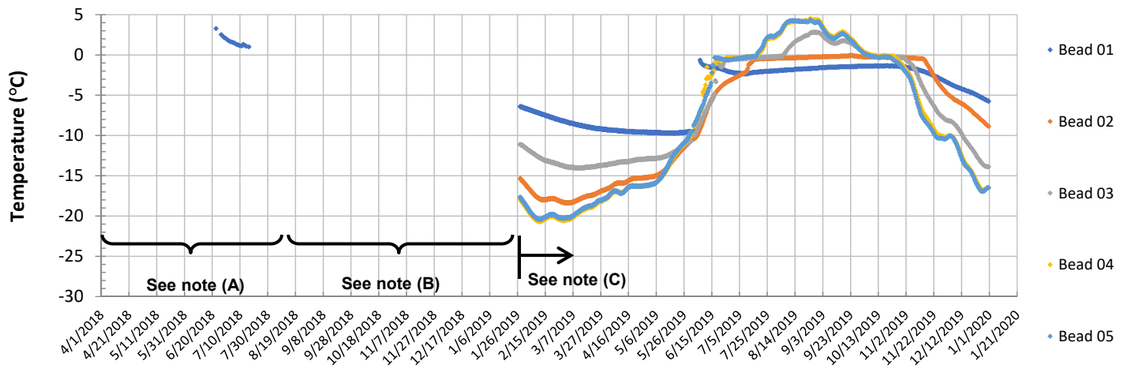
Legend:

GTC Status: Cable irreparably damaged

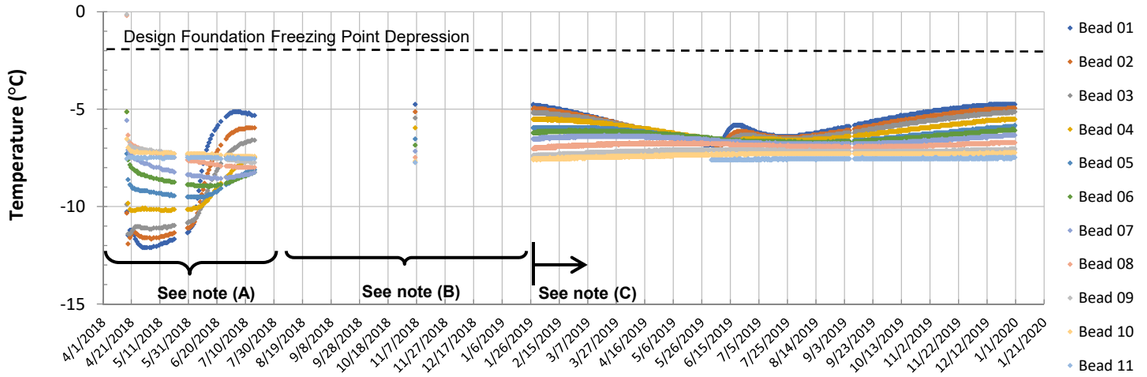
GTC Status: Bead damaged or data missing



SD-HTS-065-US



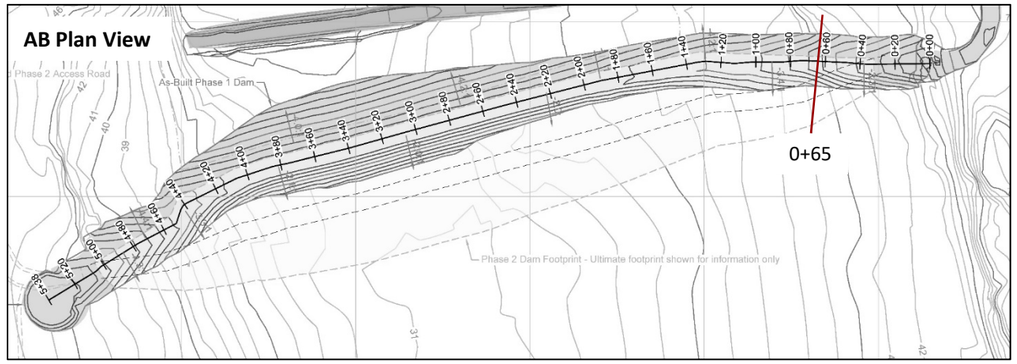
SD-VTS-065-KT

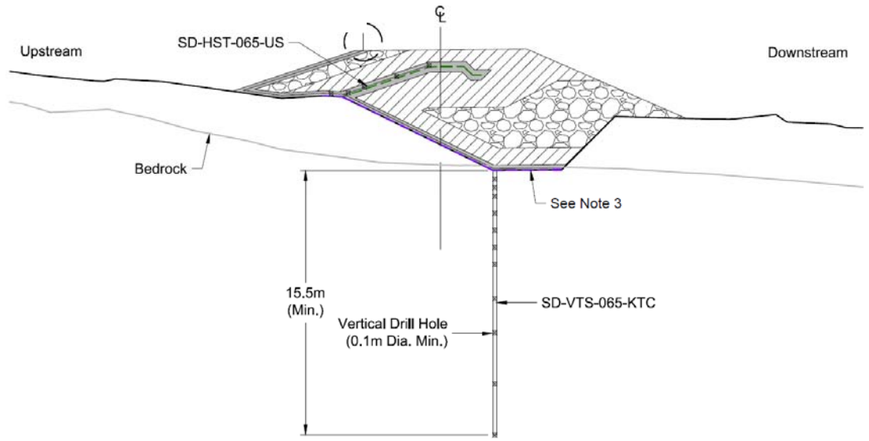


Notes:

- Bead numbers increase from upstream to downstream (horizontal) and top to bottom (vertical)
- Cables were damaged after construction but repaired.
- **(A)** Measurements collected between April and August 2018 were taken during construction
- **(B)** No measurements were collected between September 2018 to late January 2019 as the GTC's were extended and repaired, and the data loggers were set up on site. One set of manual spot measurements were collected in November 2018 to check interim dam performance
- **(C)** From the end of January 2019 onwards, data loggers were installed and placed on site, providing higher resolution and more frequent data transmissions

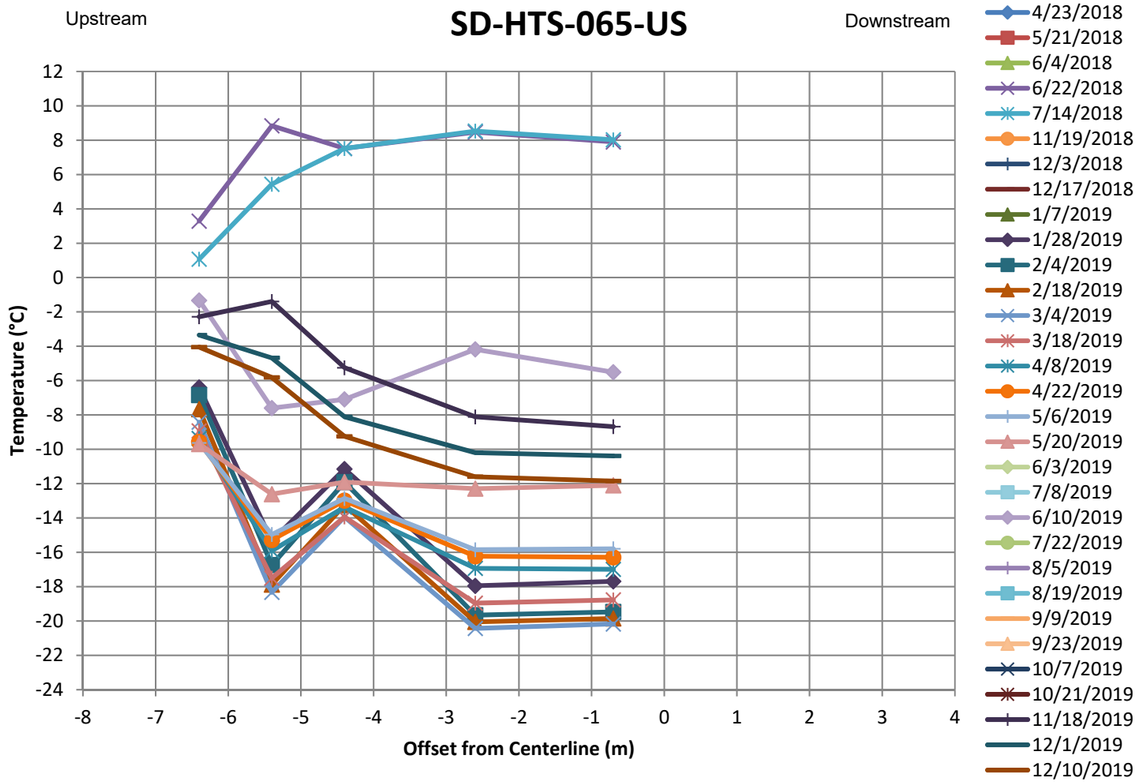
srk consulting	TMAC RESOURCES	2019 AGI - South Dam
Job No: 1CT022.038 Filename: AppB_1CT022.038_SD_GTC	DORIS TIA	**Station 0+65** **Ground Temperature Cable** **Temperature Vs. Time**
		Date: Mar. 2020 / Approved: AB / Figure: **B.16**

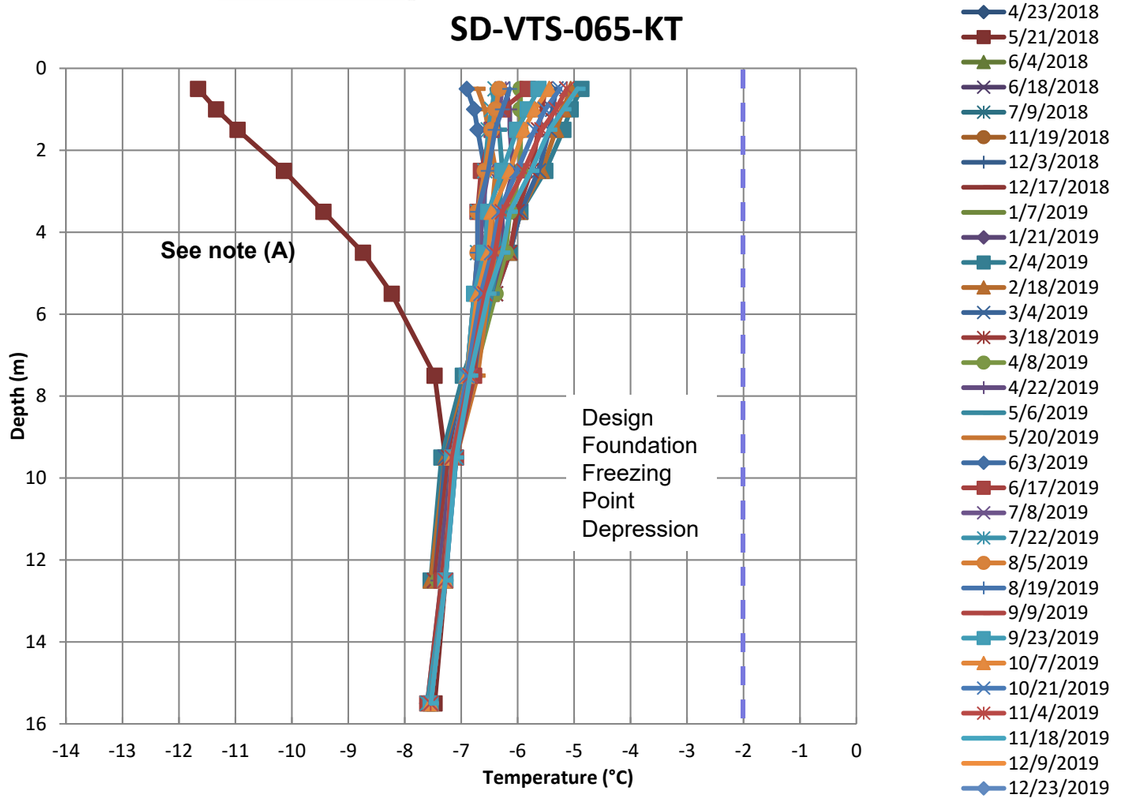




Legend:

- GTC Status: Cable irreparably damaged
- GTC Status: Bead damaged or data missing



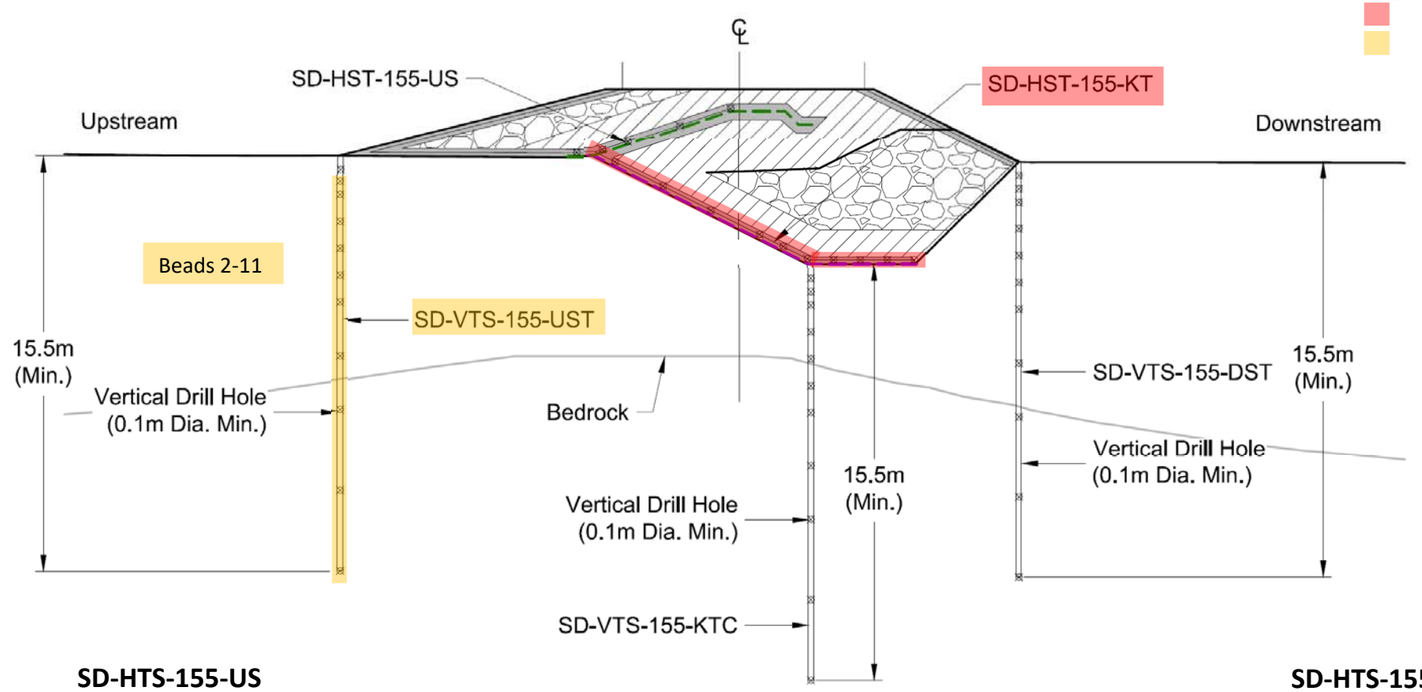


Note:

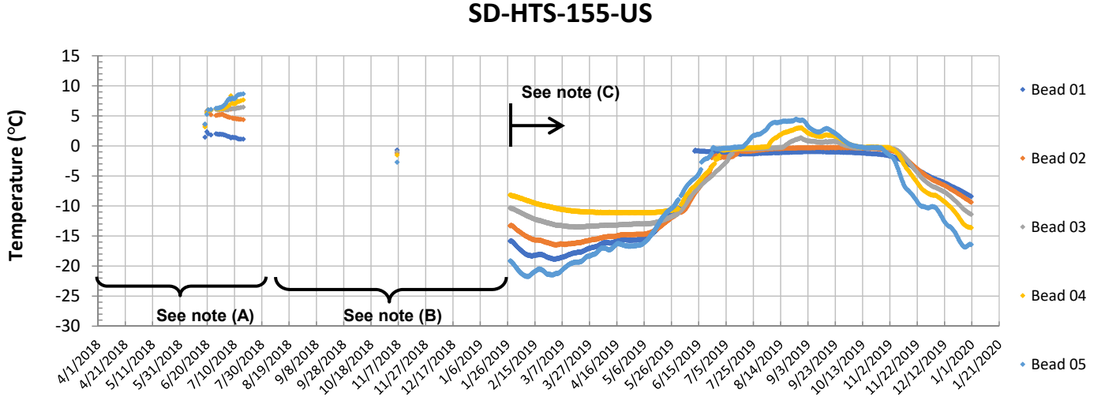
- Legend represents full monitoring year. Only dates with available data are shown on chart
- No data collected between September 16, 2018 to January 27, 2019
- **(A)** Data collected during construction

srk consulting	TMAC RESOURCES	2019 AGI - South Dam
		South Dam Station 0+65 Ground Temperature Cable Readings by Location
Job No: 1CT022.038 Filename: AppB_1CT022.038_SD_GTC	**Doris TIA**	Date: Mar. 2020 · Approved: PL · Figure: **B.17**

Legend:
- GTC Status: Cable irreparably damaged
- GTC Status: Bead damaged or data missing



SD-HTS-155-US

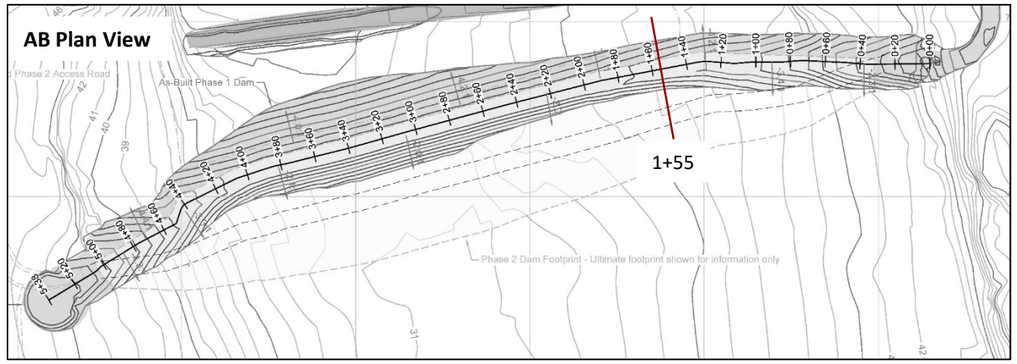


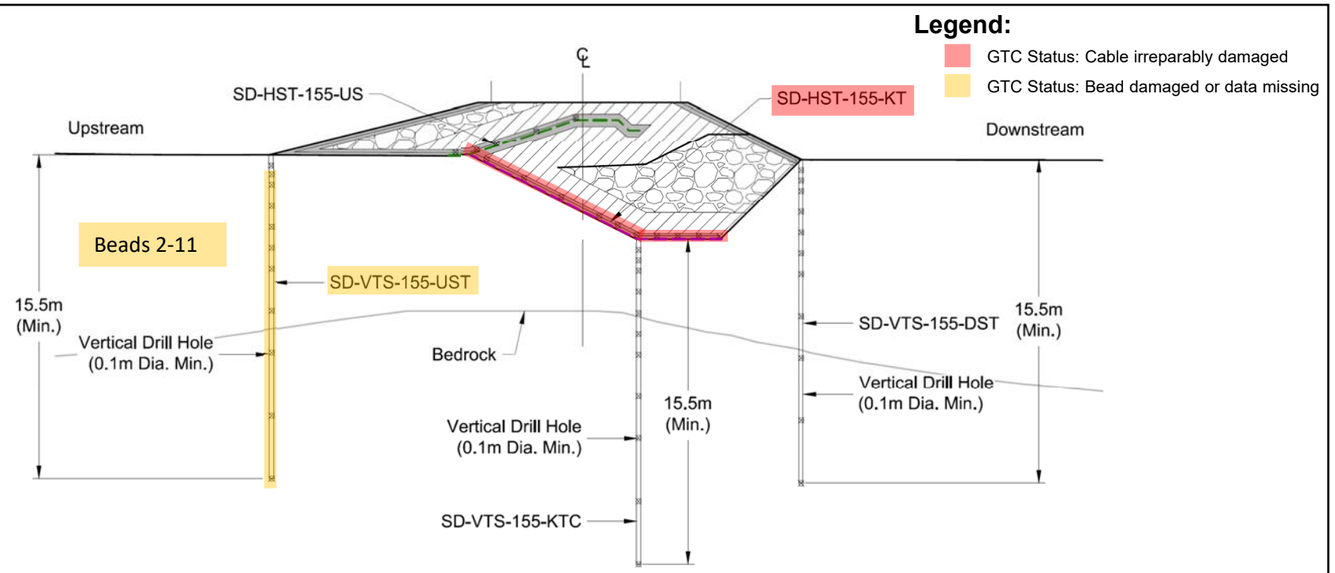
SD-HTS-155-KT

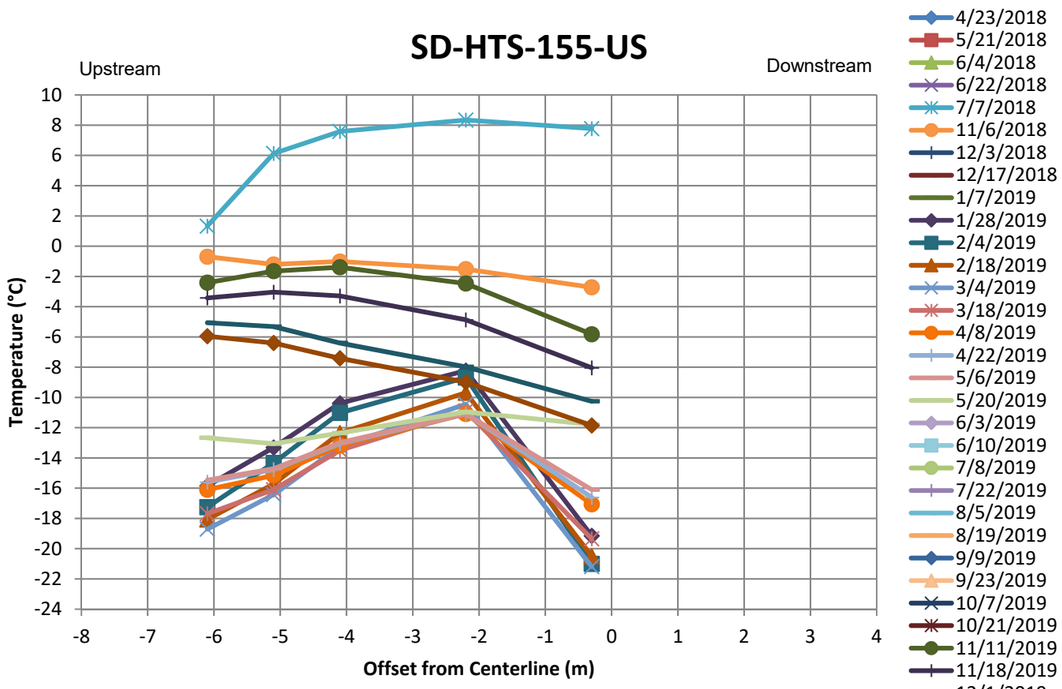


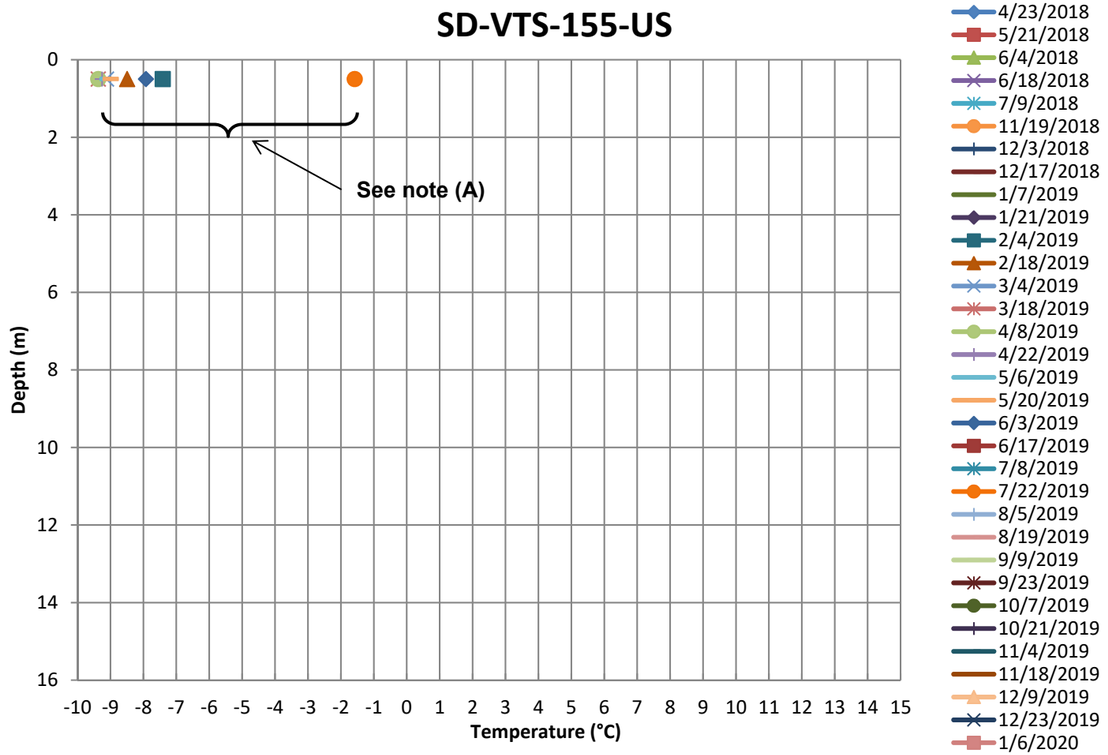
Notes:
- Bead numbers increase from upstream to downstream (horizontal) and top to bottom (vertical)
- SD-HTS-155-KT cable irreparably damaged during construction
- **(A)** Measurements collected between April and August 2018 were taken during construction
- **(B)** No measurements were collected between September 2018 to late January 2019 as the GTC's were extended and repaired, and the data loggers were set up on site. One set of manual spot measurements were collected in November 2018 to check interim dam performance
- **(C)** From the end of January 2019 onwards, data loggers were installed and placed on site, providing higher resolution and more frequent data transmissions

srk consulting	TMAC RESOURCES	2019 AGI - South Dam
		Station 1+55 **Horizontal Ground Temperature** **Cable Temperature Vs. Time**
Job No: 1CT022.038 Filename: AppB_1CT022.038_SD_GTC	**DORIS TIA**	Date: Mar. 2020 / Approved: AB / Figure: **B.18**





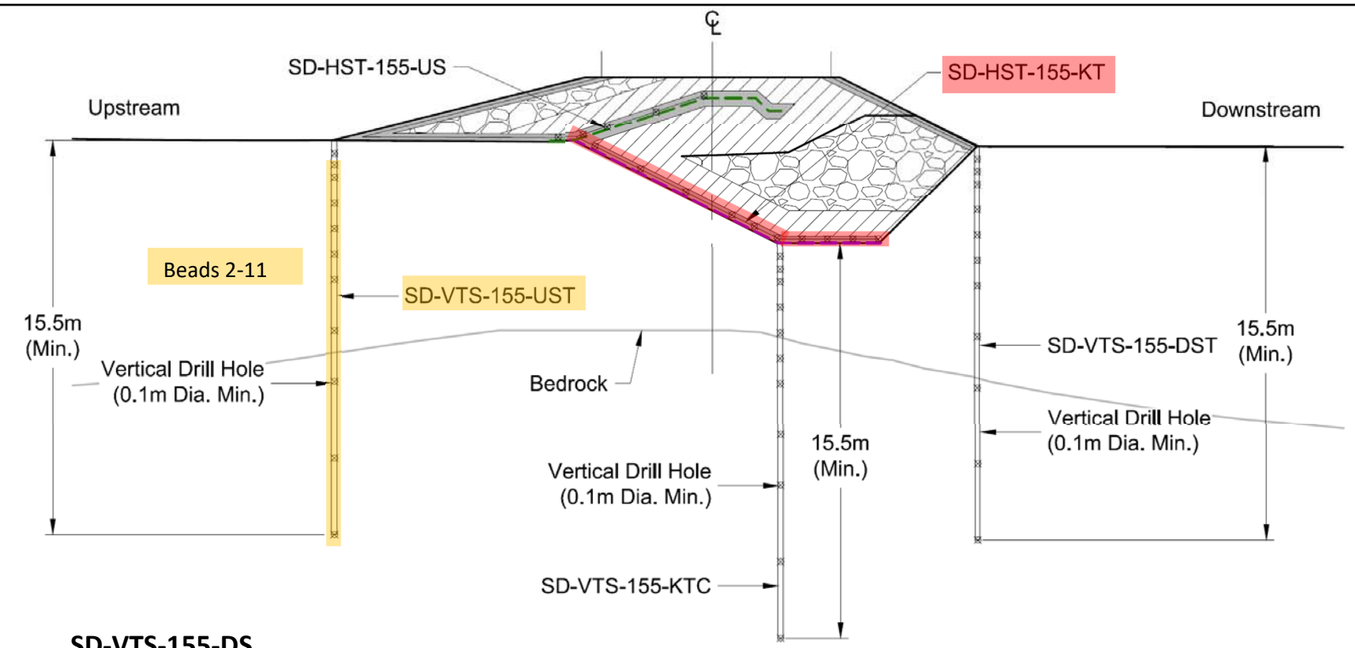




Notes:

- Legend represents full monitoring year. Only dates with available data are shown on chart
- SD-HTS-155-KT irreparably damaged during construction
- No data collected between September 16, 2018 to January 27, 2019. One reading recorded for SD-HTS-155-US on November 6, 2018
- **(A)** Only Bead 1 is transmitting. Beads 2-11 are damaged and are not transmitting

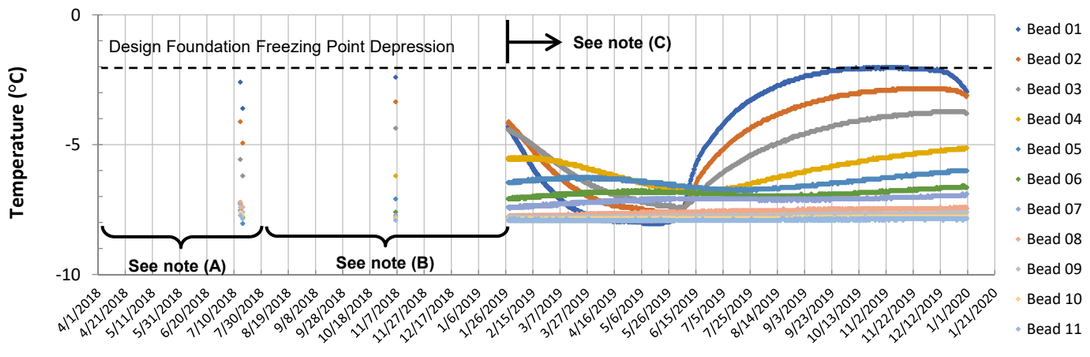
srk consulting	TMAC RESOURCES	2019 AGI - South Dam
		South Dam Station 1+55 Ground Temperature Cable Readings by Location
Job No: 1CT022.038 Filename: AppB_1CT022.038_SD_GTC	**Doris TIA**	Date: Mar. 2020 / Approved: PL / Figure: **B.19**



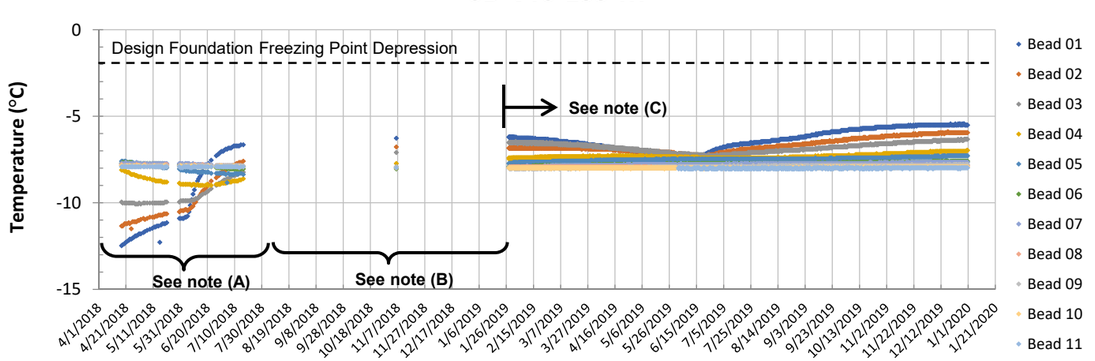
Legend:

- GTC Status: Cable irreparably damaged
- GTC Status: Bead damaged or data missing

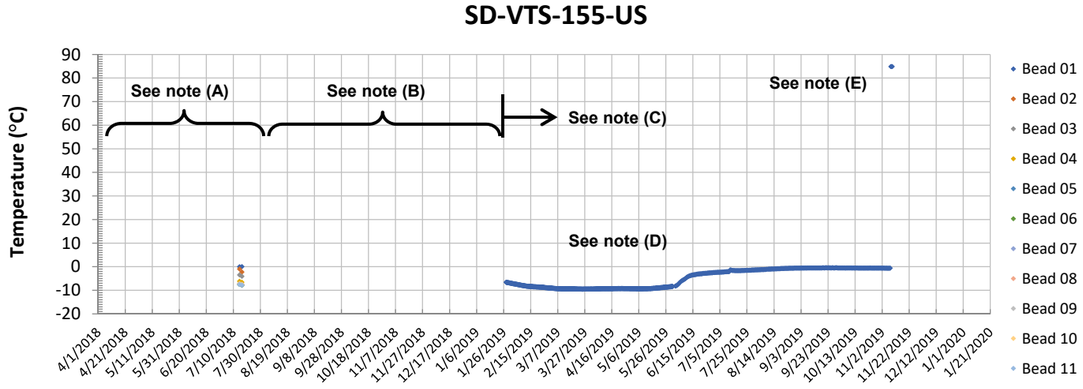
SD-VTS-155-DS



SD-VTS-155-KT



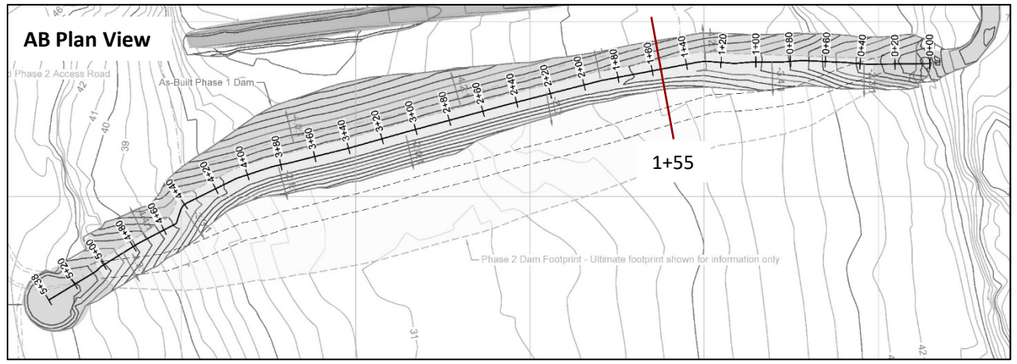
SD-VTS-155-US

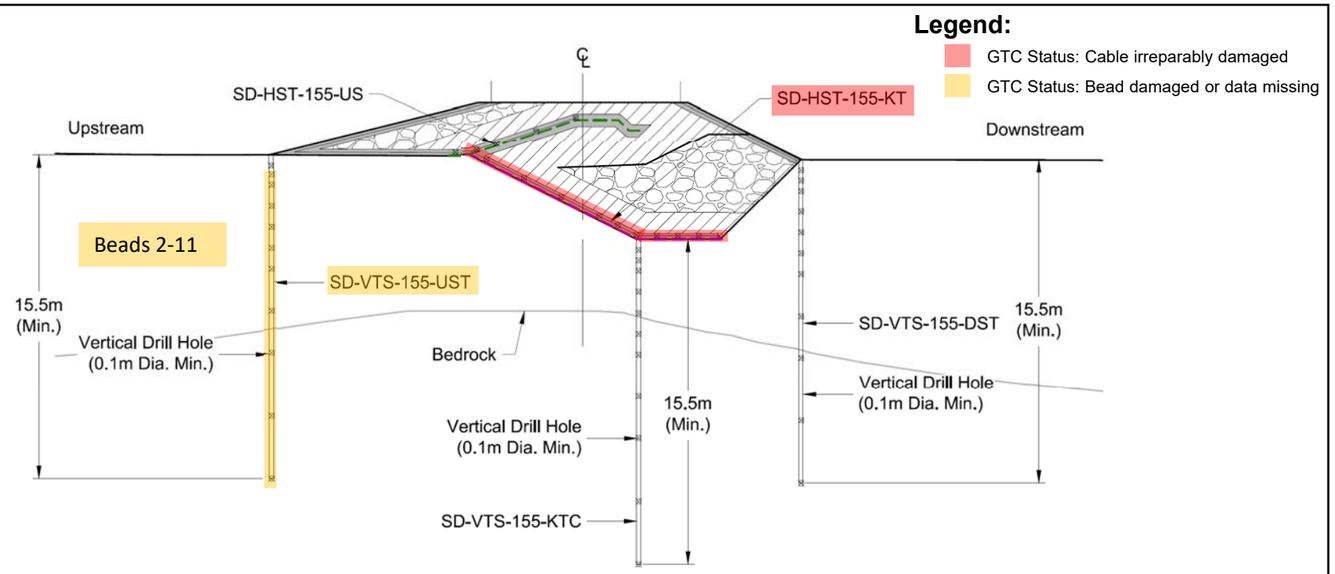


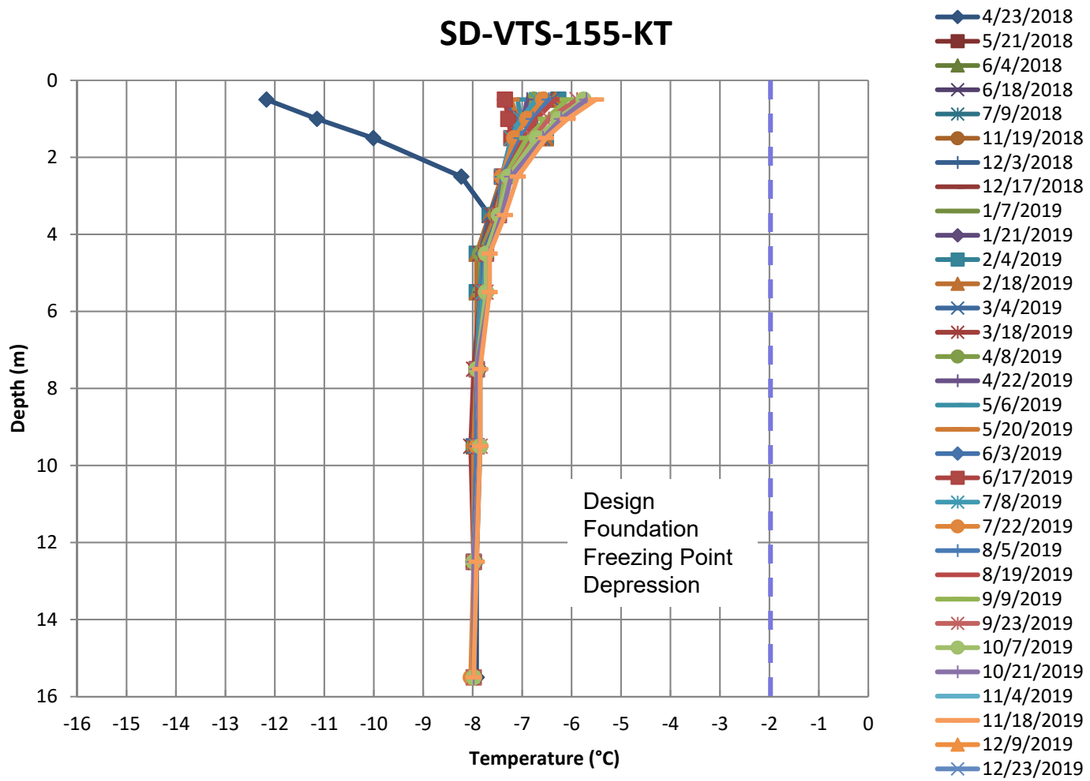
Notes:

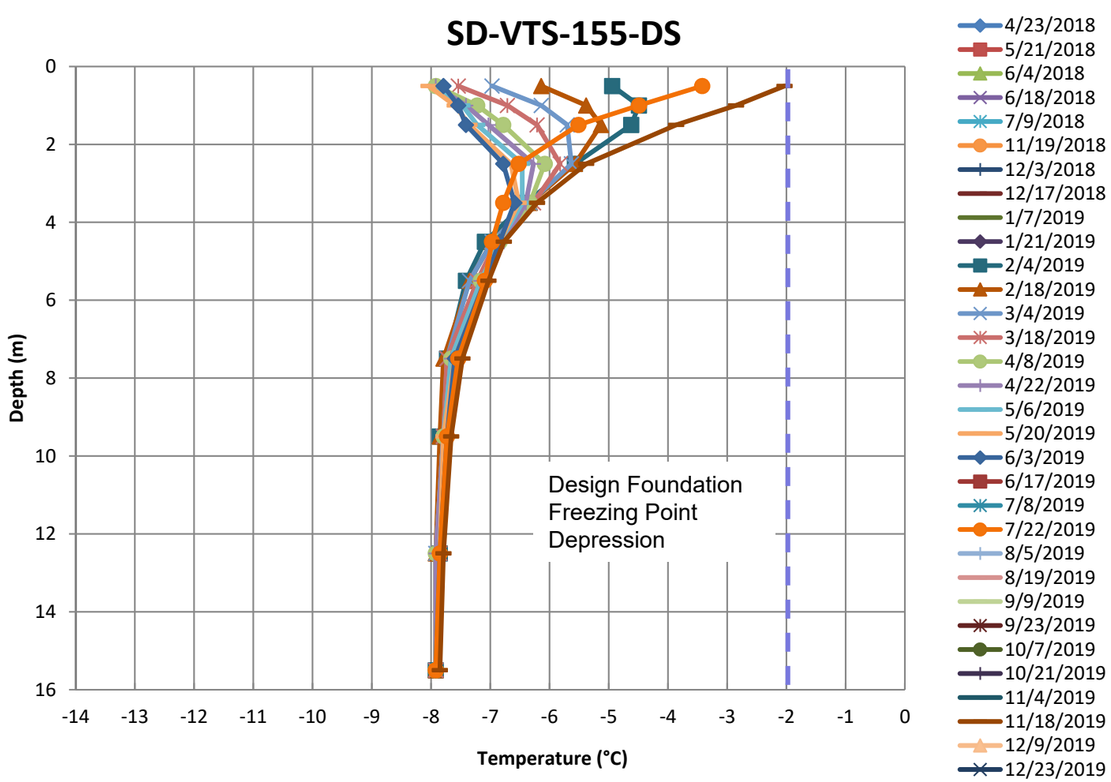
- Bead numbers increase from upstream to downstream (horizontal) and top to bottom (vertical)
- **(A)** Measurements collected between April and August 2018 were taken during construction
- **(B)** No measurements were collected between September 2018 to late January 2019 as the GTC's were extended and repaired, and the data loggers were set up on site. One set of manual spot measurements were collected for some cables in November 2018 to check interim dam performance.
- **(C)** From the end of January 2019 onwards, data loggers were installed and placed on site, providing higher resolution and more frequent data transmissions.
- **(D)** Only top bead working. Beads 2-11 are damaged and not transmitting.
- **(E)** Unrealistically high reading. Likely instrumentation error.

srk consulting	TMAC RESOURCES	2019 AGI - South Dam
		Station 1+55 **Vertical Ground Temperature Cable** **Temperature Vs. Time**
Job No: 1CT022.038 Filename: AppB_1CT022.038_SD_GTC	**DORIS TIA**	Date: Mar. 2020 · Approved: AB · Figure: **B.20**





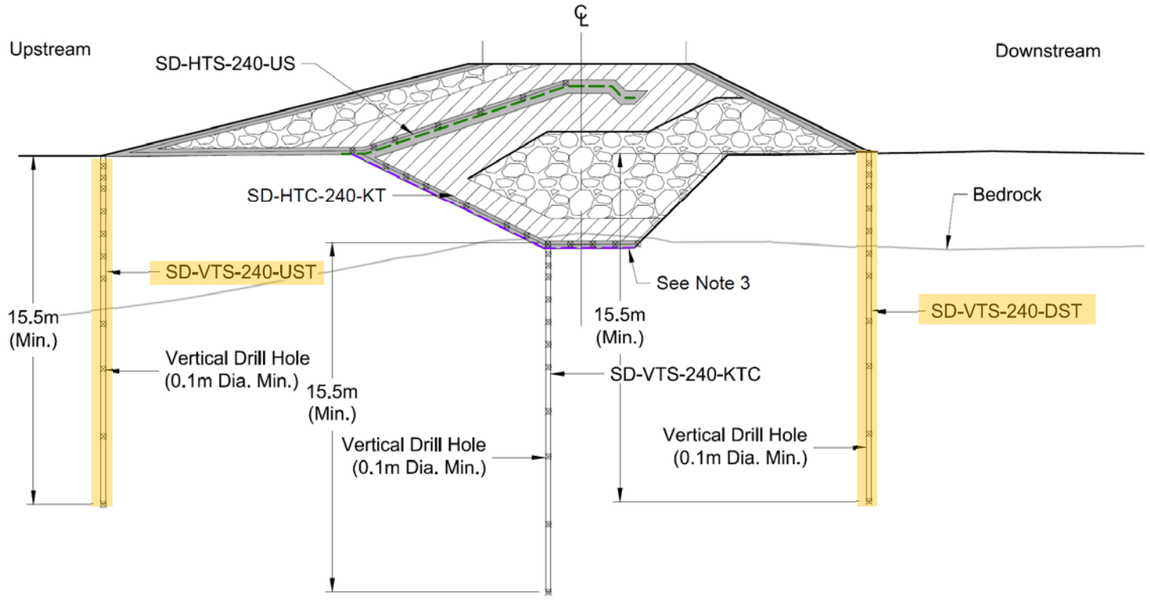




Note:

- Legend represents full monitoring year. Only dates with available data are shown on chart
- No data collected for SD-VTS-155-DS prior to September 14, 2018
- No data collected between September 16, 2018 to January 27, 2019. One data point collected on November 6, 2018

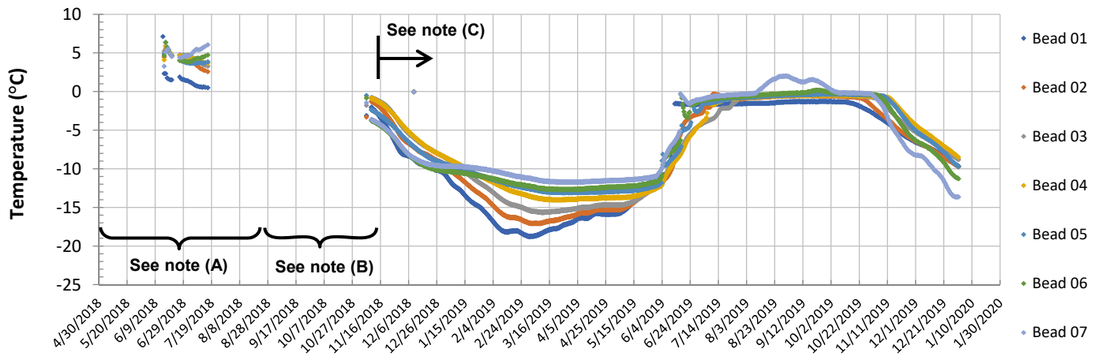
srk consulting	MAC RESOURCES	2019 AGI - South Dam
		South Dam Station 1+55 Ground Temperature Cable Readings by Location
Job No: 1CT022.038 Filename: AppB_1CT022.038_SD_GTC	**Doris TIA**	Date: Mar. 2020 / Approved: PL / Figure: **B.21**



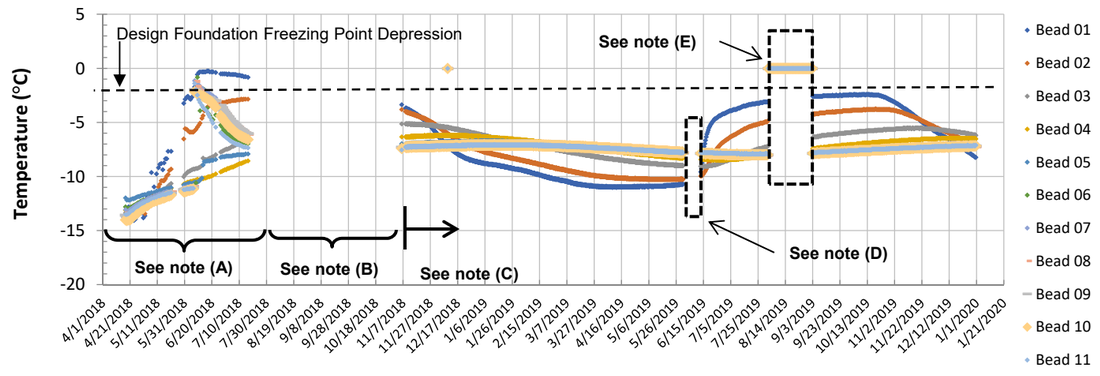
Legend:

- GTC Status: Cable irreparably damaged
- GTC Status: Bead damaged or data missing

SD-HTS-240-US



SD-HTS-240-KT

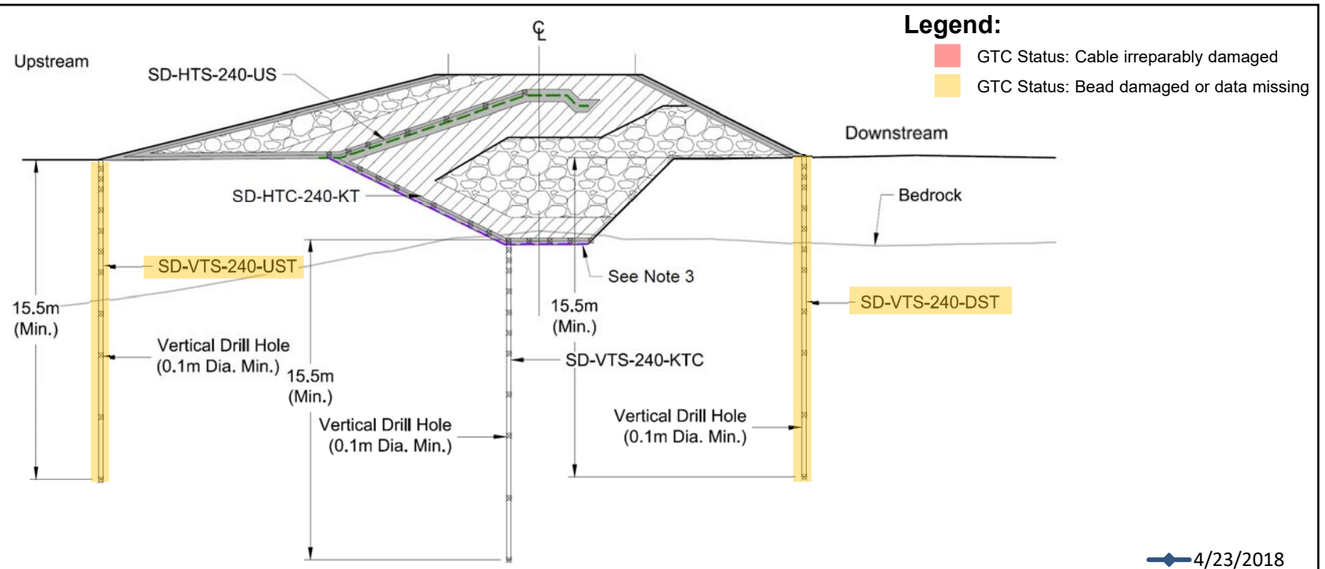


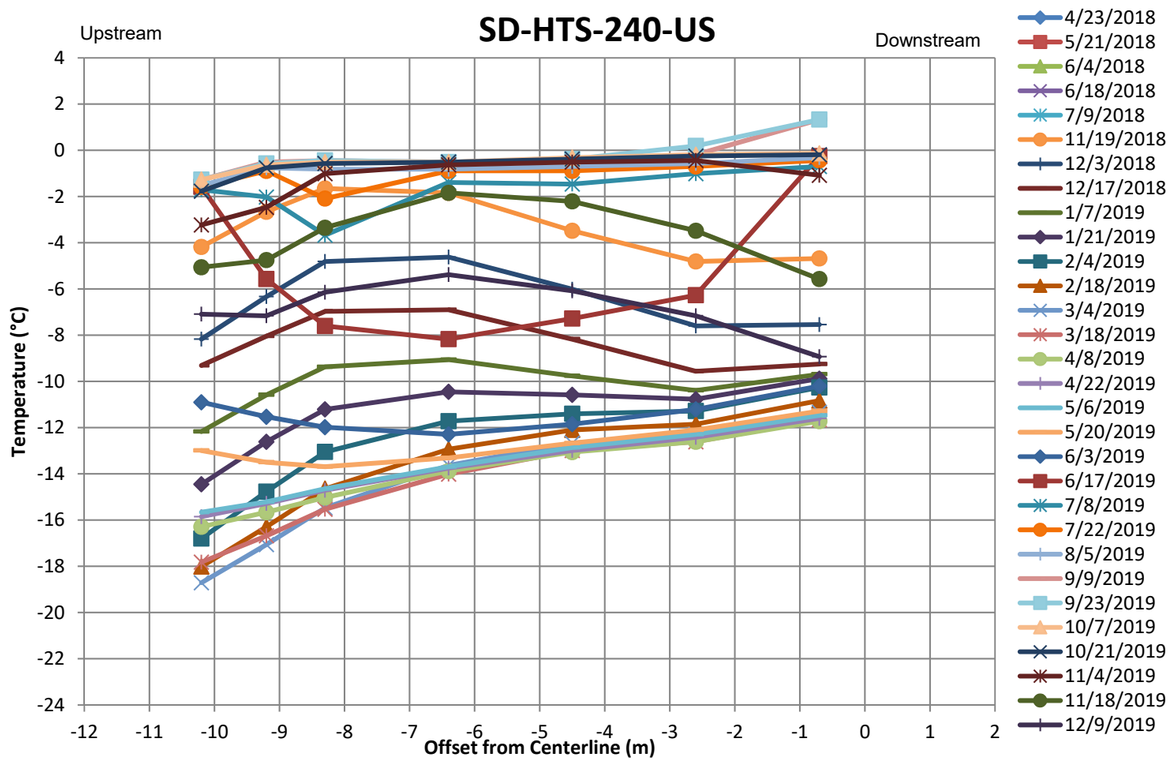
Notes:

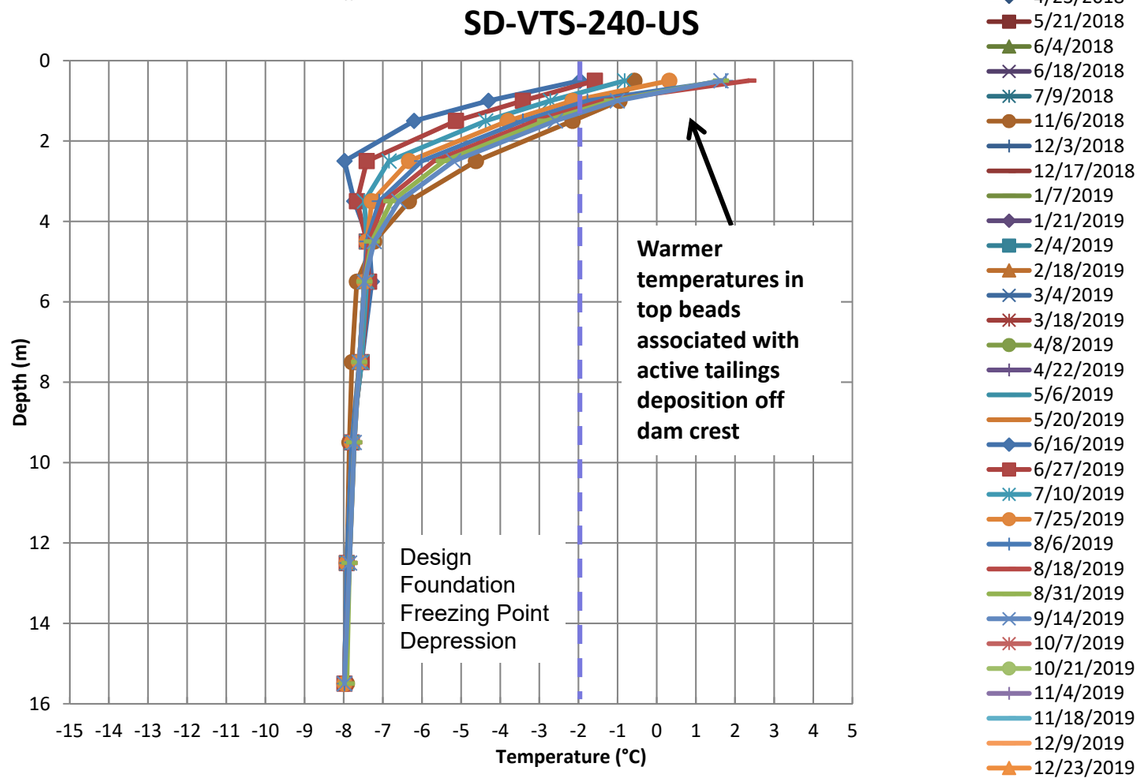
- Bead numbers increase from upstream to downstream (horizontal) and top to bottom (vertical)
- **(A)** Measurements collected between April and August 2018 were taken during construction
- **(B)** No measurements were collected between September 2018 to November 2018 as the data loggers were set up on site.
- **(C)** From November 2018 onwards, data loggers were installed and placed on site, providing higher resolution and more frequent data transmissions.
- **(D)** No data collected between May 31, 2019 and June 13, 2019
- **(E)** Incorrect zero values for all beads. No data collected between August 1, 2019 to September 2, 2019.

srk consulting	MAC RESOURCES	2019 AGI - South Dam
Job No: 1CT022.038 Filename: AppB_1CT022.038_SD_GTC	DORIS TIA	**Station 2+40 Horizontal Ground Temperature Cable Temperature Vs. Time**
		Date: Mar. 2020 / Approved: AB / Figure: **B.22**





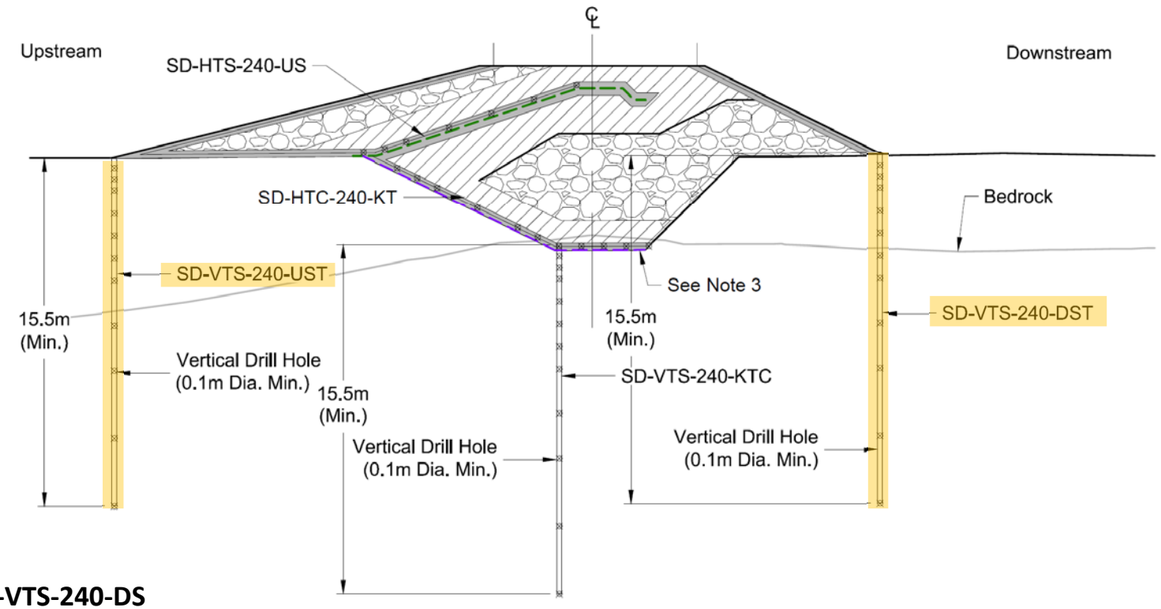




Note:

- Legend represents full monitoring year. Only dates with available data are shown on chart
- No data collected between September 16, 2018 to November 6, 2018
- No data collected for SD-VTS-240-US between November 25, 2018 and June 13, 2019
- Data readings ended on October 10, 2019 for SD-VTS-240-DS

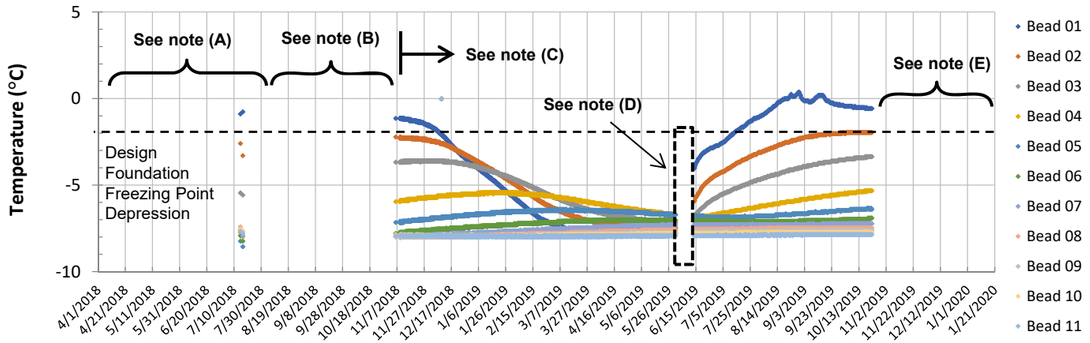
srk consulting	MAC RESOURCES	2019 AGI - South Dam
Job No: 1CT022.038 Filename: AppB_1CT022.038_SD_GTC	Doris TIA	**South Dam Station 2+40 Ground Temperature Cable Readings by Location** Date: Mar. 2020 · Approved: PL · Figure: **B.23**



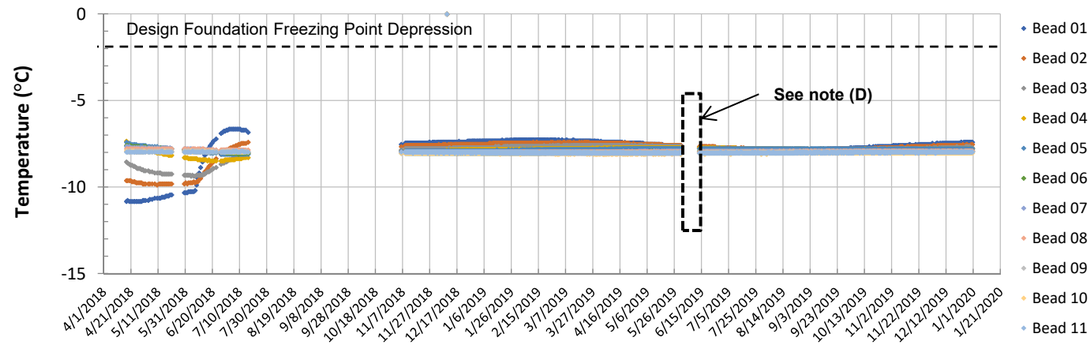
Legend:

- GTC Status: Cable irreparably damaged
- GTC Status: Bead damaged or data missing

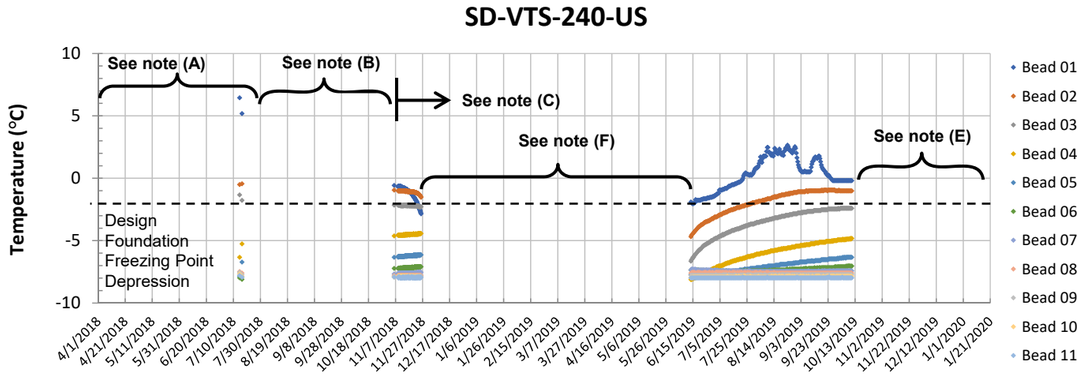
SD-VTS-240-DS



SD-VTS-240-KT



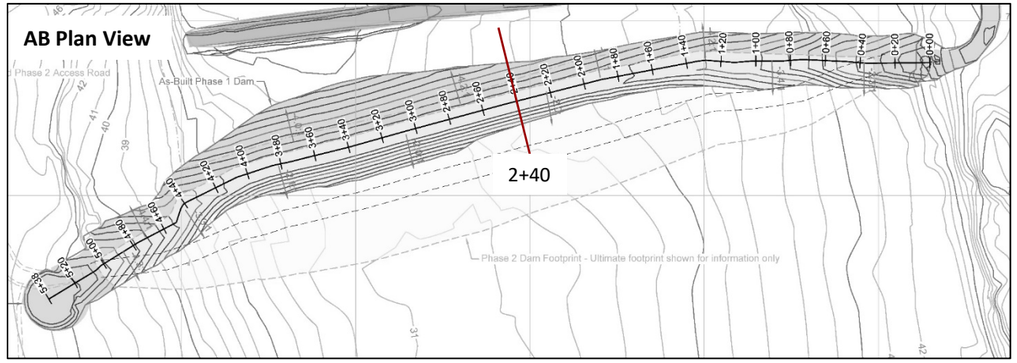
SD-VTS-240-US

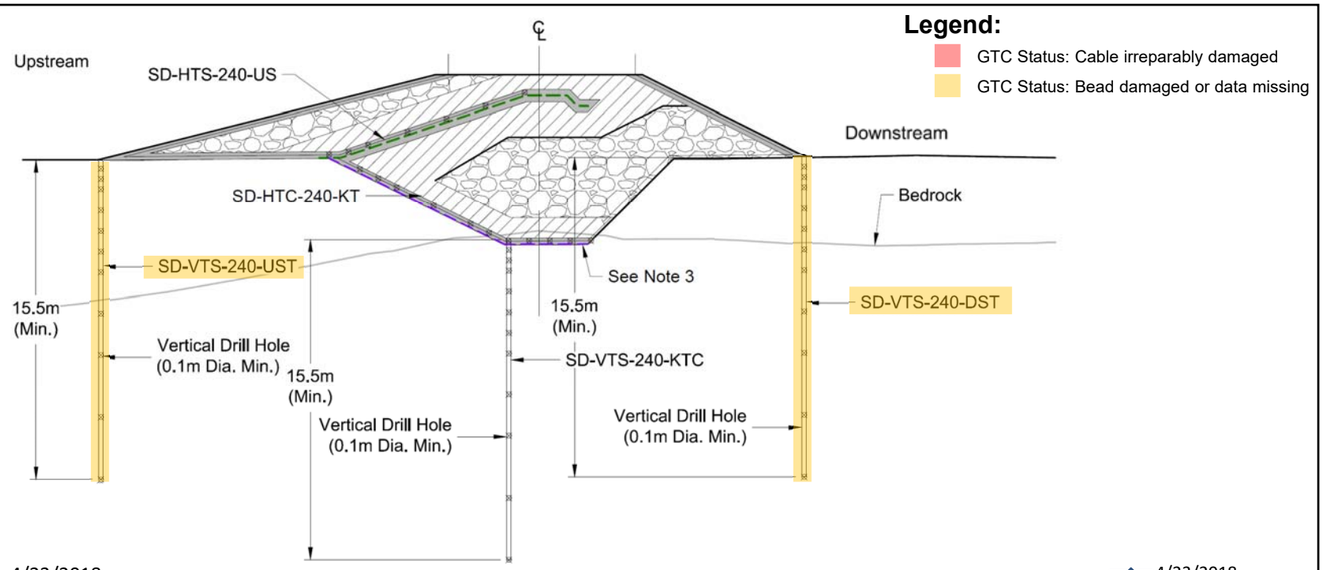


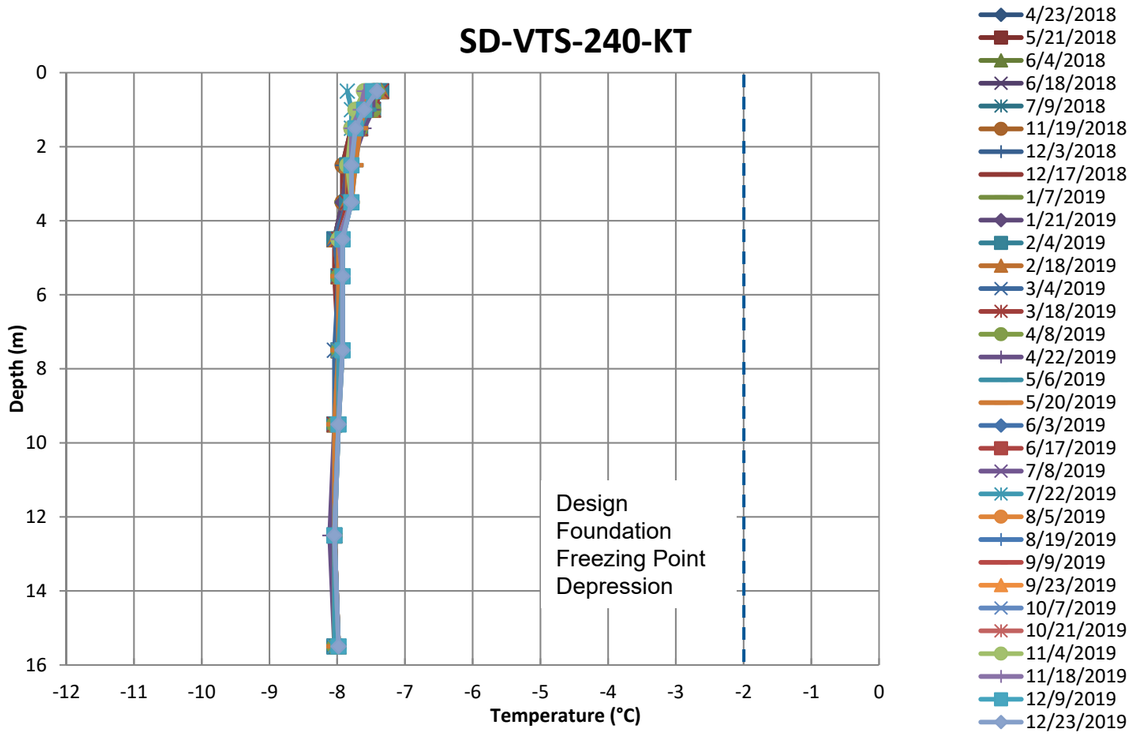
Notes:

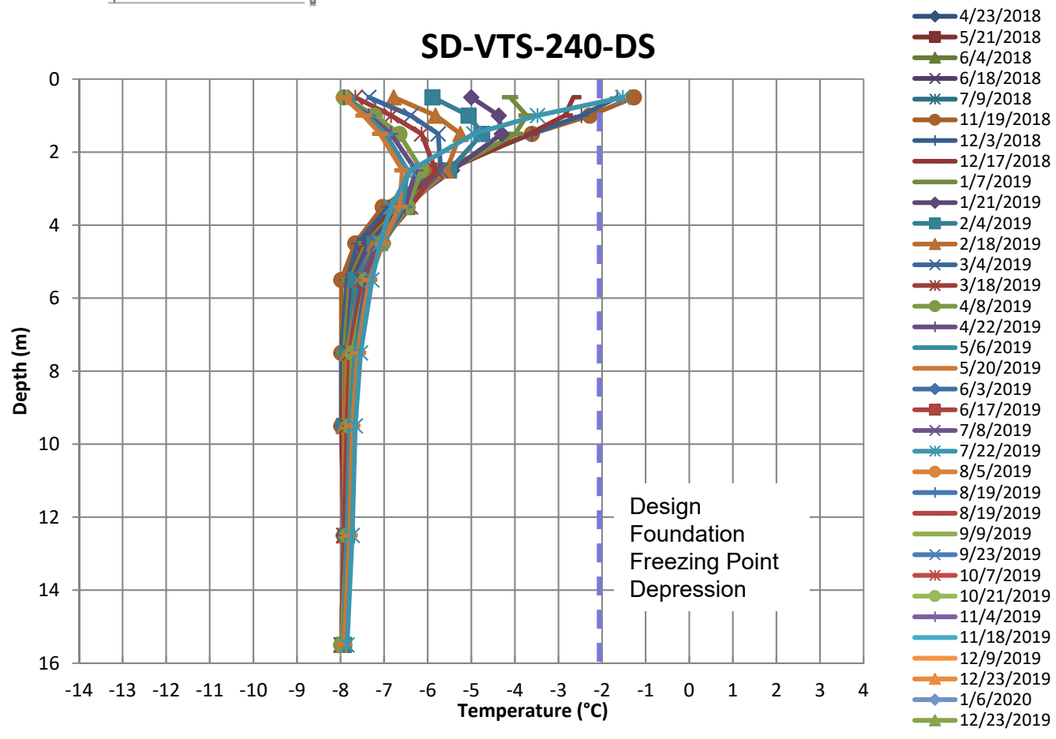
- Bead numbers increase from upstream to downstream (horizontal) and top to bottom (vertical)
- **(A)** Measurements collected between April and August 2018 were taken during construction
- **(B)** No measurements were collected between September 2018 to November 2018 as the data loggers were set up on site.
- **(C)** From November 2018 onwards, data loggers were installed and placed on site, providing higher resolution and more frequent data transmissions.
- **(D)** No data collected between May 31, 2019 and June 13, 2019
- **(E)** Data readings ended in October 2019
- **(F)** No readings, cable was damaged and repaired in June 2019.

srk consulting	MAC RESOURCES	2019 AGI - South Dam
		Station 2+40 **Vertical Ground Temperature Cable Temperature Vs. Time**
Job No: 1CT022.038 Filename: AppB_1CT022.038_SD_GTC	**DORIS TIA**	Date: Mar. 2020 / Approved: AB / Figure: **B.24**





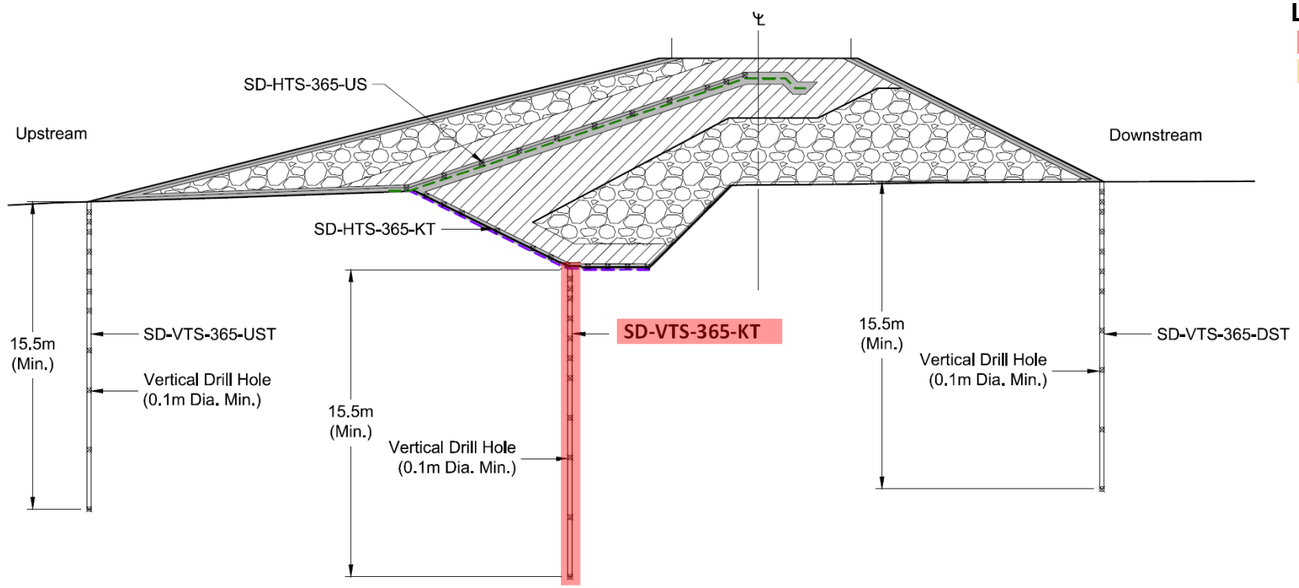




Note:

- Legend represents full monitoring year. Only dates with available data are shown on chart
- No data collected between September 16, 2018 to November 6, 2018
- No data collected between May 31, 2019 and June 13, 2019
- Data readings ended on October 22, 2019 for SD-VTS-240-DS

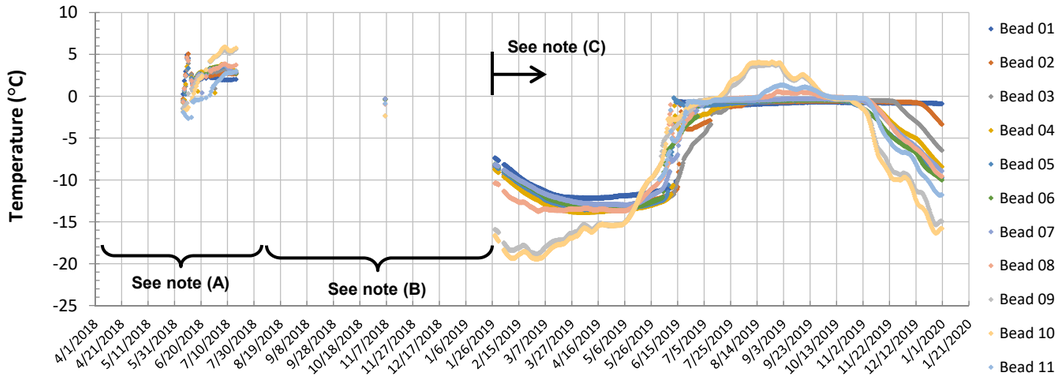
srk consulting	TMAC RESOURCES	2019 AGI - South Dam
		South Dam Station 2+40 Ground Temperature Cable Readings by Location
Job No: 1CT022.038 Filename: AppB_1CT022.038_SD_GTC	**Doris TIA**	Date: Mar. 2020 / Approved: PL / Figure: **B.210**



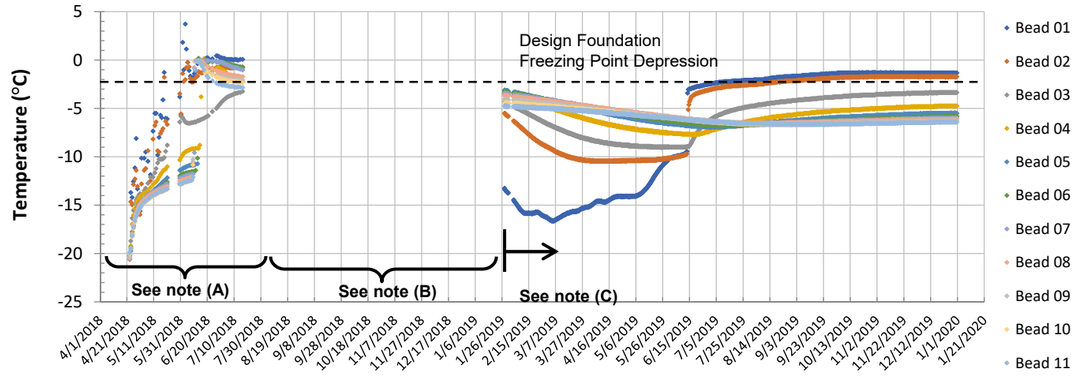
Legend:

- GTC Status: Cable irreparably damaged
- GTC Status: Bead damaged or data missing

SD-HTS-365-US



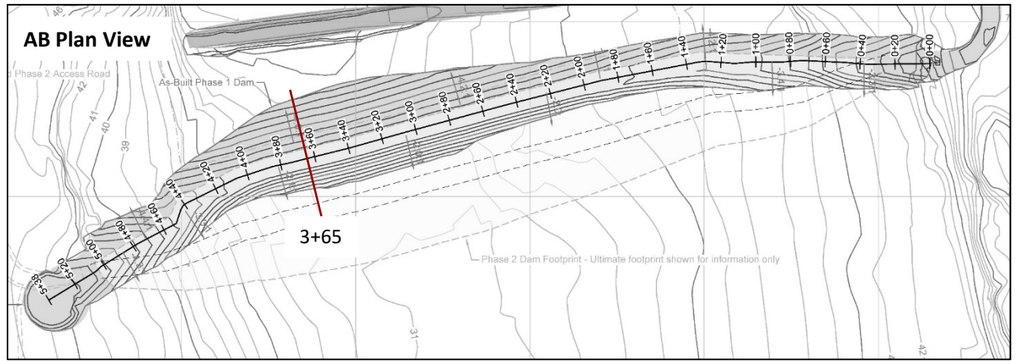
SD-HTS-365-KT

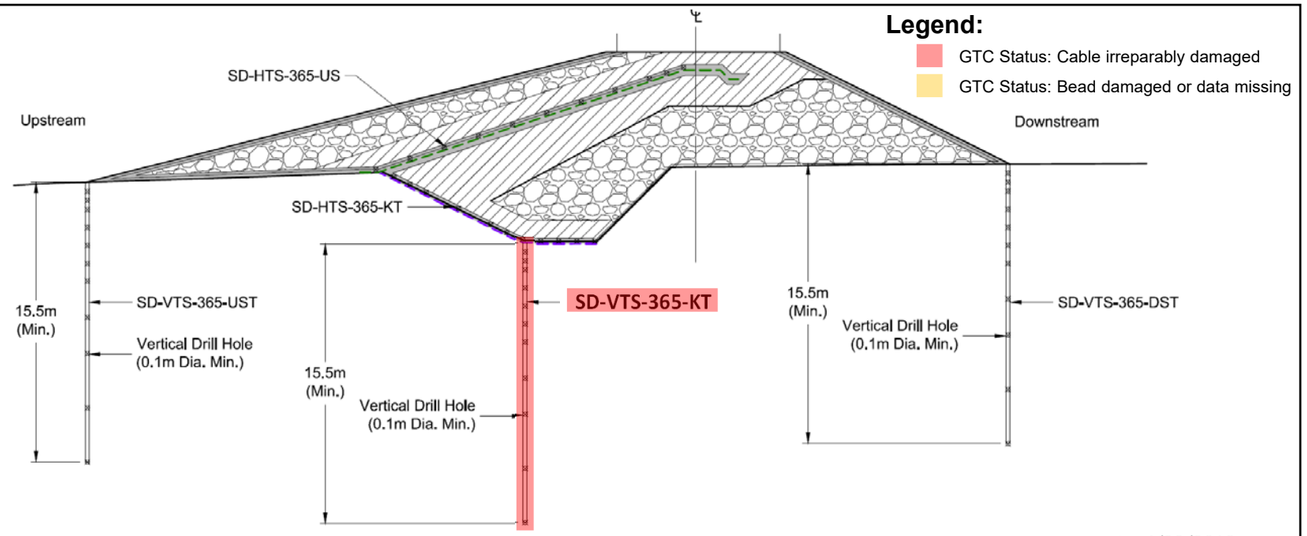


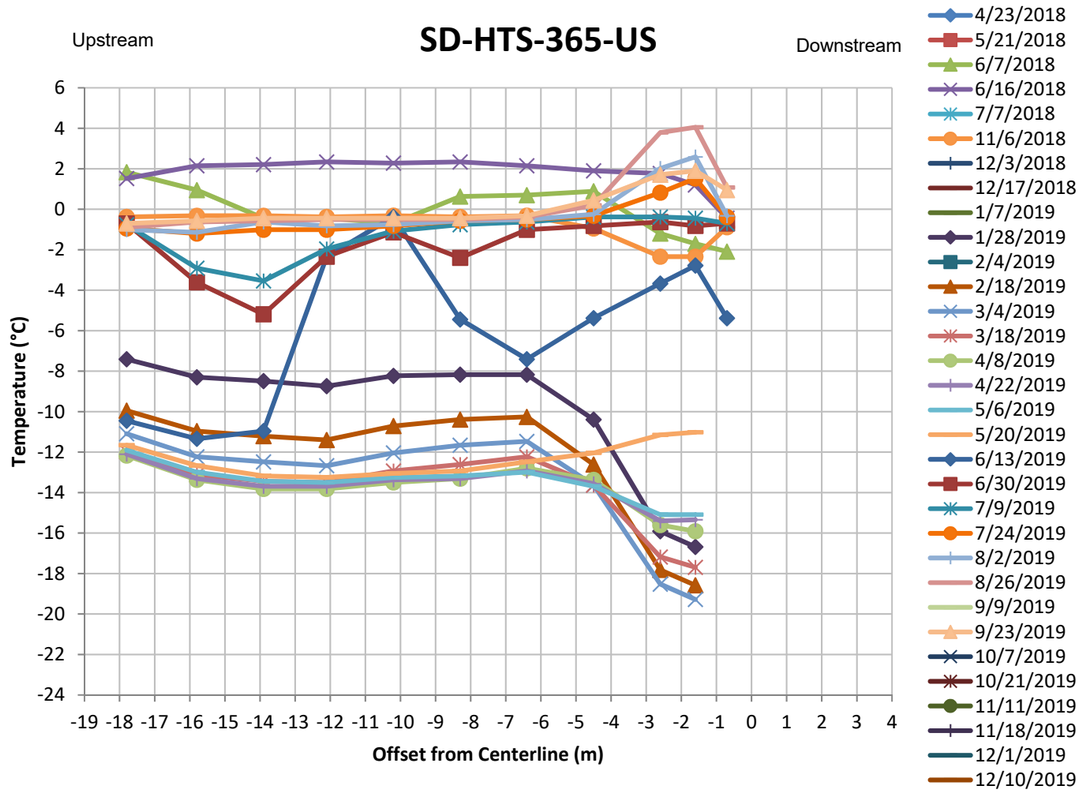
Notes:

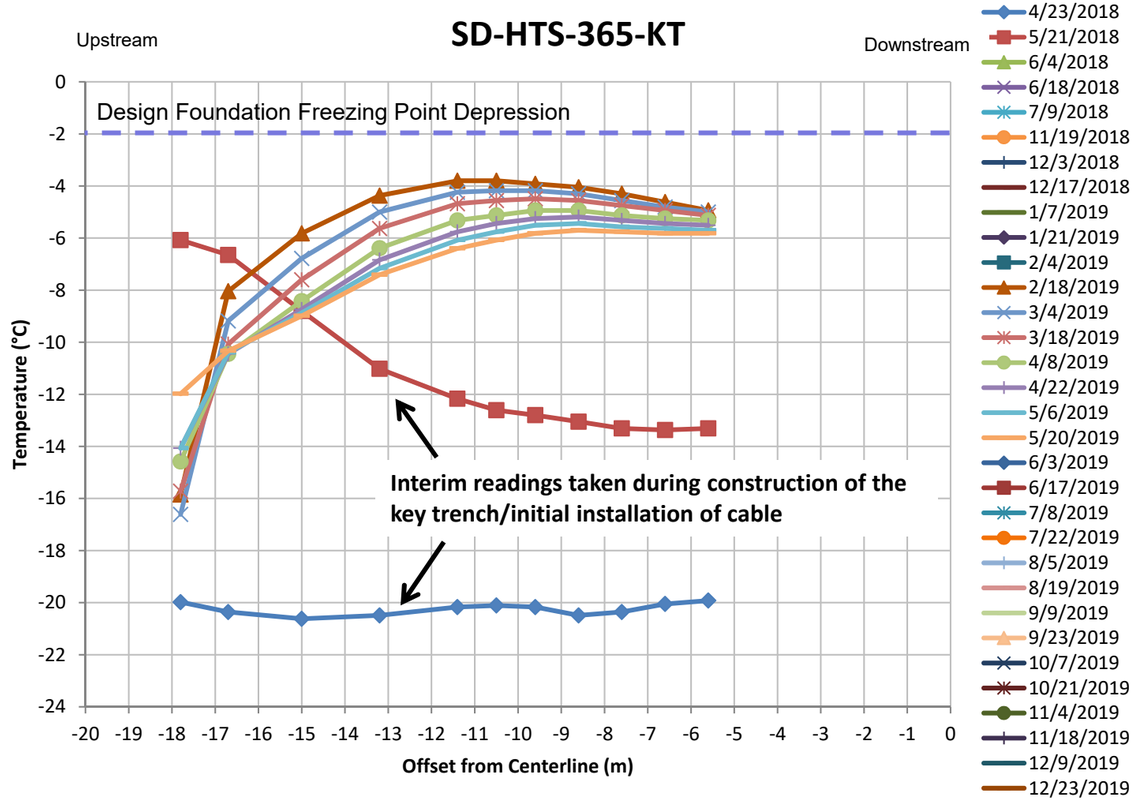
- Bead numbers increase from upstream to downstream (horizontal) and top to bottom (vertical)
- **(A)** Measurements collected between April and August 2018 were taken during construction
- **(B)** No measurements were collected between September 2018 to late January 2019 as the GTC's were extended and repaired, and the data loggers were set up on site. One set of manual spot measurements were collected for some cables in November 2018 to check interim dam performance.
- **(C)** From the end of January 2019 onwards, data loggers were installed and placed on site, providing higher resolution and more frequent data transmissions.

srk consulting	TMAC RESOURCES	2019 AGI - South Dam
Job No: 1CT022.038 Filename: AppB_1CT022.038_SD_GTC	DORIS TIA	**Station 3+65** **Horizontal Ground Temperature** **Cable Temperature Vs. Time**
		Date: Mar. 2020 / Approved: AB / Figure: **B.26**





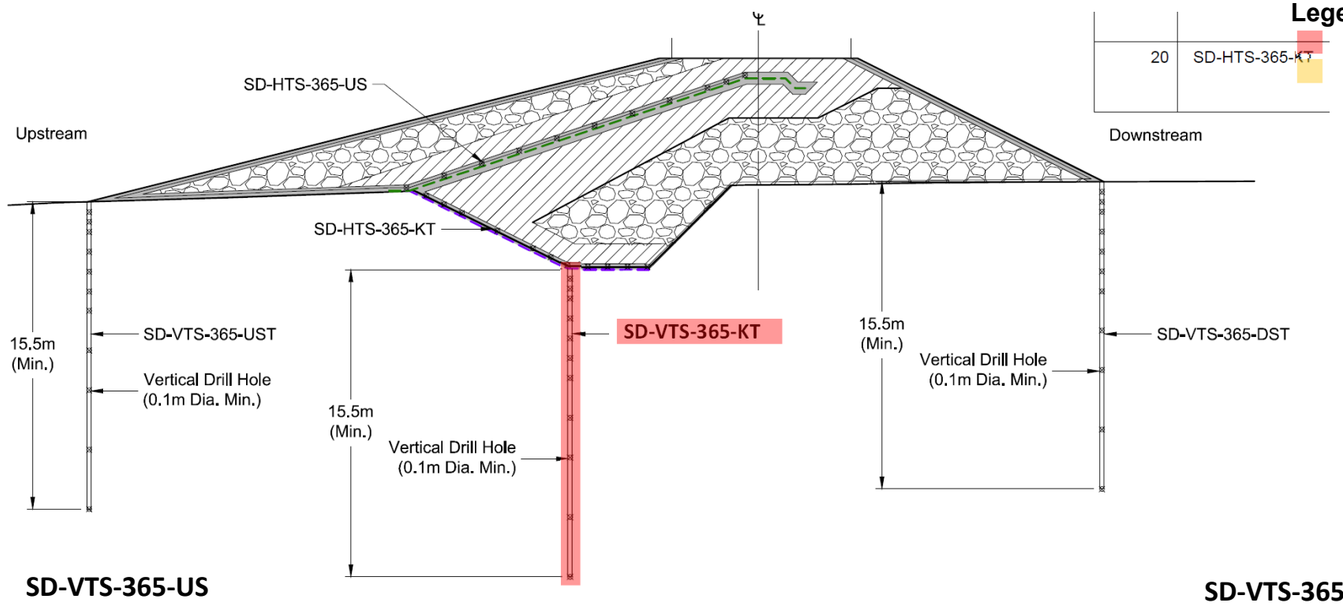




Note:

- Legend represents full monitoring year. Only dates with available data are shown on chart
- No data collected between September 16, 2018 to January 28, 2019

srk consulting	MAC RESOURCES	2019 AGI - South Dam
		South Dam Station 3+65 Ground Temperature Cable Readings by Location
Job No: 1CT022.038 Filename: AppB_1CT022.038_SD_GTC	**Doris TIA**	Date: Mar. 2020 / Approved: PL / Figure: **B.27**

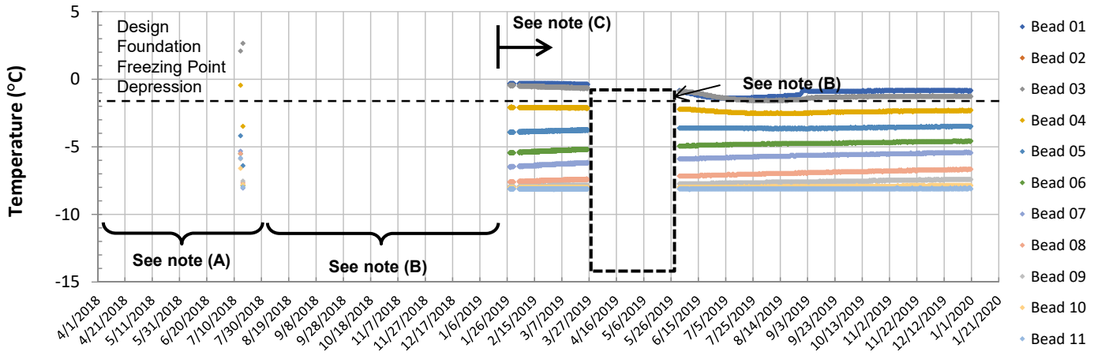


Legend:

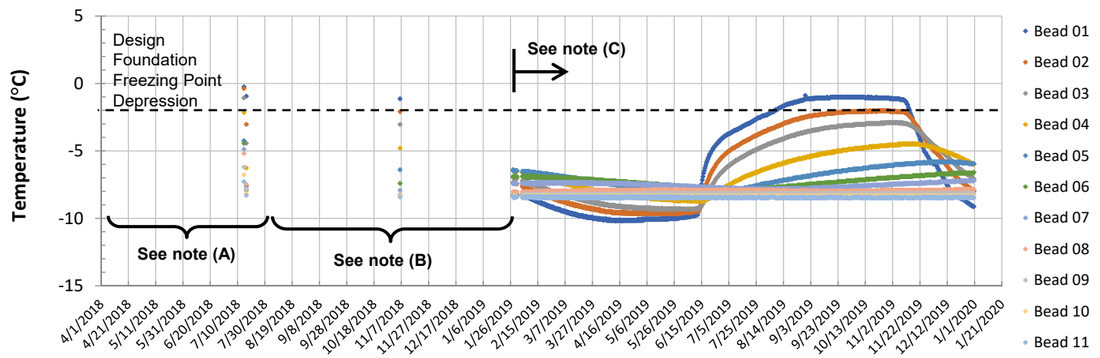
GTC Status: Cable irreparably damaged

GTC Status: Bead damaged or data missing

SD-VTS-365-US



SD-VTS-365-DS



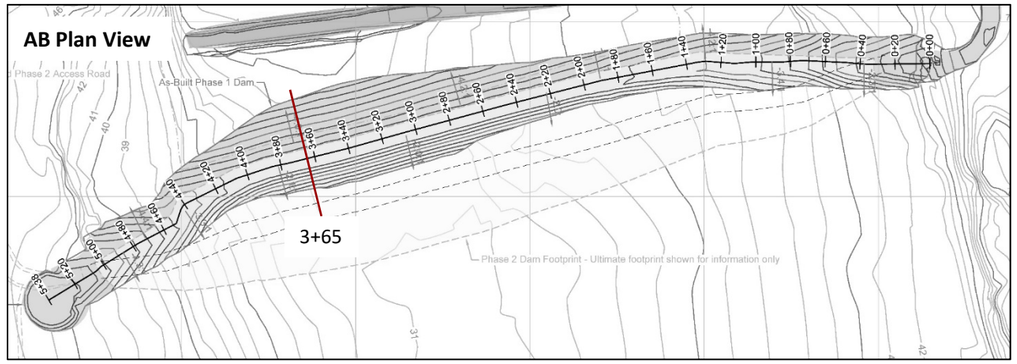
SD-VTS-365-KT

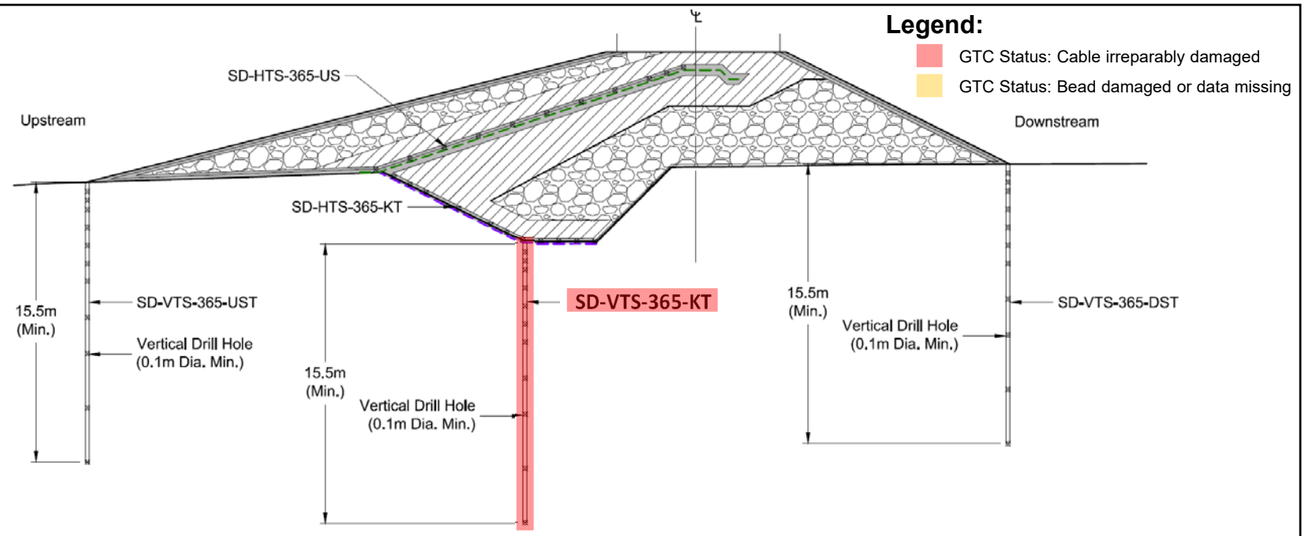


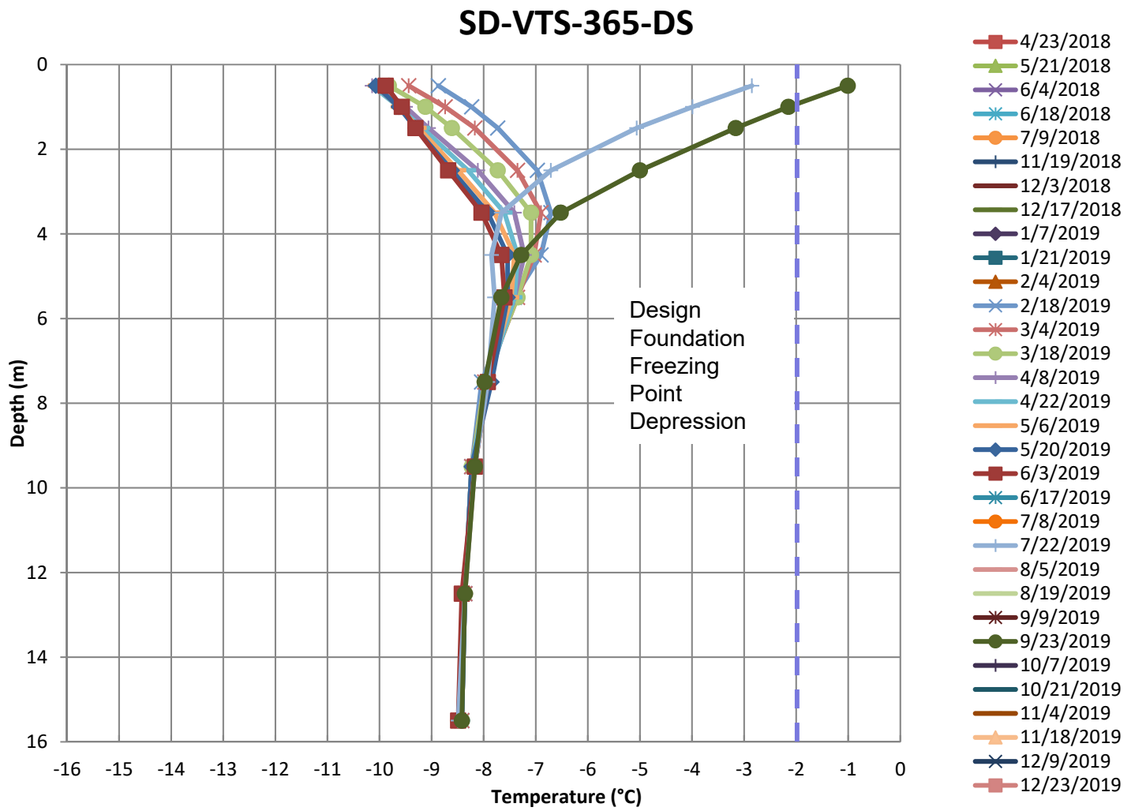
Notes:

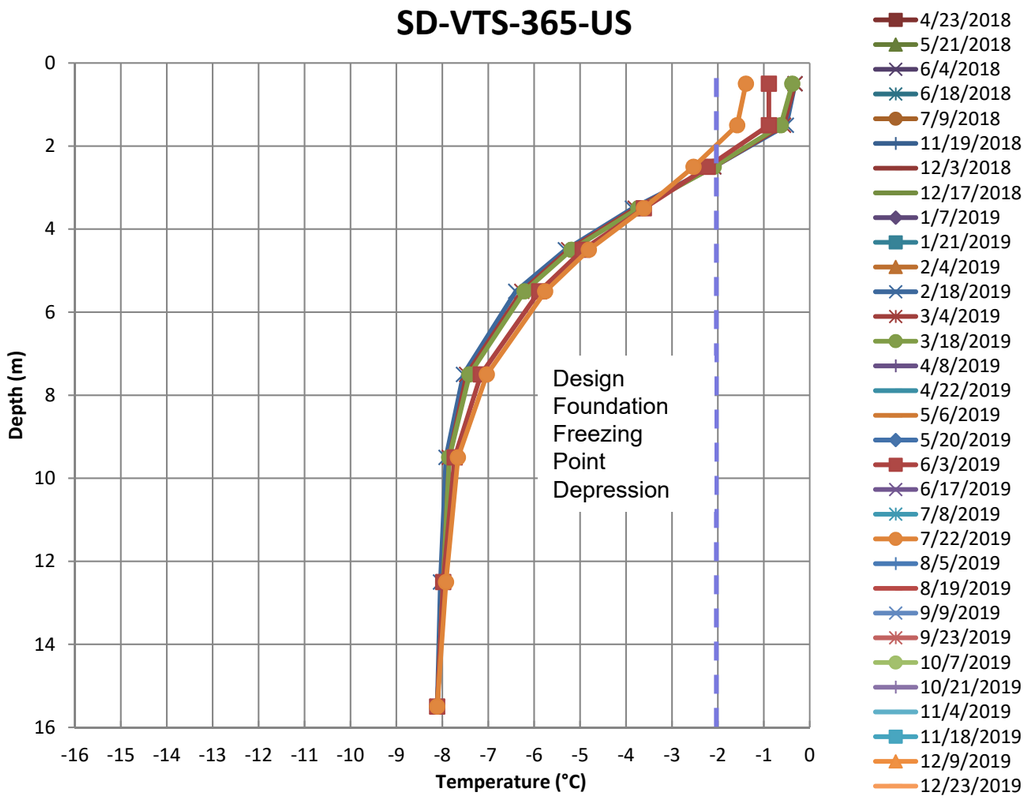
- Bead numbers increase from upstream to downstream (horizontal) and top to bottom (vertical)
- SD-VTS-365-US cable damaged after construction but repaired
- SD-VTS-365-KT irreparably damaged after construction
- **(A)** Measurements collected between April and August 2018 were taken during construction
- **(B)** No measurements were collected between September 2018 to late January 2019 as the GTC's were extended and repaired, and the data loggers were set up on site. One set of manual spot measurements were collected for some cables in November 2018 to check interim dam performance.
- **(C)** From the end of January 2019 onwards, data loggers were installed and placed on site, providing higher resolution and more frequent data transmissions.

srk consulting	TMAC RESOURCES	2019 AGI - South Dam
		Station 3+65 **Vertical Ground Temperature Cable** **Temperature Vs. Time**
Job No: 1CT022.038 Filename: AppB_1CT022.038_SD_GTC	**DORIS TIA**	Date: Mar. 2020 / Approved: AB / Figure: **B.28**









Note:

- Legend represents full monitoring year. Only dates with available data are shown on chart
- No data collected between September 16, 2018 to January 27, 2019. One reading recorded for SD-VTS-365-DS on November 6, 2018.
- No data collected for SD-VTS-365-US between March 25, 2019 and June 1, 2019

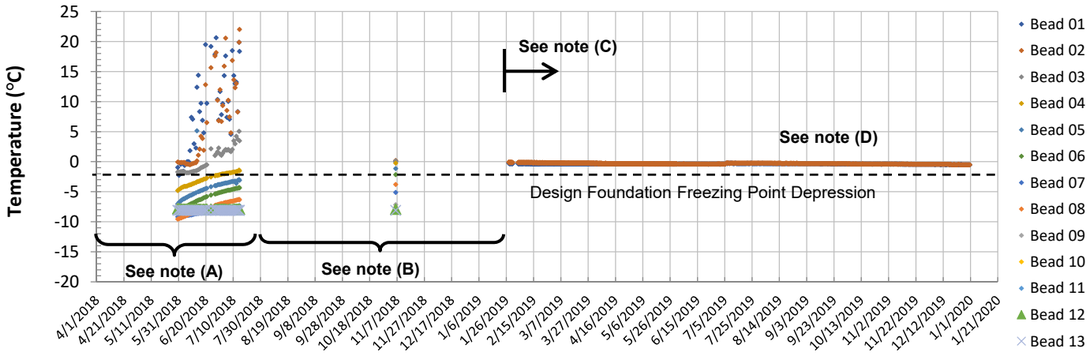
srk consulting	TMAC RESOURCES	2019 AGI - South Dam
		South Dam Station 3+65 Ground Temperature Cable Readings by Location
Job No: 1CT022.038 Filename: AppB_1CT022.038_SD_GTC	**Doris TIA**	Date: Mar. 2020 / Approved: PL / Figure: **B.29**

Legend:

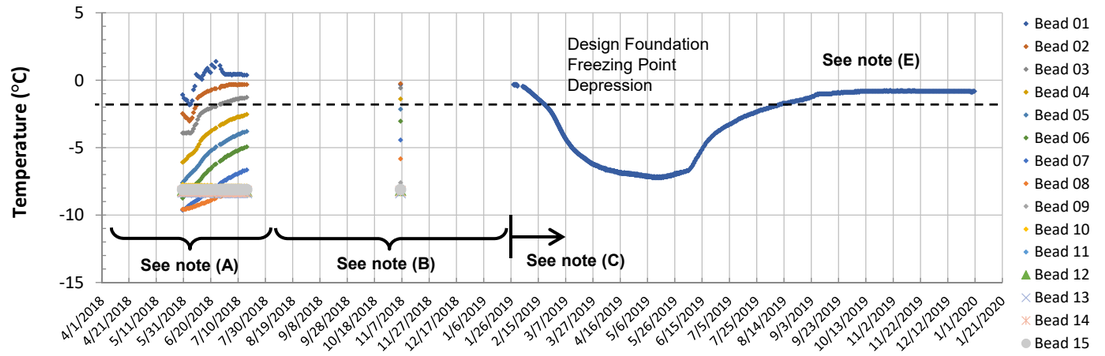
GTC Status: Cable irreparably damaged

GTC Status: Bead damaged or data missing

SD-VTS-US1



SD-VTS-US2

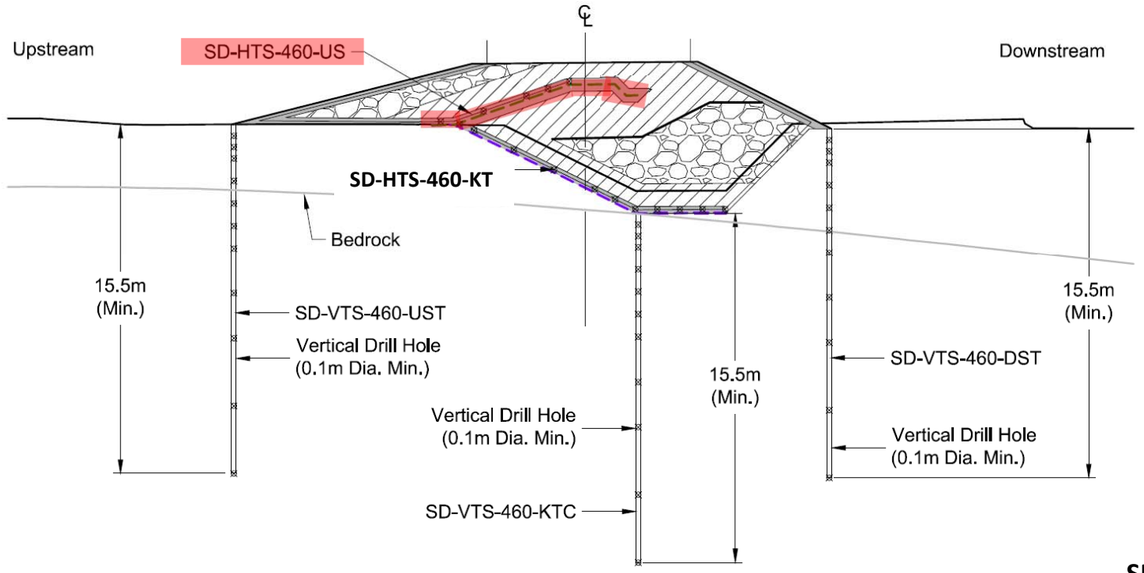


Notes:

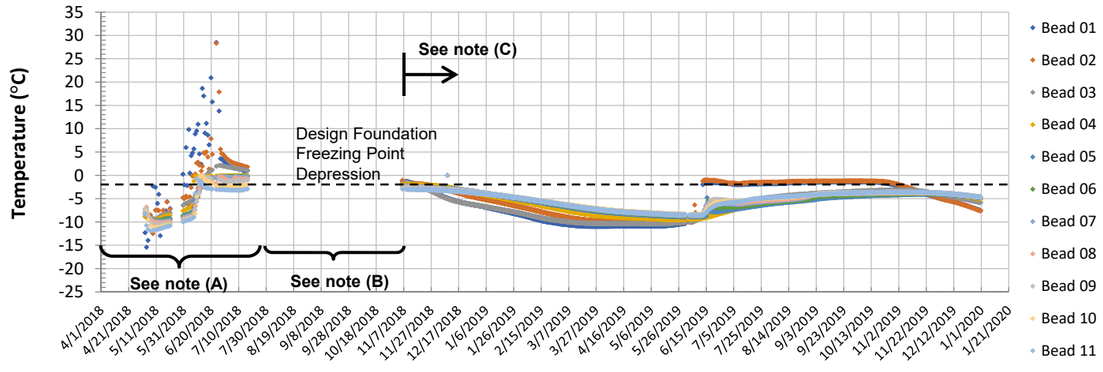
- Bead numbers increase from upstream to downstream (horizontal) and top to bottom (vertical)
- **(A)** Measurements collected between April and August 2018 were taken during construction
- **(B)** No measurements were collected between September 2018 to late January 2019 as the GTC's were extended and repaired, and the data loggers were set up on site. One set of manual spot measurements were collected in November 2018 to check interim dam performance
- **(C)** From the end of January 2019 onwards, data loggers were installed and placed on site, providing higher resolution and more frequent data transmissions
- **(D)** Only top two beads are working (Bead 01 and Bead 02) for SD-VTS-US1
- **(E)** Only top bead working (Bead 01) for SD-VTS-US2

srk consulting	TMAC RESOURCES	2019 AGI - South Dam
		Station 3+65 **Vertical Ground Temperature Cable** **Temperature Vs. Time**
Job No: 1CT022.038 Filename: AppB_1CT022.038_SD_GTC	**DORIS TIA**	Date: Mar. 2020 | Approved: AB | Figure: **B.30**

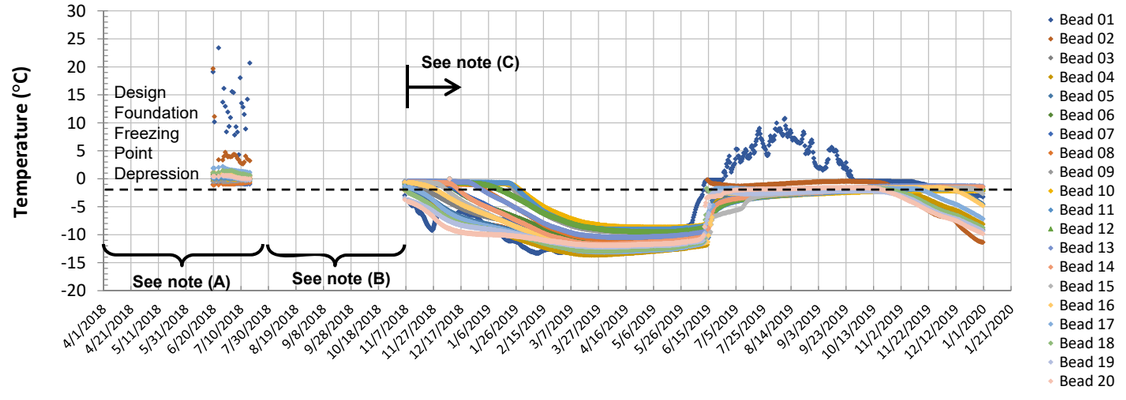
Legend:
- GTC Status: Cable irreparably damaged
- GTC Status: Bead damaged or data missing



SD-HTS-460-KT



SD-HTS-B1-KT



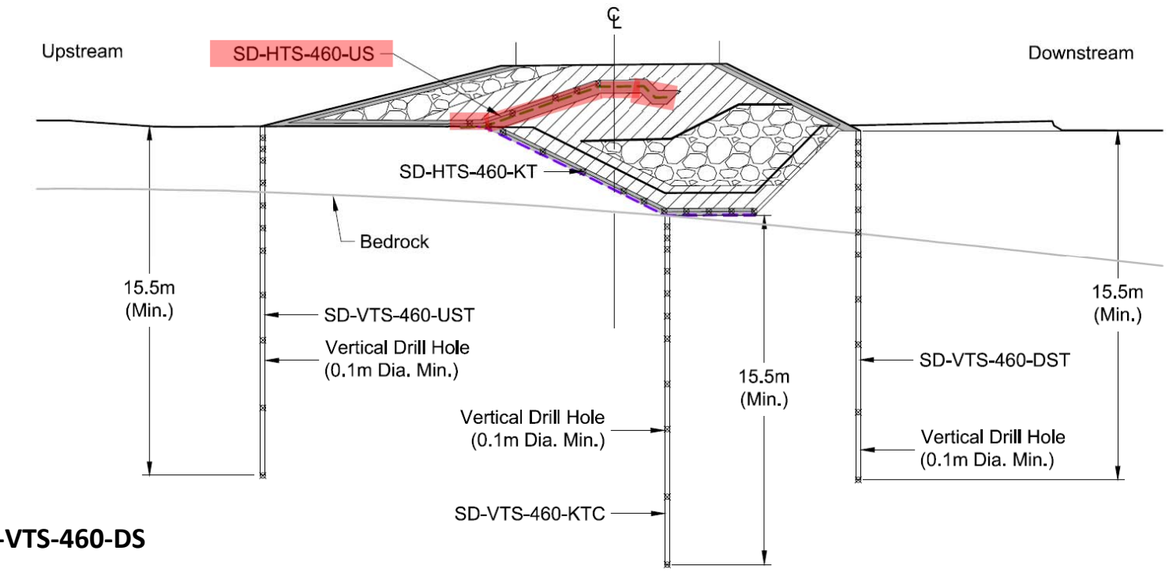
SD-HTS-460-US



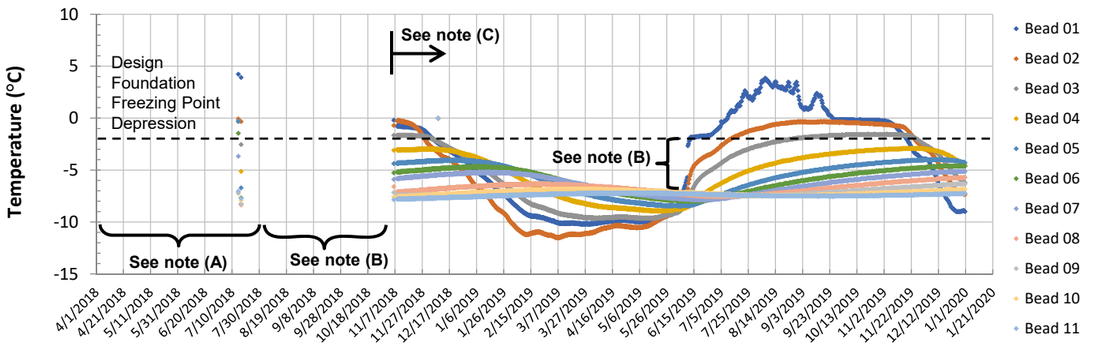
Notes:
- Bead numbers increase from upstream to downstream (horizontal) and top to bottom (vertical)
- SD-HTS-B1-KT is located along upstream crest of key trench (not shown in drawing)
- **(A)** Measurements collected between April and August 2018 were taken during construction
- **(B)** No measurements were collected between September 2018 to November 2018 as the GTC's were extended and repaired, and the data loggers were set up on site.
- **(C)** From November 2018 onwards, data loggers were installed and placed on site, providing higher resolution and more frequent data transmissions

srk consulting	TMAC RESOURCES	2019 AGI - South Dam
Job No: 1CT022.038 Filename: AppB_1CT022.038_SD_GTC	DORIS TIA	**Station 4+60** **Horizontal Ground Temperature** **Cable Temperature Vs. Time**
		Date: Mar. 2020 / Approved: AB / Figure: **B.31**

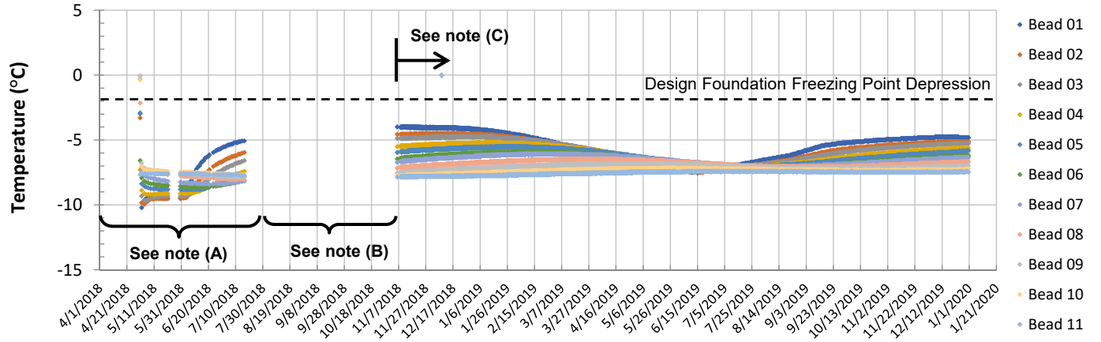
Legend:
- GTC Status: Cable irreparably damaged
- GTC Status: Bead damaged or data missing



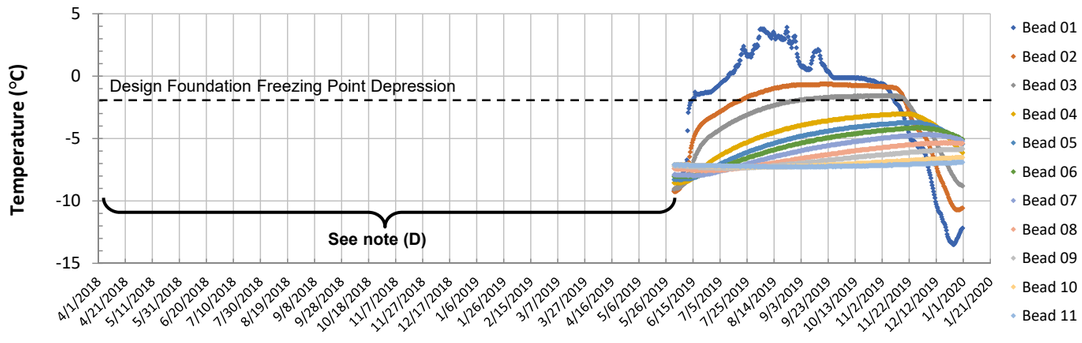
SD-VTS-460-DS



SD-VTS-460-KT

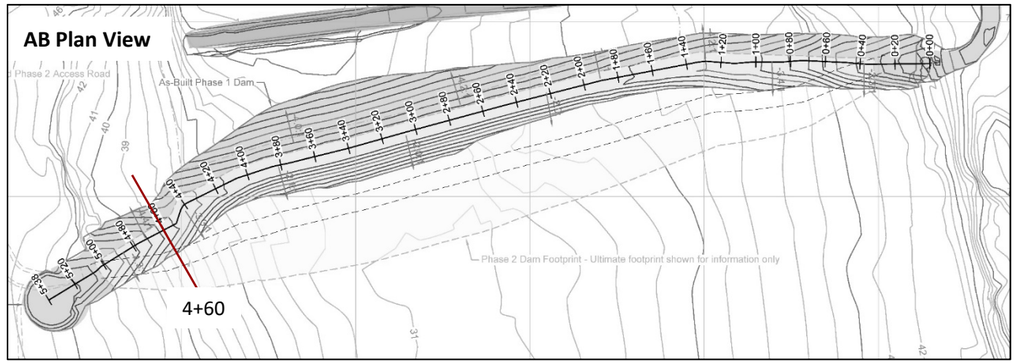


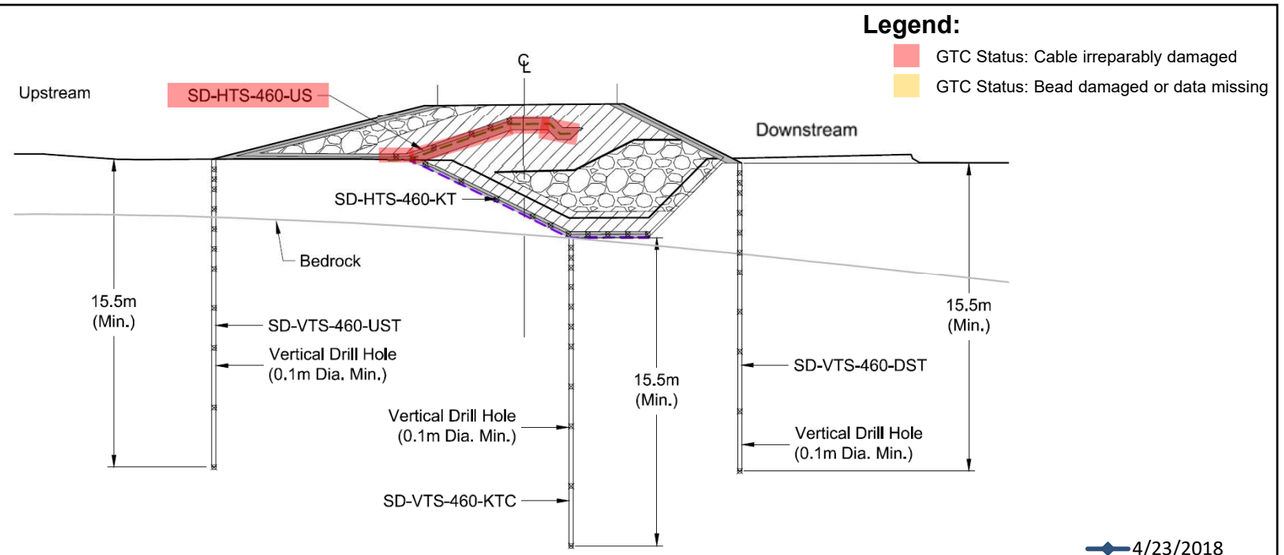
SD-VTS-460-US

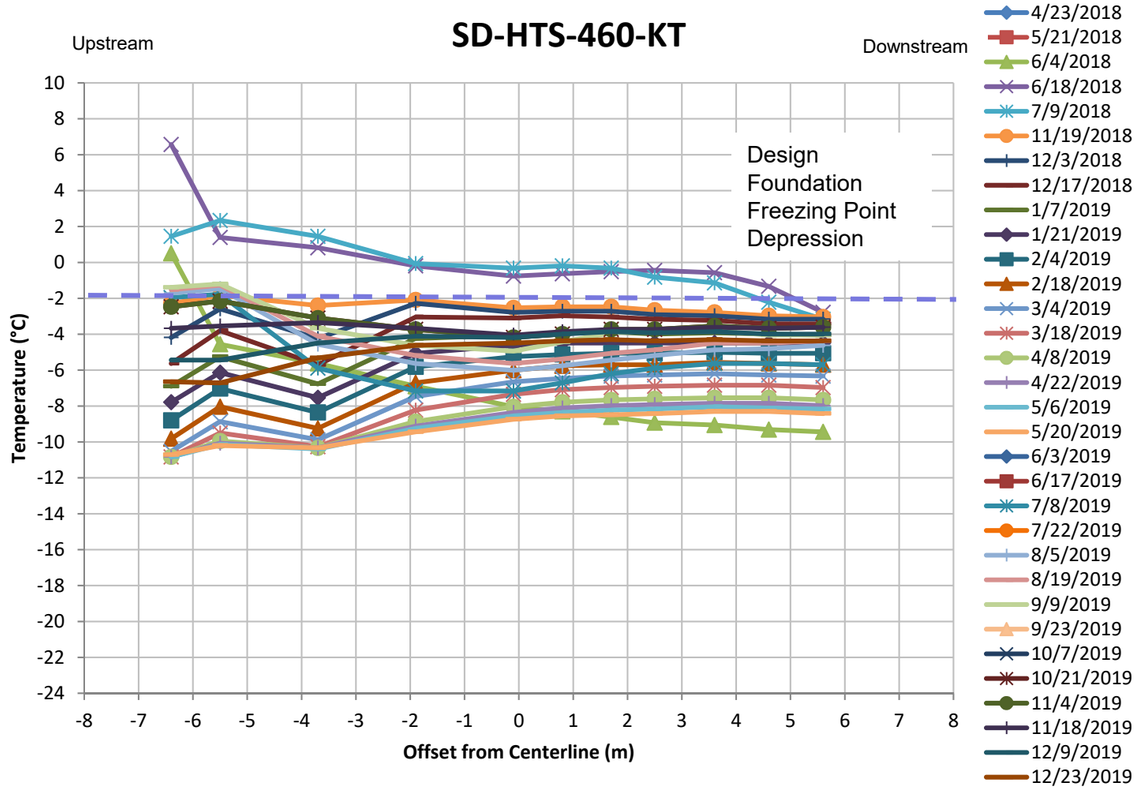


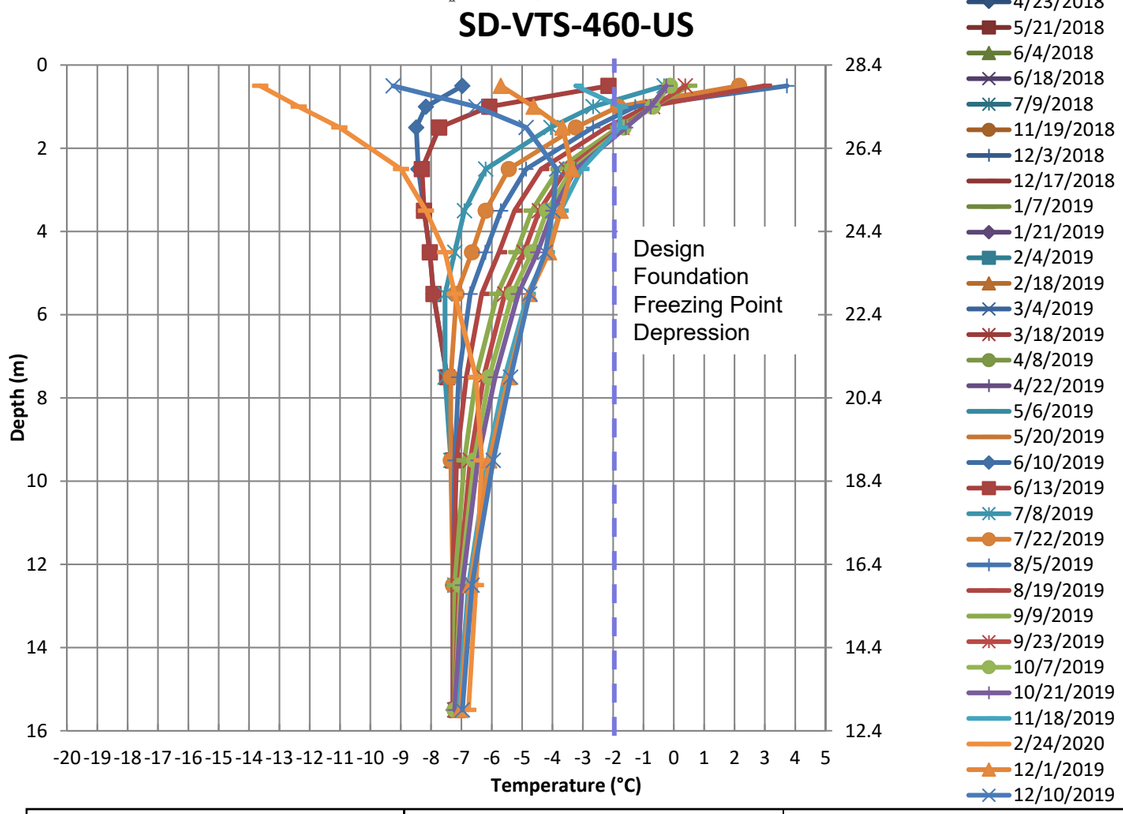
Notes:
- Bead numbers increase from upstream to downstream (horizontal) and top to bottom (vertical)
- **(A)** Measurements collected between April and August 2018 were taken during construction
- **(B)** No measurements were collected between September 2018 to November 2018 as the GTC's were extended and repaired, and the data loggers were set up on site.
- **(C)** From November 2018 onwards, data loggers were installed and placed on site, providing higher resolution and more frequent data transmissions
- **(D)** SD-VTS-460-US cable was damaged after construction but repaired, started transmitting late August 2019.

srk consulting	MAC RESOURCES	2019 AGI - South Dam
		Station 4+60 **Vertical Ground Temperature Cable** **Temperature Vs. Time**
Job No: 1CT022.038 Filename: AppB_1CT022.038_SD_GTC	**DORIS TIA**	Date: Mar. 2020 / Approved: AB / Figure: **B.32**





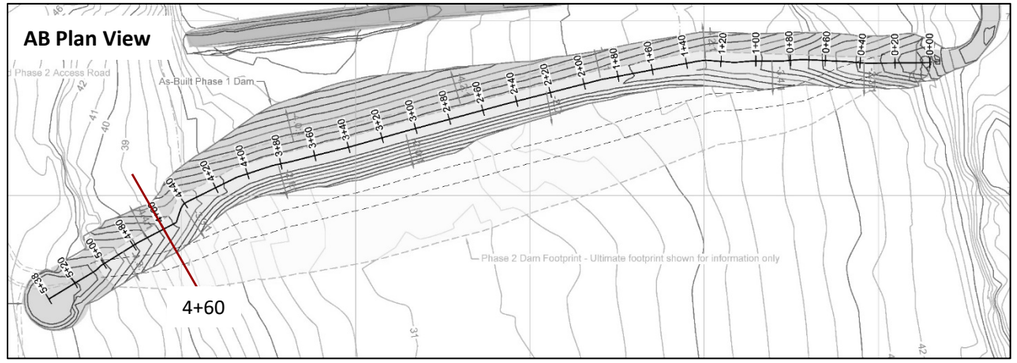


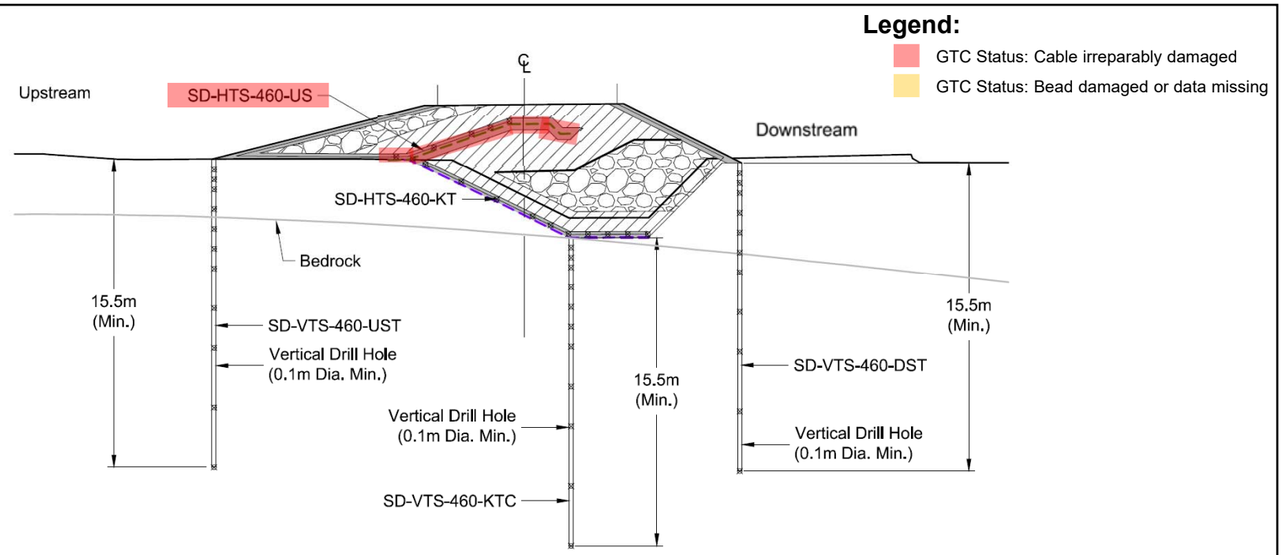


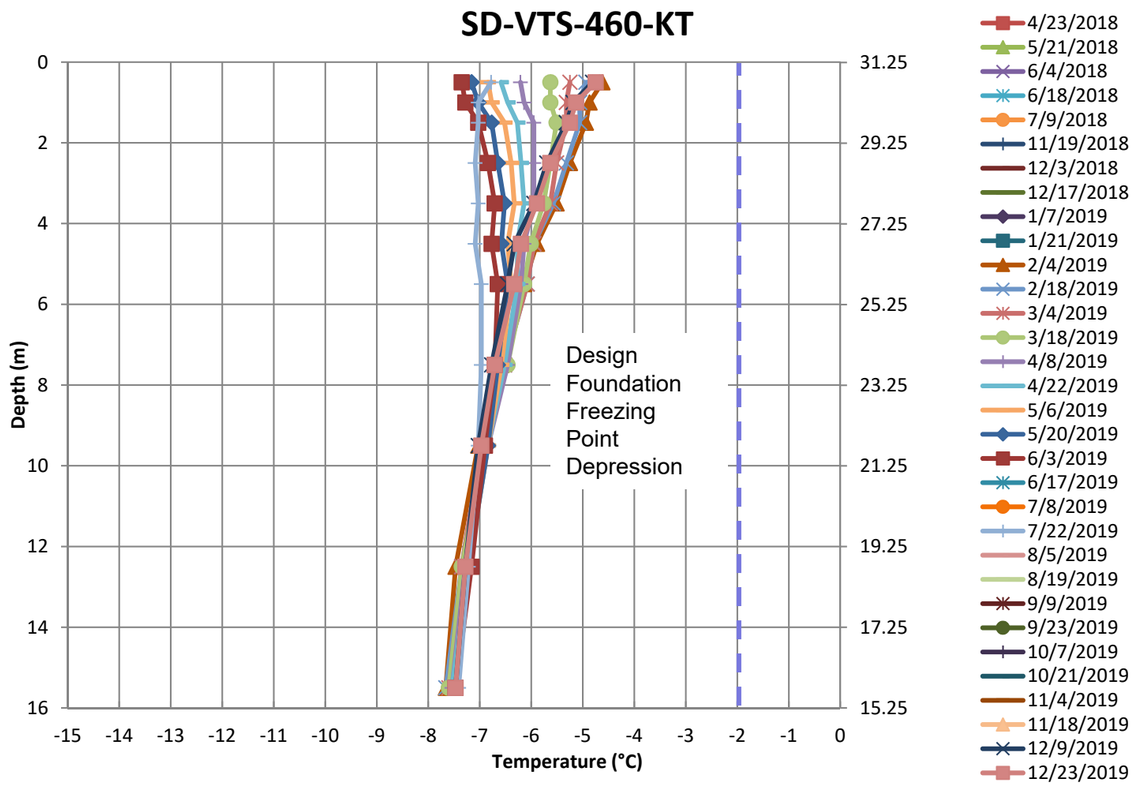
Note:

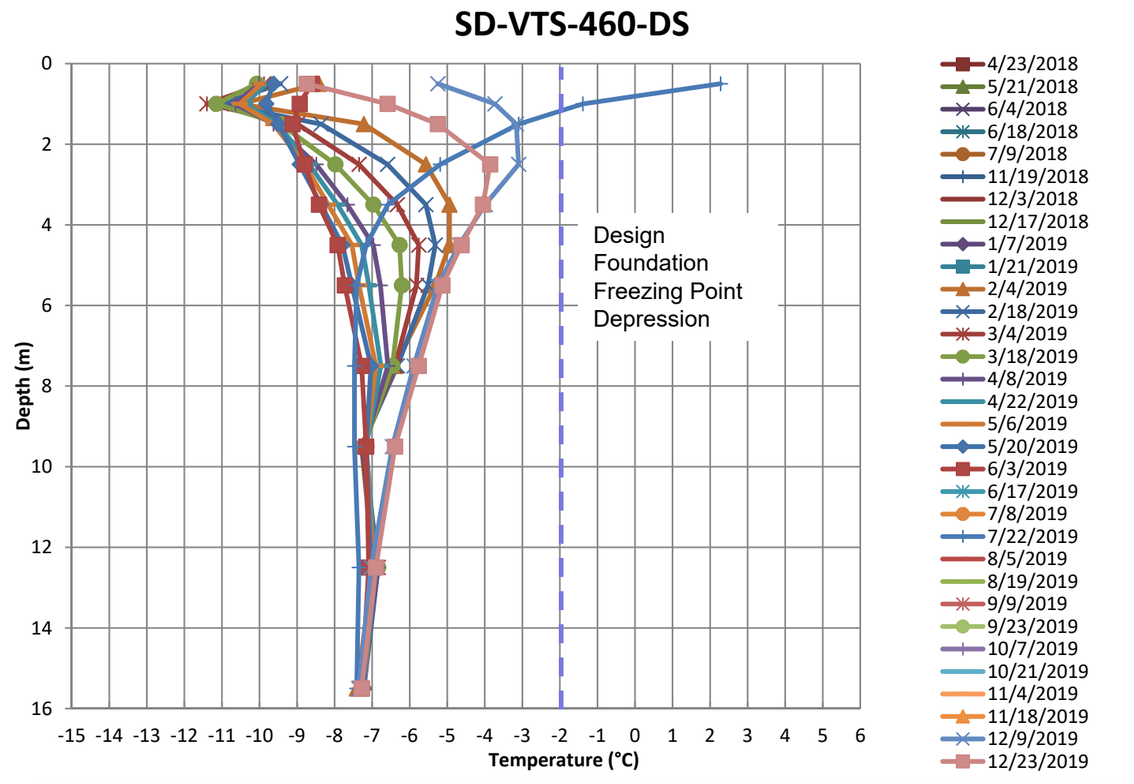
- Legend represents full monitoring year. Only dates with available data are shown on chart
- Bead offset from centerline for SD-HTS-460-US is approximate.
- No data collected between September 16, 2018 and November 6, 2018

srk consulting	TMAC RESOURCES	2019 AGI - South Dam
		South Dam Station 4+60 Ground Temperature Cable Readings by Location
Job No: 1CT022.038 Filename: AppB_1CT022.038_SD_GTC	**Doris TIA**	Date: Mar. 2020 · Approved: PL · Figure: **B.33**







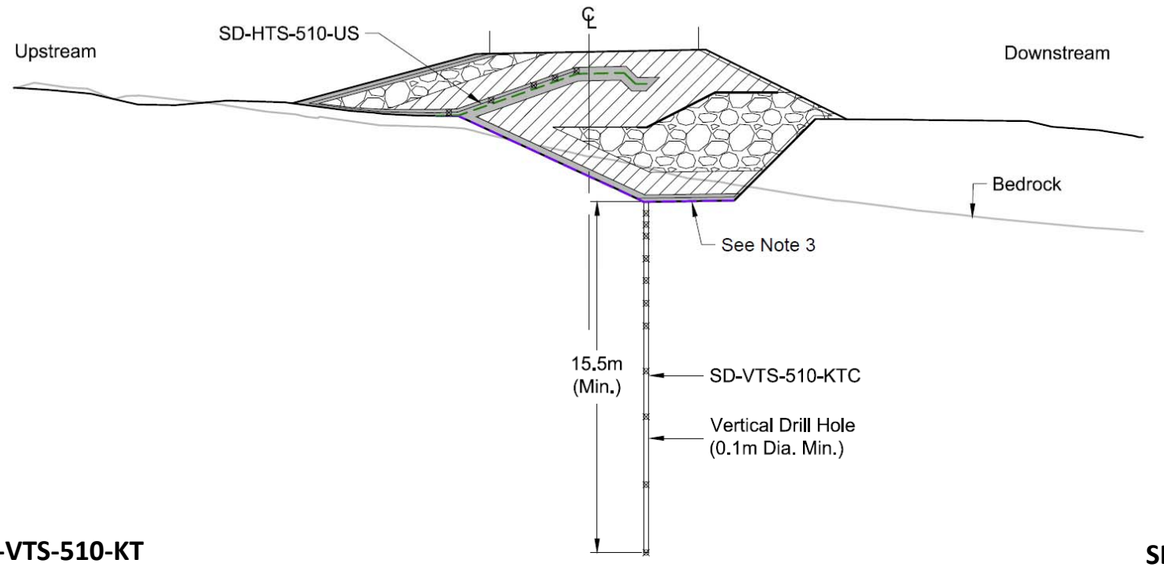


Note:

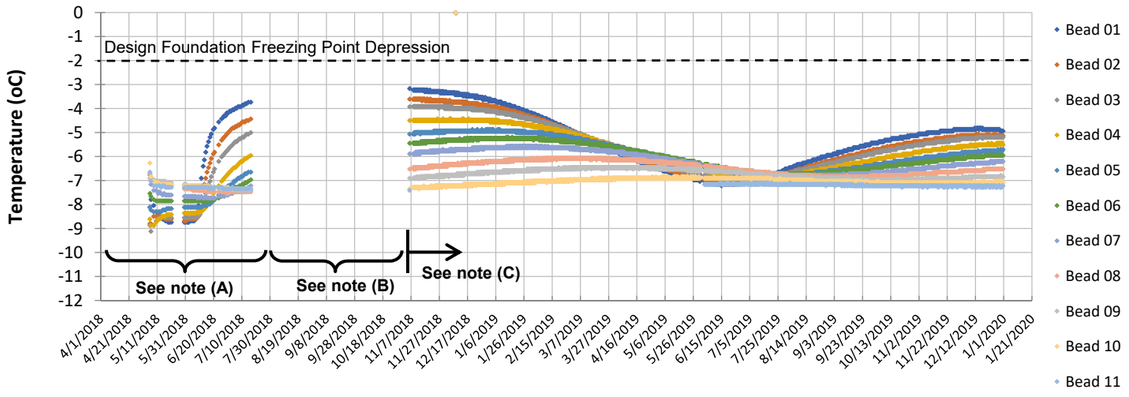
- Legend represents full monitoring year. Only dates with available data are shown on chart
- No data collected between September 16, 2018 and November 6, 2018

srk consulting	TMAC RESOURCES	2019 AGI - South Dam
		South Dam Station 4+60 Ground Temperature Cable Readings by Location
Job No: 1CT022.038 Filename: AppB_1CT022.038_SD_GTC	**Doris TIA**	Date: Mar. 2020 / Approved: PL / Figure: **B.34**

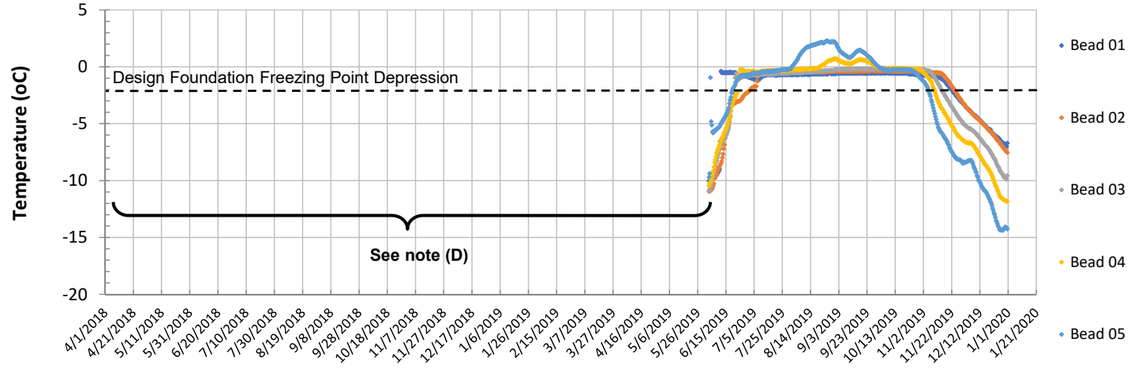
Legend:
- GTC Status: Cable irreparably damaged
- GTC Status: Bead damaged or data missing



SD-VTS-510-KT

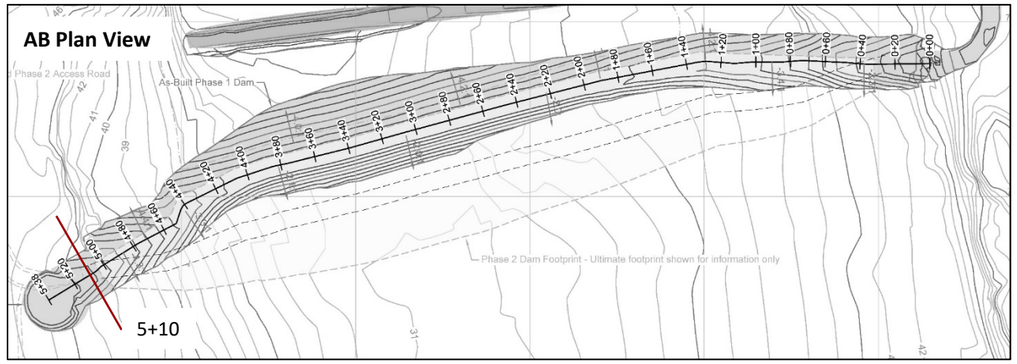


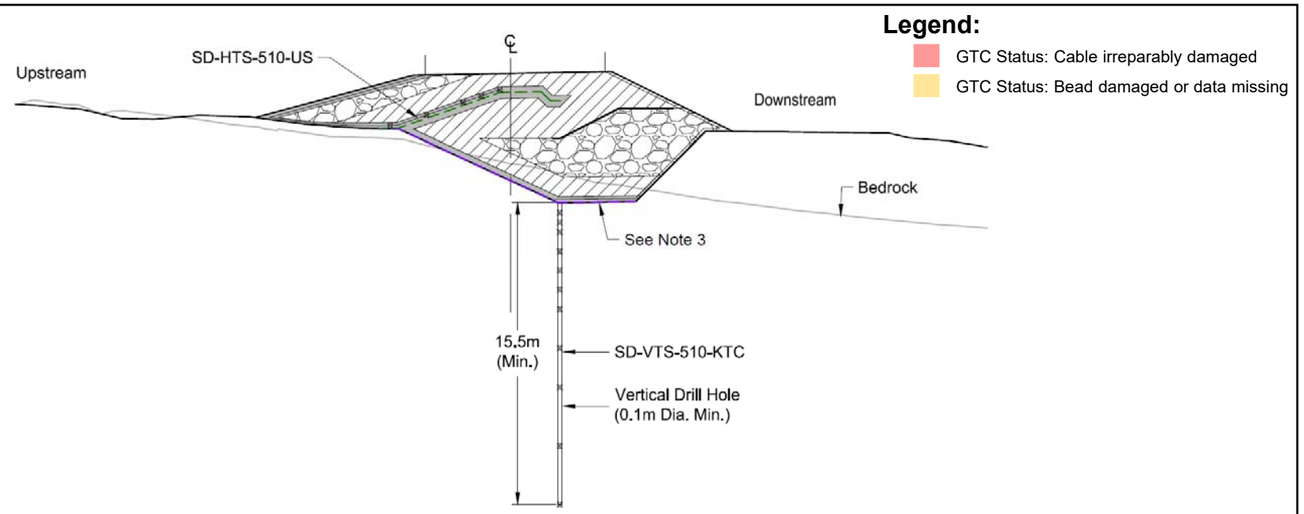
SD-VTS-510-KT

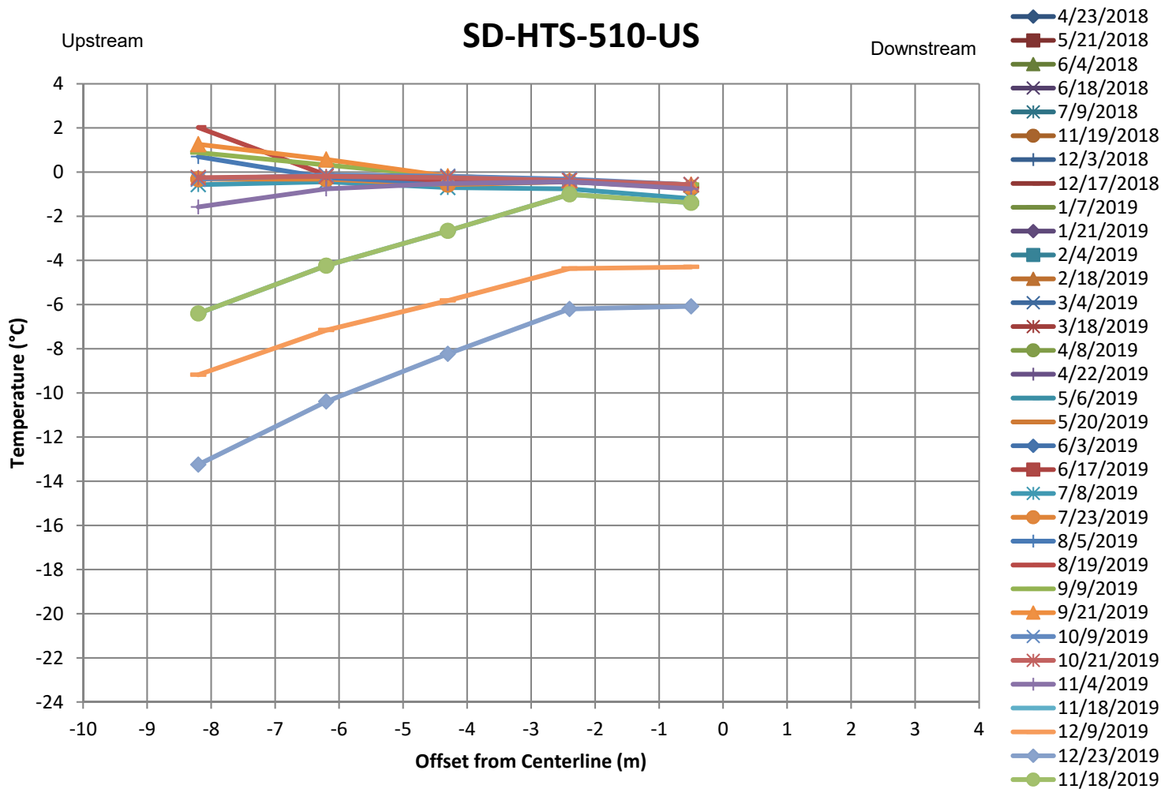


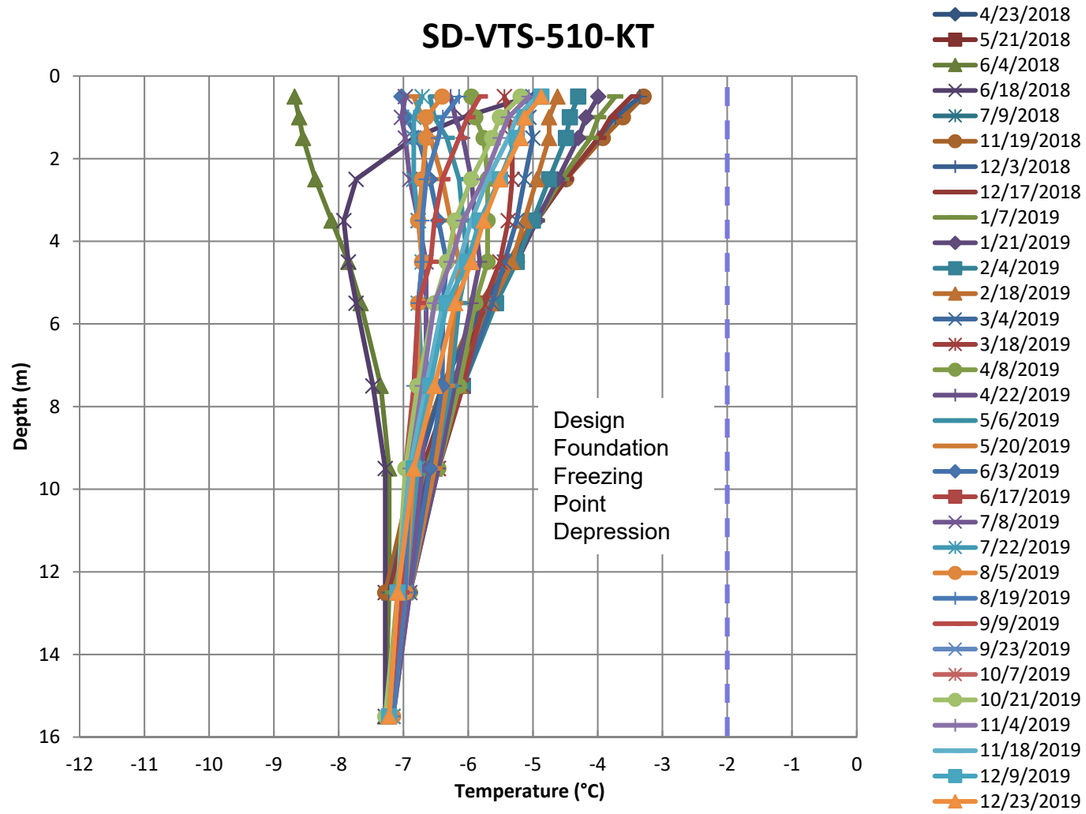
Notes:
- Bead numbers increase from upstream to downstream (horizontal) and top to bottom (vertical)
- **(A)** Measurements collected between April and August 2018 were taken during construction
- **(B)** No measurements were collected between September 2018 to November 2018 as the GTC's were extended and repaired, and the data loggers were set up on site.
- **(C)** From November 2018 onwards, data loggers were installed and placed on site, providing higher resolution and more frequent data transmissions
- **(D)** SD-HTS-510-US cable was damaged after construction but repaired, started transmitting in May 2019

srk consulting	TMAC RESOURCES	2019 AGI - South Dam
		Station 5+10 Ground Temperature Cable Temperature Vs. Time
Job No: 1CT022.038 Filename: AppB_1CT022.038_SD_GTC	**DORIS TIA**	Date: Mar. 2020 / Approved: AB / Figure: **B.35**









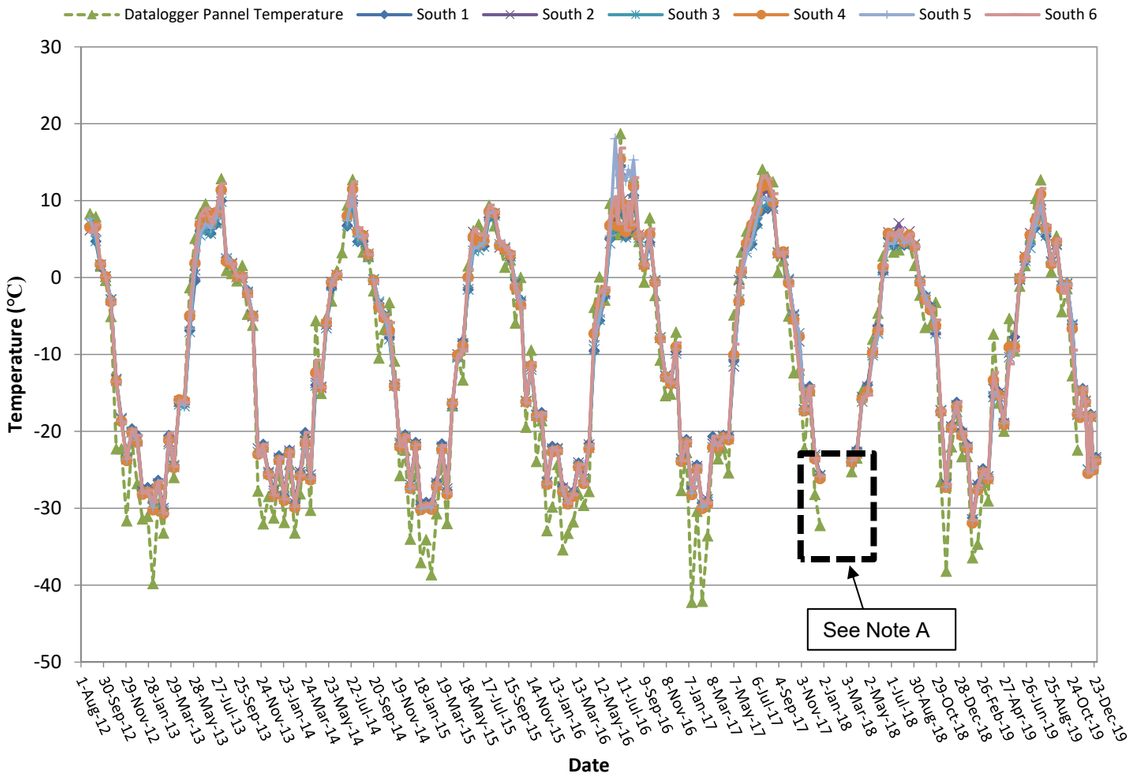
Note:

- Legend represents full monitoring year. Only dates with available data are shown on chart
- No data collected prior to May 2019 for SD-HTS-510-US
- No data collected between September 16, 2018 and November 6, 2018.

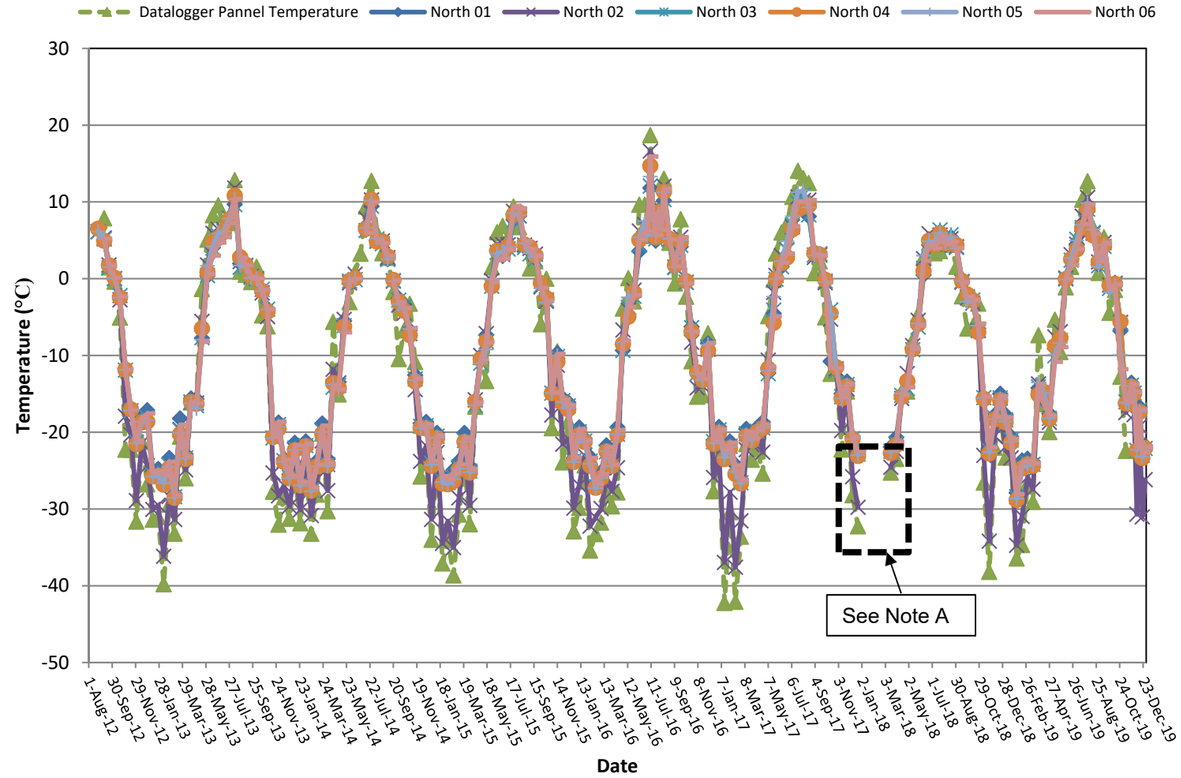
srk consulting	MAC RESOURCES	2019 AGI - South Dam
		South Dam Station 5+10 Ground Temperature Cable Readings by Location
Job No: 1CT022.038 Filename: AppB_1CT022.038_SD_GTC	**Doris TIA**	Date: Mar. 2020 · Approved: PL · Figure: **B.36**

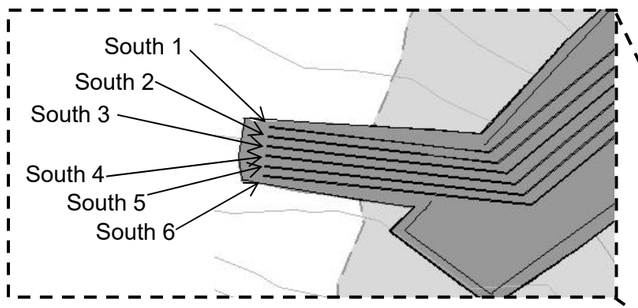
Appendix C – Thermosyphons

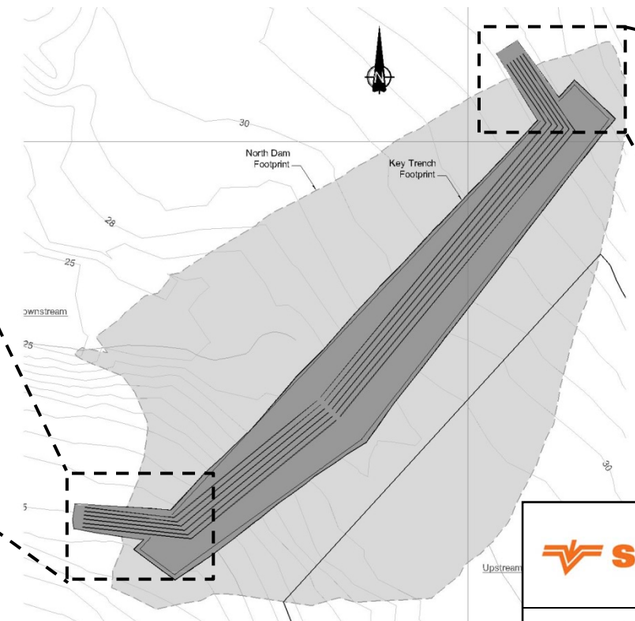
South Thermosyphon Monitoring

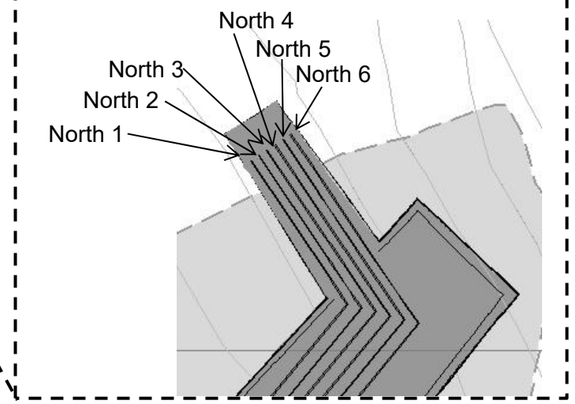


North Thermosyphon Monitoring







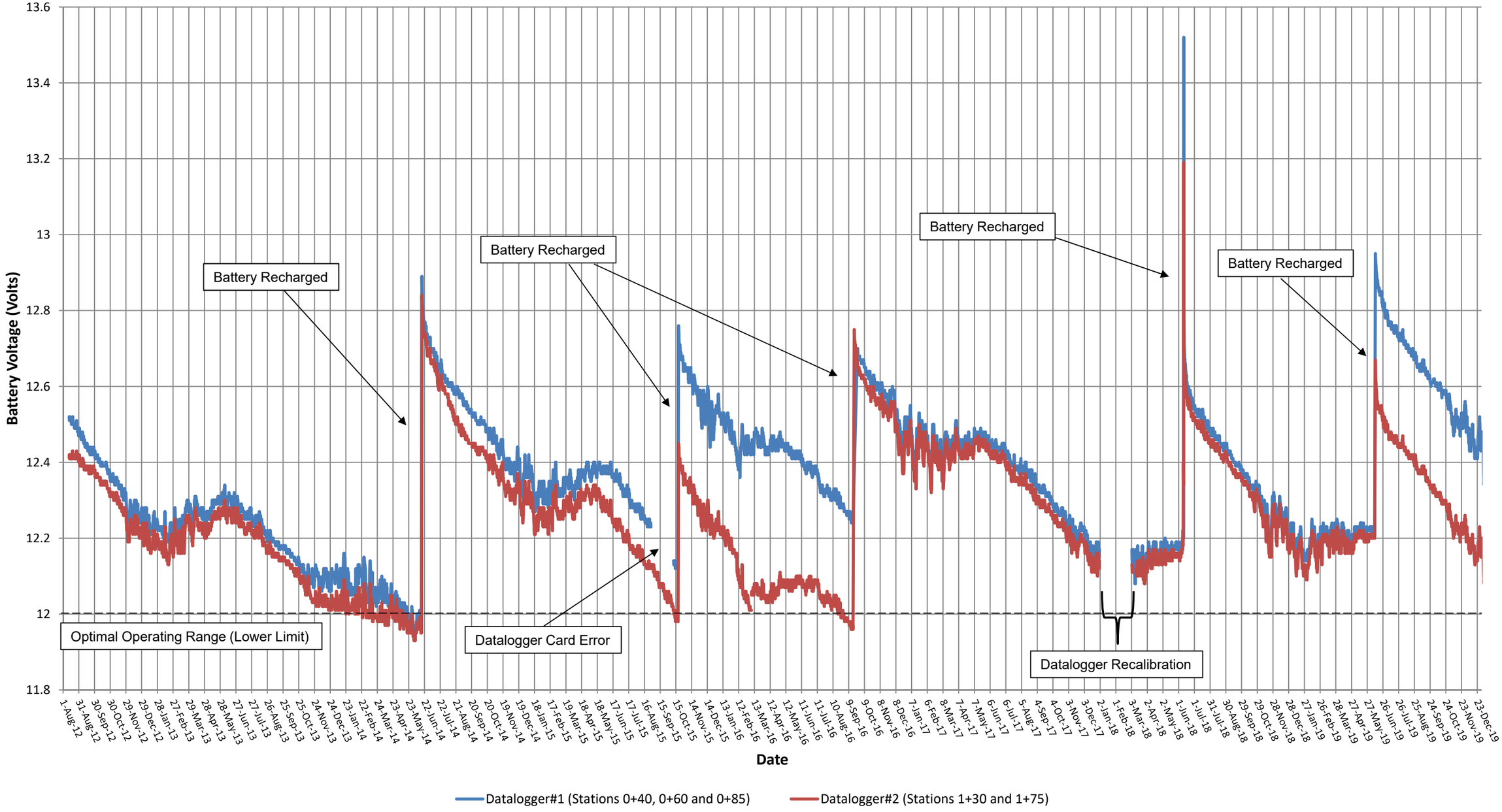


Notes:

- A) Datalogger was disconnected (Jan 1, 2018 – Mar 3, 2018) for recalibration

srk consulting	TMAC RESOURCES	2019 AGI – North Dam	
Job No: 1CT022.038 Filename: AppendixC_Thermosyphons.pptx	DORIS TIA	**North Dam Thermosyphon Monitoring**	
		Date: Feb. 2020	Approved: AB	Figure: **C.1**

Appendix D – Datalogger Battery Levels



Notes:
1. Operating voltage range is 9.6 to 16 V
2. Optimal operating voltage is 12 to 14 V
3. Data logger will shut down if voltage drops below 9.6 V

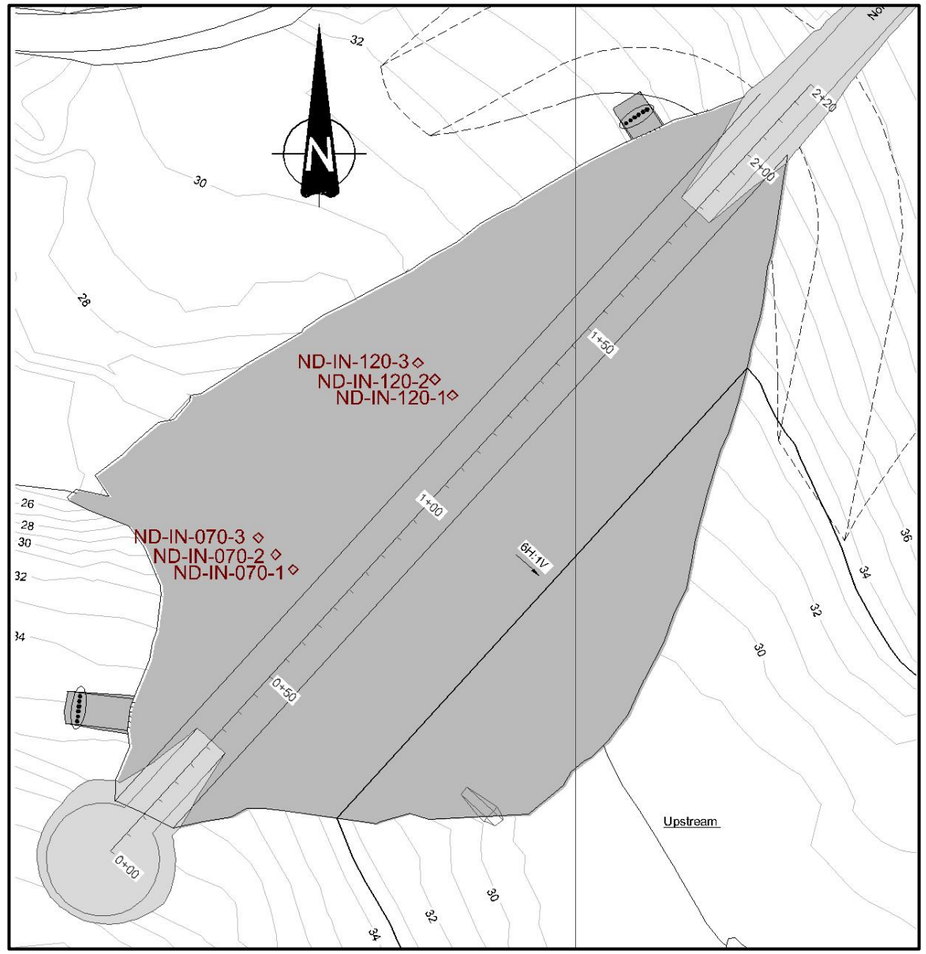
srk consulting	MAC RESOURCES	2019 AGI – North Dam
Job No: 1CT022.038 Filename: AppendixD_1CT022.038_Batteries.pptx	DORIS TIA	**North Dam Datalogger Battery Voltage with Time**
		Date: Feb. 2020 | Approved: AB | Figure: **D.1**

Appendix E – Inclinometers

	Inclinometers Measured						
Date	**070-1**	**070-2**	**070-3**	**120-1**	**120-2**	**120-3**	**Data Quality**
10-Nov-18	x	x	x	x	x	x	
1-Jan-19	x	x	x	x	x	x	
25-Jan-19	x	x	x	x	x	x	
14-Feb-19	x	x	x	x	x	x	February survey performed over two days. 070-2 has readings for Feb 14/19 and Feb 16/19
16-Feb-19	x	x	x	x	x	x	070-2 Severed "B" wire, incorrect values; 120-1, 120-2 and 120-3 Blank/incorrect values for "B" wires
14-Apr-19	x	x	x	x	x	x	070-2 Severed "B" wire repaired
10-May-19	x	x	x	x	x	x	
11-Jun-19	x	x	x	x	x	x	
27-Jul-19	x	x	x	x	x	x	
25-Aug-19	x	x	x	x	x	x	
28-Sep-19	x	x	x	x	x	x	
26-Oct-19	x	x	x	x	x	x	120-1 Multiple duplicate readings, excluded from graph
23-Nov-19	x	x	x	x	x	x	
14-Dec-19	x	x	x	x	x	x	

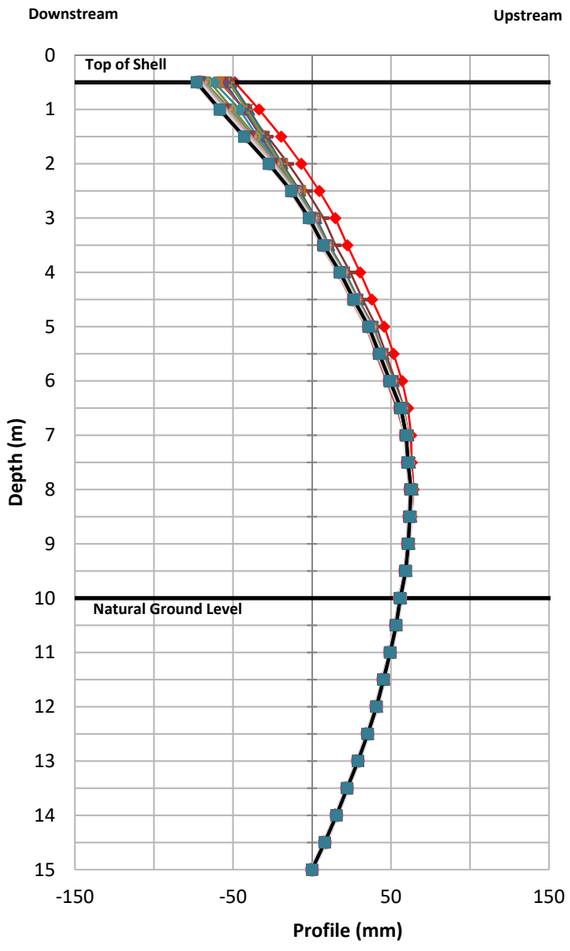
Notes:

1. Green marks good quality survey data
2. Orange marks poor quality survey data (excluded from graphs or modified)
3. Grey indicates that no survey data was collected

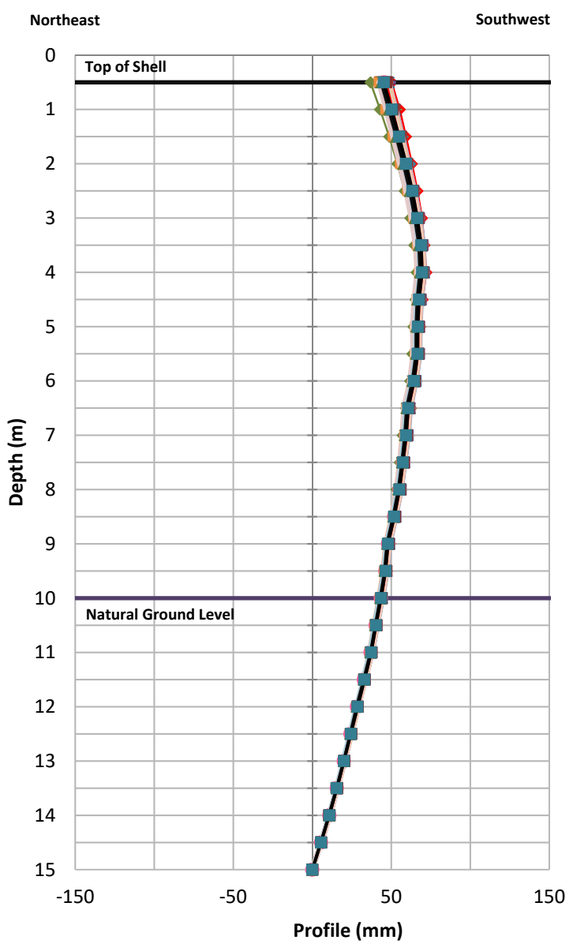


srk consulting	TMAC RESOURCES	2019 AGI - North Dam
		Inclinometer Data Summary
Job No: 1CT022.038 Filename: AppEX_1CT022.038_Inclinometers.pptx	**DORIS TIA**	Date: Feb. 2020 / Approved: AB / Figure: **E.1**

Profile Perpendicular to Centerline

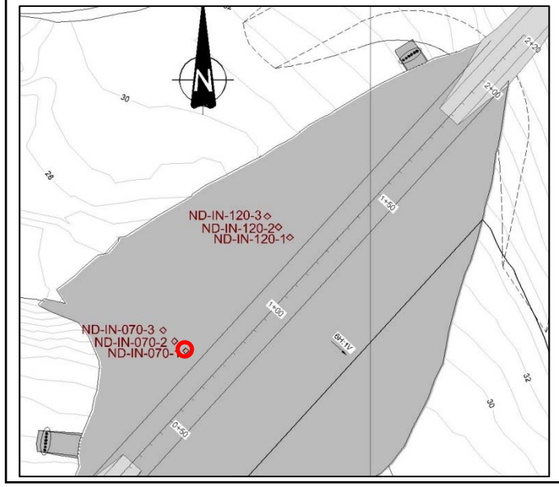


Profile Parallel to Centerline



LEGEND:

- Initial Reading (9/8/2012)
- 7/26/2013
- 10/1/2013
- 5/18/2014
- 7/12/2014
- 8/8/2014
- 9/1/2014
- 10/1/2014
- 2/2/2015
- 3/21/2015
- 4/8/2015
- 4/16/2015
- 5/18/2015
- 6/25/2015
- 7/9/2015
- 8/2/2015
- 9/4/2015
- 10/9/2015
- 11/25/2015
- 12/30/2015
- 2/8/2016
- 3/7/2016
- 4/11/2016
- 7/2/2016
- 8/14/2016
- 9/25/2016
- 11/26/2016
- 12/24/2016
- 1/26/2017
- 2/23/2017
- 3/23/2017
- 4/15/2017
- 5/20/2017
- 6/25/2017
- 7/16/2017
- 8/9/2017
- 9/14/2017
- 10/14/2017
- 11/16/2017
- 12/16/2017
- 1/16/2018
- 2/16/2018
- 3/21/2018
- 4/20/2018
- 5/19/2018
- 6/8/2018
- 7/7/2018
- 8/3/2018
- 9/29/2018
- 10/21/2018
- 11/10/2018
- 1/1/2019
- 1/25/2019
- 2/14/2019
- 4/14/2019
- 5/10/2019
- 6/11/2019
- 7/27/2019
- 8/25/2019
- 9/28/2019
- 10/26/2019
- 11/23/2019
- 1/16/2020
- 2/18/2020

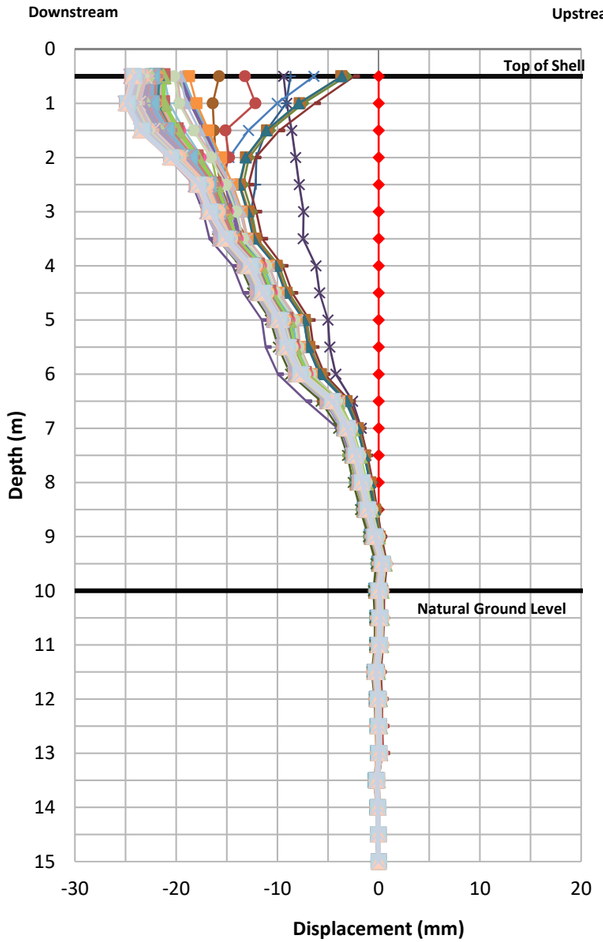


Notes:

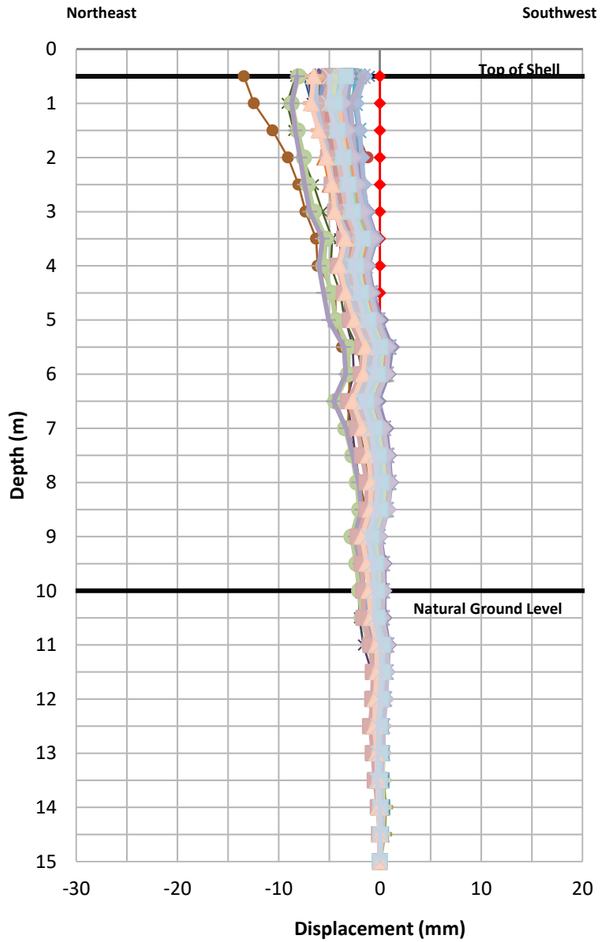
1. Manufacture's accuracy is +/- 0.25 mm per location
2. Survey data excluded from the charts is noted on Figure E.1

srk consulting	TMAC RESOURCES	2019 AGI - North Dam
Job No: 1CT022.038 Filename: AppE_1CT022.038_Inclinometers.pptx	DORIS TIA	**Inclinometer 070-1 Profiles**
		Date: Feb. 2020 / Approved: AB / Figure: **E.2**

Displacement Perpendicular to Centerline

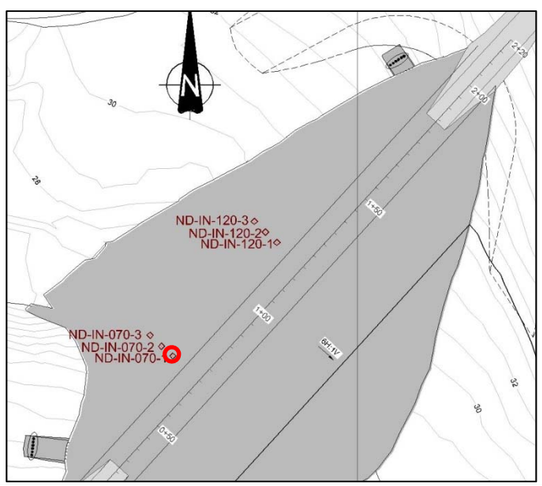


Displacement Parallel to Centerline



LEGEND:



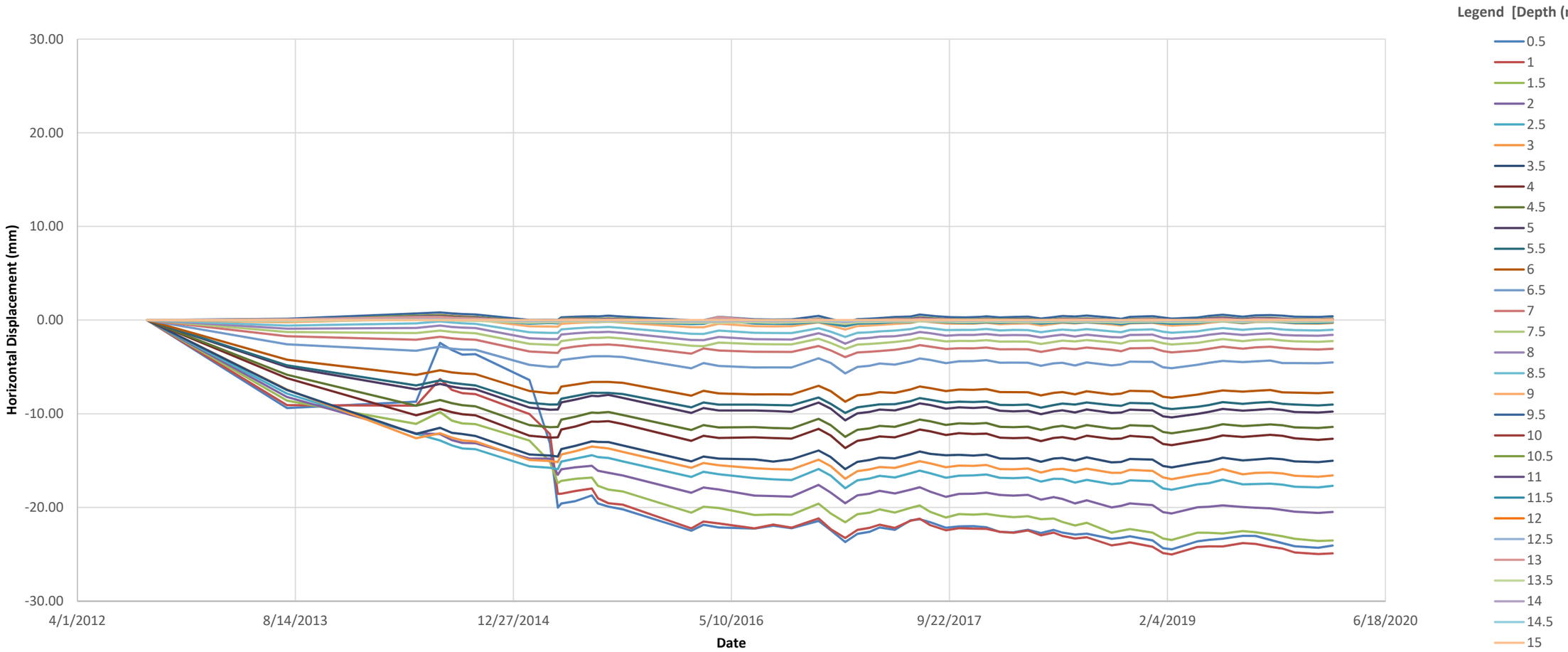


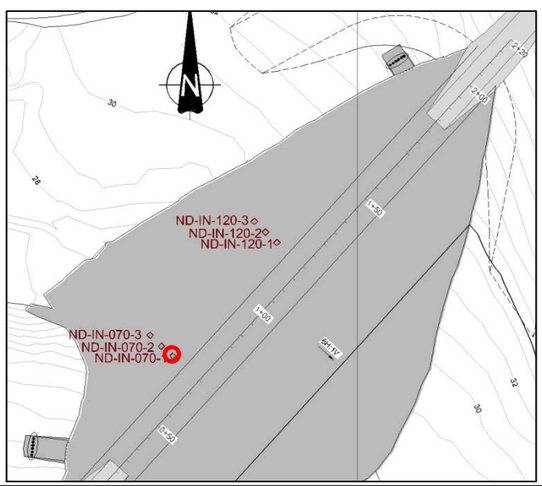
Notes:

1. Manufacture's accuracy is +/- 0.25 mm per location
2. Survey data excluded from the charts is noted on Figure E.1

srk consulting	TMAC RESOURCES	2019 AGI - North Dam
Job No: 1CT022.038 Filename: AppE_1CT022.038_Inclinometers.pptx	DORIS TIA	**Inclinometer 070-1 Displacements** Date: Feb. 2020 | Approved: AB | Figure: **E.3**

Inclinometer 070-1A Timeseries

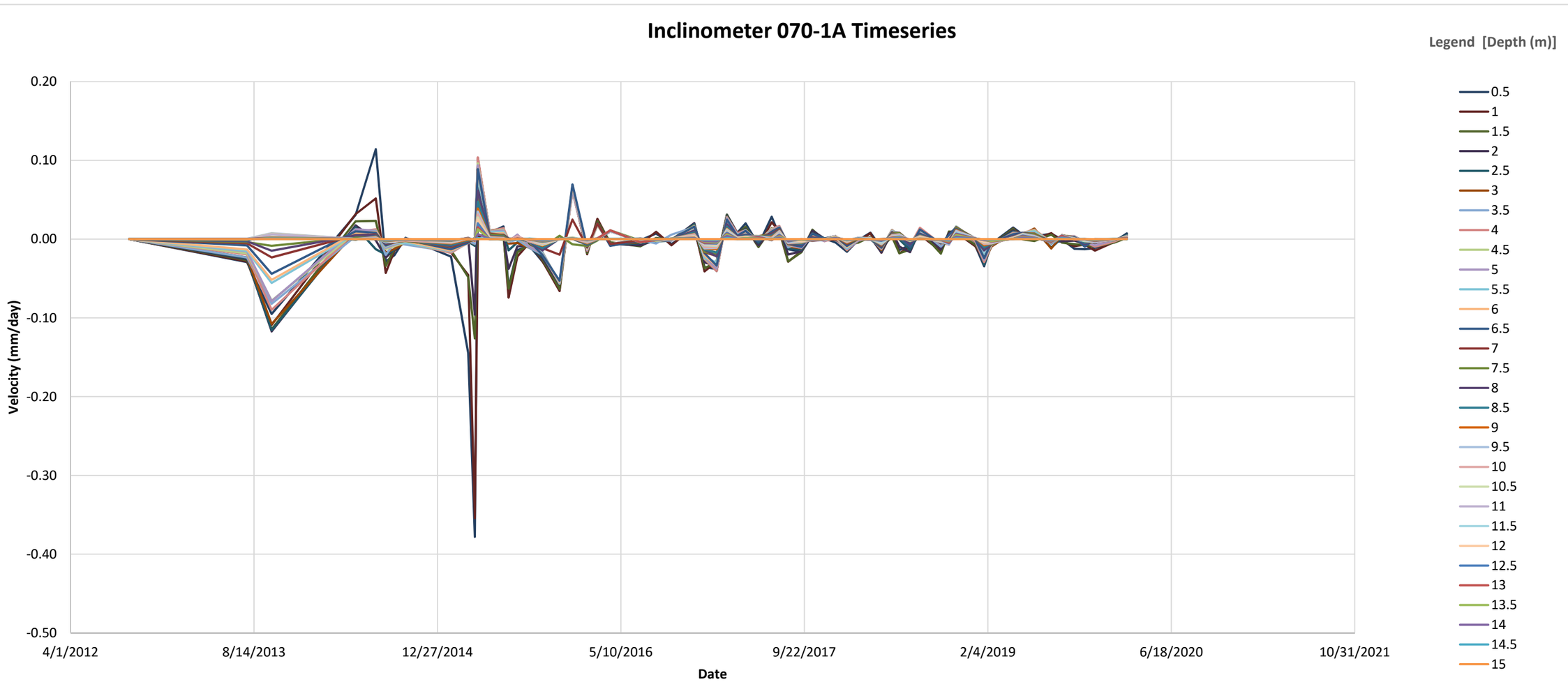


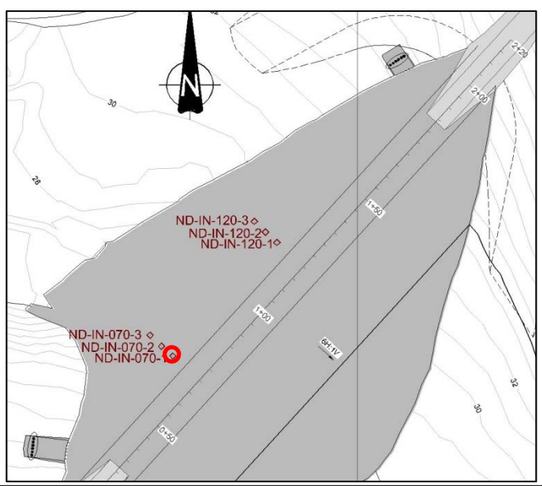


Notes:

1. Manufacture's accuracy is +/- 0.25 mm per location
2. Survey data excluded from the charts is noted on Figure E.1
3. Dashed lines represent depths at or below the natural ground surface

srk consulting	TMAC RESOURCES	2019 AGI - North Dam
		Inclinometer 070-1A Displacement Time Series
Job No: 1CT022.038 Filename: AppE_1CT022.038_Inclinometers.pptx	**DORIS TIA**	Date: Feb. 2020 / Approved: AB / Figure: **E.4**



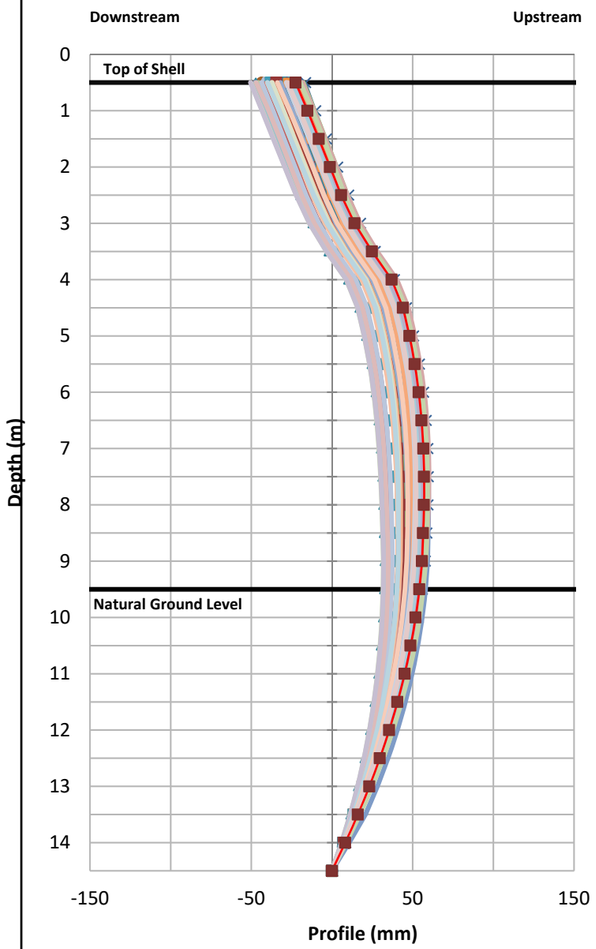


Notes:

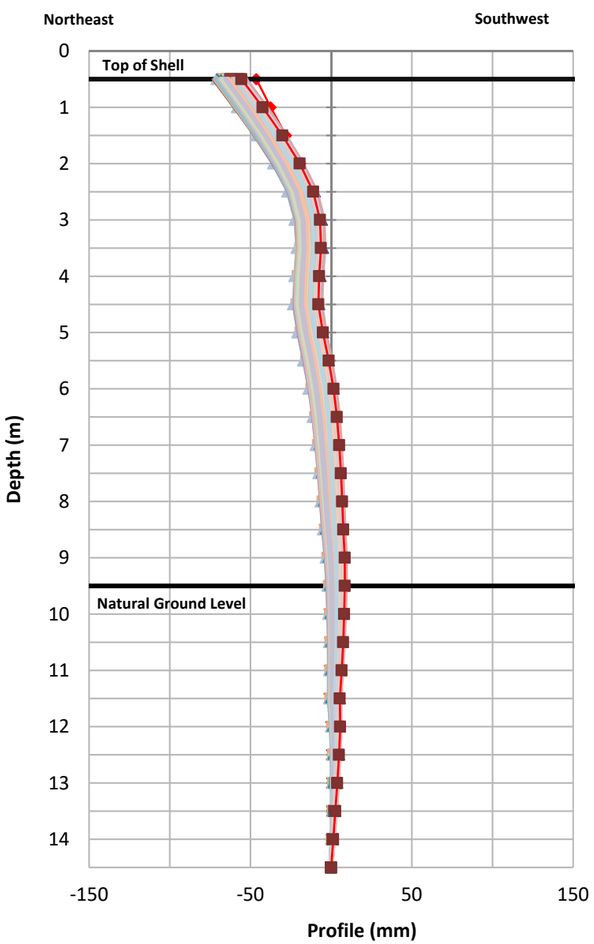
1. Manufacture's accuracy is +/- 0.25 mm per location
2. Survey data excluded from the charts is noted on Figure E.1
3. Dashed lines represent depths at or below the natural ground surface

srk consulting	MAC RESOURCES	2019 AGI - North Dam
Job No: 1CT022.038 Filename: AppE_1CT022.038_Inclinometers.pptx	DORIS TIA	**Inclinometer 070-1A Velocity Time Series**
		Date: Feb. 2020 / Approved: AB / Figure: **E.5**

Profile Perpendicular to Centerline

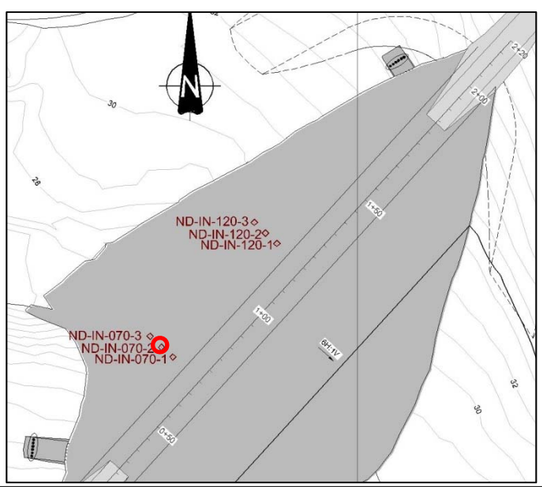


Profile Parallel to Centerline



LEGEND:



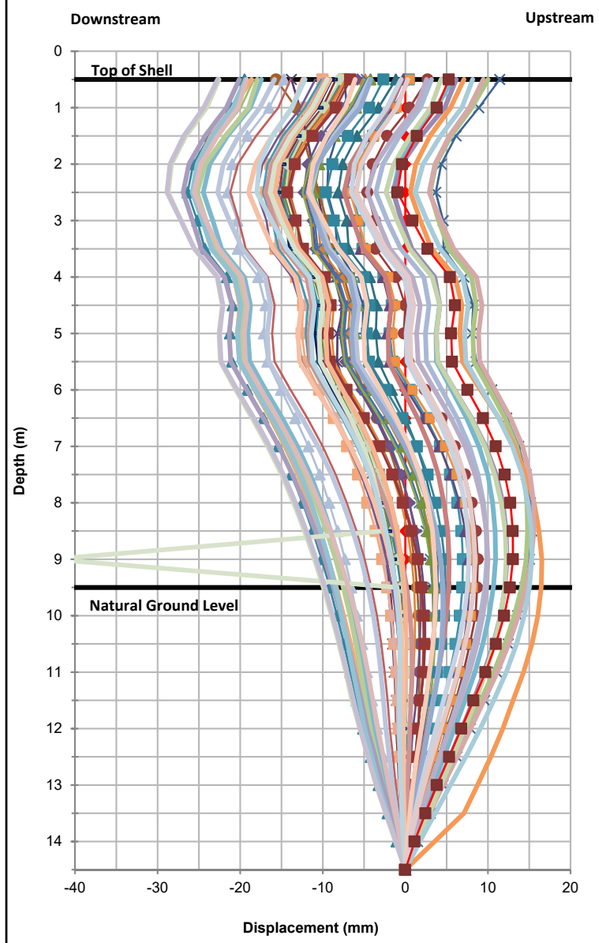


Notes:

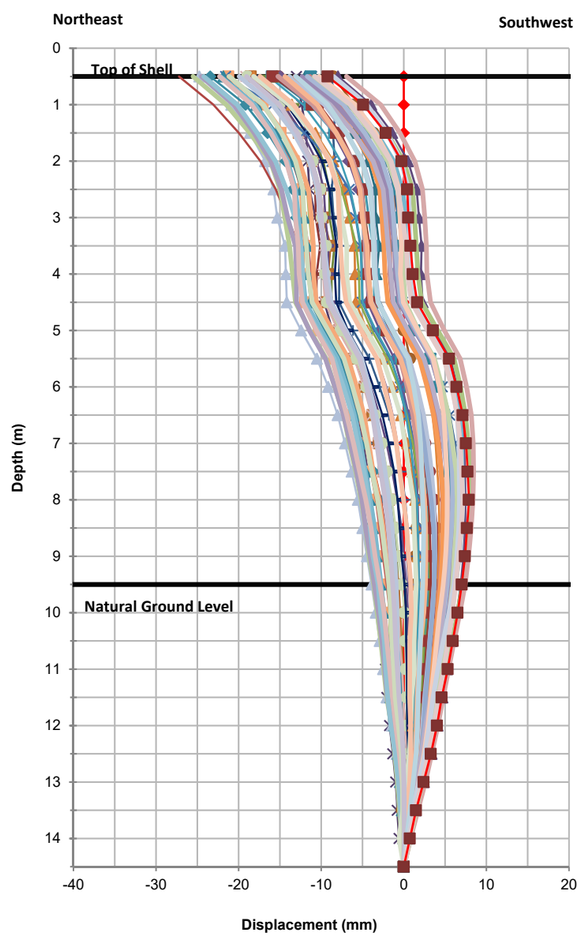
1. Manufacture's accuracy is +/- 0.25 mm per location
2. Survey data excluded from the charts is noted on Figure E.1

srk consulting	TMAC RESOURCES	2019 AGI - North Dam
Job No: 1CT022.038 Filename: AppE_1CT022.038_Inclinometers.pptx	DORIS TIA	**Inclinometer 070-2 Profiles**
		Date: Feb. 2020 / Approved: AB / Figure: **E.6**

Displacement Perpendicular to Centerline

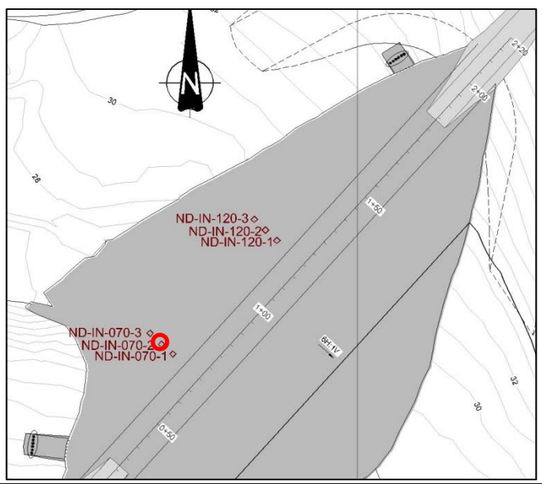


Displacement Parallel to Centerline



LEGEND:

- Initial Reading (9/8/2012)
- 10/1/2013
- 7/12/2014
- 9/1/2014
- 2/1/2015
- 4/16/2015
- 6/25/2015
- 8/2/2015
- 9/4/2015
- 11/25/2015
- 2/8/2016
- 4/11/2016
- 8/14/2016
- 11/26/2016
- 2/23/2017
- 4/15/2017
- 6/25/2017
- 8/9/2017
- 10/14/2017
- 12/16/2017
- 2/16/2018
- 4/20/2018
- 6/8/2018
- 8/3/2018
- 10/21/2018
- 1/1/2019
- 2/14/2019
- 4/14/2019
- 6/11/2019
- 8/25/2019
- 10/26/2019
- 1/16/2020
- 7/26/2013
- 5/20/2014
- 8/8/2014
- 10/1/2014
- 3/21/2015
- 5/18/2015
- 7/9/2015
- 8/8/2015
- 10/9/2015
- 12/30/2015
- 3/7/2016
- 7/2/2016
- 9/26/2016
- 12/24/2016
- 3/23/2017
- 5/20/2017
- 7/16/2017
- 9/14/2017
- 11/16/2017
- 1/16/2018
- 3/21/2018
- 5/19/2018
- 7/7/2018
- 9/29/2018
- 11/10/2018
- 1/28/2019
- 2/16/2019
- 5/10/2019
- 7/27/2019
- 9/28/2019
- 11/23/2019
- 2/18/2020

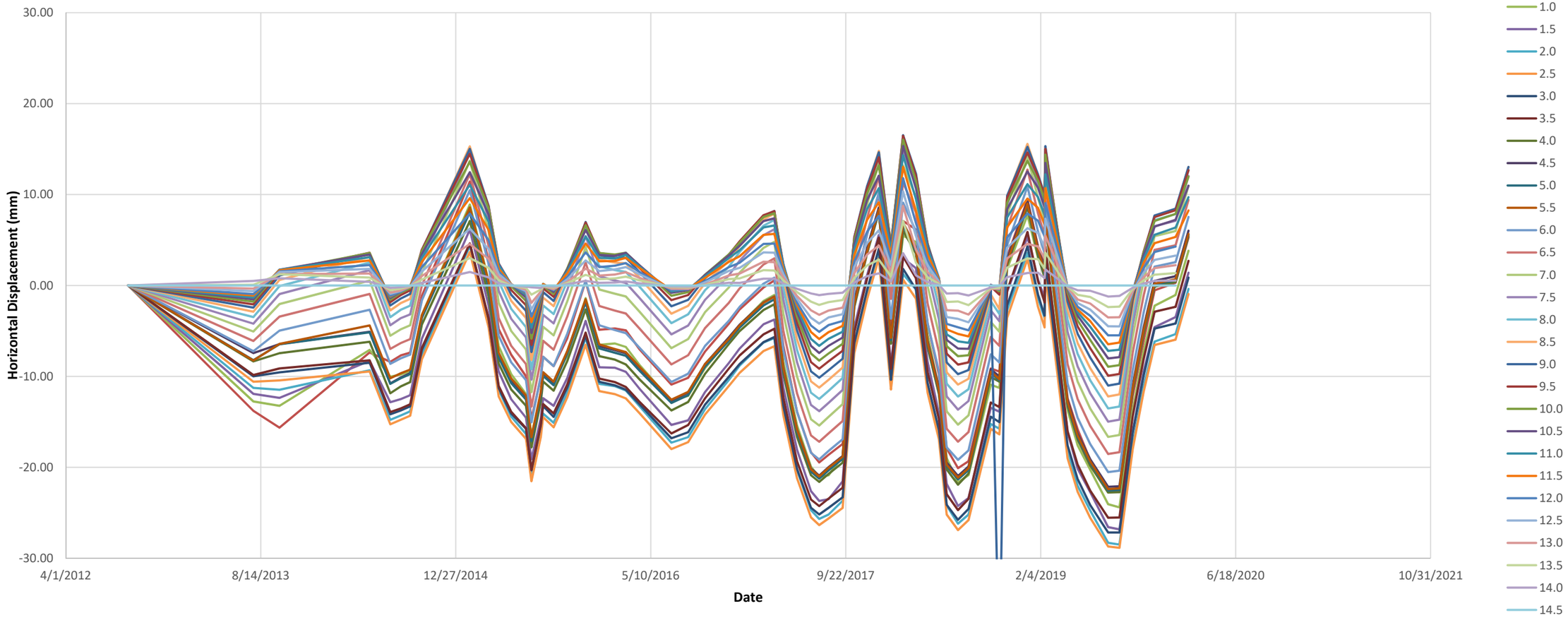


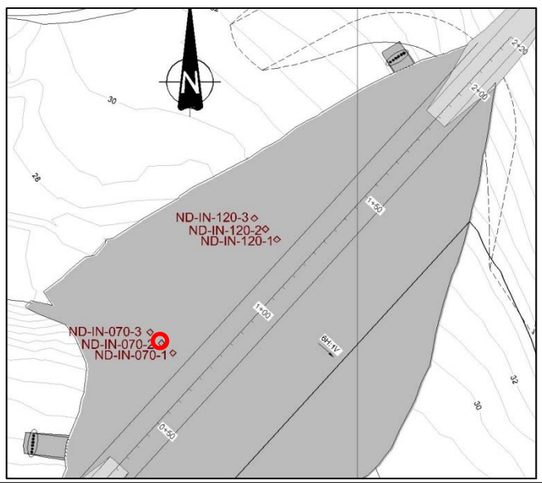
Notes:

1. Manufacture's accuracy is +/- 0.25 mm per location
2. Survey data excluded from the charts is noted on Figure E.1

srk consulting	MAC RESOURCES	2019 AGI - North Dam
Job No: 1CT022.038 Filename: AppE_1CT022.038_Inclinometers.pptx	DORIS TIA	**Inclinometer 070-2 Displacements** Date: Feb. 2020 / Approved: AB / Figure: **E.7**

Inclinometer 070-2A Timeseries



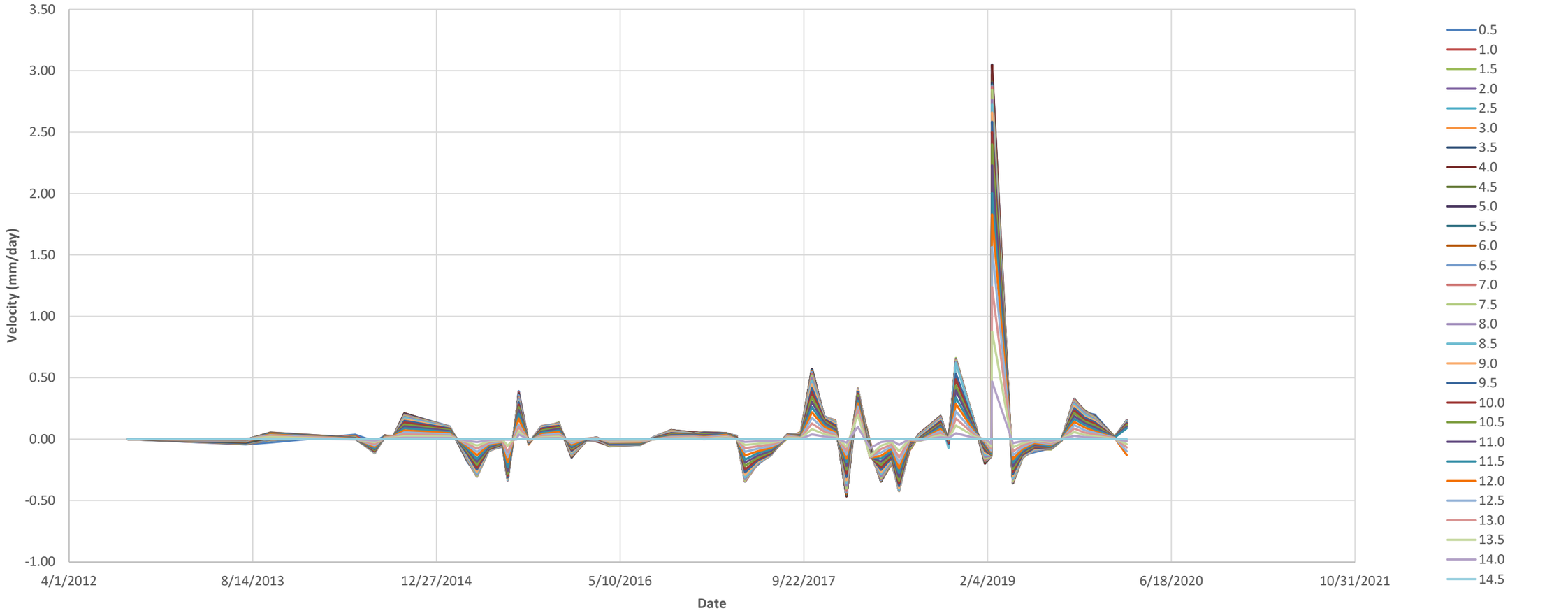


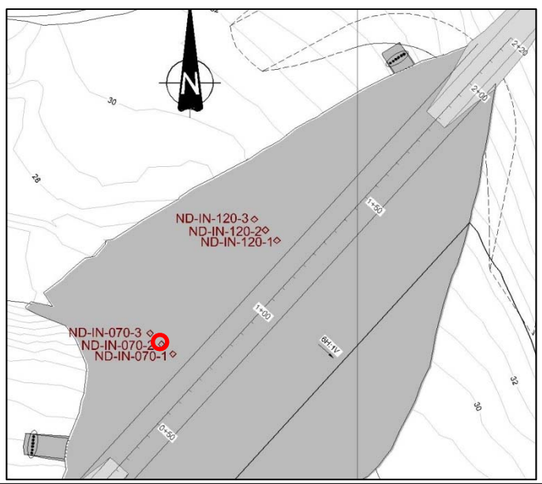
Notes:

1. Manufacture's accuracy is +/- 0.25 mm per location
2. Survey data excluded from the charts is noted on Figure E.1
3. Dashed lines represent depths at or below the natural ground surface

srk consulting	TMAC RESOURCES	2019 AGI - North Dam
		Inclinometer 070-2A Displacement Time Series
Job No: 1CT022.038 Filename: AppE_1CT022.038_Inclinometers.pptx	**DORIS TIA**	Date: Feb. 2020 / Approved: AB / Figure: **E.8**

Inclinometer 070-2A Velocity Timeseries



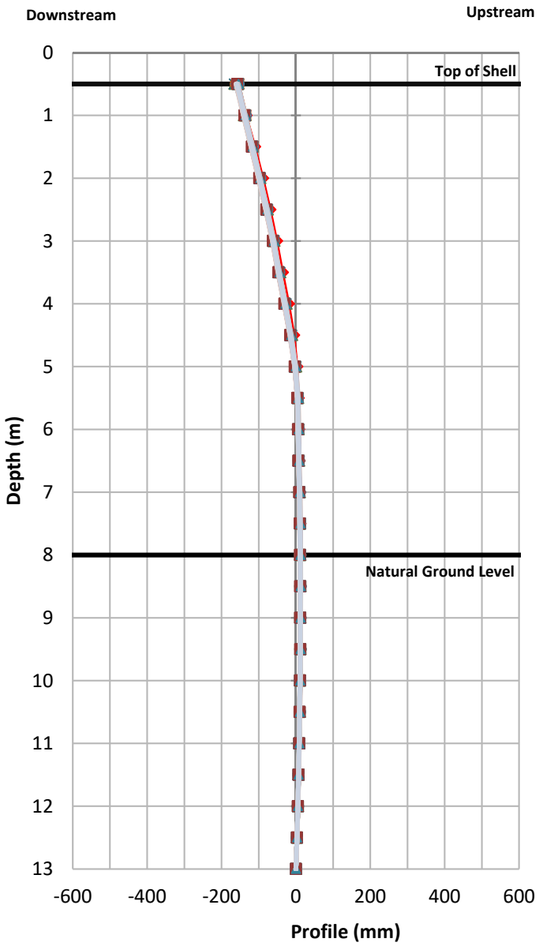


Notes:

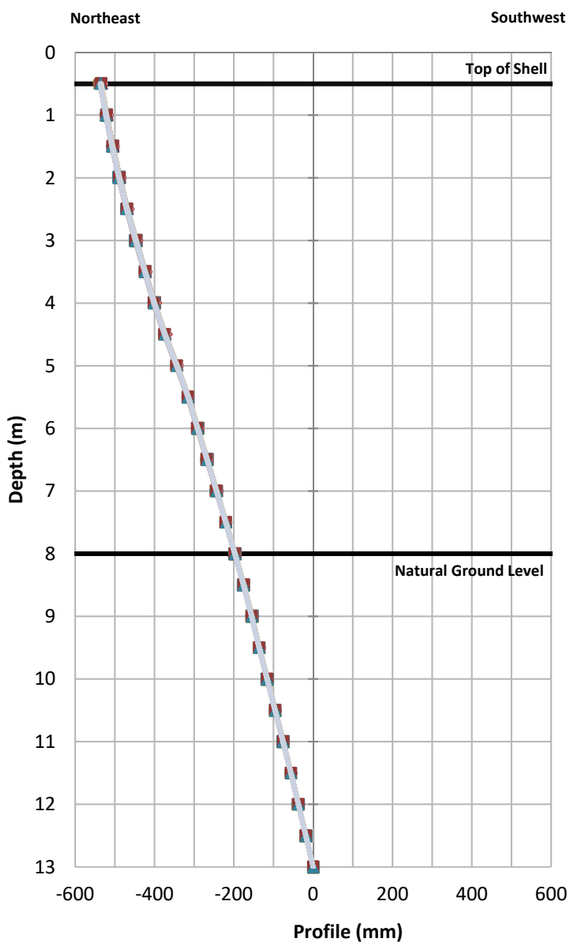
1. Manufacture's accuracy is +/- 0.25 mm per location
2. Survey data excluded from the charts is noted on Figure E.1
3. Dashed lines represent depths at or below the natural ground surface

srk consulting	TMAC RESOURCES	2019 AGI - North Dam
		Inclinometer 070-2A Velocity Time Series
Job No: 1CT022.038 Filename: AppE_1CT022.038_Inclinometers.pptx	**DORIS TIA**	Date: Feb. 2020 / Approved: AB / Figure: **E.9**

Profile Perpendicular to Centerline

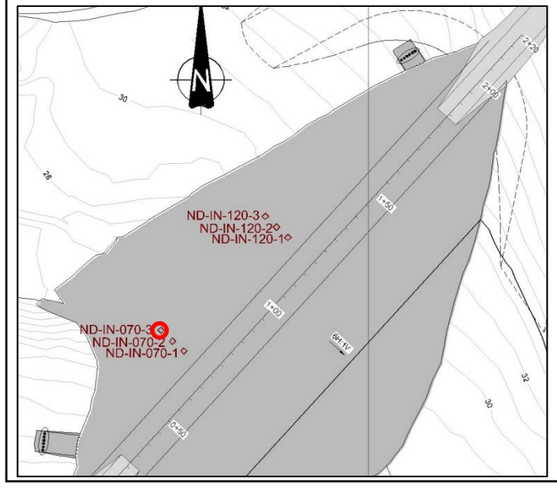


Profile Parallel to Centerline



LEGEND:



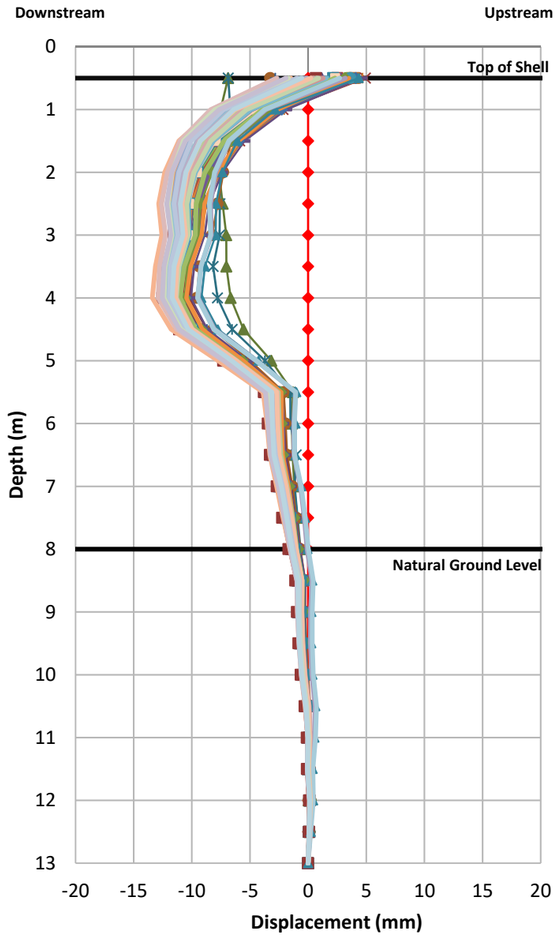


Notes:

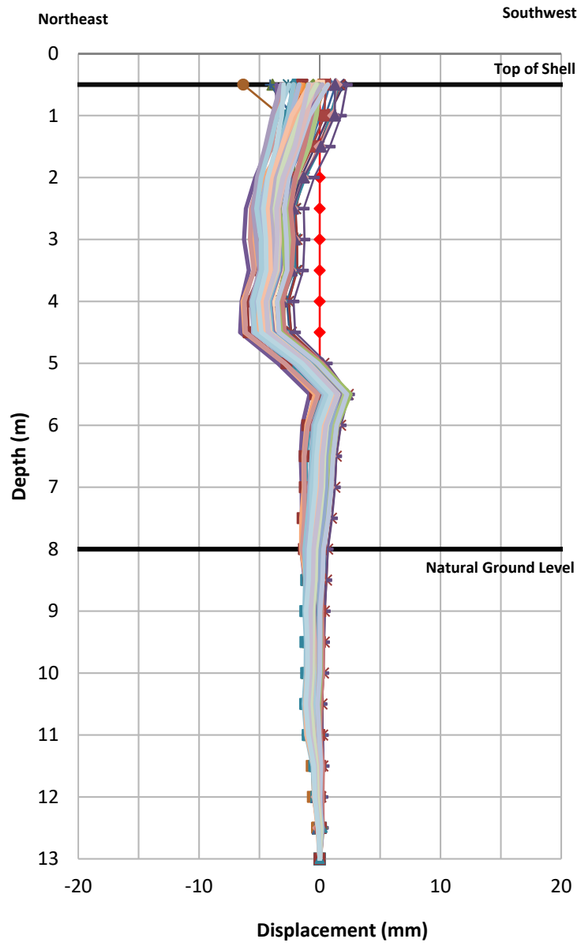
1. Manufacture's accuracy is +/- 0.25 mm per location
2. Survey data excluded from the charts is noted on Figure E.1

srk consulting	TMAC RESOURCES	2019 AGI - North Dam
		Inclinometer 070-3 Profiles
Job No: 1CT022.038 Filename: AppE_1CT022.038_Inclinometers.pptx	**DORIS TIA**	Date: Feb. 2020 / Approved: AB / Figure: **E.10**

Displacement Perpendicular to Centerline

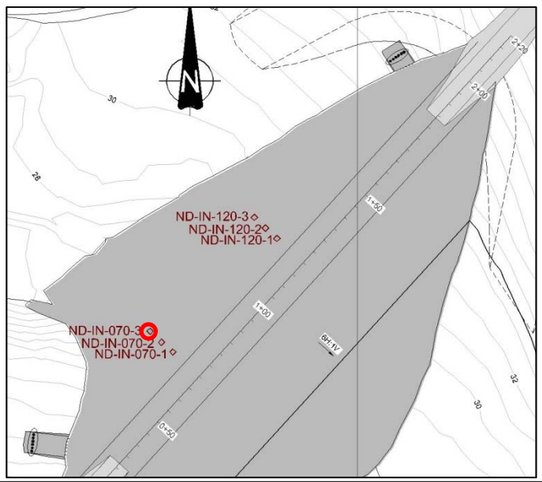


Displacement Parallel to Centerline



LEGEND:



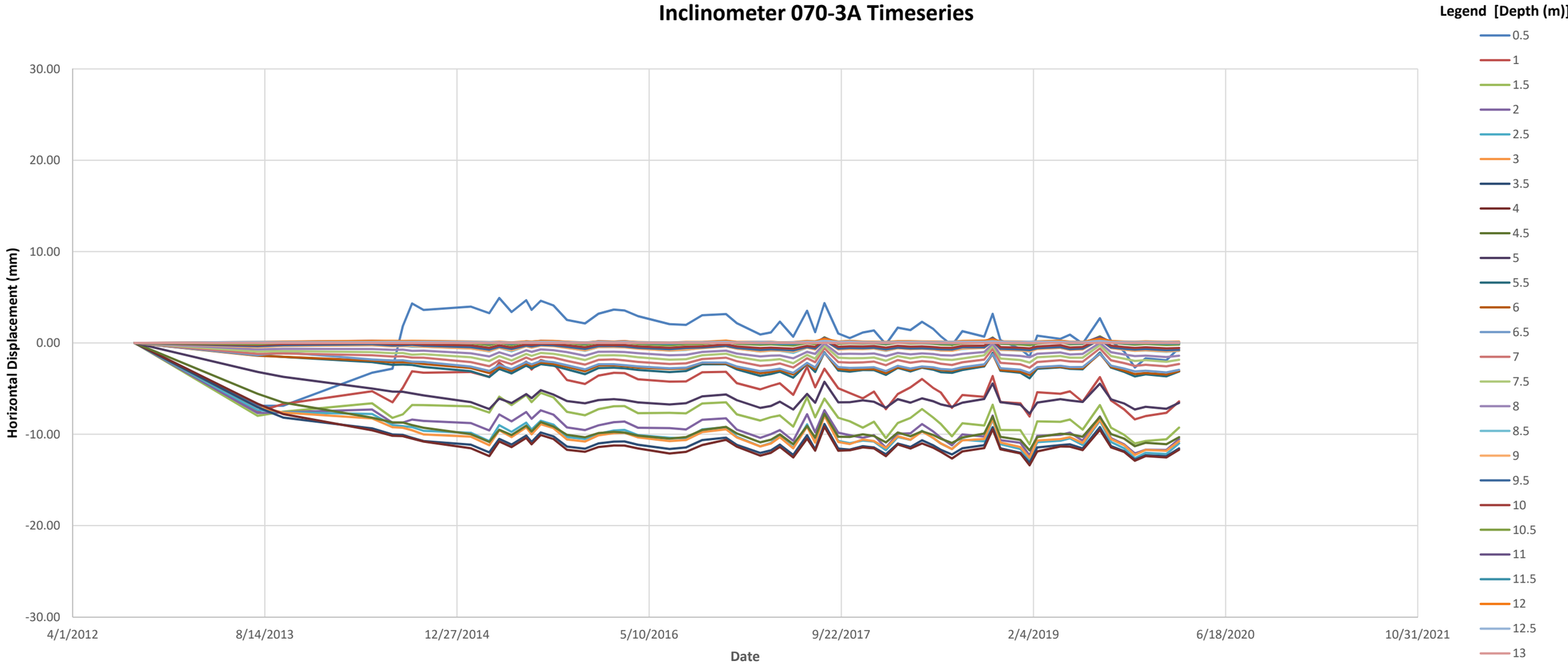


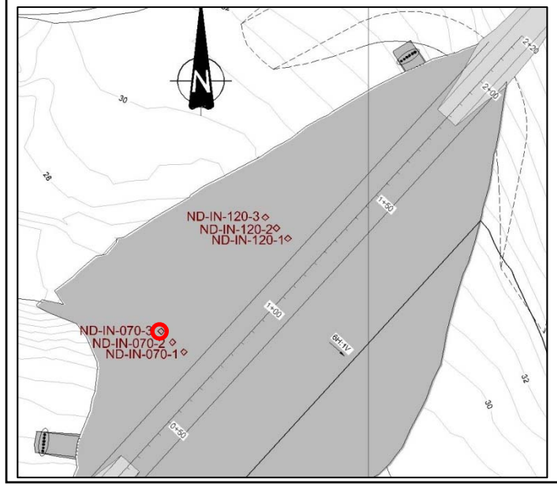
Notes:

1. Manufacture's accuracy is +/- 0.25 mm per location
2. Survey data excluded from the charts is noted on Figure E.1

srk consulting	TMAC RESOURCES	2019 AGI - North Dam
Job No: 1CT022.038 Filename: AppE_1CT022.038_Inclinometers.pptx	DORIS TIA	**Inclinometer 070-3 Displacements**
		Date: Feb. 2020 / Approved: AB / Figure: **E.11**

Inclinometer 070-3A Timeseries



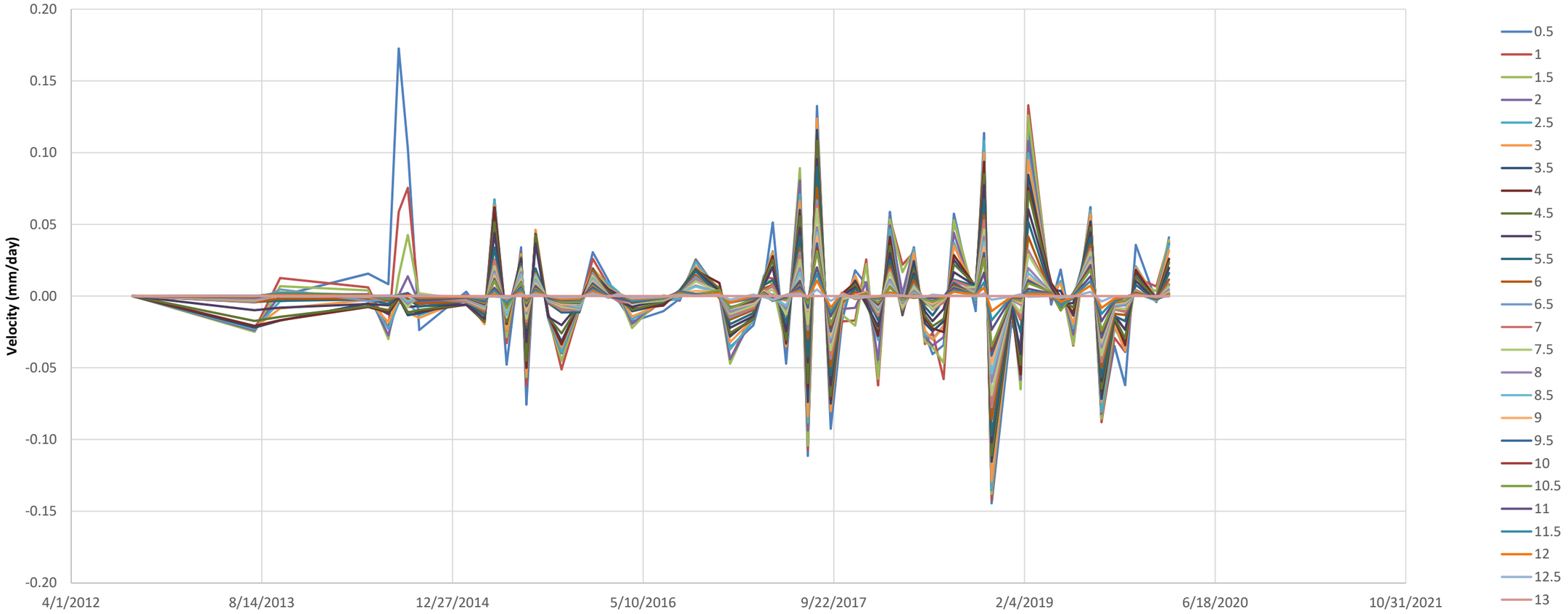


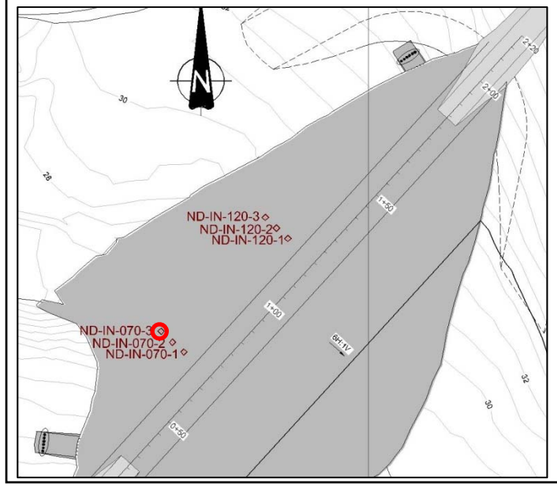
Notes:

1. Manufacture's accuracy is +/- 0.25 mm per location
2. Survey data excluded from the charts is noted on Figure E.1
3. Dashed lines represent depths at or below the natural ground surface

srk consulting	MAC RESOURCES	2019 AGI - North Dam
		Inclinometer 070-3A Displacement Time Series
Job No: 1CT022.038 Filename: AppE_1CT022.038_Inclinometers.pptx	**DORIS TIA**	Date: Feb. 2020 / Approved: AB / Figure: **E.12**

Inclinometer 070-3A Velocity Timeseries



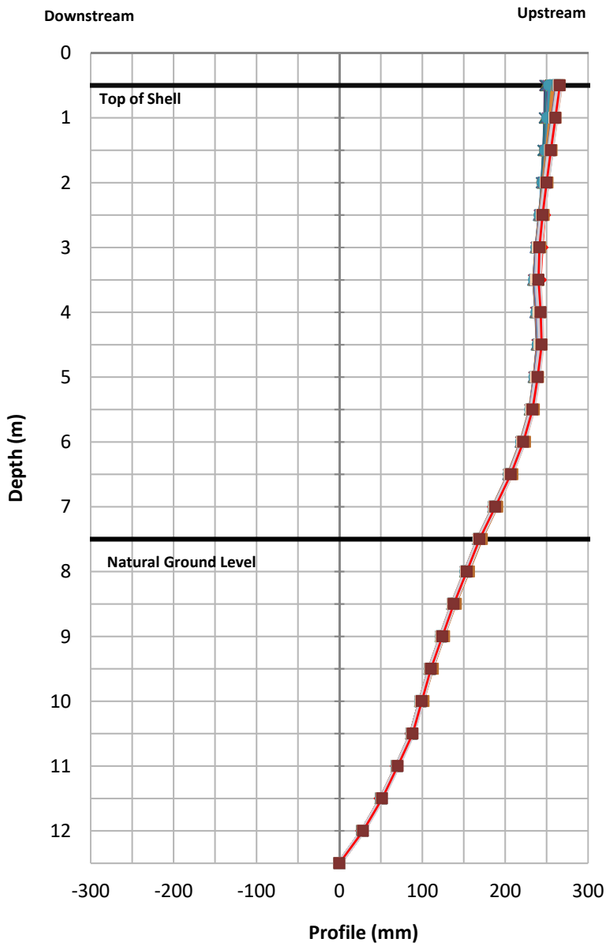


Notes:

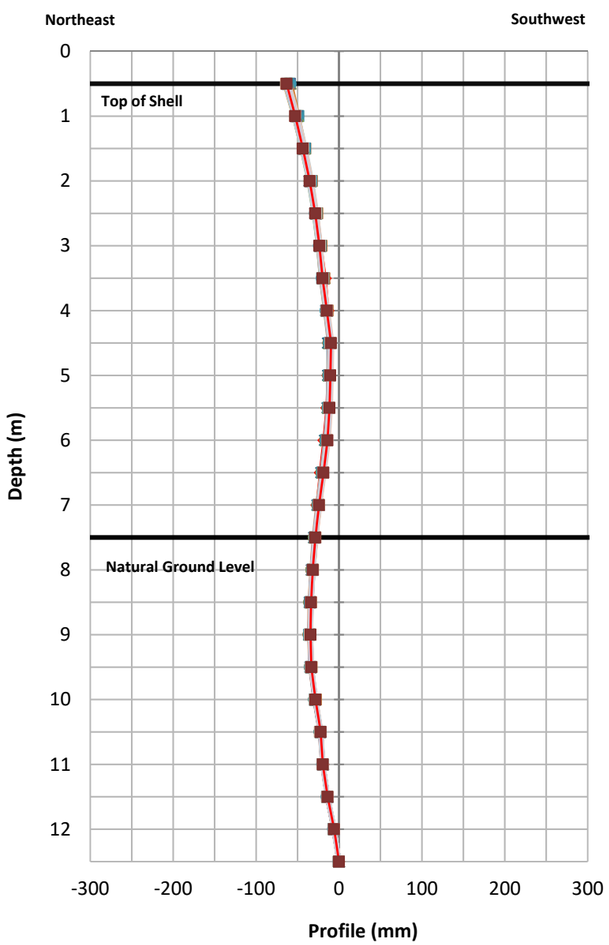
1. Manufacture's accuracy is +/- 0.25 mm per location
2. Survey data excluded from the charts is noted on Figure E.1
3. Dashed lines represent depths at or below the natural ground surface

srk consulting	TMAC RESOURCES	2019 AGI - North Dam
		Inclinometer 070-3A Velocity Time Series
Job No: 1CT022.038 Filename: AppE_1CT022.038_Inclinometers.pptx	**DORIS TIA**	Date: Feb. 2020 / Approved: AB / Figure: **E.13**

Profile Perpendicular to Centerline

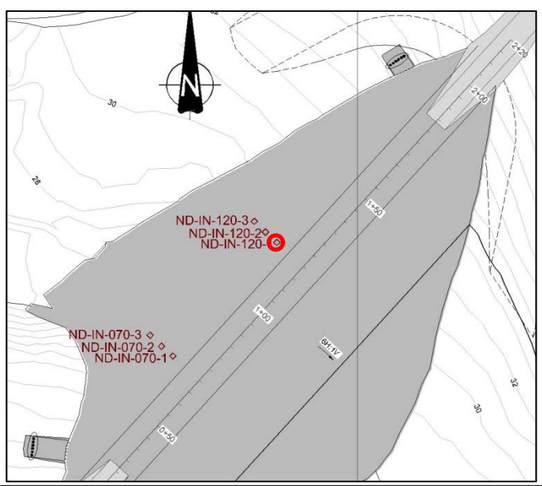


Profile Parallel to Centerline



LEGEND:

- Initial Reading (9/8/2012)
- 8/28/2013
- 5/20/2014
- 8/8/2014
- 10/1/2014
- 3/21/2015
- 5/18/2015
- 7/9/2015
- 9/4/2015
- 11/25/2015
- 3/7/2016
- 7/2/2016
- 9/25/2016
- 12/24/2016
- 3/23/2017
- 5/20/2017
- 7/16/2017
- 9/14/2017
- 11/17/2017
- 1/16/2018
- 3/21/2018
- 5/19/2018
- 7/7/2018
- 9/29/2018
- 11/10/2018
- 1/28/2019
- 4/15/2019
- 6/12/2019
- 8/25/2019
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- 4/11/2016
- 8/14/2016
- 11/26/2016
- 2/23/2017
- 4/15/2017
- 6/25/2017
- 8/9/2017
- 10/14/2017
- 12/16/2017
- 2/16/2018
- 4/20/2018
- 6/8/2018
- 8/3/2018
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- 9/28/2019
- 1/20/2020

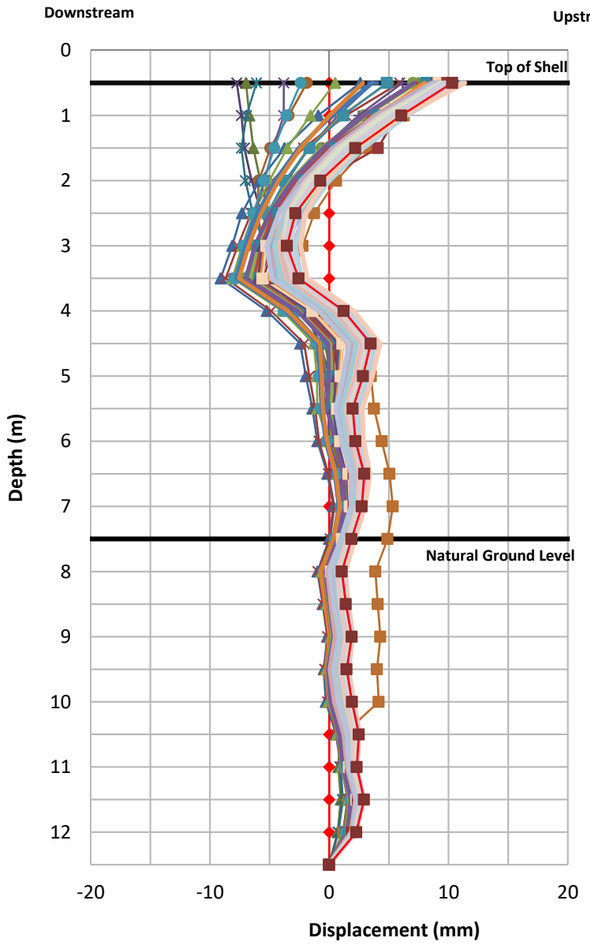


Notes:

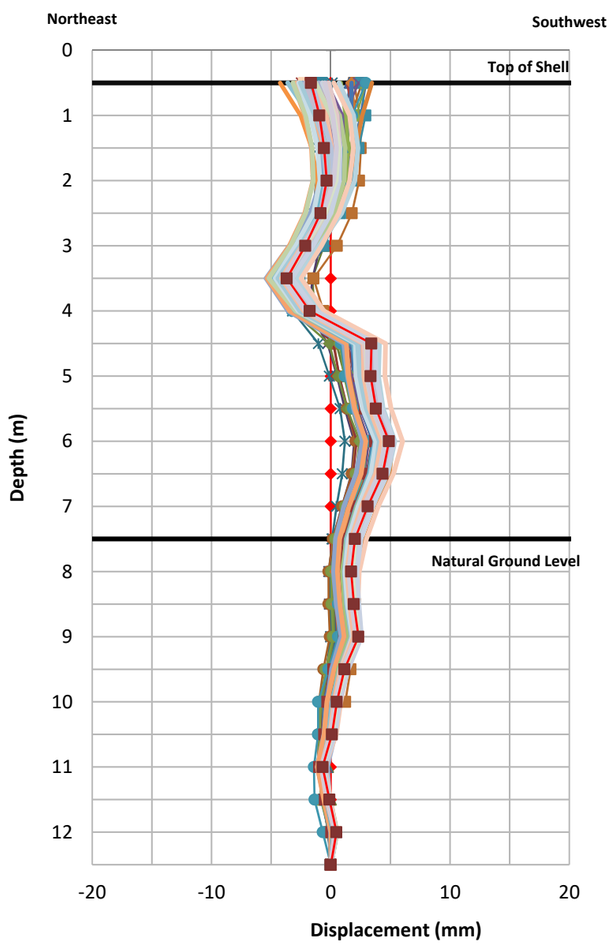
1. Manufacture's accuracy is +/- 0.25 mm per location
2. Survey data excluded from the charts is noted on Figure E.1

srk consulting	MAC RESOURCES	2019 AGI - North Dam
Job No: 1CT022.038 Filename: AppE_1CT022.038_Inclinometers.pptx	DORIS TIA	**Inclinometer 120-1 Profiles**
		Date: Feb. 2020 / Approved: AB / Figure: **E.14**

Displacement Perpendicular to Centerline

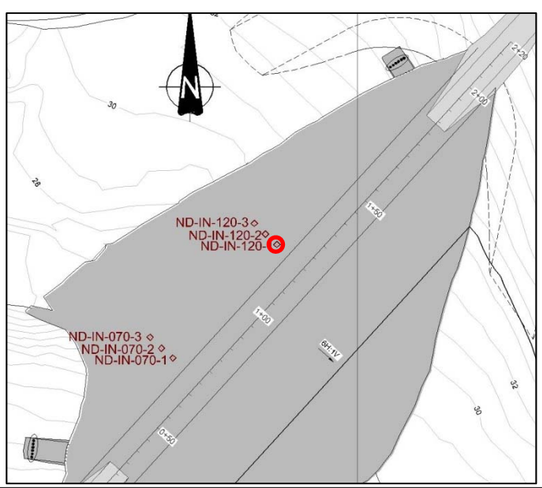


Displacement Parallel to Centerline



LEGEND:



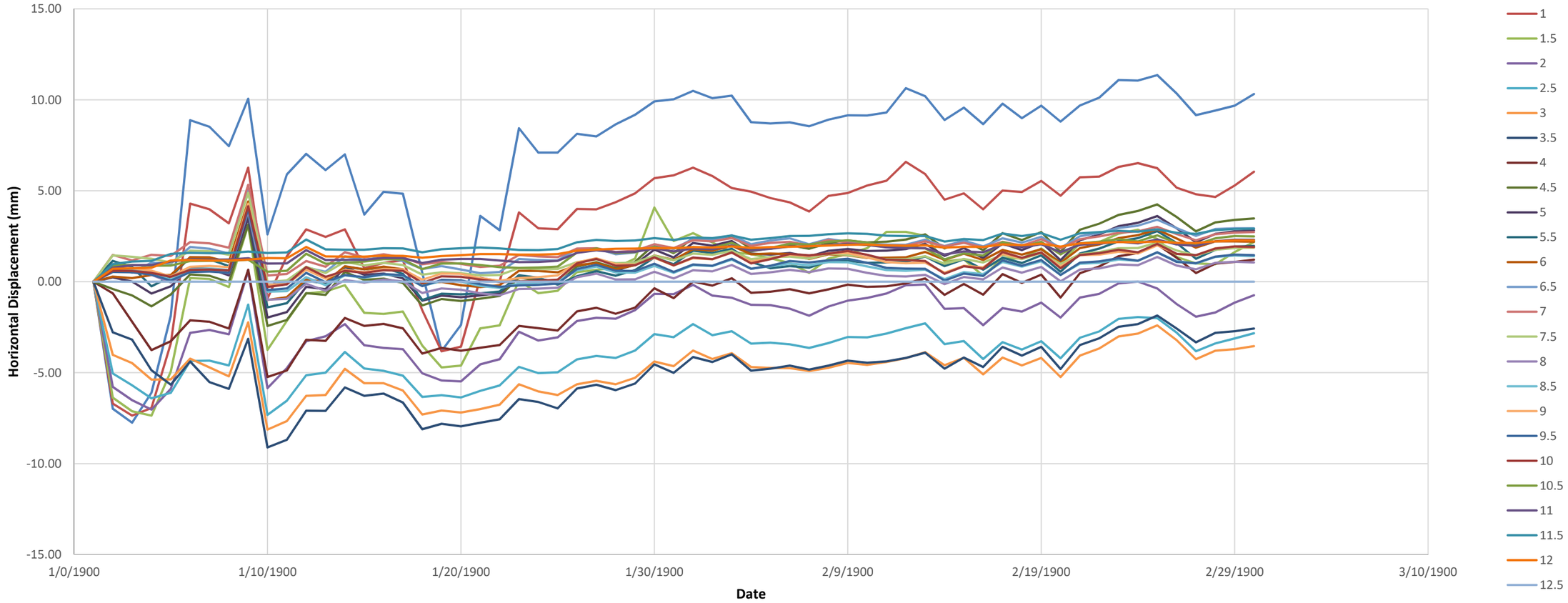


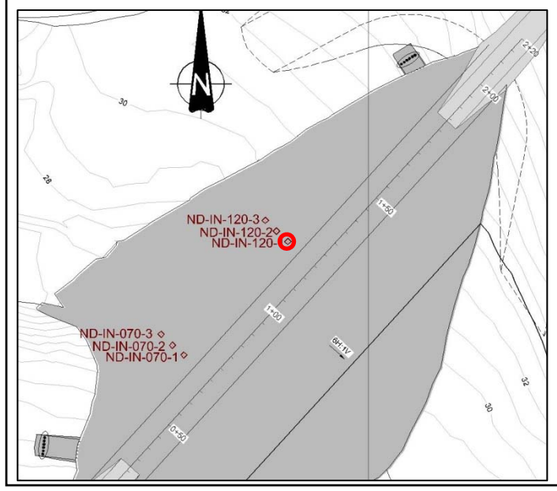
Notes:

1. Manufacture's accuracy is +/- 0.25 mm per location
2. Survey data excluded from the charts is noted on Figure E.1

srk consulting	TMAC RESOURCES	2019 AGI - North Dam
Job No: 1CT022.038 Filename: AppE_1CT022.038_Inclinometers.pptx	DORIS TIA	**Inclinometer 120-1 Displacements**
		Date: Feb. 2020 | Approved: AB | Figure: **E.15**

Inclinometer 120-1A Timeseries

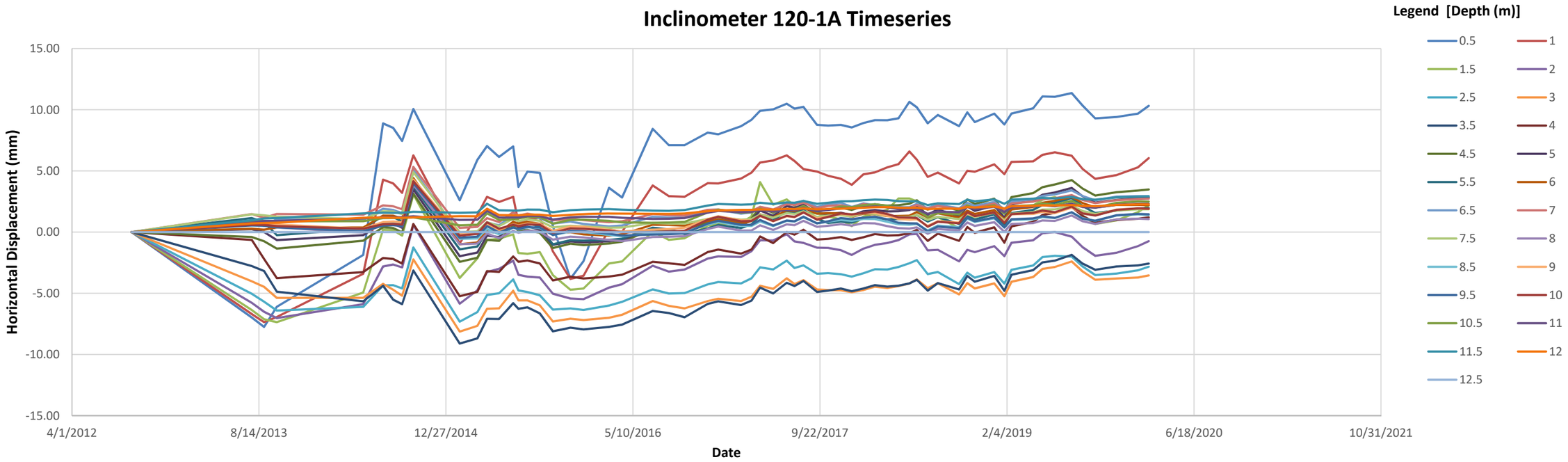


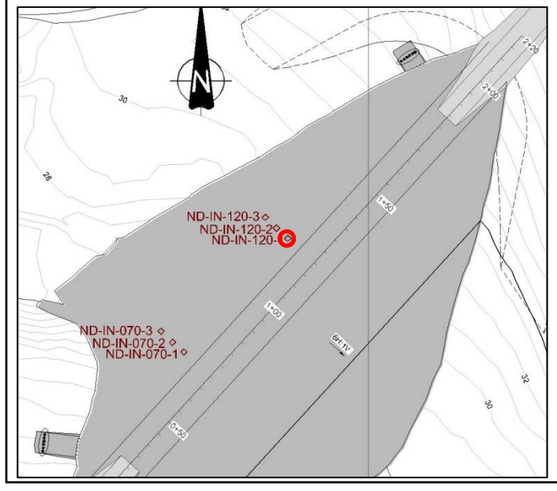


Notes:

1. Manufacture's accuracy is +/- 0.25 mm per location
2. Survey data excluded from the charts is noted on Figure E.1
3. Dashed lines represent depths at or below the natural ground surface

srk consulting	TMAC RESOURCES	2019 AGI - North Dam
		Inclinometer 120-1A Displacement Time Series
Job No: 1CT022.038 Filename: AppE_1CT022.038_Inclinometers.pptx	**DORIS TIA**	Date: Feb. 2020 / Approved: AB / Figure: **E.16**



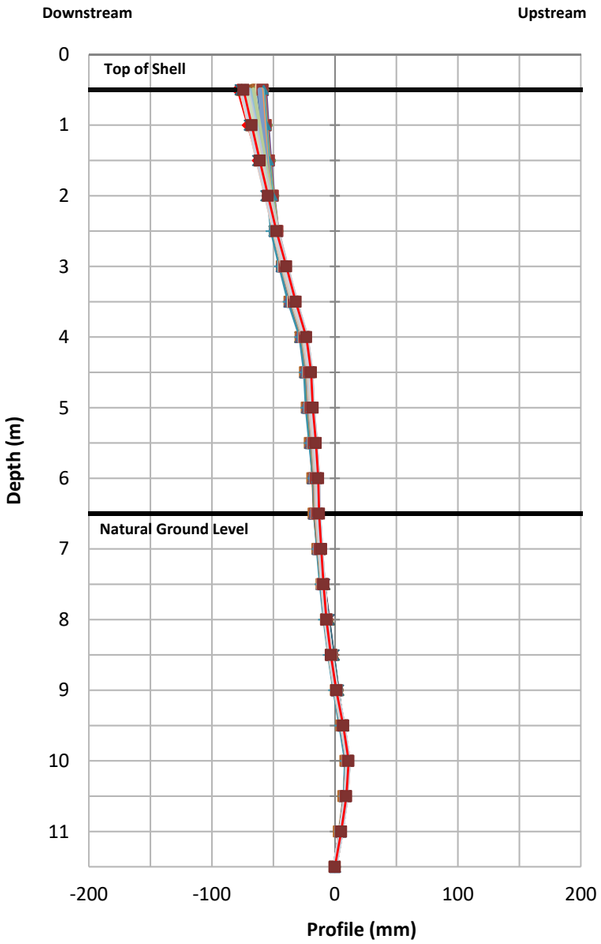


Notes:

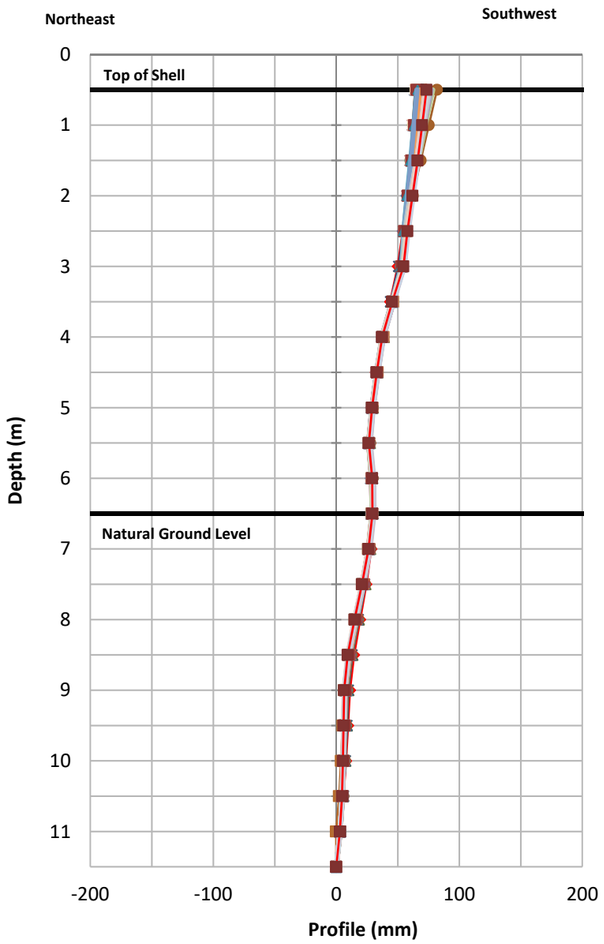
1. Manufacture's accuracy is +/- 0.25 mm per location
2. Survey data excluded from the charts is noted on Figure E.1
3. Dashed lines represent depths at or below the natural ground surface

srk consulting	TMAC RESOURCES	2019 AGI - North Dam
		Inclinometer 120-1A Velocity Time Series
Job No: 1CT022.038 Filename: AppE_1CT022.038_Inclinometers.pptx	**DORIS TIA**	Date: Feb. 2020 / Approved: AB / Figure: **E.17**

Profile Perpendicular to Centerline

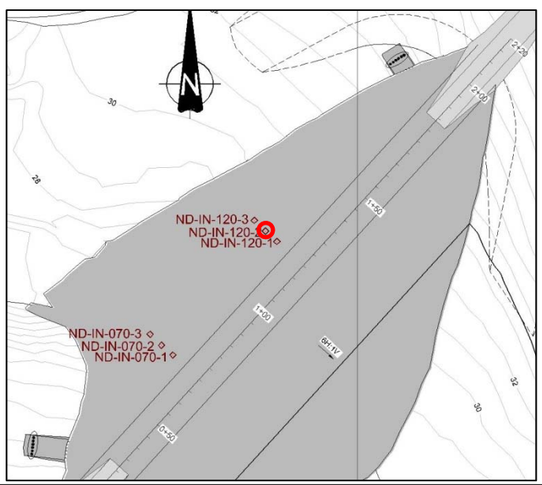


Profile Parallel to Centerline



LEGEND:

- Initial Reading (9/8/2012)
- 8/28/2013
- 5/20/2014
- 8/8/2014
- 10/1/2014
- 3/21/2015
- 4/20/2015
- 6/26/2015
- 8/2/2015
- 10/9/2015
- 12/30/2015
- 3/7/2016
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- 11/24/2019
- 2/18/2020

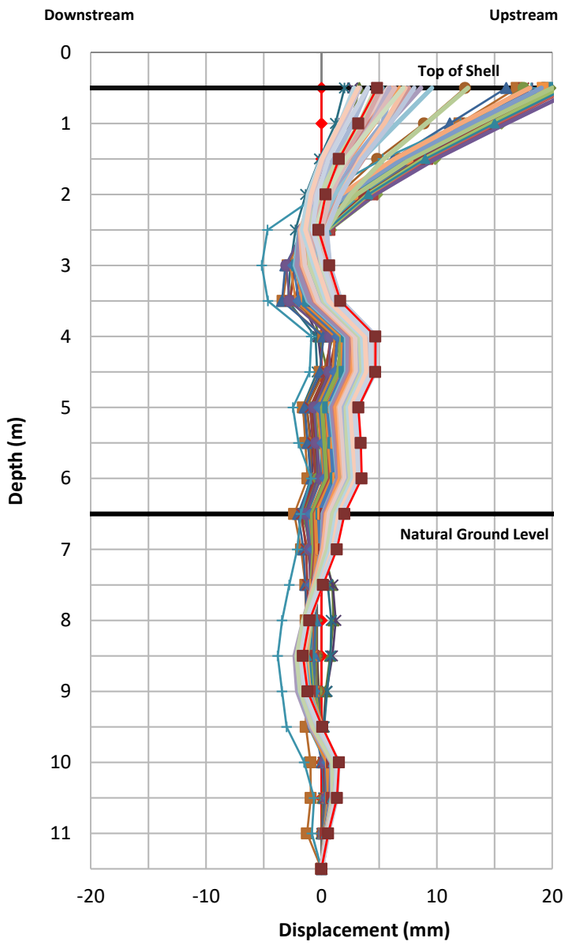


Notes:

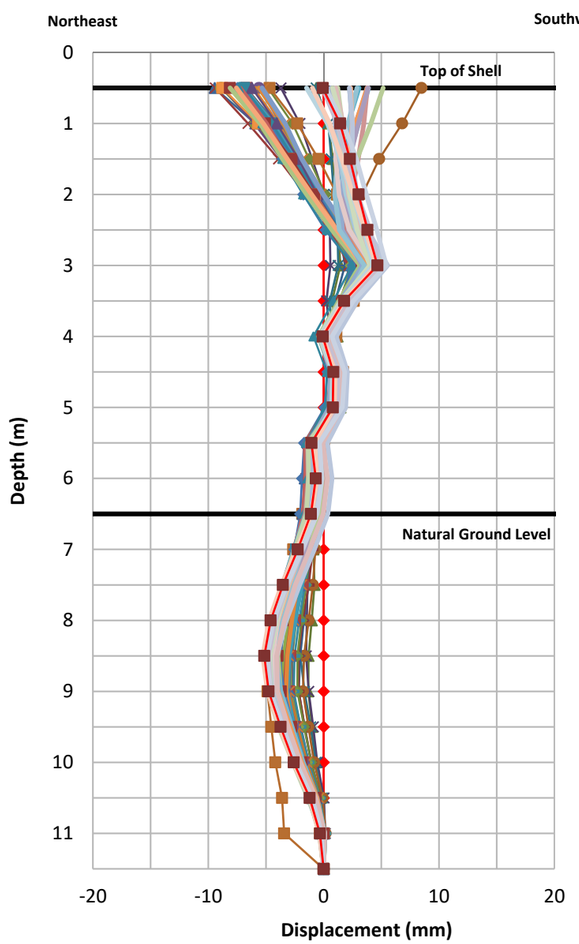
1. Manufacture's accuracy is +/- 0.25 mm per location
2. Survey data excluded from the charts is noted on Figure E.1

srk consulting	MAC RESOURCES	2019 AGI - North Dam
		Inclinometer 120-2 Profiles
Job No: 1CT022.038 Filename: AppE_1CT022.038_Inclinometers.pptx	**DORIS TIA**	Date: Feb. 2020 / Approved: AB / Figure: **E.18**

Displacement Perpendicular to Centerline

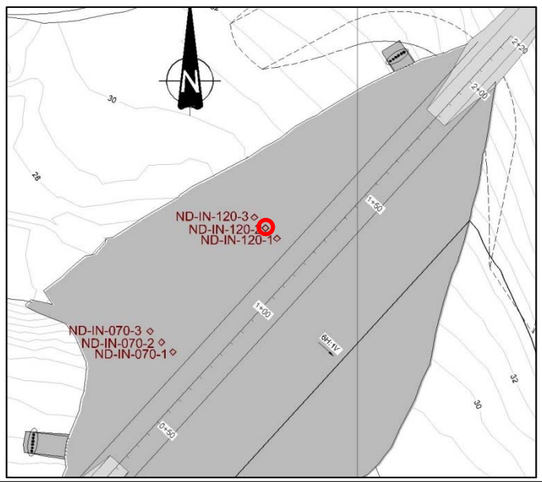


Displacement Parallel to Centerline



LEGEND:



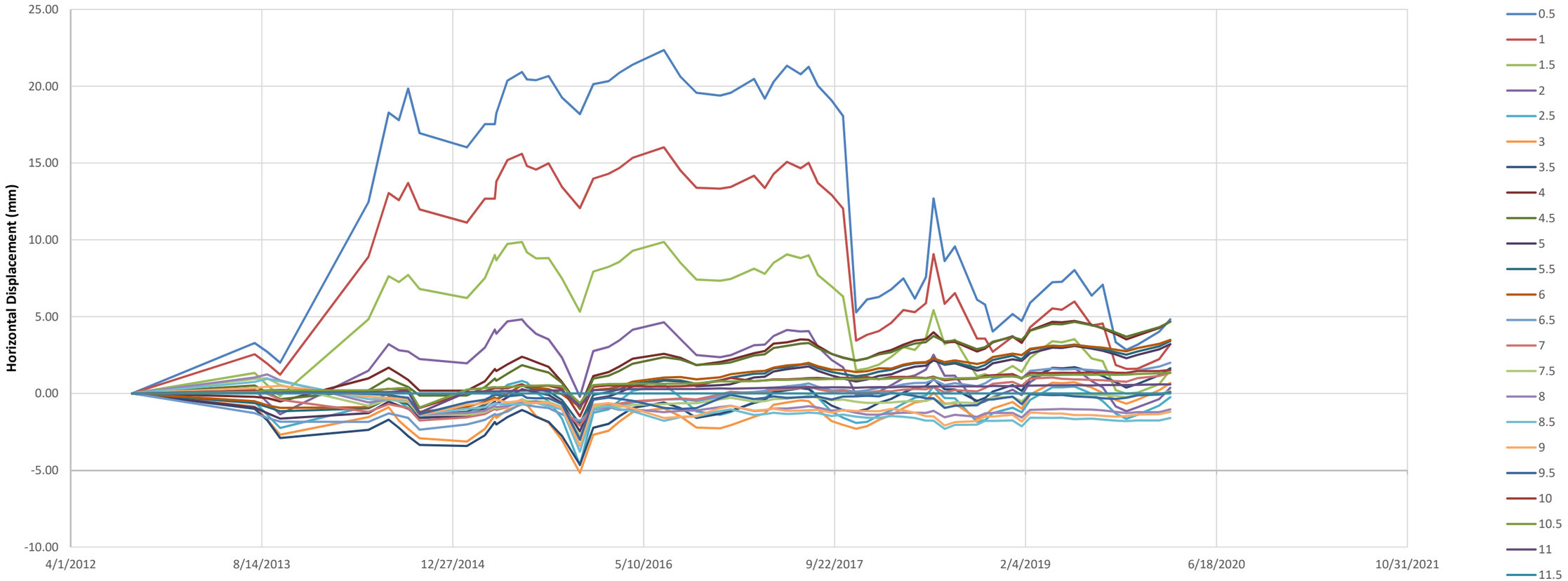


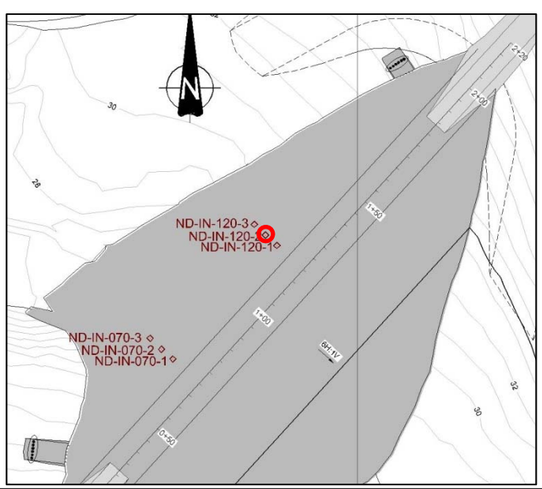
Notes:

1. Manufacture's accuracy is +/- 0.25 mm per location
2. Survey data excluded from the charts is noted on Figure E.1

srk consulting	TMAC RESOURCES	2019 AGI - North Dam
		Inclinometer 120-2 Displacements
Job No: 1CT022.038 Filename: AppE_1CT022.038_Inclinometers.pptx	**DORIS TIA**	Date: Feb. 2020 / Approved: AB / Figure: **E.19**

Inclinometer 120-2A Timeseries



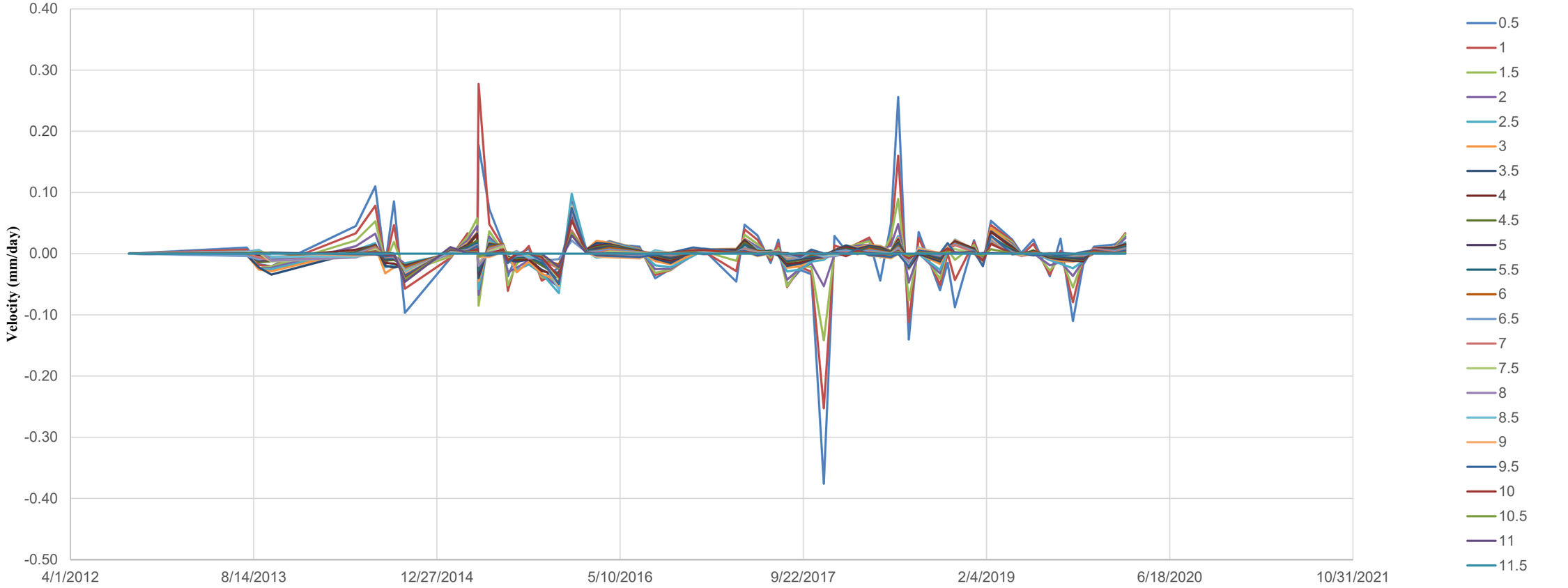


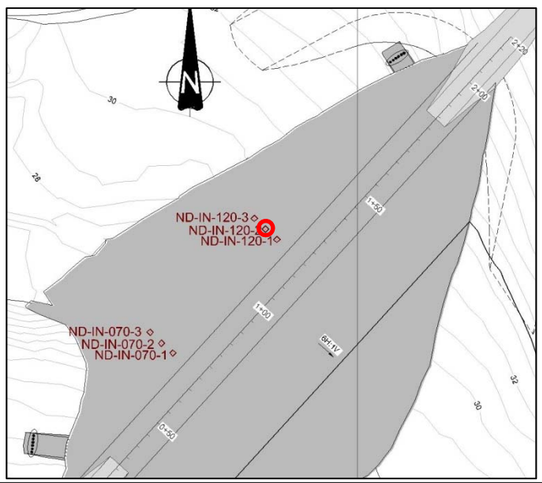
Notes:

1. Manufacture's accuracy is +/- 0.25 mm per location
2. Survey data excluded from the charts is noted on Figure E.1
3. Dashed lines represent depths at or below the natural ground surface

srk consulting	MAC RESOURCES	2019 AGI - North Dam
		Inclinometer 120-2A Displacement Time Series
Job No: 1CT022.038 Filename: AppE_1CT022.038_Inclinometers.pptx	**DORIS TIA**	Date: Feb. 2020 / Approved: AB / Figure: **E.20**

Inclinometer 120-2A Velocity Timeseries



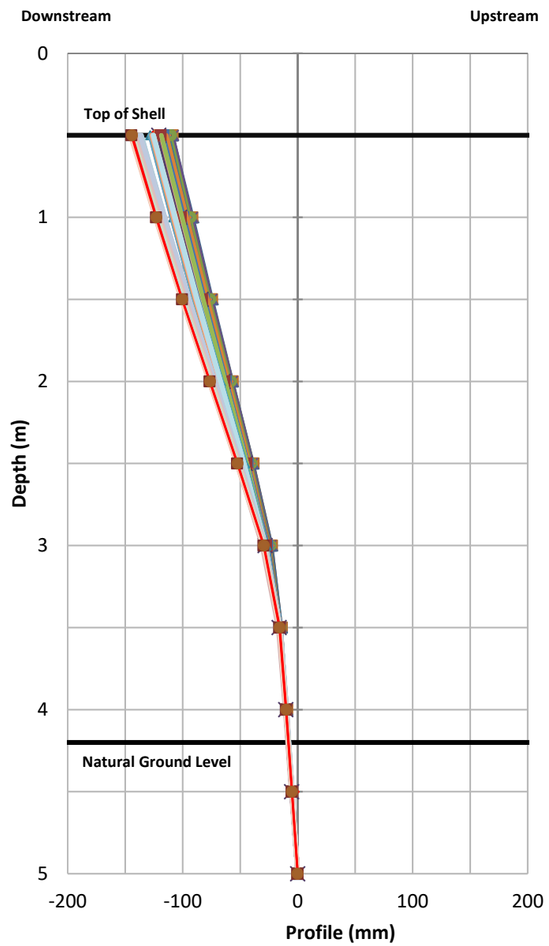


Notes:

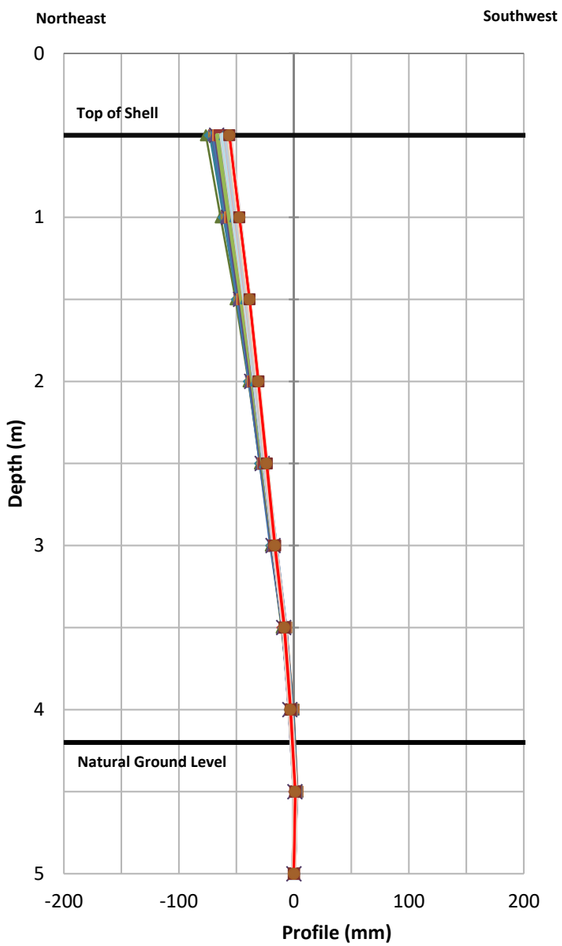
1. Manufacture's accuracy is +/- 0.25 mm per location
2. Survey data excluded from the charts is noted on Figure E.1
3. Dashed lines represent depths at or below the natural ground surface

srk consulting	TMAC RESOURCES	2019 AGI - North Dam
		Inclinometer 120-2A Velocity Time Series
Job No: 1CT022.038 Filename: AppE_1CT022.038_Inclinometers.pptx	**DORIS TIA**	Date: Feb. 2020 · Approved: AB · Figure: **E.21**

Profile Perpendicular to Centerline

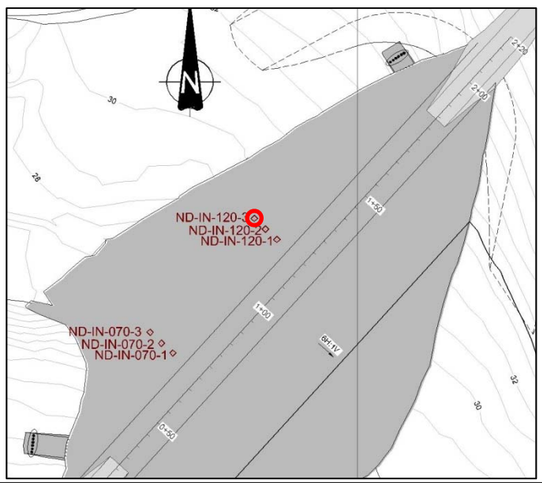


Profile Parallel to Centerline



LEGEND:

- Initial Reading (9/8/2012)
- 5/20/2014
- 7/6/2014
- 8/8/2014
- 10/1/2014
- 3/21/2015
- 5/20/2015
- 7/9/2015
- 8/28/2015
- 10/9/2015
- 12/30/2015
- 3/7/2016
- 7/2/2016
- 9/25/2016
- 1/3/2017
- 2/23/2017
- 4/15/2017
- 6/25/2017
- 8/9/2017
- 10/14/2017
- 12/16/2017
- 2/17/2018
- 4/20/2018
- 6/8/2018
- 8/3/2018
- 10/21/2018
- 1/1/2019
- 2/16/2019
- 5/10/2019
- 7/27/2019
- 9/28/2019
- 11/24/2019
- 2/18/2020
- 7/26/2013
- 6/18/2014
- 7/12/2014
- 9/1/2014
- 2/2/2015
- 4/20/2015
- 6/26/2015
- 8/2/2015
- 9/4/2015
- 11/25/2015
- 2/8/2016
- 4/11/2016
- 8/14/2016
- 11/26/2016
- 1/26/2017
- 3/23/2017
- 5/20/2017
- 7/16/2017
- 9/14/2017
- 11/17/2017
- 1/17/2018
- 3/21/2018
- 5/19/2018
- 7/7/2018
- 9/29/2018
- 11/10/2018
- 1/25/2019
- 4/15/2019
- 6/12/2019
- 8/25/2019
- 10/26/2019
- 1/20/2020



Notes:

1. Manufacture's accuracy is +/- 0.25 mm per location
2. Survey data excluded from the charts is noted on Figure E.1

srk consulting

Job No: 1CT022.038

Filename: AppE_1CT022.038_Inclinometers.pptx

TMAC RESOURCES

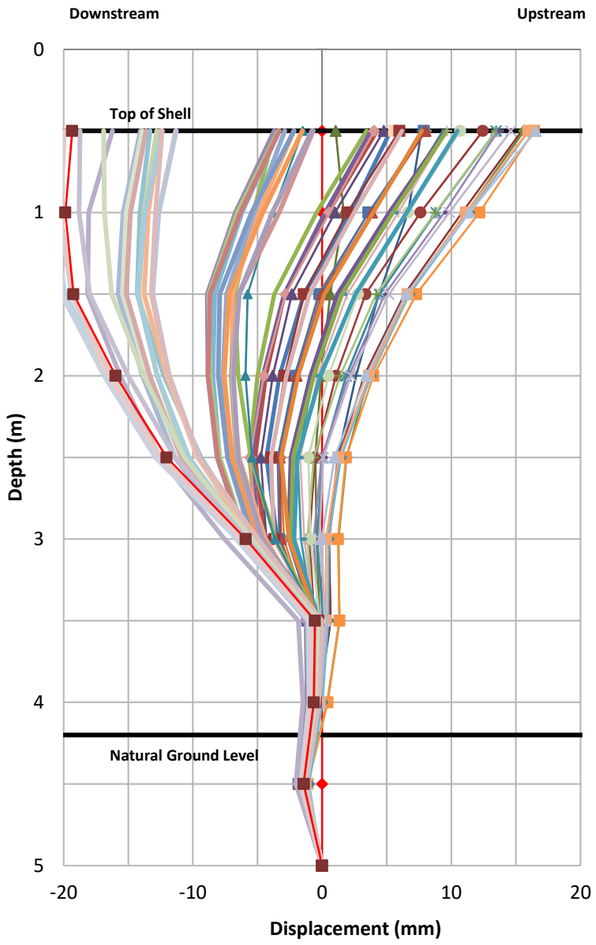
DORIS TIA

2019 AGI - North Dam

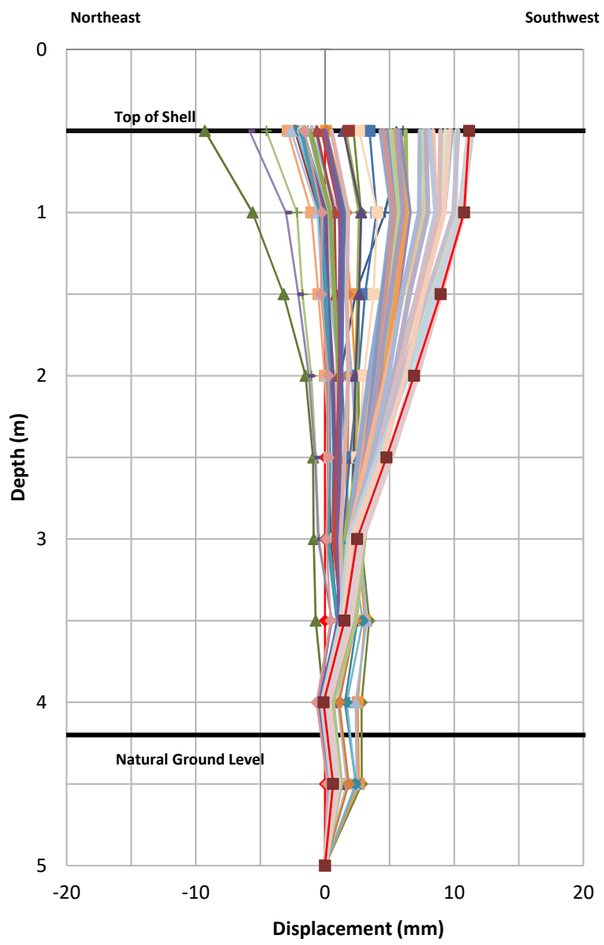
Inclinometer 120-3 Profiles

Date:	Approved:	Figure:
Feb. 2020	AB	**E.22**

Displacement Perpendicular to Centerline

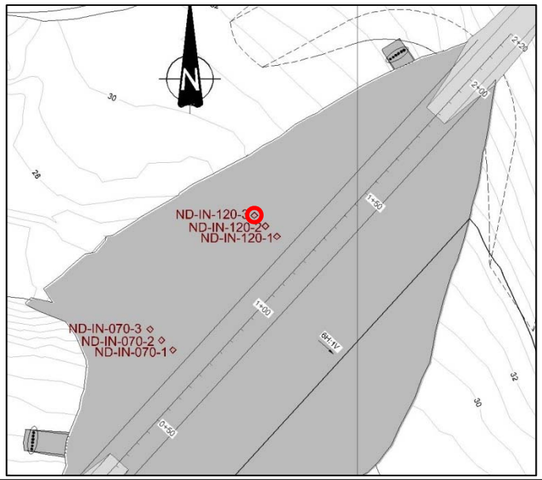


Displacement Parallel to Centerline



LEGEND:



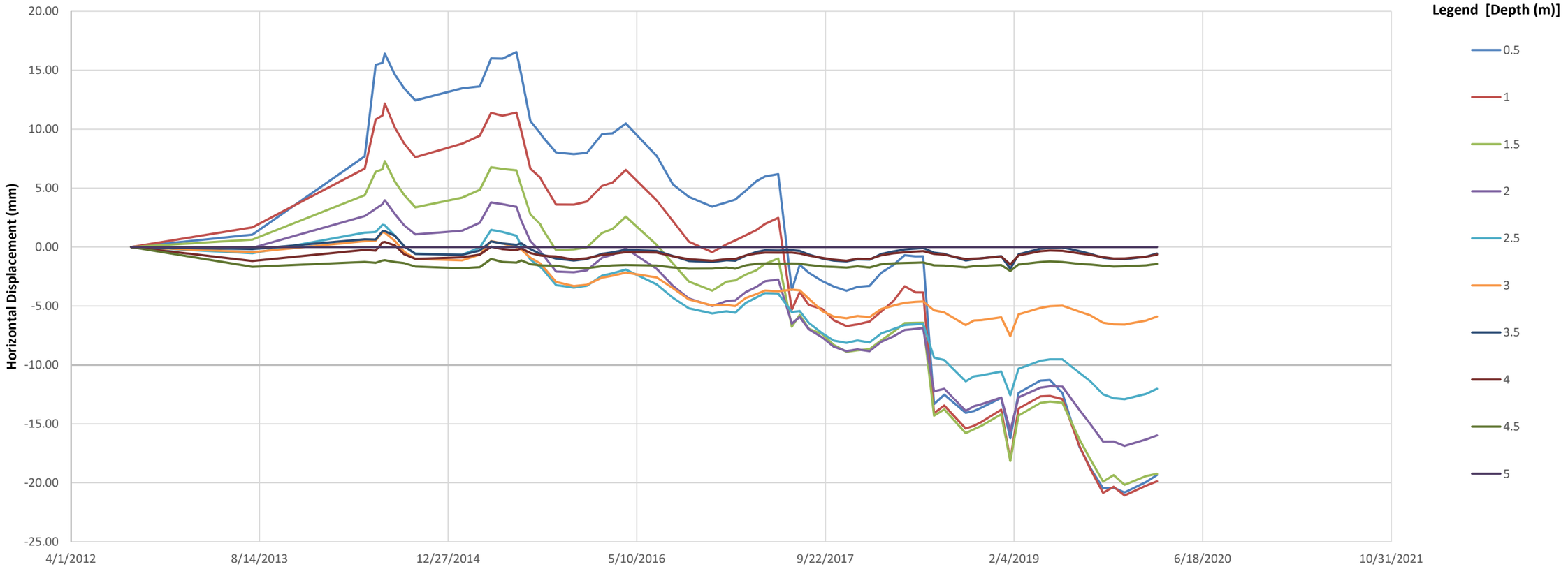


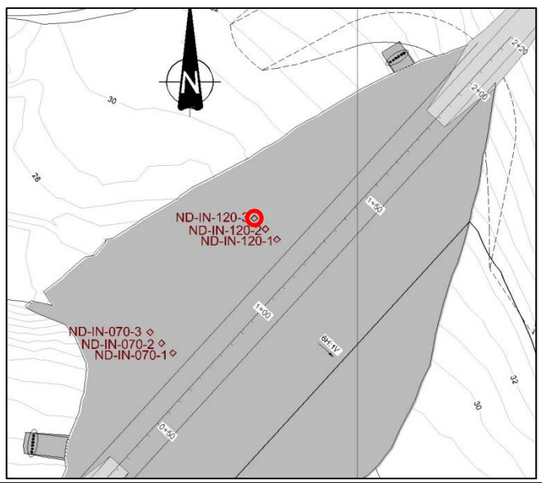
Notes:

1. Manufacture's accuracy is +/- 0.25 mm per location
2. Survey data excluded from the charts is noted on Figure E.1

srk consulting	TMAC RESOURCES	2019 AGI - North Dam
		Inclinometer 120-3 Displacements
Job No: 1CT022.038 Filename: AppE_1CT022.038_Inclinometers.pptx	**DORIS TIA**	Date: Feb. 2020 / Approved: AB / Figure: **E.23**

Inclinometer 120-3A Timeseries



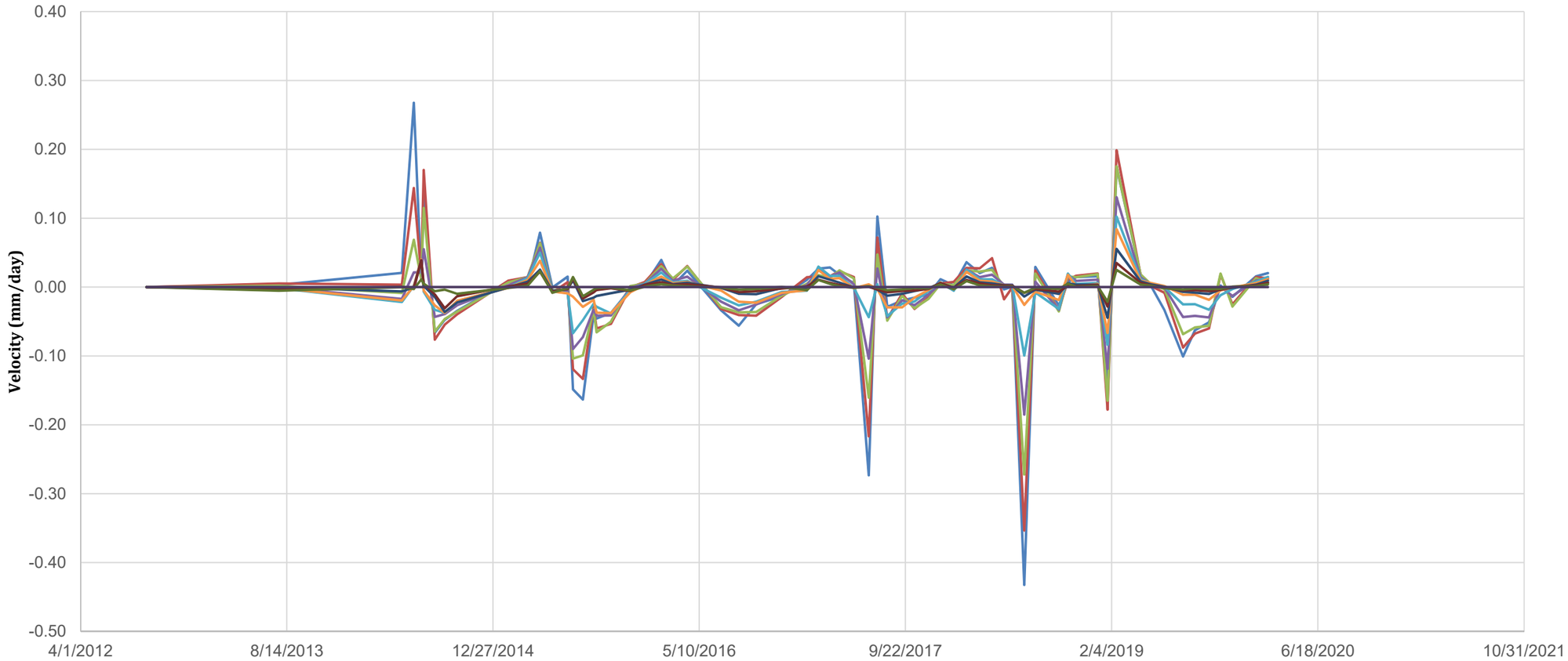


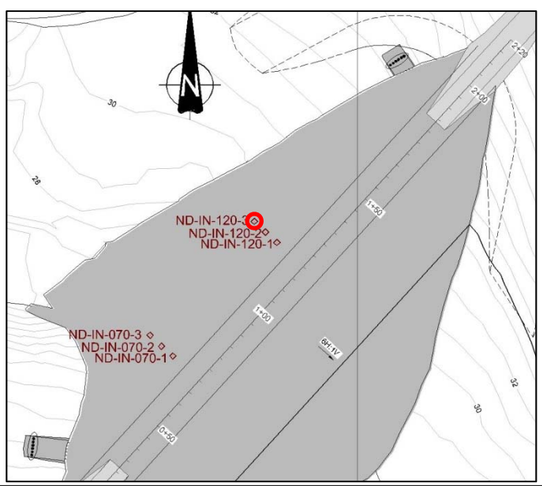
Notes:

1. Manufacture's accuracy is +/- 0.25 mm per location
2. Survey data excluded from the charts is noted on Figure E.1
3. Dashed lines represent depths at or below the natural ground surface

srk consulting	TMAC RESOURCES	2019 AGI - North Dam
		Inclinometer 120-3A Displacement Time Series
Job No: 1CT022.038 Filename: AppE_1CT022.038_Inclinometers.pptx	**DORIS TIA**	Date: Feb. 2020 / Approved: AB / Figure: **E.24**

Inclinometer 120-3A Velocity Timeseries





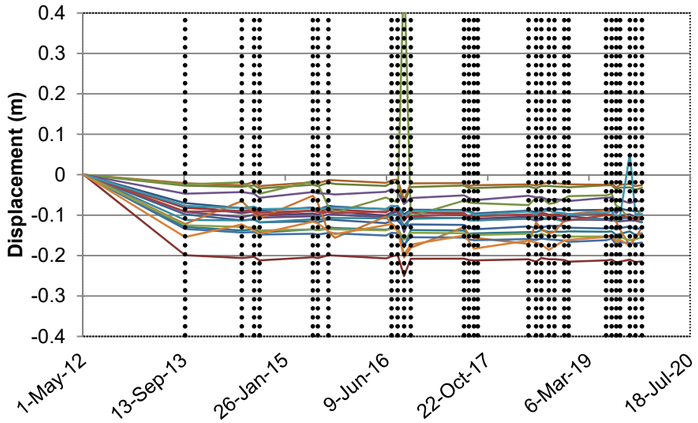
Notes:

1. Manufacture's accuracy is +/- 0.25 mm per location
2. Survey data excluded from the charts is noted on Figure E.1
3. Dashed lines represent depths at or below the natural ground surface

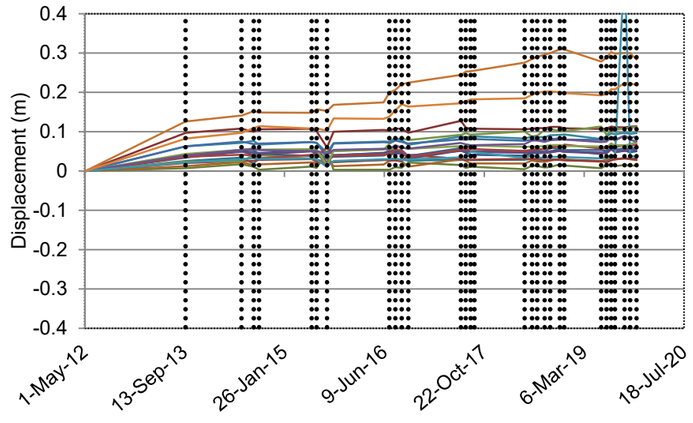
srk consulting	TMAC RESOURCES	2019 AGI - North Dam
		Inclinometer 120-3A Velocity Time Series
Job No: 1CT022.038 Filename: AppE_1CT022.038_Inclinometers.pptx	**DORIS TIA**	Date: Feb. 2020 | Approved: AB | Figure: **E.25**

Appendix F – Survey Monitoring

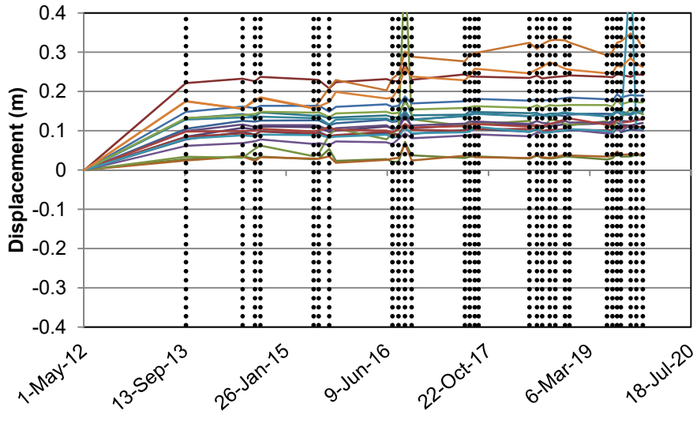
Vertical Displacement



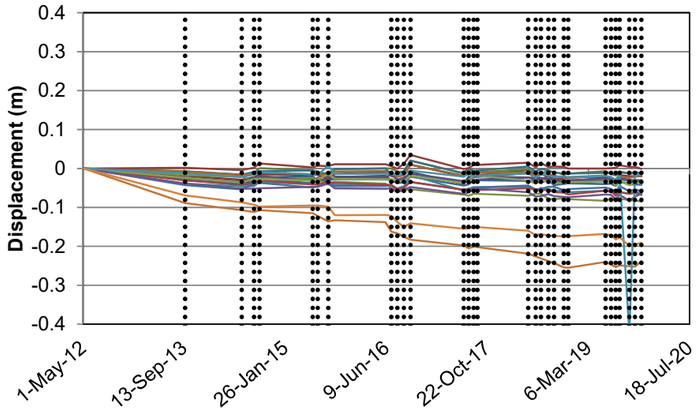
Horizontal Displacement



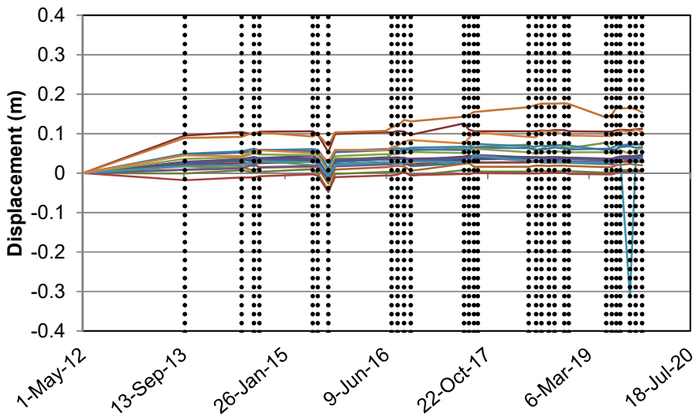
Total Displacement

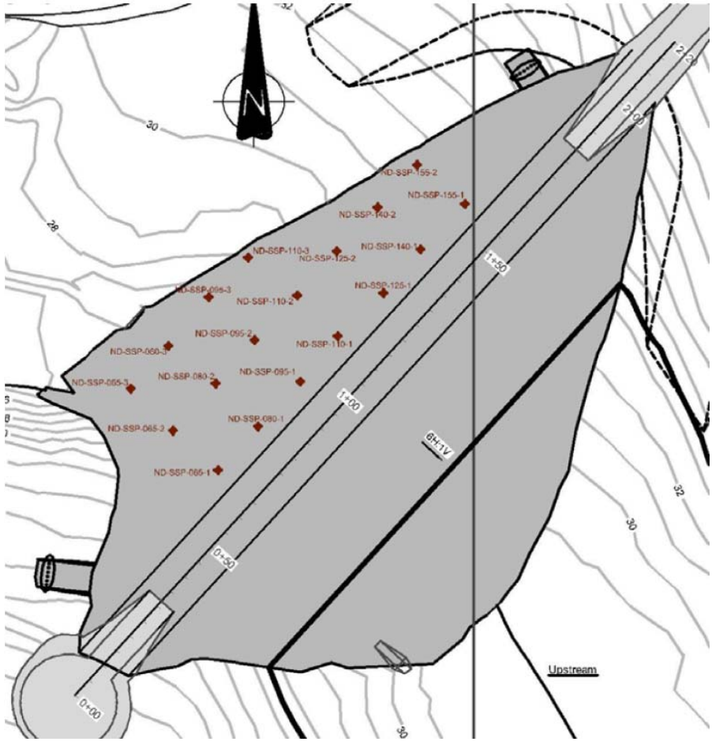


Change in Easting



Change in Northing





LEGEND

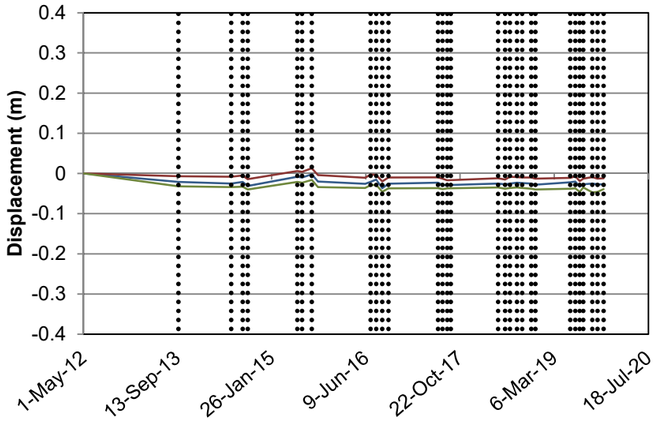
- ND-SSP-065-1
- ND-SSP-065-2
- ND-SSP-065-3
- ND-SSP-080-1
- ND-SSP-080-2
- ND-SSP-080-3
- ND-SSP-095-1
- ND-SSP-095-2
- ND-SSP-095-3
- ND-SSP-110-1
- ND-SSP-110-2
- ND-SSP-110-3
- ND-SSP-125-1
- ND-SSP-125-2
- ND-SSP-140-1
- ND-SSP-140-2
- ND-SSP-155-1
- ND-SSP-155-2
- ..... Survey Date

NOTES:

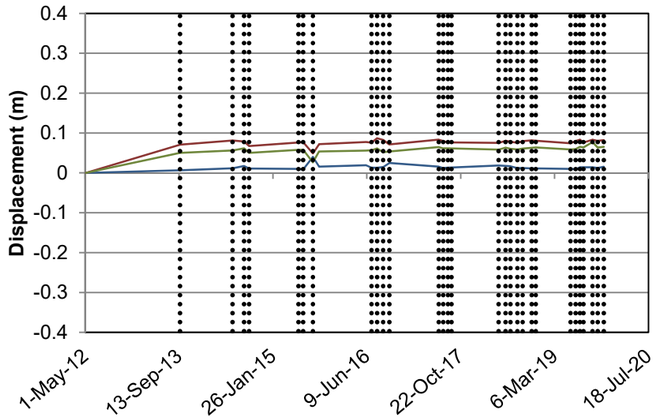
1. The anomolous horizontal displacement observed are Settlement point ND-SSP-110-3 and ND-SSP-155-1 near the downstream toe of the dam and ND-SSP-155-2 near the crest of the dam

srk consulting	TMAC RESOURCES	2019 AGI - North Dam
		Surface Survey Monitoring Points Displacement Timeseries
Job No: 1CT022.038 Filename: AppA_1CT022038_ND_GTC_20200226	DORIS TIA	Date: Feb, 2020 / Approved: PL / Figure: F.1

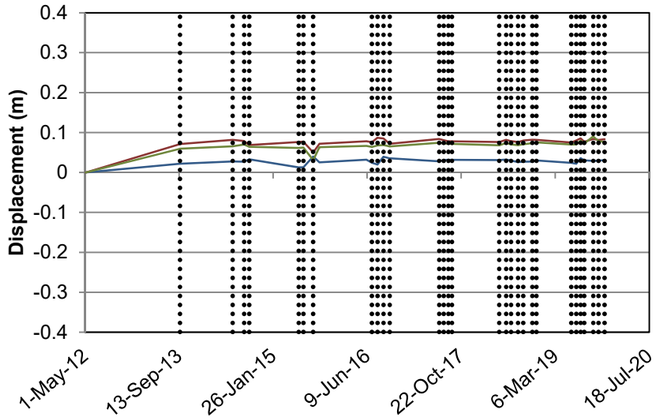
Vertical Displacement



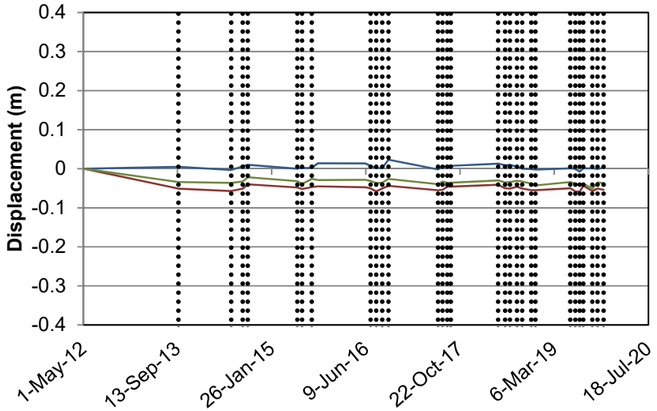
Horizontal Displacement



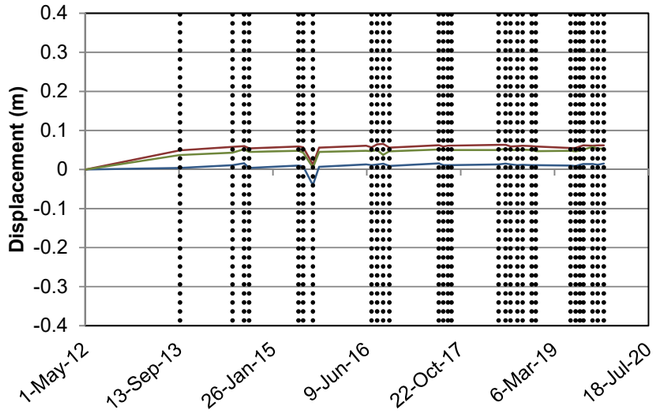
Total Displacement

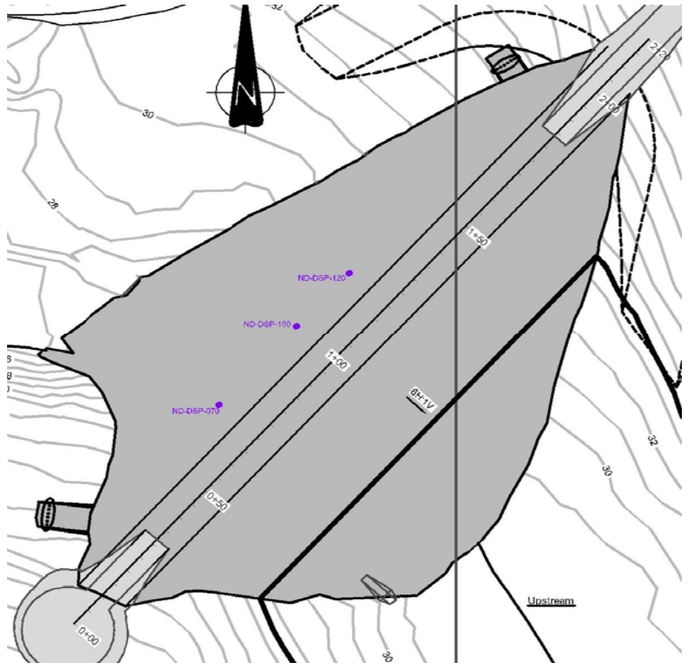


Change in Easting



Change in Northing



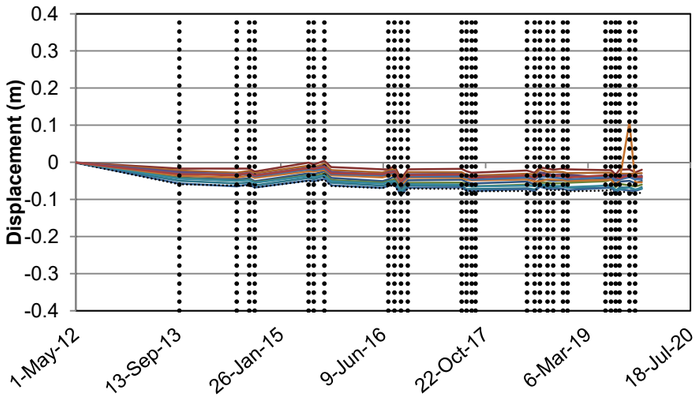


LEGEND

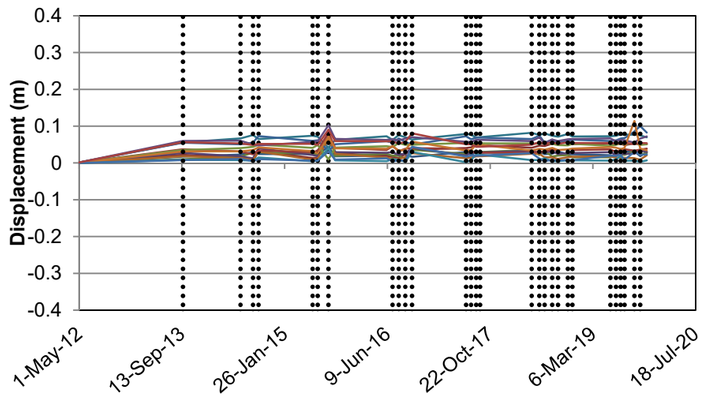
- ND-DSP-070
- ND-DSP-100
- ND-DSP-120
- Survey Date

srk consulting	TMAC RESOURCES	2019 AGI - North Dam
		Deep Survey Monitoring Points Displacement Timeseries
Job No: 1CT022.038 Filename: AppA_1CT022038_ND_GTC_20200226	DORIS TIA	Date: Feb, 2020 / Approved: PL / Figure: F.2

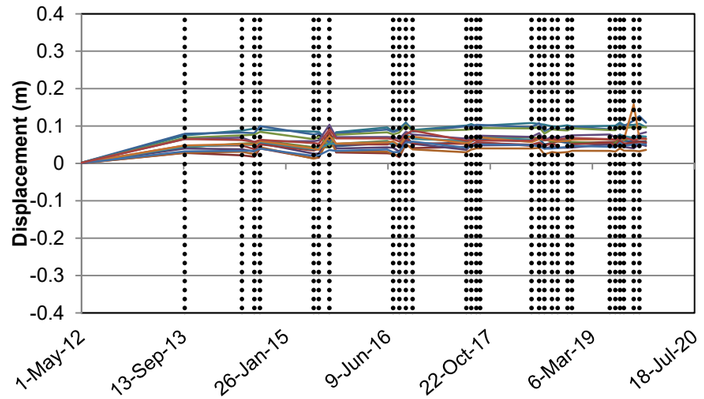
Vertical Displacement



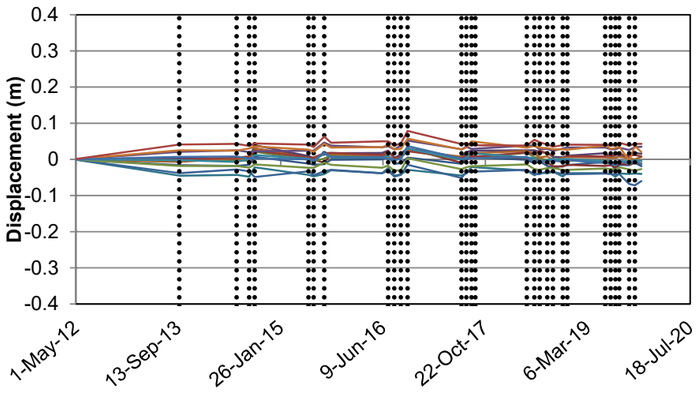
Horizontal Displacement



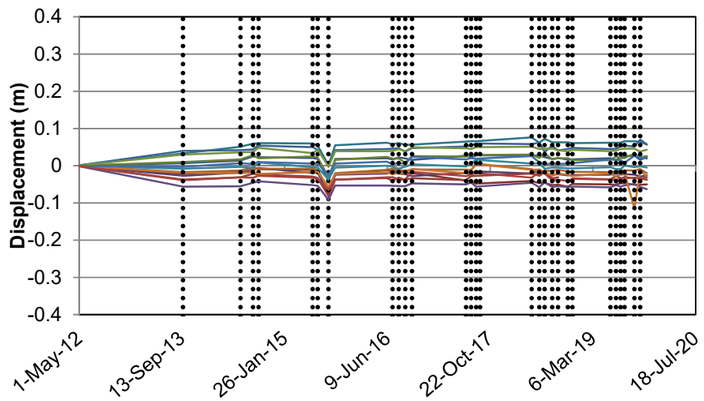
Total Displacement

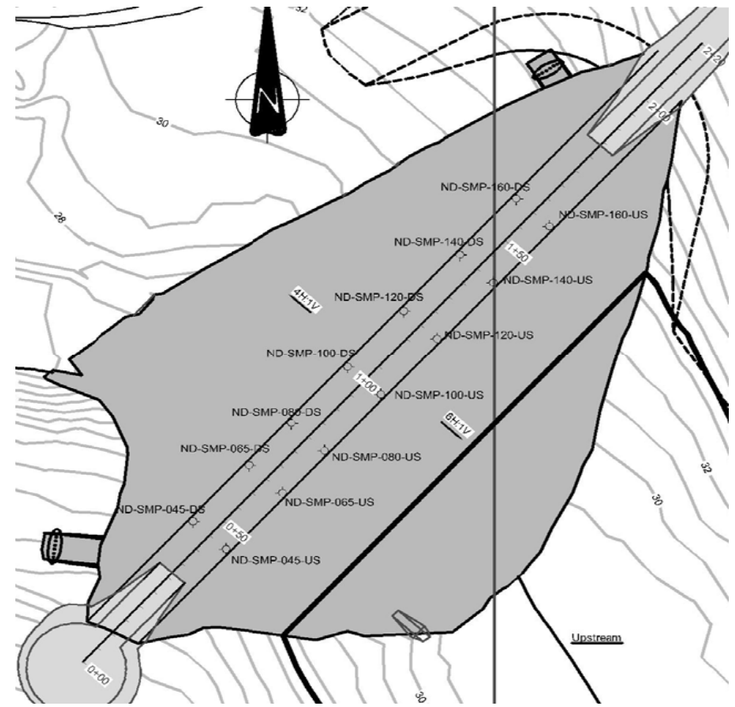


Change in Easting



Change in Northing



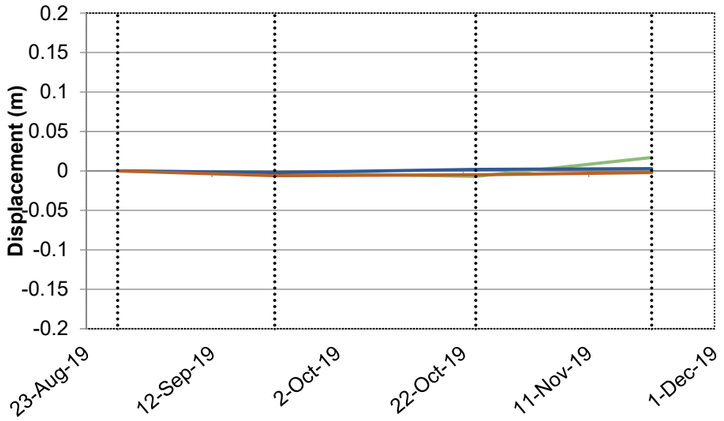


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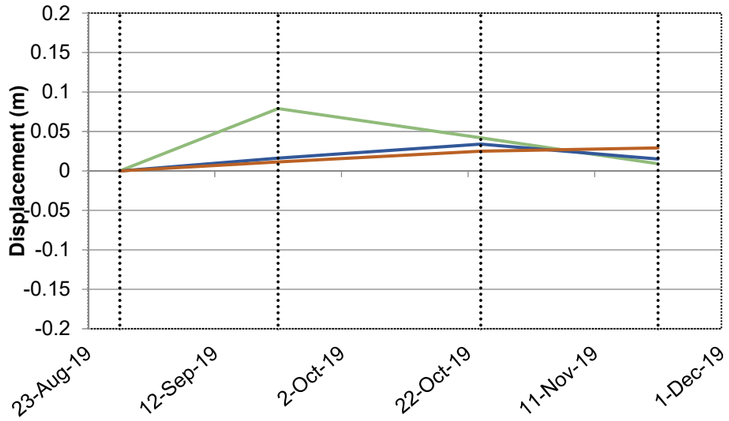
- ND-SMP-045-DS
- ND-SMP-045-US
- ND-SMP-065-DS
- ND-SMP-065-US
- ND-SMP-080-DS
- ND-SMP-080-US
- ND-SMP-100-DS
- ND-SMP-100-US
- ND-SMP-120-DS
- ND-SMP-120-US
- ND-SMP-140-DS
- ND-SMP-140-US
- ND-SMP-160-DS
- ND-SMP-160-US
- Survey Date

srk consulting	TMAC RESOURCES	2019 AGI - North Dam
		Crest Survey Monitoring Pionts Displacement Timeseries
Job No: 1CT022.038 Filename: AppA_1CT022038_ND_GTC_20200226	DORIS TIA	Date: Feb, 2020 / Approved: PL / Figure: F.3

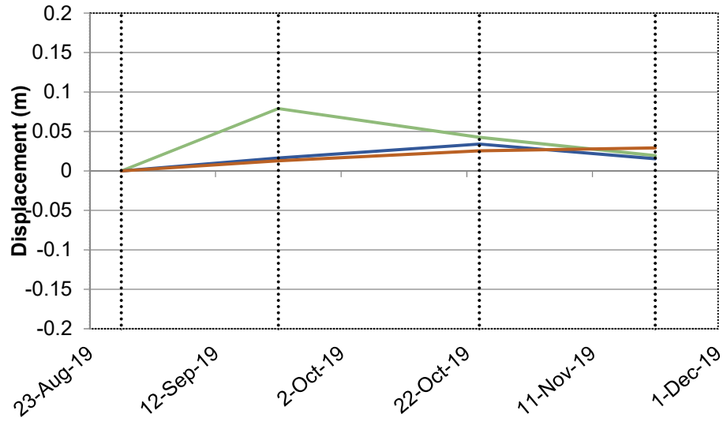
Vertical Displacement



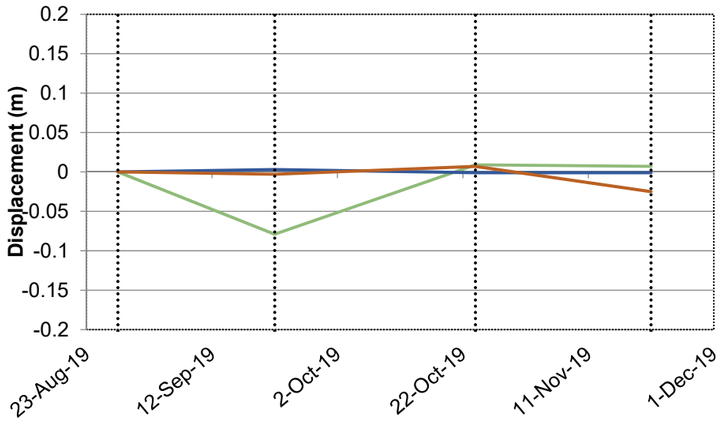
Horizontal Displacement



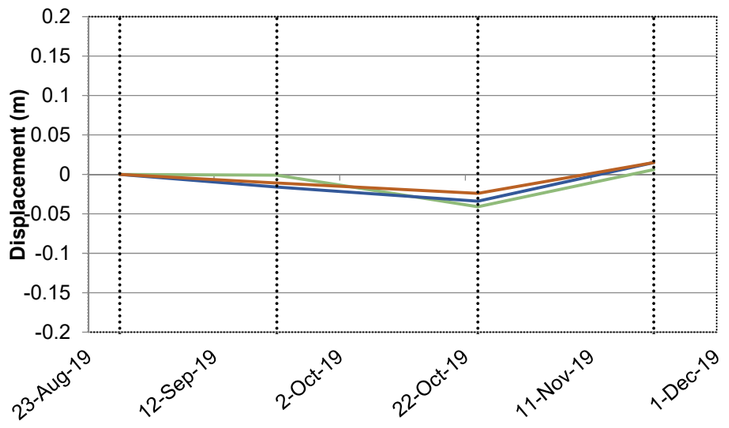
Total Displacement



Change in Easting



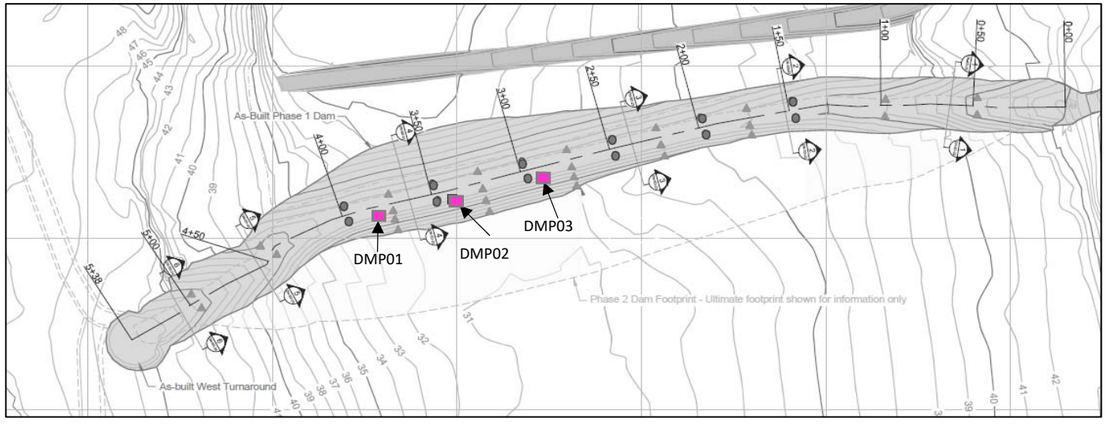
Change in Northing



LEGEND:

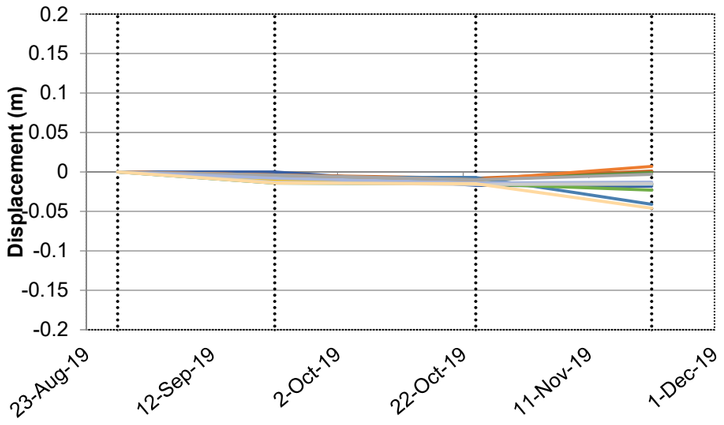
- SD-DMP-01
- SD-DMP-02
- SD-DMP-03

NOTES:

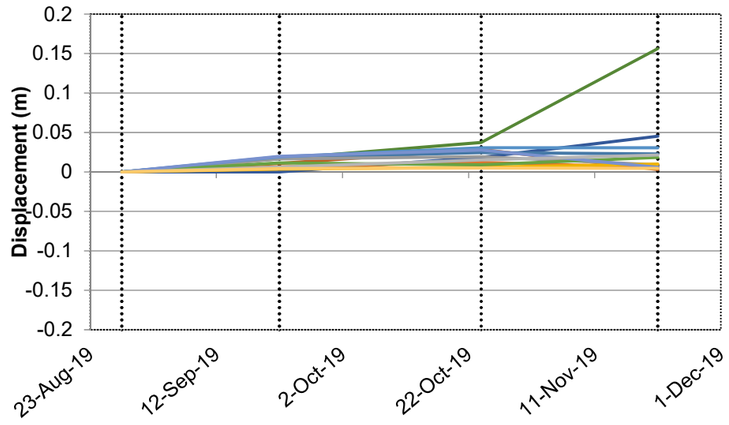


srk consulting	MAC RESOURCES	2019 AGI - South Dam
		Deep Monitoring Points Displacement Timeseries
Job No: 1CT022.038 Filename: AppA_1CT022038_SD_GTC_20200306	DORIS TIA	Date: Mar, 2020 / Approved: PL / Figure: F.1

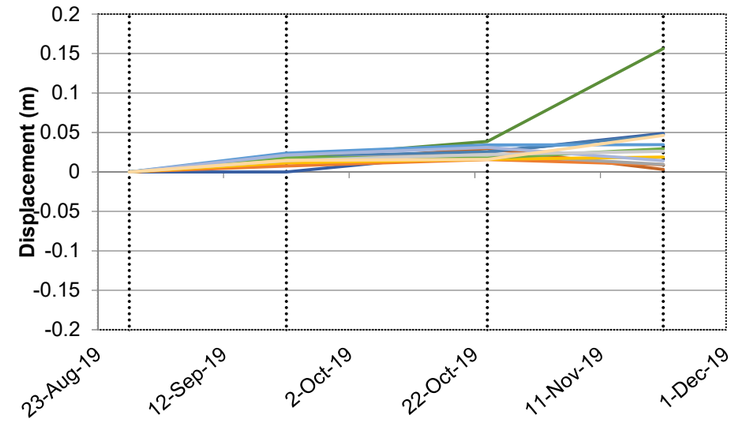
Vertical Displacement



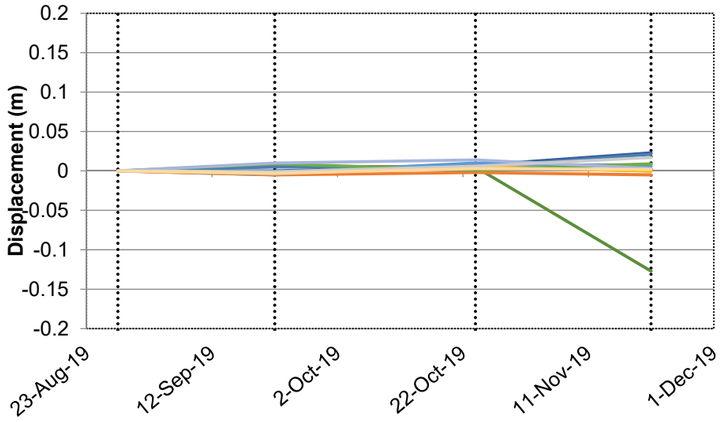
Horizontal Displacement



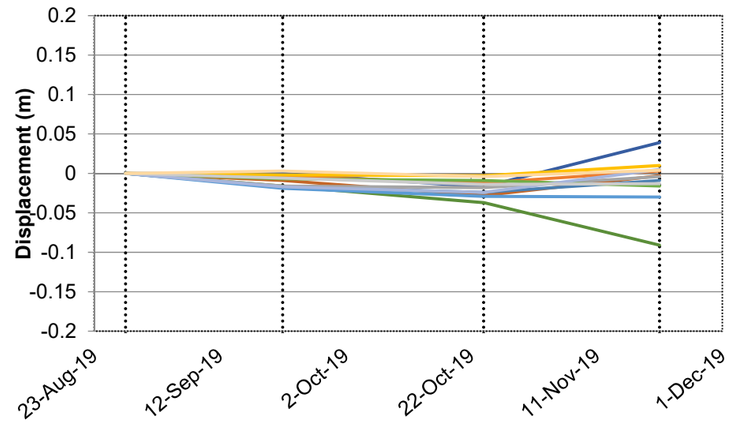
Total Displacement



Change in Easting



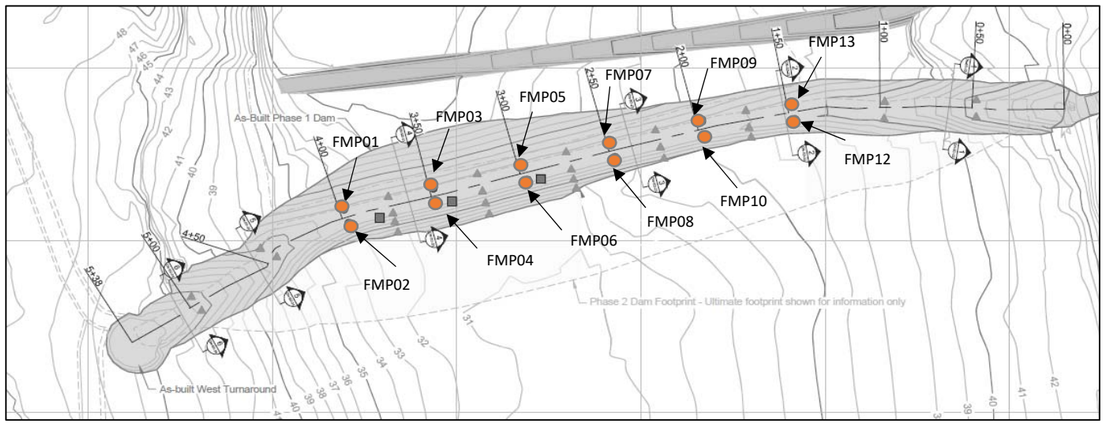
Change in Northing



LEGEND:

- SD-FMP-01
- SD-FMP-02
- SD-FMP-03
- SD-FMP-04
- SD-FMP-05
- SD-FMP-06
- SD-FMP-07
- SD-FMP-08
- SD-FMP-09
- SD-FMP-10
- SD-FMP-12
- SD-FMP-13

NOTES:



srk consulting

MAC RESOURCES

Job No: 1CT022.038
Filename: AppA_1CT022038_ND_GTC_20200306

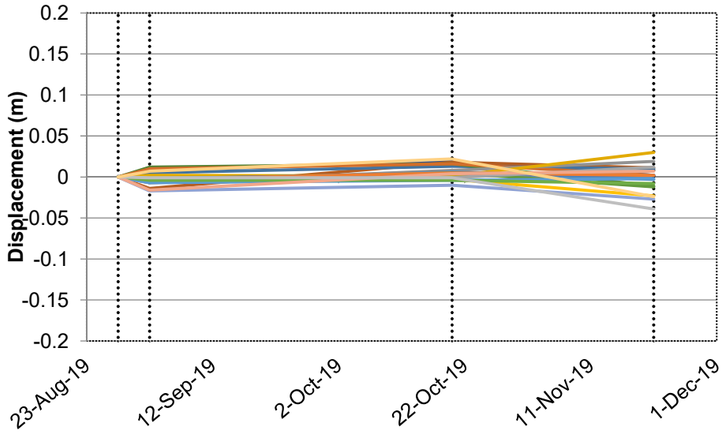
DORIS TIA

2019 AGI - South Dam

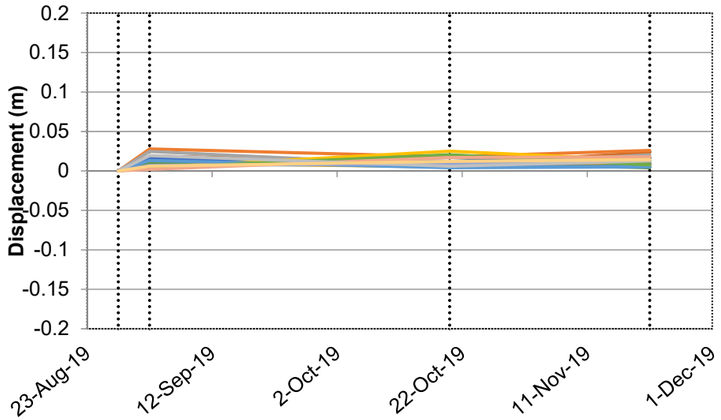
Fixed Survey Monitoring Points Displacement Timeseries

Date:	Approved:	Figure:
Mar, 2020	PL	F.1

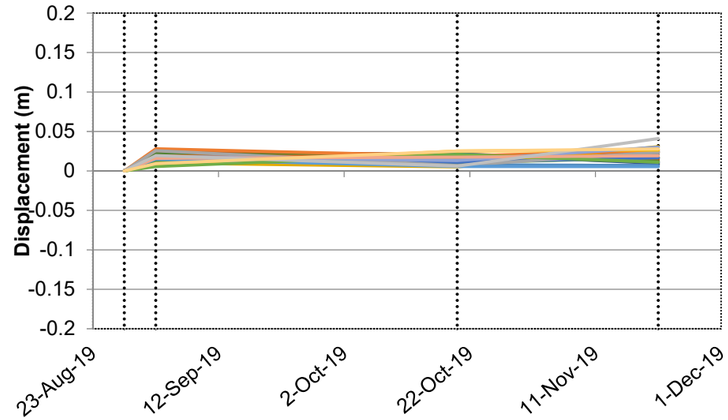
Vertical Displacement



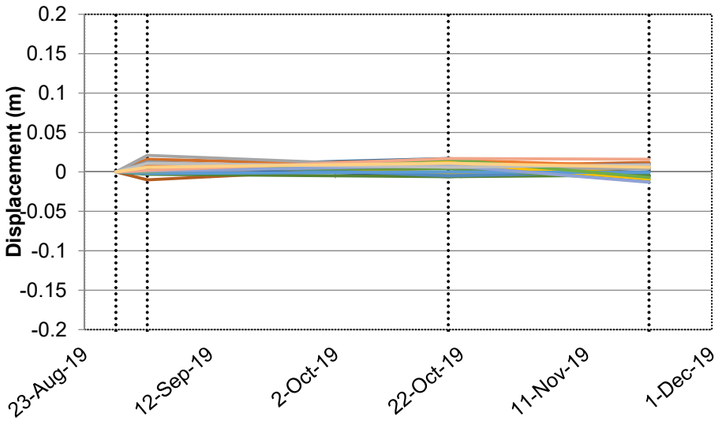
Horizontal Displacement



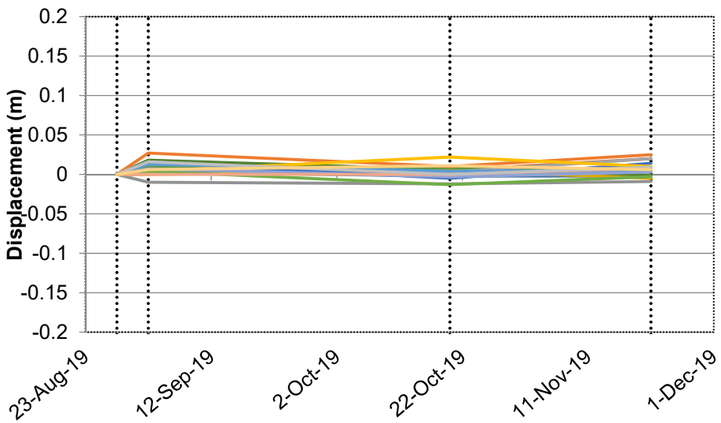
Total Displacement



Change in Easting



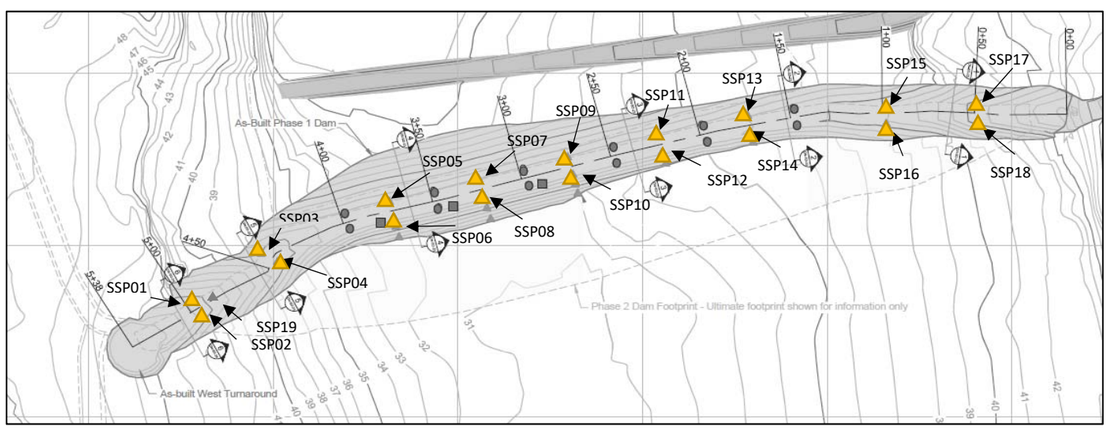
Change in Northing



LEGEND:

- SD-SSP-01
- SD-SSP-02
- SD-SSP-03
- SD-SSP-04
- SD-SSP-05
- SD-SSP-06
- SD-SSP-07
- SD-SSP-08
- SD-SSP-09
- SD-SSP-10
- SD-SSP-11
- SD-SSP-12
- SD-SSP-13
- SD-SSP-14
- SD-SSP-15
- SD-SSP-16
- SD-SSP-17
- SD-SSP-18
- SD-SSP-19

NOTES:



srk consulting

Job No: 1CT022.038

Filename: AppA_1CT022038_ND_GTC_20200226

TMAC RESOURCES

DORIS TIA

2019 AGI - South Dam

Surficial Survey Monitoring Points Displacement Timeseries

Date:	Approved:	Figure:
Mar, 2020	PL	**F.1**

Appendix G – Walk Over Surveys

North Dam Weekly Walkover Survey Report

Date:	Nov. 03, 2018
Inspected By:	Jian Chen, Mike Tanasa
Conditions:	(ie. snow on ground, clear) Snow on ground.

Visual Inspection:

This weekly walkover survey report is a means to track the condition on the North Dam, please provide details on changes that have developed since the previous inspection and/or any observations of particular concern. All photos are appreciated. Please send the completed form (scans are fine) and any photos to hopebaymonitoring@srk.com and pluedke@srk.com

Upstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Downstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	(No)
Crest of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Thermosyphons South Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Instrumentation (on crest and downstream side)		
Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers		
Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen)		
Any suspended sediment in Tail Lake?	Yes	(No)
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	(No)

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

All covered in frozen snow









North Dam Weekly Walkover Survey Report

Date:	NOV. 12 '18
Inspected By:	Sian chen.
Conditions:	(ie. snow on ground, clear) snow covered all Dam

Visual Inspection:

This weekly walkover survey report is a means to track the condition on the North Dam, please provide details on changes that have developed since the previous inspection and/or any observations of particular concern. All photos are appreciated. Please send the completed form (scans are fine) and any photos to hopebaymonitoring@srk.com and pluedke@srk.com

Upstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	No ✓
Downstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	No ✓
Crest of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	No ✓
Thermosyphons North Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	No ✓
Thermosyphons South Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	No ✓
Instrumentation (on crest and downstream side)		
Any visible concerns? (bent, rusted, cracked, etc.)	Yes	No ✓
Thermistors and Dataloggers		
Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	No ✓
Suspended Sediment in TIA (When not frozen)		
Any suspended sediment in Tail Lake?	Yes	No
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes Can't see	No

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

North Dam Weekly Walkover Survey Report

Date:	Nov 14, 2018
Inspected By:	Josh Fris.
Conditions:	(ie. snow on ground, clear) Snow covered.

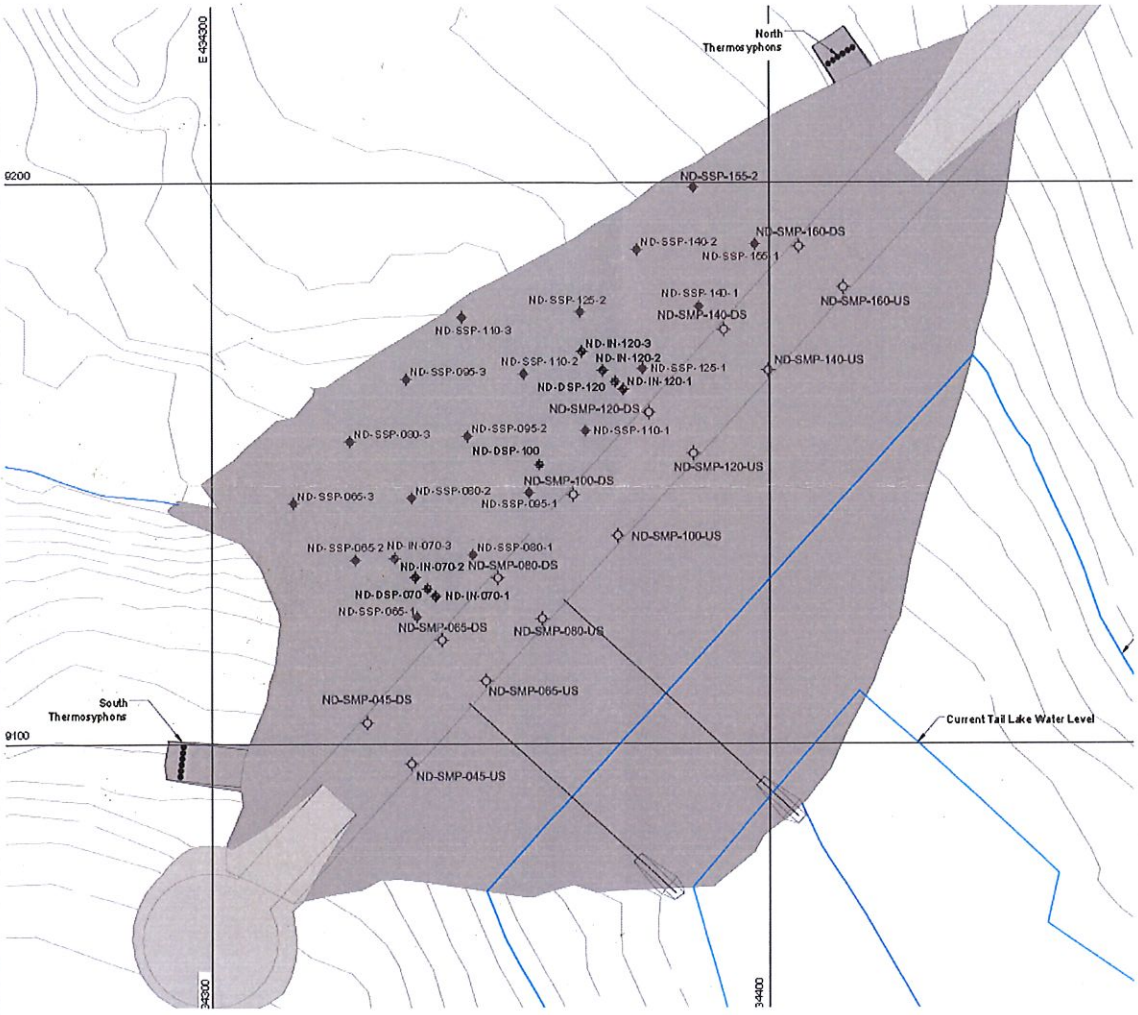
Visual Inspection:

This weekly walkover survey report is a means to track the condition on the North Dam, please provide details on changes that have developed since the previous inspection and/or any observations of particular concern. All photos are appreciated. Please send the completed form (scans are fine) and any photos to hopebaymonitoring@srk.com and pluedke@srk.com

Upstream Side of Dam Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Downstream Side of Dam Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	(No)
Crest of Dam Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side Minor Rust Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Thermosyphons South Side Minor rust. Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Instrumentation (on crest and downstream side) Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen) Any suspended sediment in Tail Lake?	Yes	(No)
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	(No)

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos: Photo from north end looking south along the dam Photo from south end looking north along the dam	☑ ☐
Other photos, please describe – Photos taken North Thermosyphon East. x2 South Thermosyphon East.	









North Dam Weekly Walkover Survey Report

Date:	Nov 21, 2018
Inspected By:	Josh Fris
Conditions:	(ie. snow on ground, clear) Snow

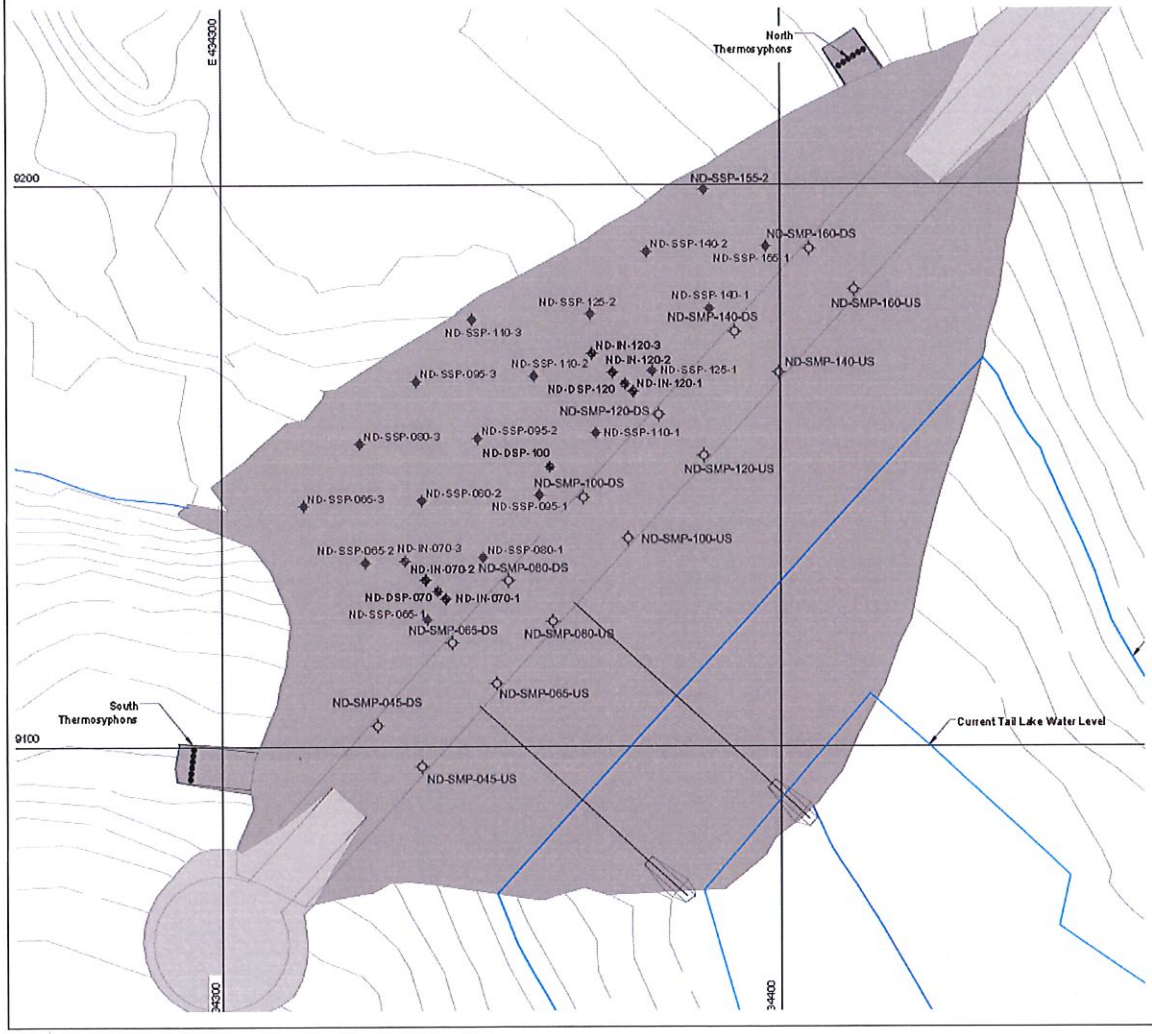
Visual Inspection:

This weekly walkover survey report is a means to track the condition on the North Dam, please provide details on changes that have developed since the previous inspection and/or any observations of particular concern. All photos are appreciated. Please send the completed form (scans are fine) and any photos to hopebaymonitoring@srk.com and pluedke@srk.com

Upstream Side of Dam Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Downstream Side of Dam Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	(No)
Crest of Dam Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side Minor Rust Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Thermosyphons South Side Minor Rust Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Instrumentation (on crest and downstream side) Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen) Any suspended sediment in Tail Lake?	Yes	(No)
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	(No)

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

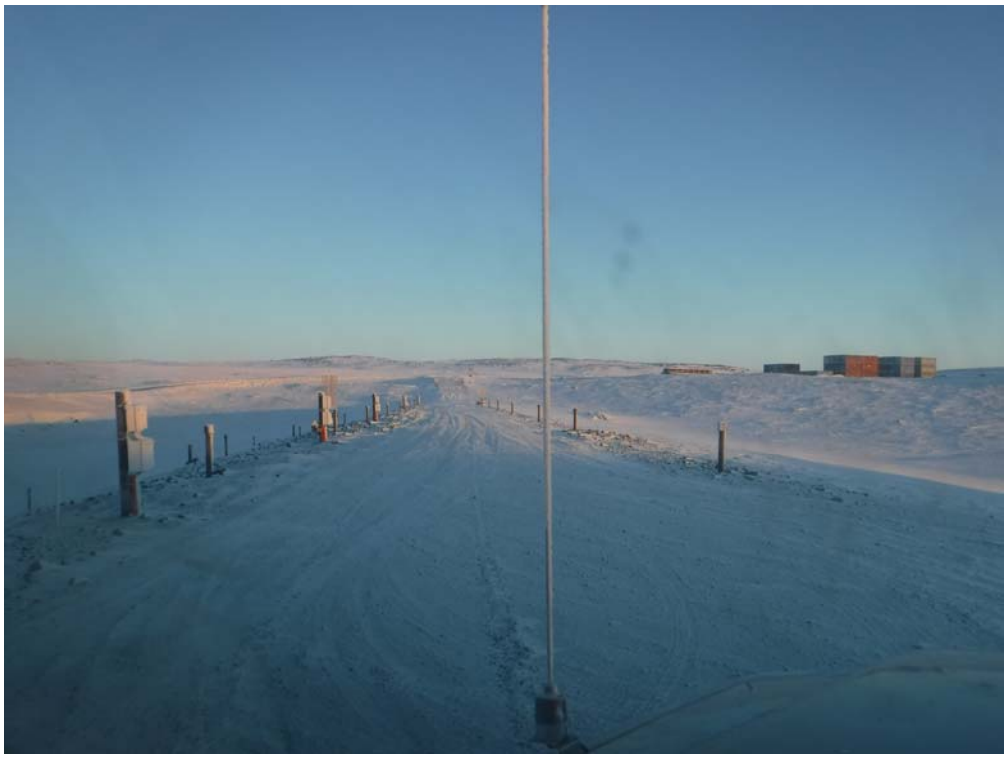
Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos: Photo from north end looking south along the dam Photo from south end looking north along the dam
Other photos, please describe – Photos taken





North Dam Weekly Walkover Survey Report

Date:	Nov 28, 2018
Inspected By:	[illegible]
Conditions:	(ie. snow on ground, clear) Snow.

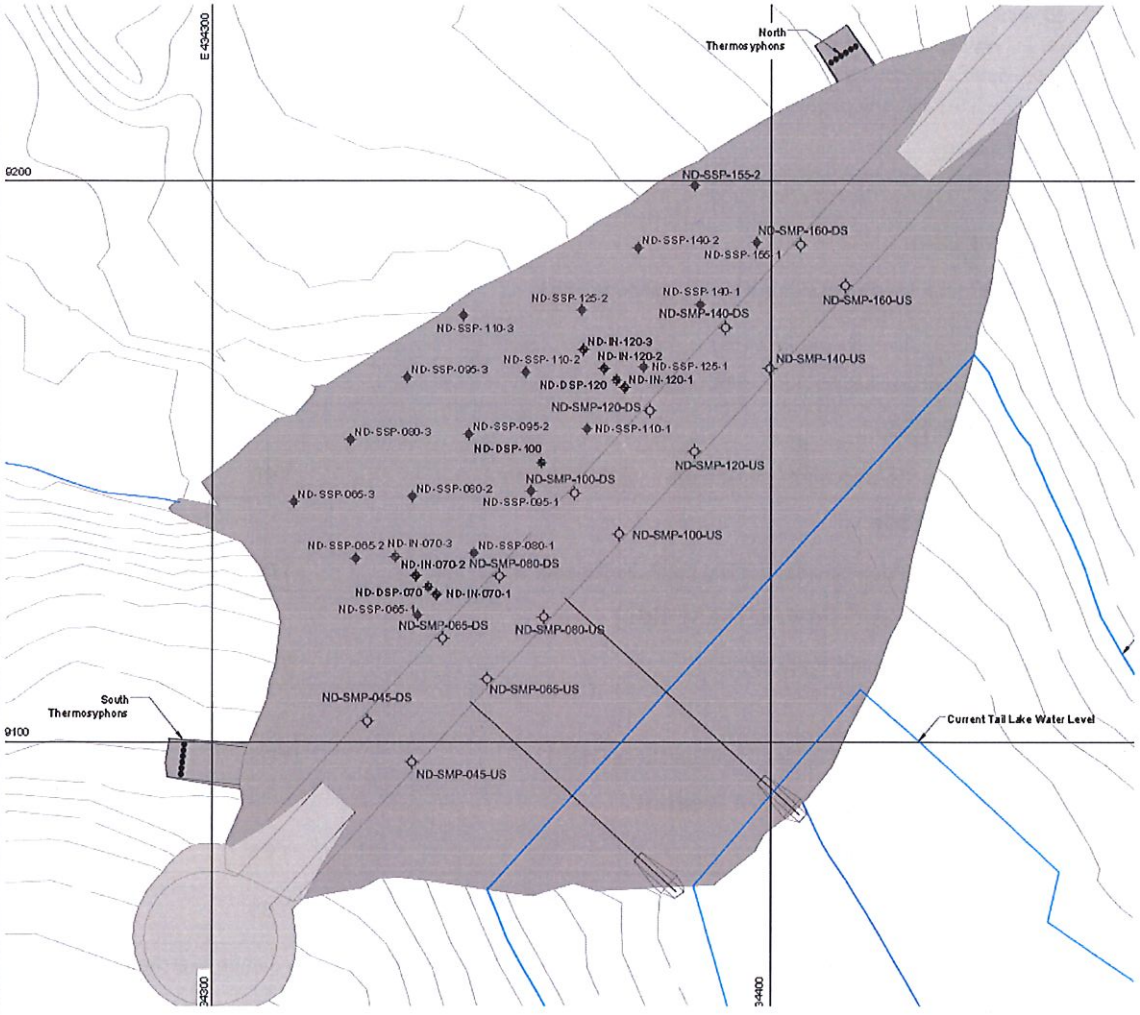
Visual Inspection:

This weekly walkover survey report is a means to track the condition on the North Dam, please provide details on changes that have developed since the previous inspection and/or any observations of particular concern. All photos are appreciated. Please send the completed form (scans are fine) and any photos to hopebaymonitoring@srk.com and pluedke@srk.com

Upstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Downstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	(No)
Crest of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Thermosyphons South Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Instrumentation (on crest and downstream side)		
Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers		
Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen)		
Any suspended sediment in Tail Lake?	Yes	(No)
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	(No)

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos:	
Photo from north end looking south along the dam	☐
Photo from south end looking north along the dam	☐
Other photos, please describe – Photos taken	





North Dam Weekly Walkover Survey Report

Date:	Dec 09. 2018
Inspected By:	MIKE TAMASA JIAN CHEN
Conditions:	(ie. snow on ground, clear) SNOW

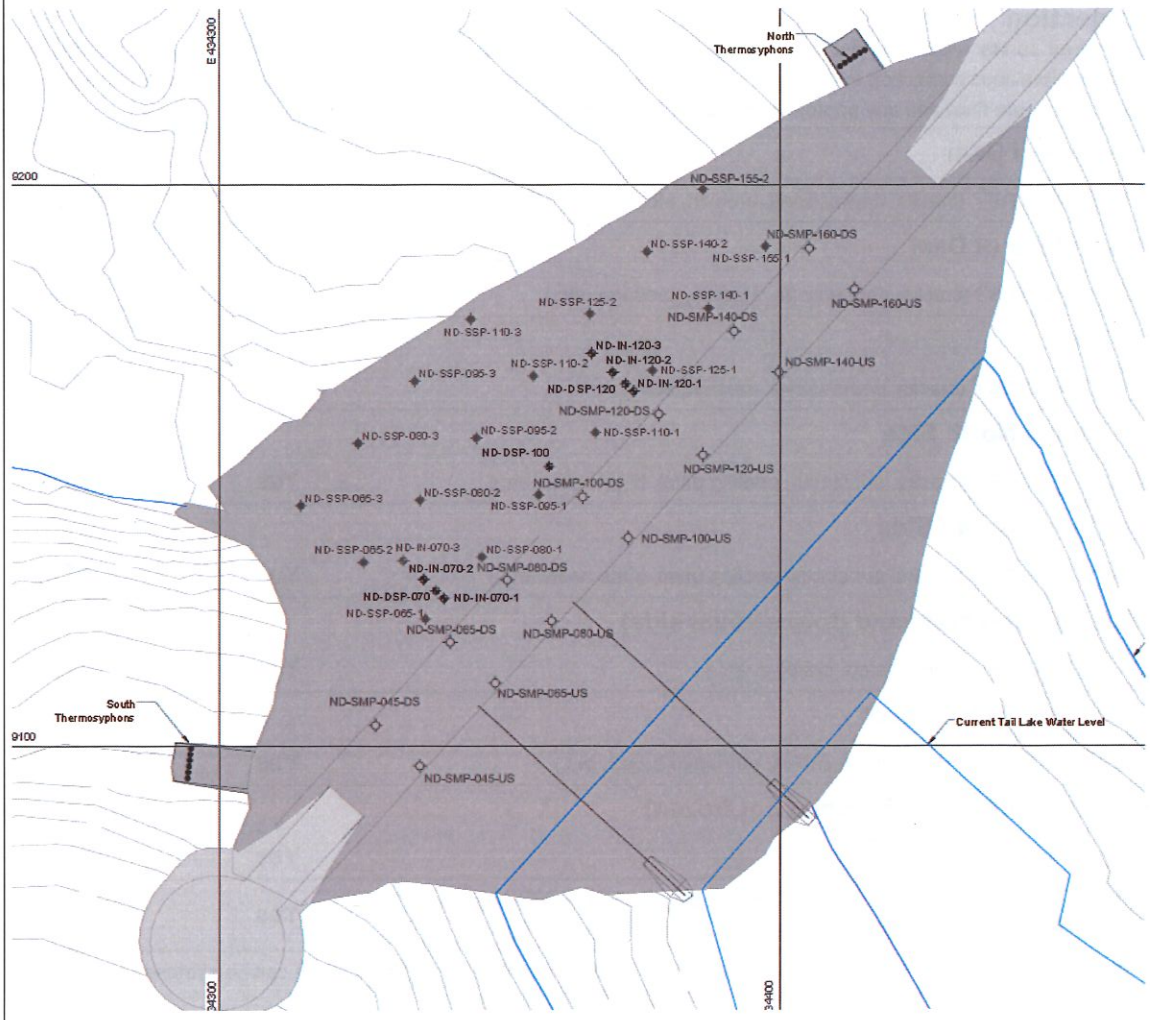
Visual Inspection:

This weekly walkover survey report is a means to track the condition on the North Dam, please provide details on changes that have developed since the previous inspection and/or any observations of particular concern. All photos are appreciated. Please send the completed form (scans are fine) and any photos to hopebaymonitoring@srk.com and pluedke@srk.com

Upstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Downstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	(No)
Crest of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Thermosyphons South Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Instrumentation (on crest and downstream side)		
Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers		
Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen)		
Any suspended sediment in Tail Lake?	Yes	No
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	(No)

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos: Photo from north end looking south along the dam Photo from south end looking north along the dam	☐ ☐
Other photos, please describe – Photos taken	





North Dam Weekly Walkover Survey Report

Date:	December 17, 2018
Inspected By:	Mike Tanasa, Jian Chen
Conditions:	(ie. snow on ground, clear) Snow

Visual Inspection:

This weekly walkover survey report is a means to track the condition on the North Dam, please provide details on changes that have developed since the previous inspection and/or any observations of particular concern. All photos are appreciated. Please send the completed form (scans are fine) and any photos to hopebaymonitoring@srk.com and pluedke@srk.com

Upstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Downstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	(No)
Crest of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Thermosyphons South Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Instrumentation (on crest and downstream side)		
Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers		
Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen)		
Any suspended sediment in Tail Lake?	Yes	No
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	(No)

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

North Dam Weekly Walkover Survey Report

Date:	December 20 / 2018
Inspected By:	MIKE TAHASA, JIAN CHEN
Conditions:	(ie. snow on ground, clear) FROZEN SNOW

Visual Inspection:

This weekly walkover survey report is a means to track the condition on the North Dam, please provide details on changes that have developed since the previous inspection and/or any observations of particular concern. All photos are appreciated. Please send the completed form (scans are fine) and any photos to hopebaymonitoring@srk.com and pluedke@srk.com

Upstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Downstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	(No)
Crest of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Thermosyphons South Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Instrumentation (on crest and downstream side)		
Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers		
Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen)		
Any suspended sediment in Tail Lake?	Yes	No
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	(No)

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

North Dam Weekly Walkover Survey Report

Date:	Jan 2, 2019.
Inspected By:	Josh Fris.
Conditions:	(ie. snow on ground, clear) Snow

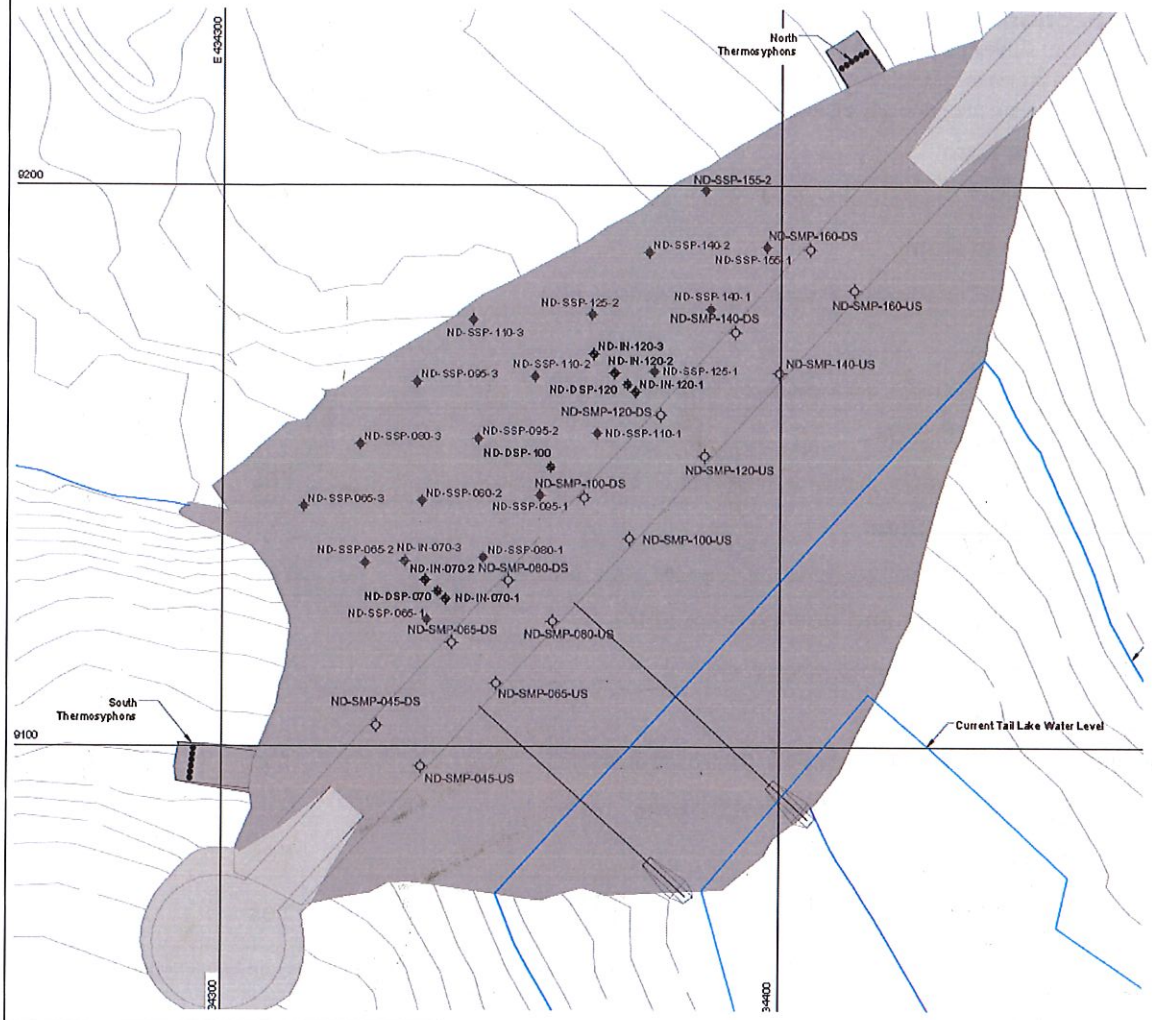
Visual Inspection:

This weekly walkover survey report is a means to track the condition on the North Dam, please provide details on changes that have developed since the previous inspection and/or any observations of particular concern. All photos are appreciated. Please send the completed form (scans are fine) and any photos to hopebaymonitoring@srk.com and pluedke@srk.com

Upstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Downstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	(No)
Crest of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side Minor rust		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Thermosyphons South Side Minor rust.		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Instrumentation (on crest and downstream side)		
Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers		
Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen)		
Any suspended sediment in Tail Lake?	Yes	(No)
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	(No)

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos: Photo from north end looking south along the dam Photo from south end looking north along the dam	☑ ☑
Other photos, please describe – Photos taken	





North Dam Weekly Walkover Survey Report

Date:	Jan 9, 2019
Inspected By:	Sash Fris
Conditions:	(ie. snow on ground, clear) Snowy

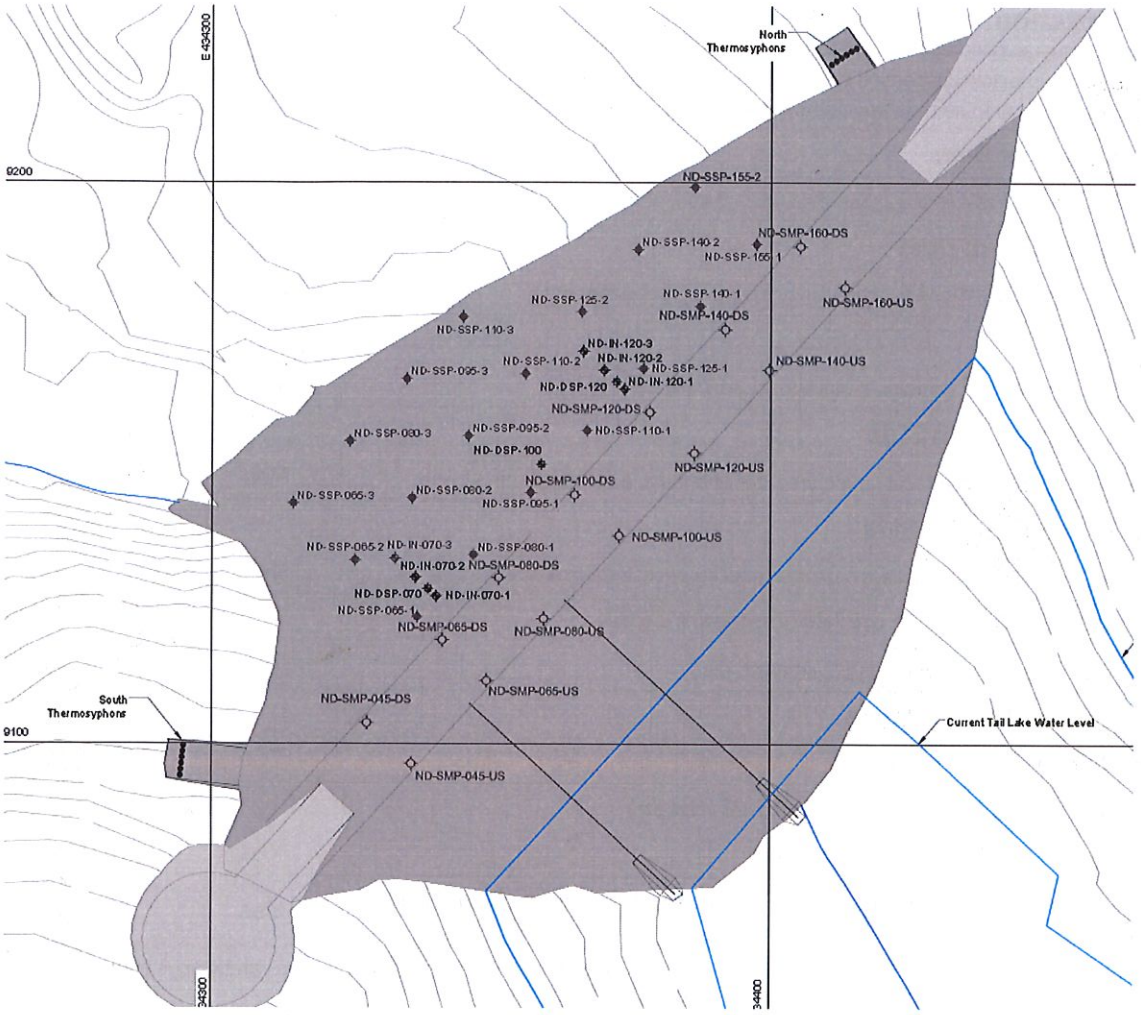
Visual Inspection:

This weekly walkover survey report is a means to track the condition on the North Dam, please provide details on changes that have developed since the previous inspection and/or any observations of particular concern. All photos are appreciated. Please send the completed form (scans are fine) and any photos to hopebaymonitoring@srk.com and pluedke@srk.com

Upstream Side of Dam Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Downstream Side of Dam Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	(No)
Crest of Dam Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Thermosyphons South Side Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Instrumentation (on crest and downstream side) Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen) Any suspended sediment in Tail Lake?	Yes	(No)
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	(No)

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos: Photo from north end looking south along the dam Photo from south end looking north along the dam	☑ ☑
Other photos, please describe – Photos taken	





North Dam Weekly Walkover Survey Report

Date:	January 22, 2018
Inspected By:	Mike Tenosa
Conditions:	(ie. snow on ground, clear) Snow

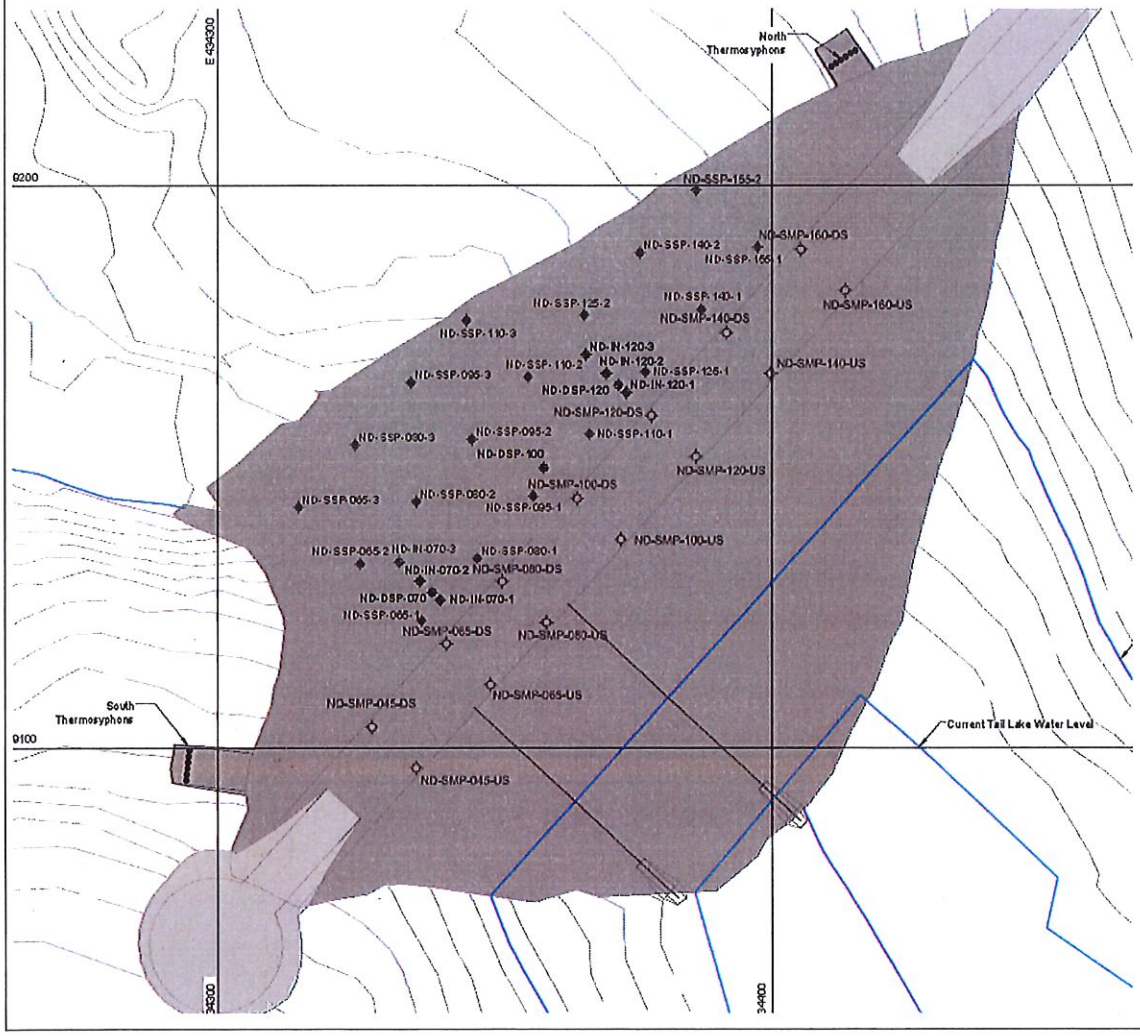
Visual Inspection:

This weekly walkover survey report is a means to track the condition on the North Dam, please provide details on changes that have developed since the previous inspection and/or any observations of particular concern. All photos are appreciated. Please send the completed form (scans are fine) and any photos to hopebaymonitoring@srk.com and pluedke@srk.com

Upstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Downstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	(No)
Crest of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Thermosyphons South Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Instrumentation (on crest and downstream side)		
Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers		
Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen)		
Any suspended sediment in Tail Lake?	Yes	(No)
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	(No)

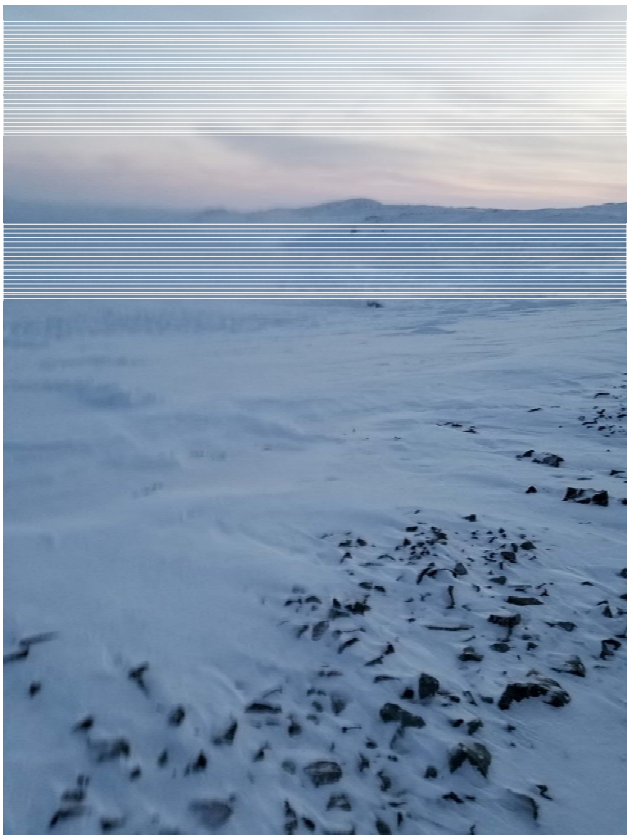
If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos: Photo from north end looking south along the dam Photo from south end looking north along the dam	☐ ☐
Other photos, please describe – Photos taken	





North Dam Weekly Walkover Survey Report

Date:	February 1st 2019
Inspected By:	MIKE TAHASA
Conditions:	(ie. snow on ground, clear) SNOW

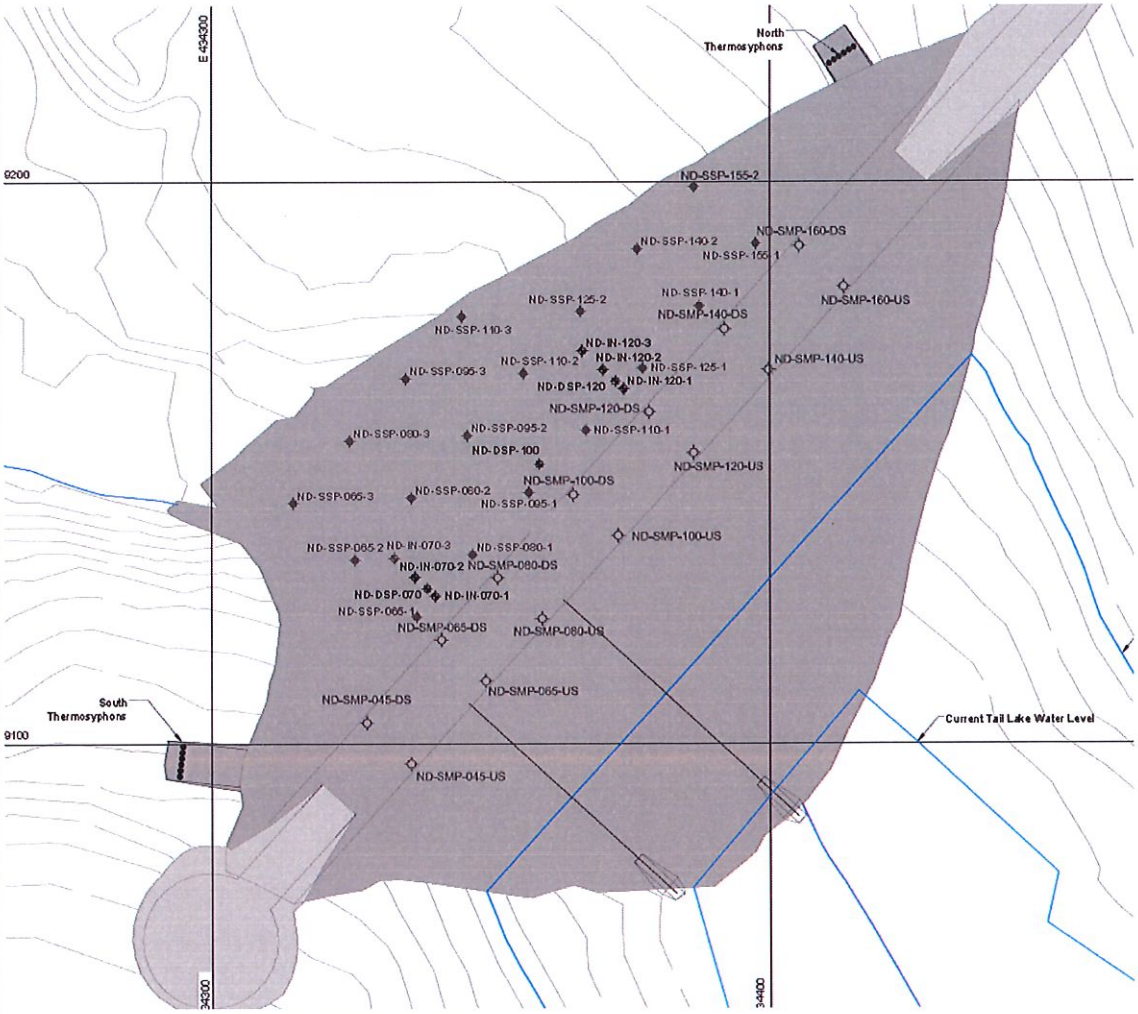
Visual Inspection:

This weekly walkover survey report is a means to track the condition on the North Dam, please provide details on changes that have developed since the previous inspection and/or any observations of particular concern. All photos are appreciated. Please send the completed form (scans are fine) and any photos to hopebaymonitoring@srk.com and pluedke@srk.com

Upstream Side of Dam Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Downstream Side of Dam Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	(No)
Crest of Dam Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Thermosyphons South Side Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Instrumentation (on crest and downstream side) Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen) Any suspended sediment in Tail Lake?	Yes	(No)
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	(No)

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos: Photo from north end looking south along the dam Photo from south end looking north along the dam	☐ ☐
Other photos, please describe – Photos taken	





North Dam Weekly Walkover Survey Report

Date:	Feb 6, 2019
Inspected By:	Josh Fris
Conditions:	(ie. snow on ground, clear) Snow

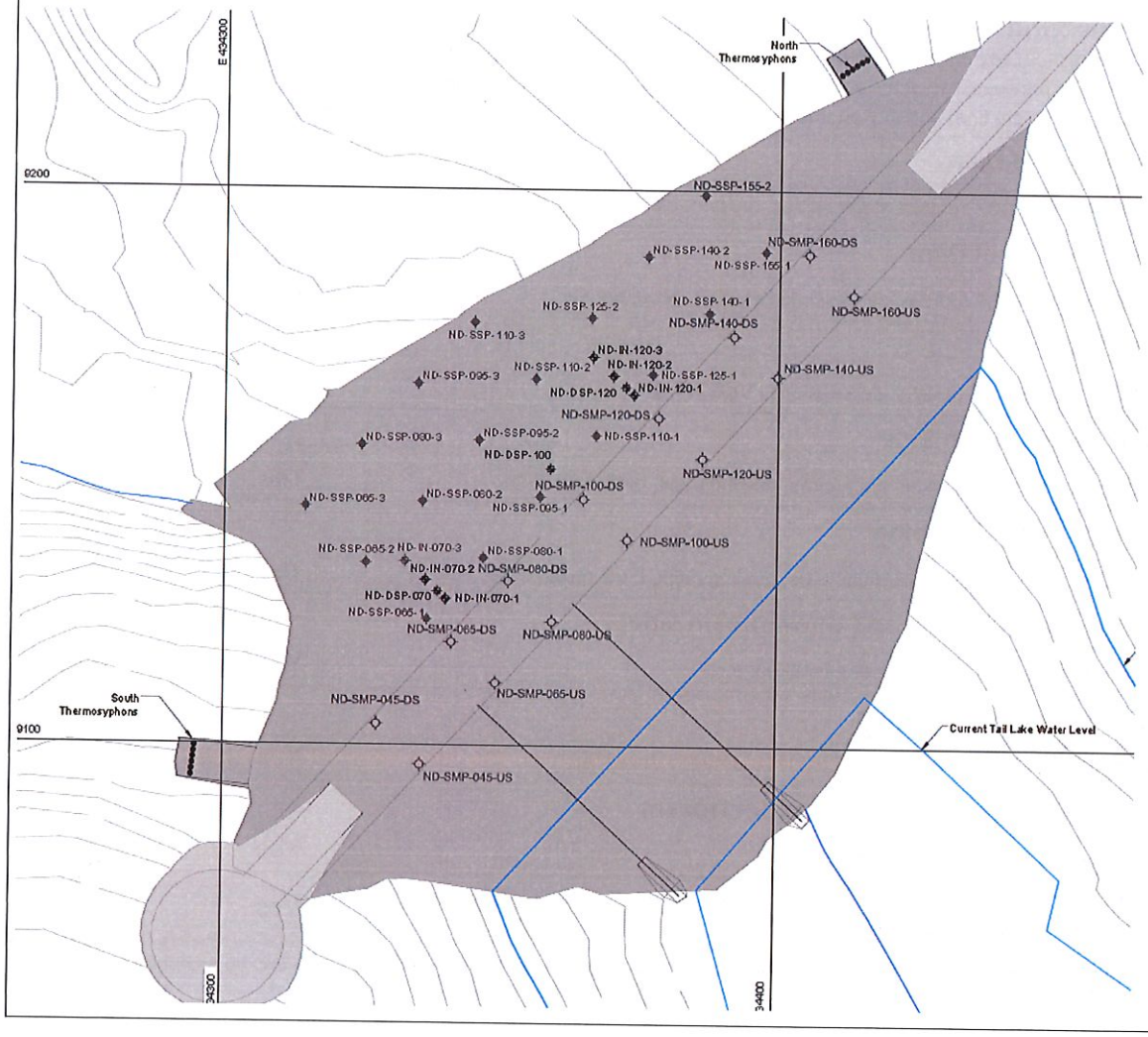
Visual Inspection:

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Upstream Side of Dam Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Downstream Side of Dam Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	(No)
Crest of Dam Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Thermosyphons South Side Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Instrumentation (on crest and downstream side) Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen) Any suspended sediment in Tail Lake?	Yes	(No)
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	(No)

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos: Photo from north end looking south along the dam ☑ Photo from south end looking north along the dam ☑
Other photos, please describe – Photos taken





North Dam Weekly Walkover Survey Report

Date:	Feb 14, 2019
Inspected By:	Josh Friis
Conditions:	(ie. snow on ground, clear)

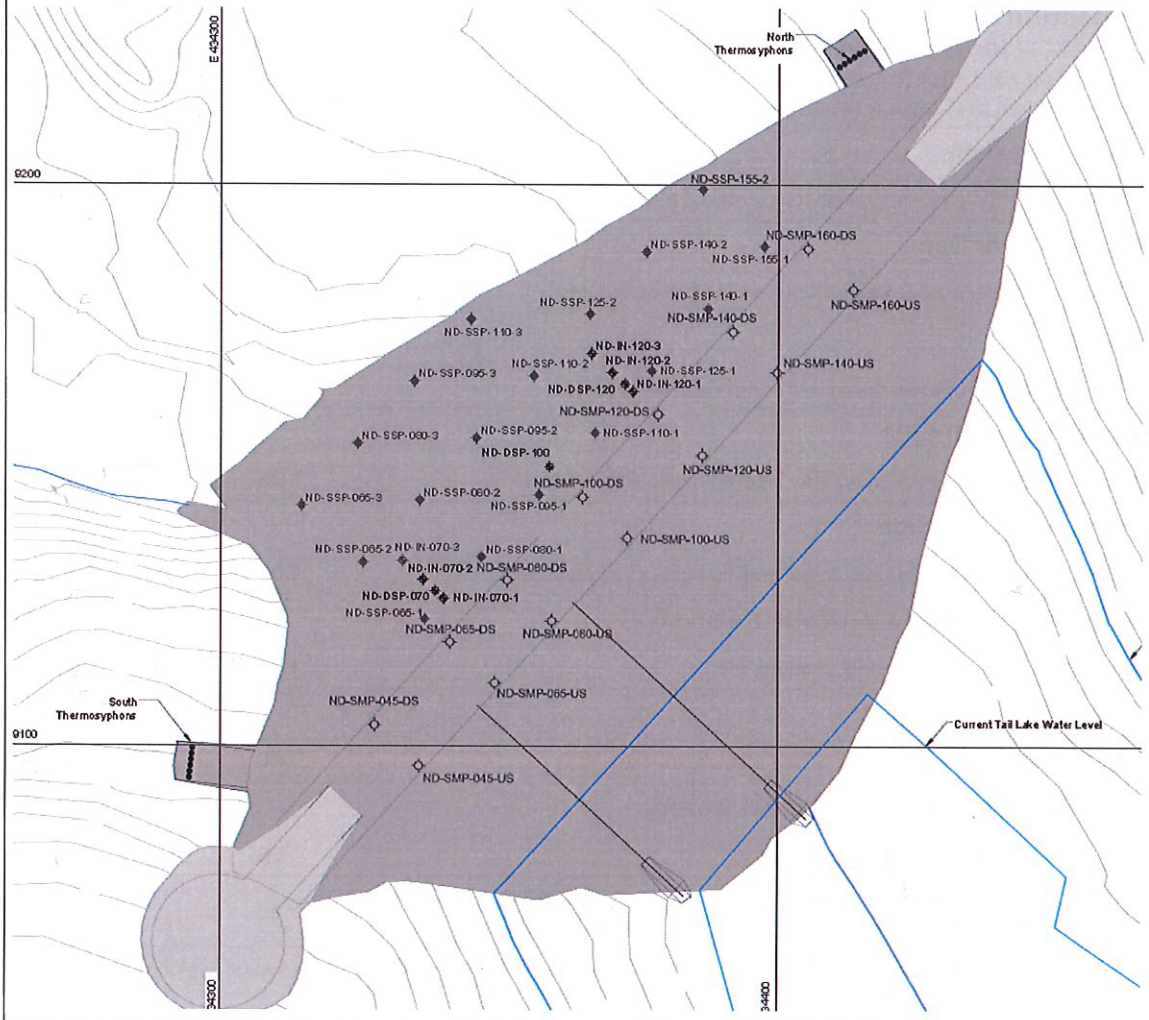
Visual Inspection:

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Upstream Side of Dam Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Downstream Side of Dam Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	(No)
Crest of Dam Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.) Minor Rust	Yes	(No)
Thermosyphons South Side Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.) Minor Rust	Yes	(No)
Instrumentation (on crest and downstream side) Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen) Any suspended sediment in Tail Lake?	Yes	(No)
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	(No)

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos: Photo from north end looking south along the dam Photo from south end looking north along the dam
Other photos, please describe – Photos taken





North Dam Weekly Walkover Survey Report

Date:	Feb 20, 2019
Inspected By:	Josh Fris
Conditions:	(ie. snow on ground, clear) Snow

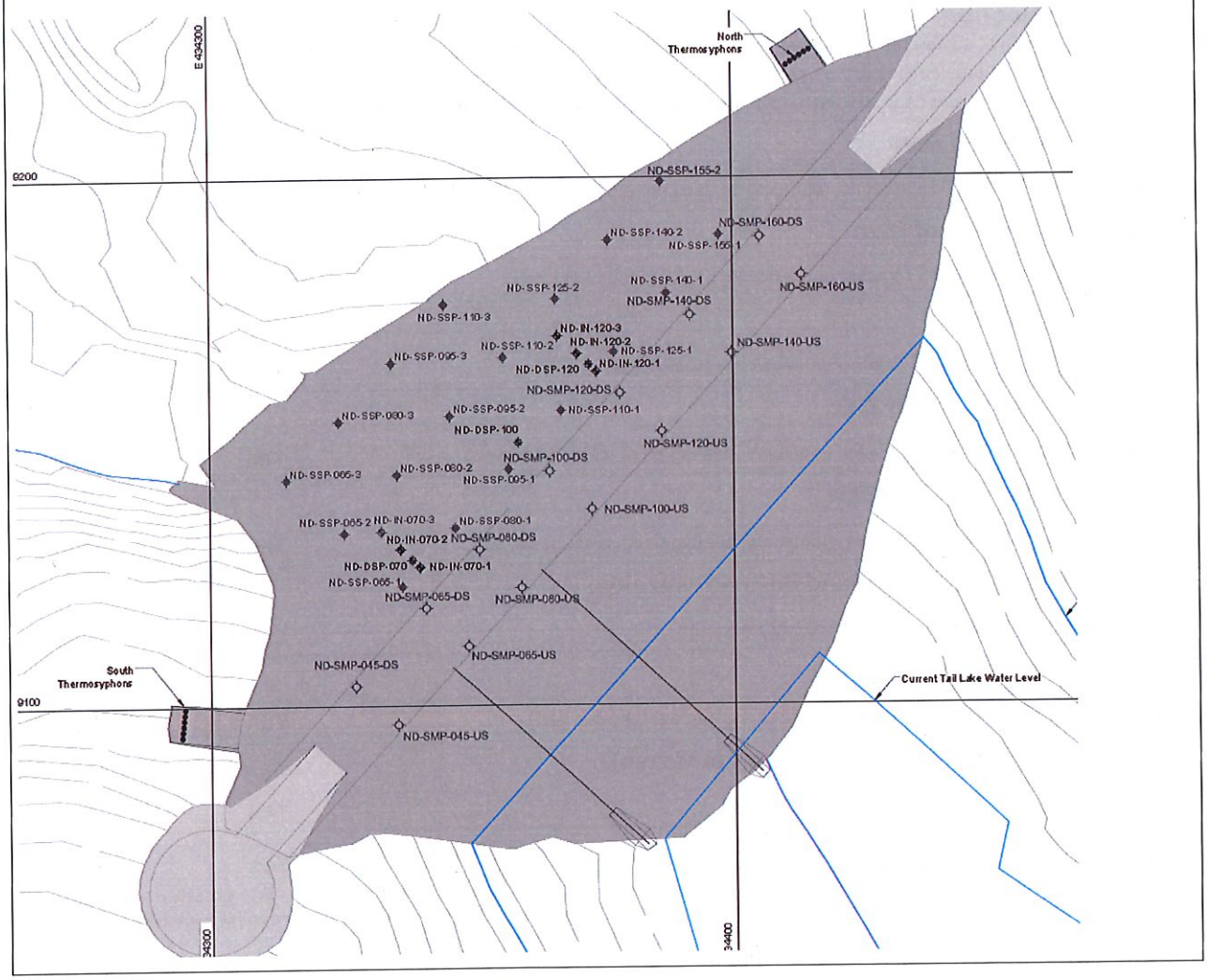
Visual Inspection:

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Upstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Downstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	(No)
Crest of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Thermosyphons South Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Instrumentation (on crest and downstream side)		
Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers		
Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen)		
Any suspended sediment in Tail Lake?	Yes	(No)
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	(No)

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos: Photo from north end looking south along the dam Photo from south end looking north along the dam	☑ ☑
Other photos, please describe – Photos taken	





North Dam Weekly Walkover Survey Report

Date:	March 09/2019
Inspected By:	Jian Chen, Mike Tarosa
Conditions:	(ie. snow on ground, clear) Snow

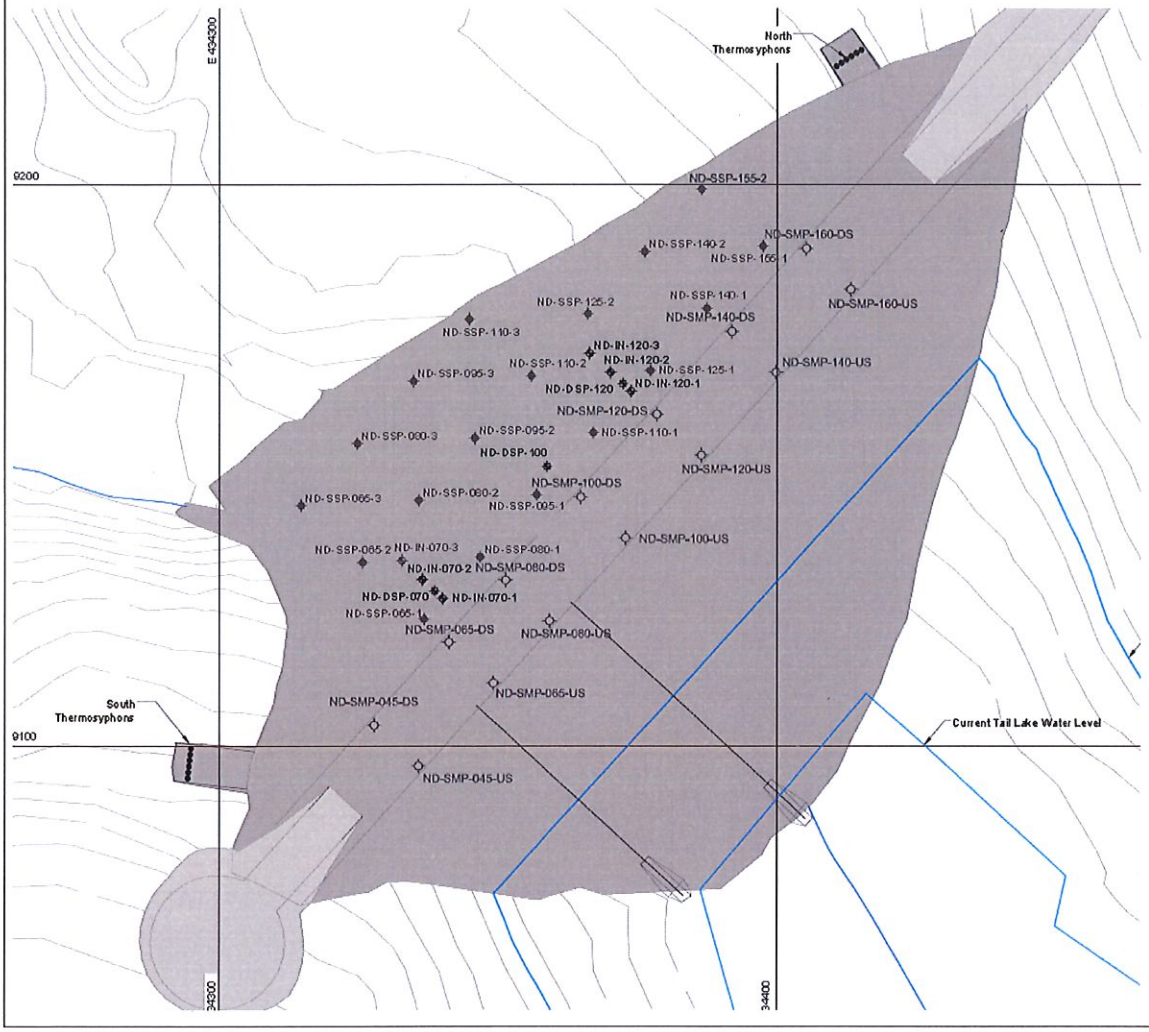
Visual Inspection:

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Upstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Downstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	(No)
Crest of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Thermosyphons South Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Instrumentation (on crest and downstream side)		
Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers		
Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen)		
Any suspended sediment in Tail Lake?	Yes	(No)
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	(No)

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos: Photo from north end looking south along the dam Photo from south end looking north along the dam	☐ ☐
Other photos, please describe – Photos taken	





North Dam Weekly Walkover Survey Report

Date:	March 18. 2019
Inspected By:	MIKE TAMASA
Conditions:	(ie. snow on ground, clear) SNOW

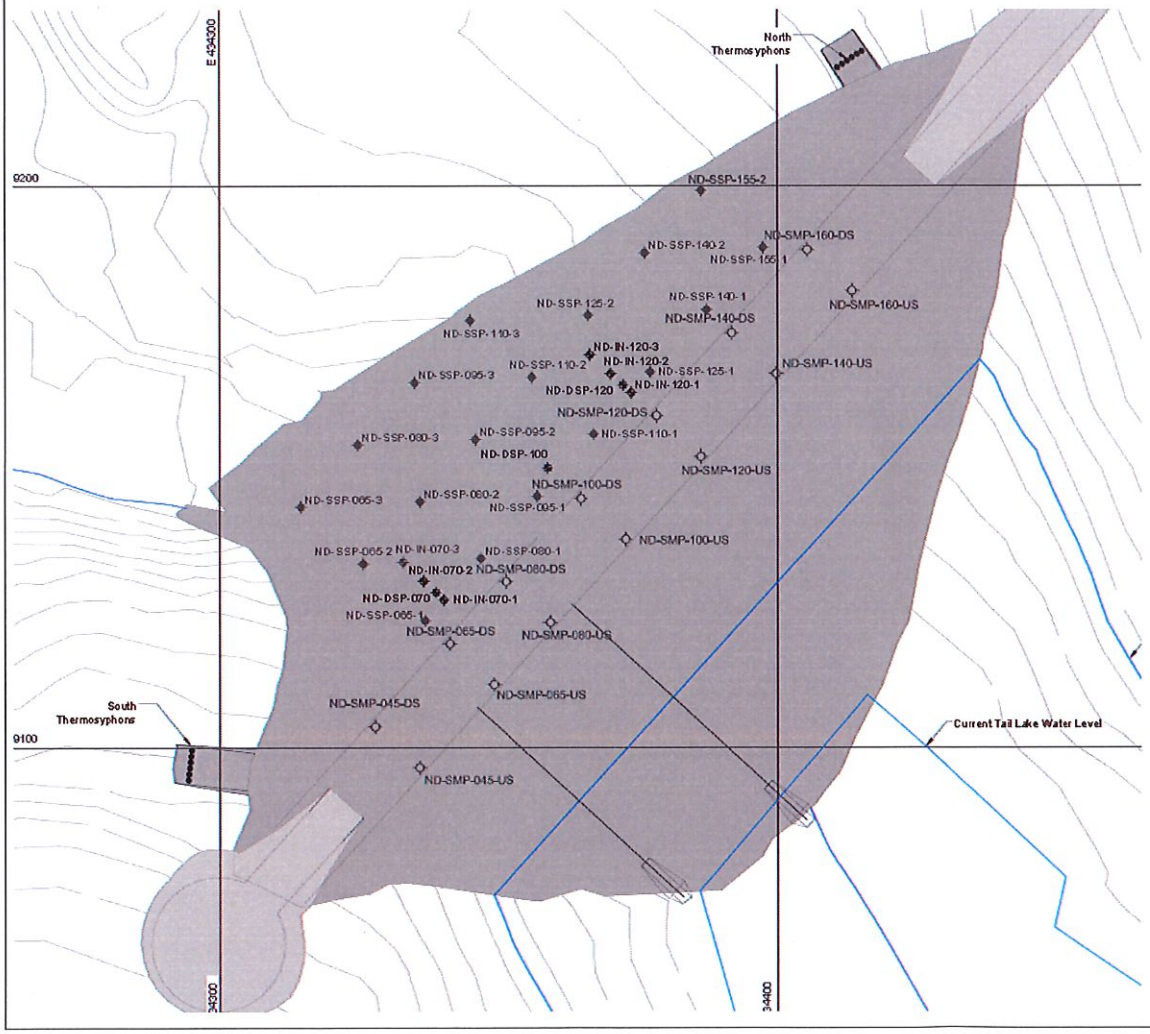
Visual Inspection:

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Upstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	No
Downstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	No
Crest of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	No
Thermosyphons North Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	No
Thermosyphons South Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	No
Instrumentation (on crest and downstream side)		
Any visible concerns? (bent, rusted, cracked, etc.)	Yes	No
Thermistors and Dataloggers		
Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	No
Suspended Sediment in TIA (When not frozen)		
Any suspended sediment in Tail Lake?	Yes	No
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	No

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos: Photo from north end looking south along the dam Photo from south end looking north along the dam	☐ ☐
Other photos, please describe – Photos taken	





North Dam Weekly Walkover Survey Report

Date:	March 29, 2019
Inspected By:	Josh Foss
Conditions:	(ie. snow on ground, clear) Snow

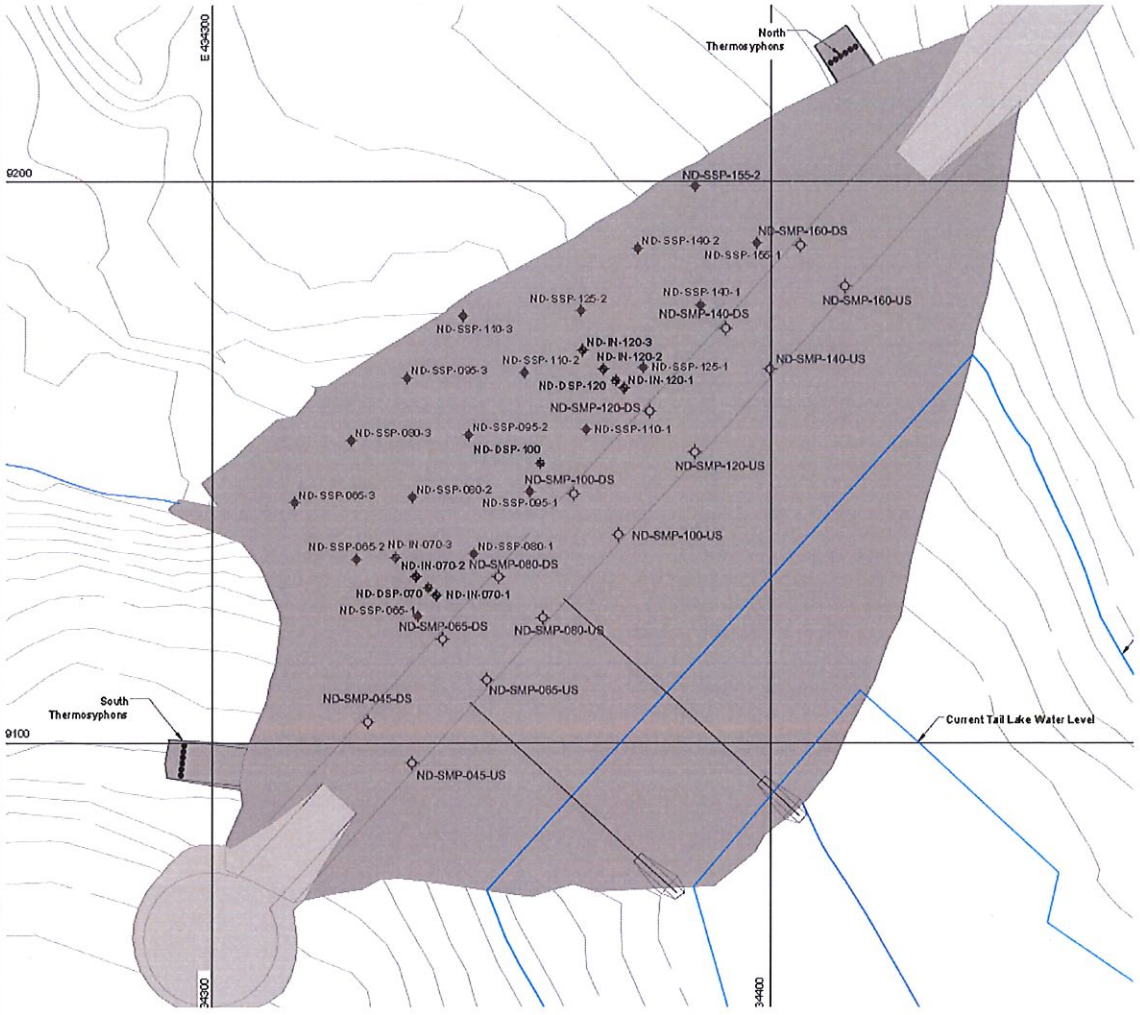
Visual Inspection:

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Upstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Downstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	(No)
Crest of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Thermosyphons South Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Instrumentation (on crest and downstream side)		
Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers		
Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen)		
Any suspended sediment in Tail Lake?	Yes	(No)
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	(No)

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos: Photo from north end looking south along the dam Photo from south end looking north along the dam	☑ ☑
Other photos, please describe – Photos taken	





North Dam Weekly Walkover Survey Report

Date:	Apr 3, 2019
Inspected By:	Josh F.
Conditions:	(ie. snow on ground, clear) Snow

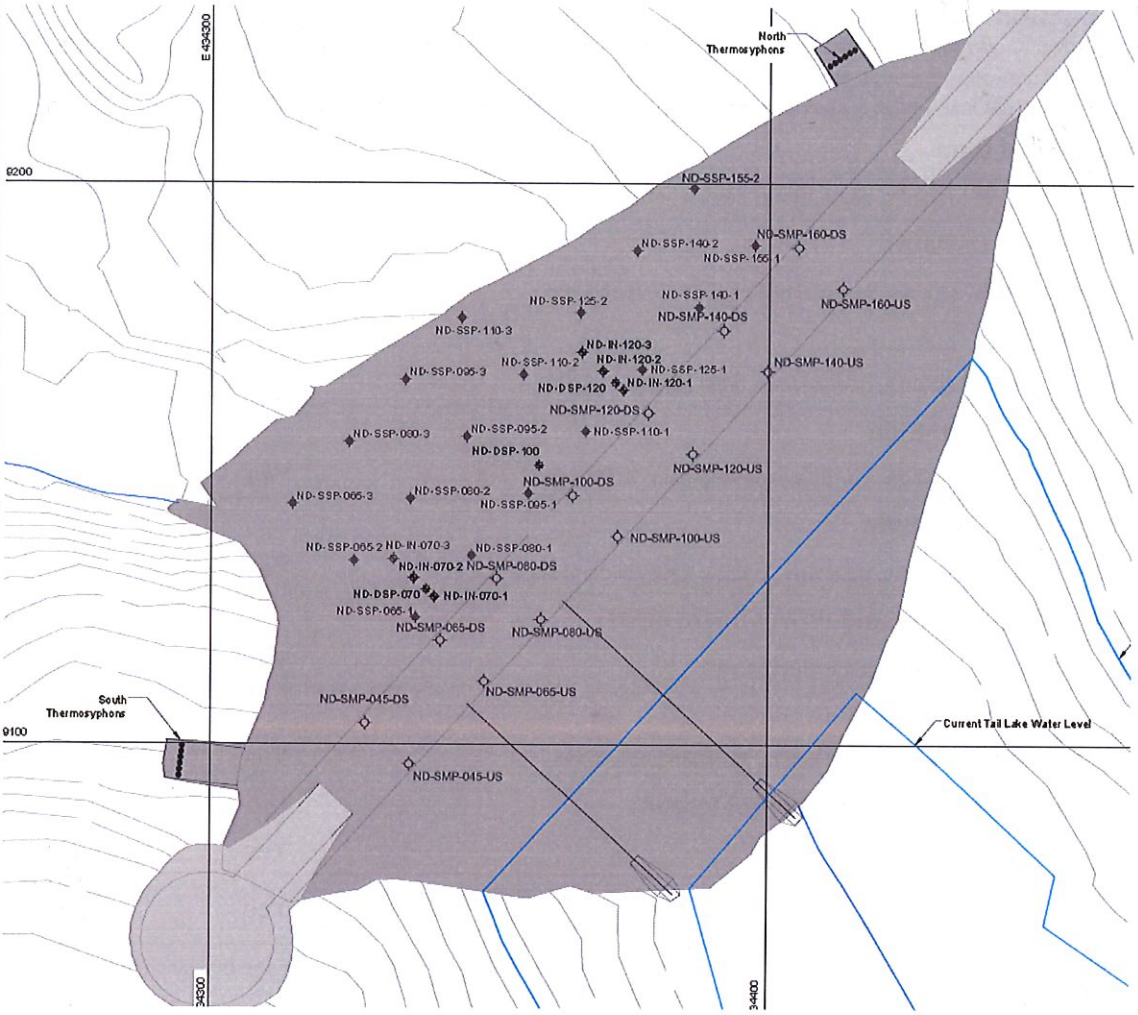
Visual Inspection:

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Upstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Downstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	(No)
Crest of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Thermosyphons South Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Instrumentation (on crest and downstream side)		
Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers		
Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen)		
Any suspended sediment in Tail Lake?	Yes	(No)
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	(No)

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos: Photo from north end looking south along the dam Photo from south end looking north along the dam	☑ ☐
Other photos, please describe – Photos taken	





North Dam Weekly Walkover Survey Report

Date:	April 14. 2019
Inspected By:	Mike Tarnoski
Conditions:	(ie. snow on ground, clear) Sfaw

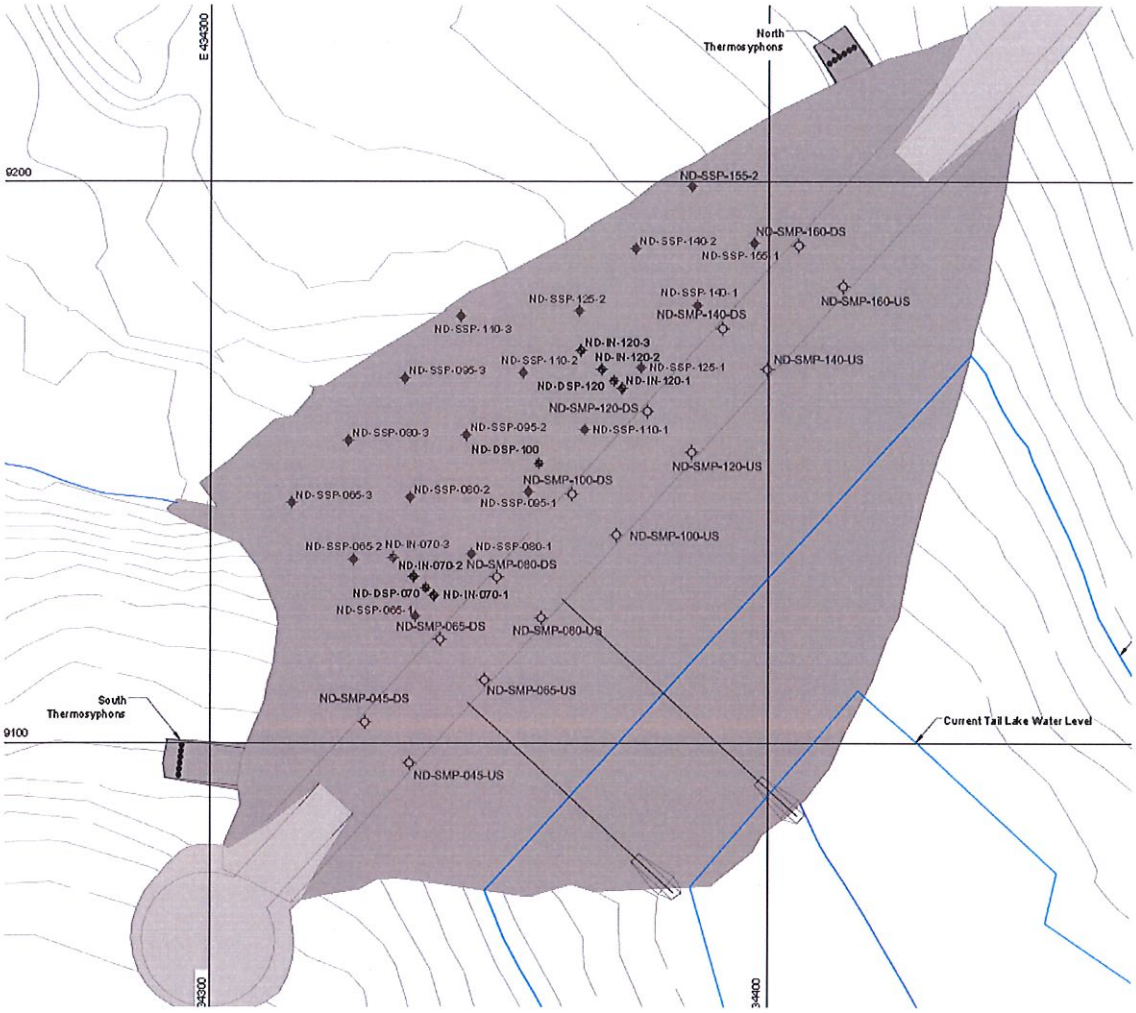
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Upstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Downstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	(No)
Crest of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Thermosyphons South Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Instrumentation (on crest and downstream side)		
Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers		
Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen)		
Any suspended sediment in Tail Lake?	Yes	(No)
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	(No)

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos: Photo from north end looking south along the dam Photo from south end looking north along the dam	☑ ☑
Other photos, please describe – Photos taken	





North Dam Weekly Walkover Survey Report

Date:	April 20, 2019
Inspected By:	MIKE TAMBSA
Conditions:	(ie. snow on ground, clear) SNOW

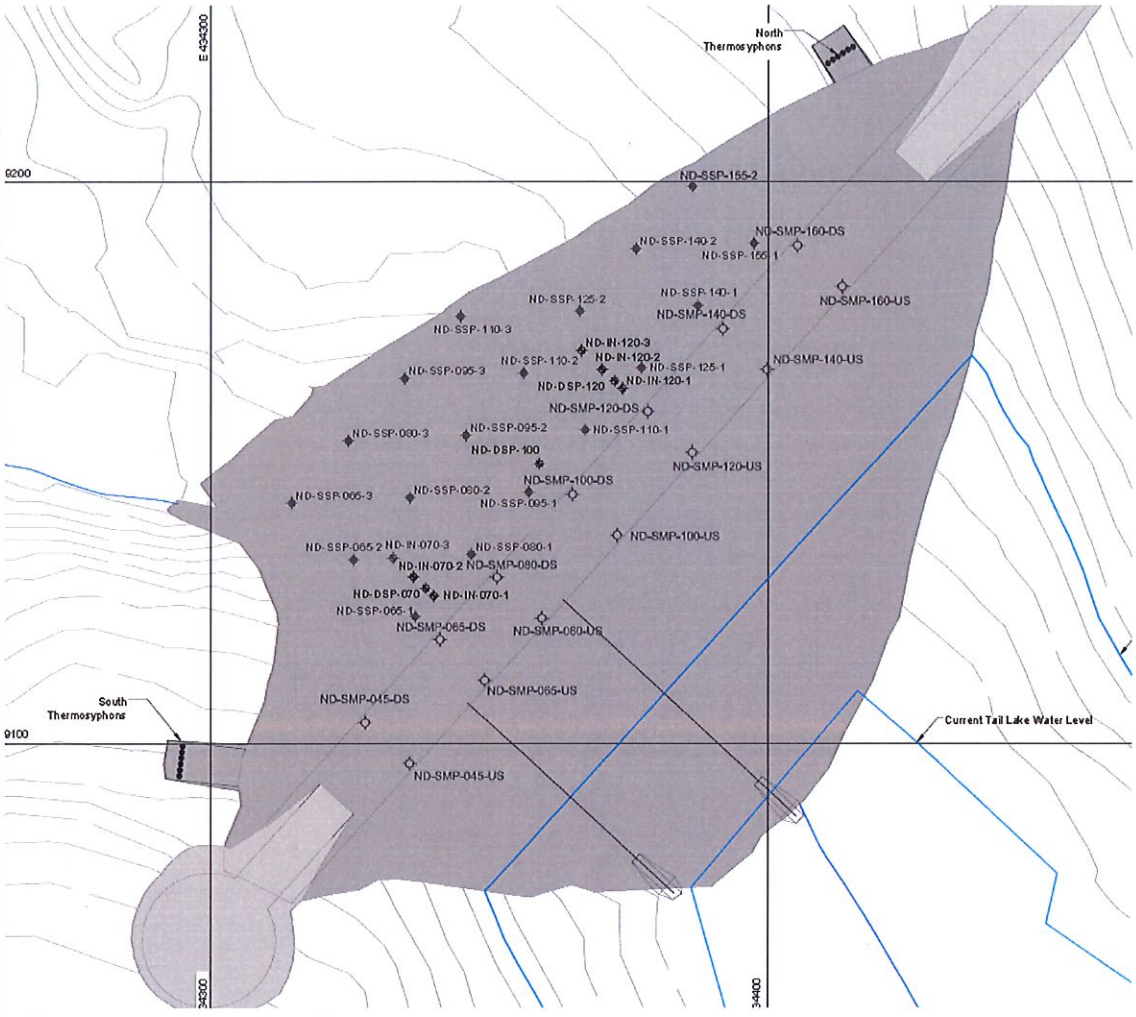
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Upstream Side of Dam Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	No
Downstream Side of Dam Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	No
Crest of Dam Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	No
Thermosyphons North Side Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	No
Thermosyphons South Side Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	No
Instrumentation (on crest and downstream side) Any visible concerns? (bent, rusted, cracked, etc.)	Yes	No
Thermistors and Dataloggers Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	No
Suspended Sediment in TIA (When not frozen) Any suspended sediment in Tail Lake?	Yes	No
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	No

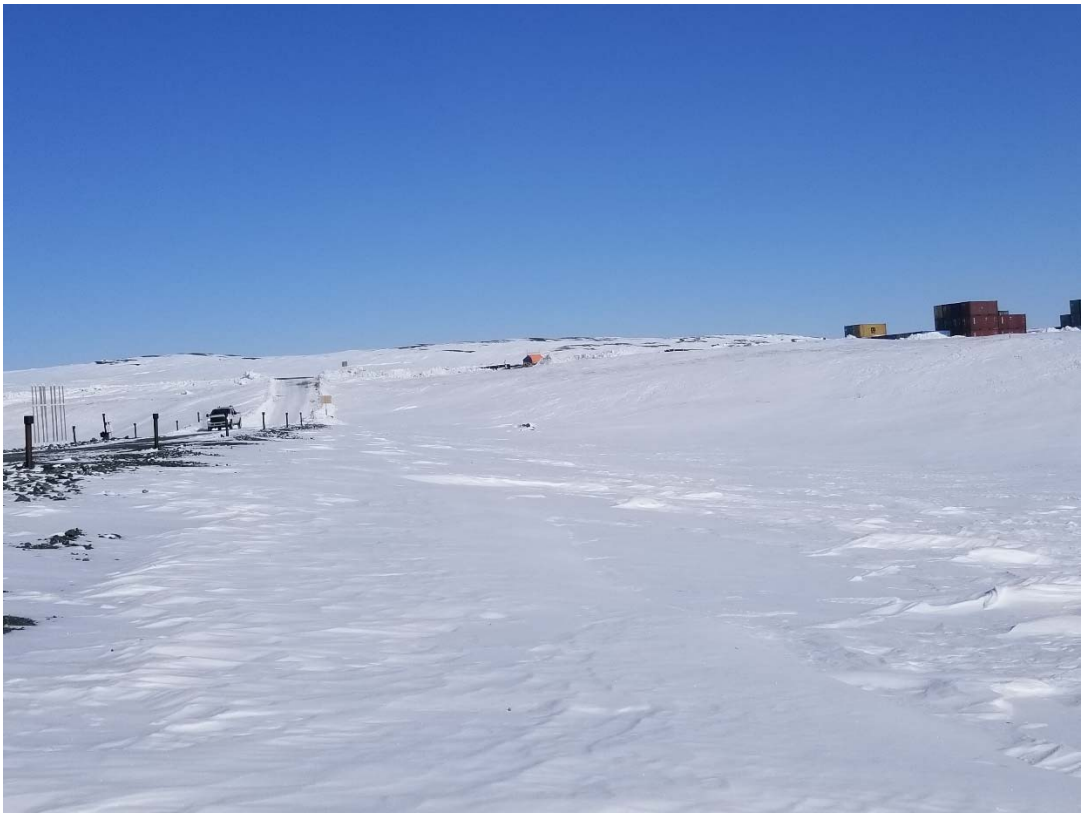
If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos:	
Photo from north end looking south along the dam	☑
Photo from south end looking north along the dam	☑
Other photos, please describe – Photos taken	





North Dam Weekly Walkover Survey Report

Date:	May 1, 2019
Inspected By:	Josh Fr.
Conditions:	(ie. snow on ground, clear) Some Snow

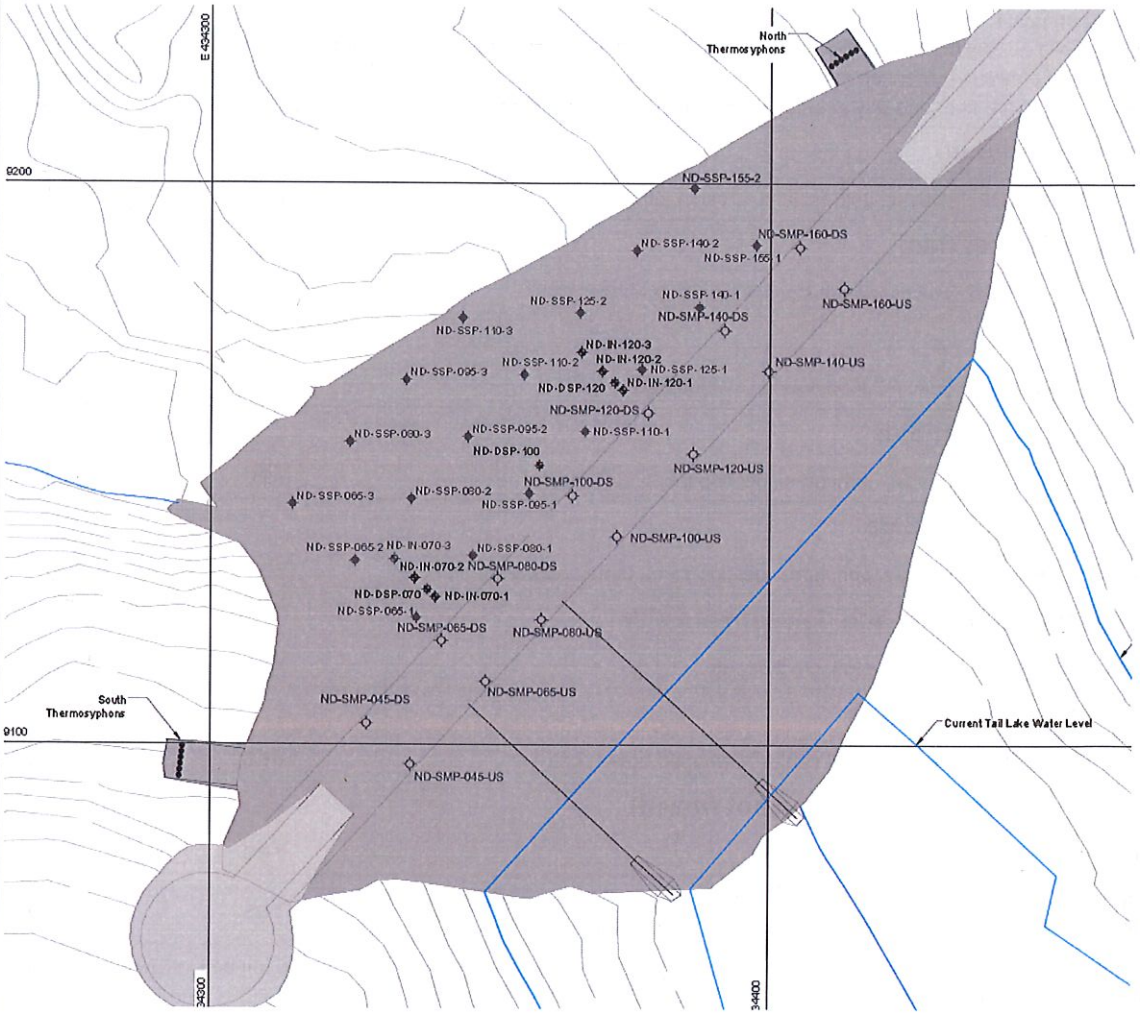
Visual Inspection:

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Upstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Downstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	(No)
Crest of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Thermosyphons South Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Instrumentation (on crest and downstream side)		
Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers		
Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen)		
Any suspended sediment in Tail Lake?	Yes	(No)
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	(No)

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos:	
Photo from north end looking south along the dam	☑
Photo from south end looking north along the dam	☑
Other photos, please describe – Photos taken	





North Dam Weekly Walkover Survey Report

Date:	May 9, 2019
Inspected By:	Josh Friis
Conditions:	(ie. snow on ground, clear) Snow

Visual Inspection:

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Upstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Downstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	(No)
Crest of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Thermosyphons South Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Instrumentation (on crest and downstream side)		
Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers		
Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen)		
Any suspended sediment in Tail Lake?	Yes	(No)
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	(No)

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.





North Dam Weekly Walkover Survey Report

Date:	May 16/2019
Inspected By:	Jian chen
Conditions:	(ie. snow on ground, clear) Snow on both up and down stream bank, clear on Top of the Dam.

Visual Inspection:

This weekly walkover survey report is a means to track the condition on the North Dam, please provide details on changes that have developed since the previous inspection and/or any observations of particular concern. All photos are appreciated. Please send the completed form (scans are fine) and any photos to hopebaymonitoring@srk.com and pluedke@srk.com

Upstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	No
Downstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	No
Crest of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	No
Thermosyphons North Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	No
Thermosyphons South Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	No
Instrumentation (on crest and downstream side)		
Any visible concerns? (bent, rusted, cracked, etc.)	Yes	No
Thermistors and Dataloggers		
Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	No
Suspended Sediment in TIA (When not frozen)		
Any suspended sediment in Tail Lake?	Yes N/A	No
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes N/A	No

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.



North Dam Weekly Walkover Survey Report

Date:	May 28 / 2018
Inspected By:	MIKE TANASA
Conditions:	(ie. snow on ground, clear) MOSTLY SNOW

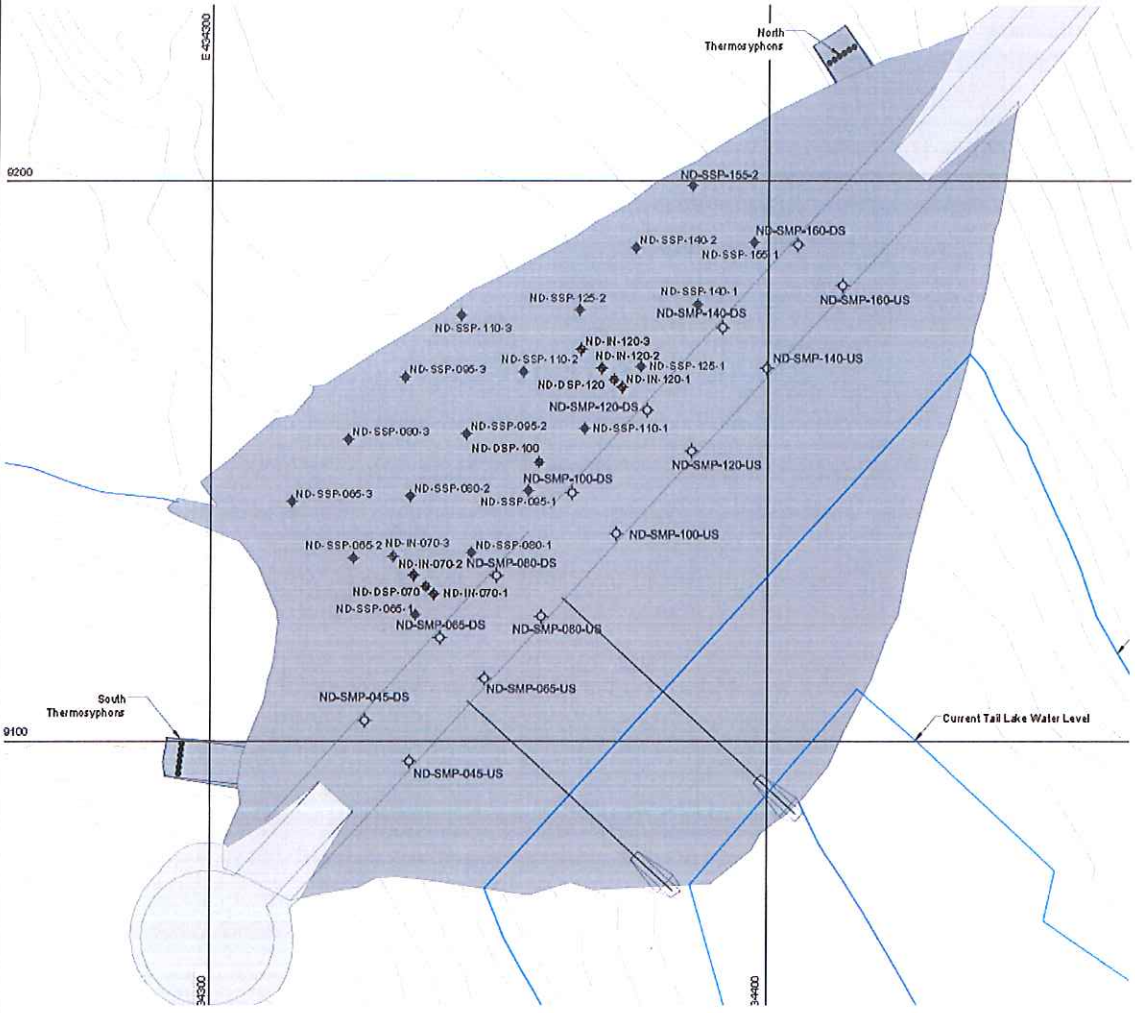
Visual Inspection:

This weekly walkover survey report is a means to track the condition on the North Dam, please provide details on changes that have developed since the previous inspection and/or any observations of particular concern. All photos are appreciated. Please send the completed form (scans are fine) and any photos to hopebaymonitoring@srk.com and pluedke@srk.com

Upstream Side of Dam Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Downstream Side of Dam Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	(No)
Crest of Dam Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Thermosyphons South Side Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Instrumentation (on crest and downstream side) Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen) Any suspended sediment in Tail Lake?	Yes	(No)
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	(No)

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos: Photo from north end looking south along the dam Photo from south end looking north along the dam	☑ ☑
Other photos, please describe – Photos taken	





North Dam Weekly Walkover Survey Report

Date:	June 08. 2019
Inspected By:	Mike TAMASI
Conditions:	(ie. snow on ground, clear)

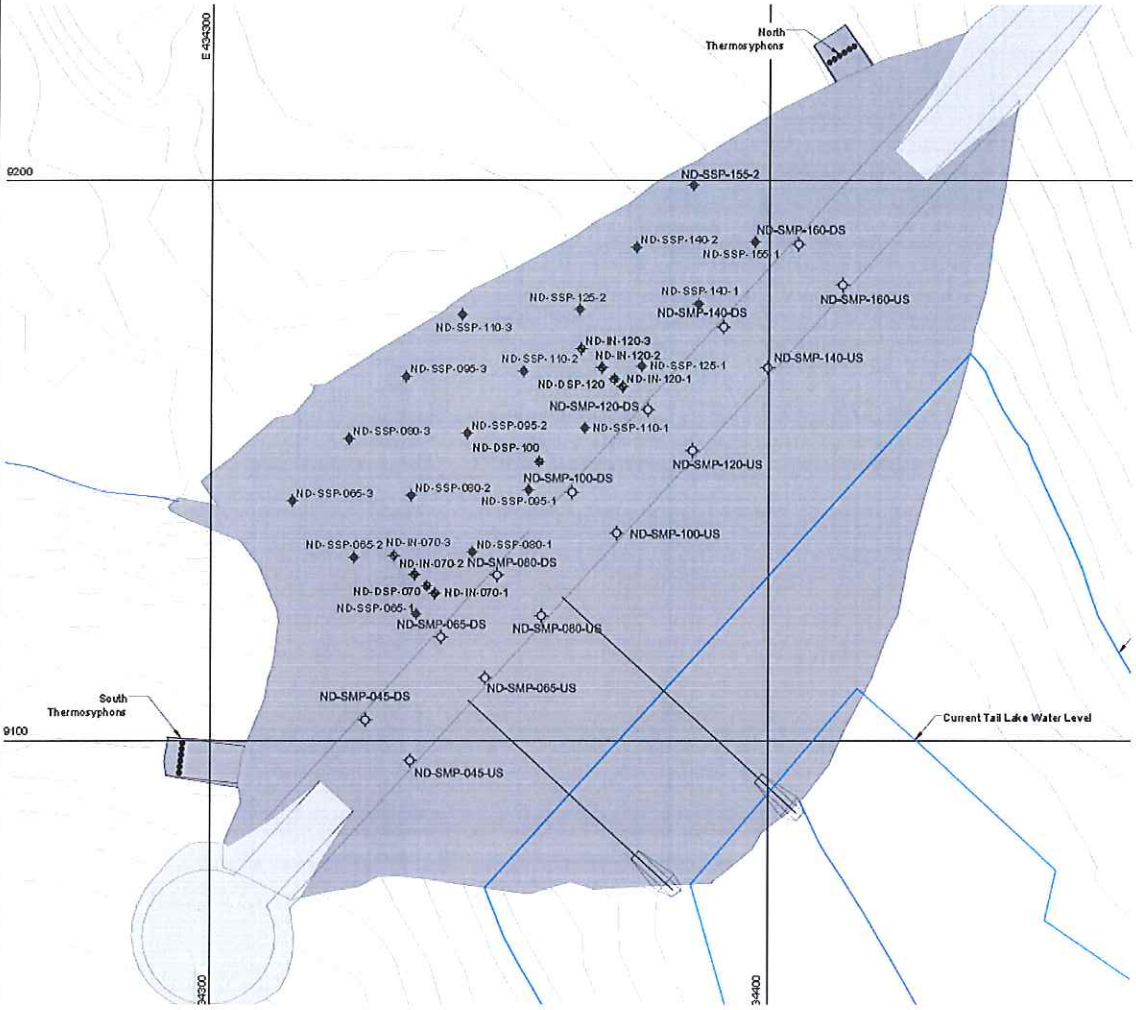
Visual Inspection:

This weekly walkover survey report is a means to track the condition on the North Dam, please provide details on changes that have developed since the previous inspection and/or any observations of particular concern. All photos are appreciated. Please send the completed form (scans are fine) and any photos to hopebaymonitoring@srk.com and pluedke@srk.com

Upstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Downstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	(No)
Crest of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Thermosyphons South Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Instrumentation (on crest and downstream side)		
Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers		
Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen)		
Any suspended sediment in Tail Lake?	Yes	(No)
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	(No)

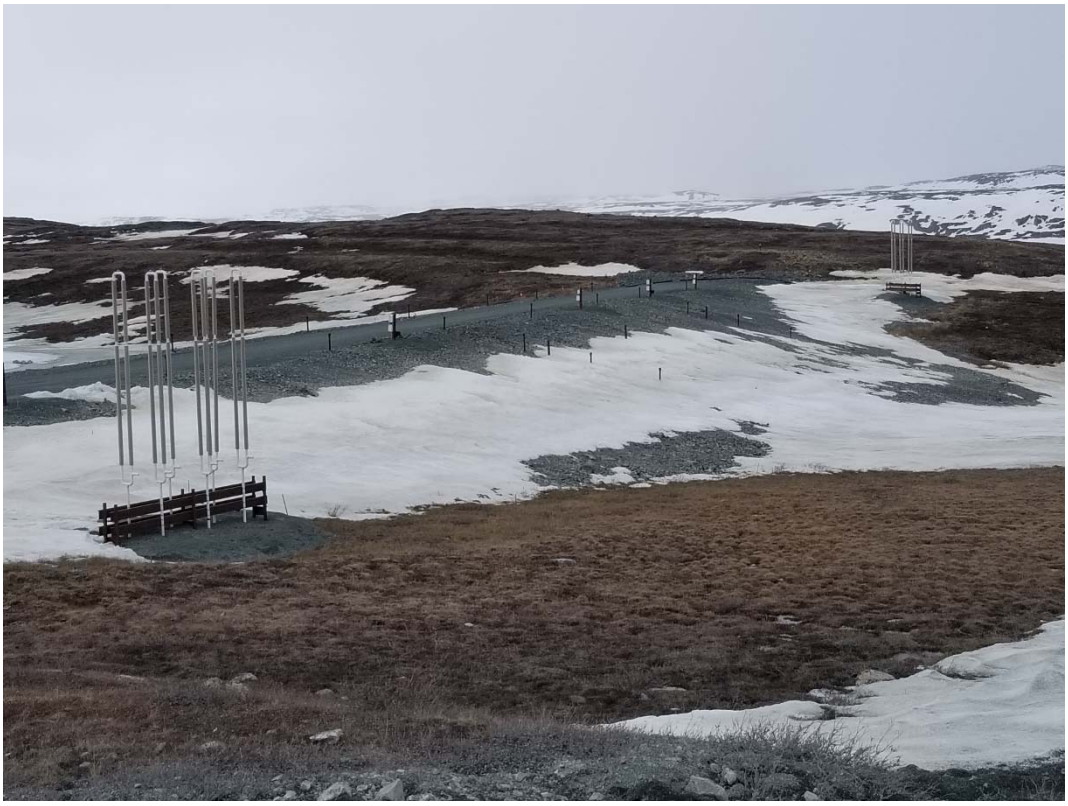
If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos: Photo from north end looking south along the dam Photo from south end looking north along the dam	☐ ☐
Other photos, please describe – Photos taken	





Add Envirc projects to list.

North Dam Weekly Walkover Survey Report

Date:	June 12, 2019
Inspected By:	Josh F.S.
Conditions:	(ie. snow on ground, clear)

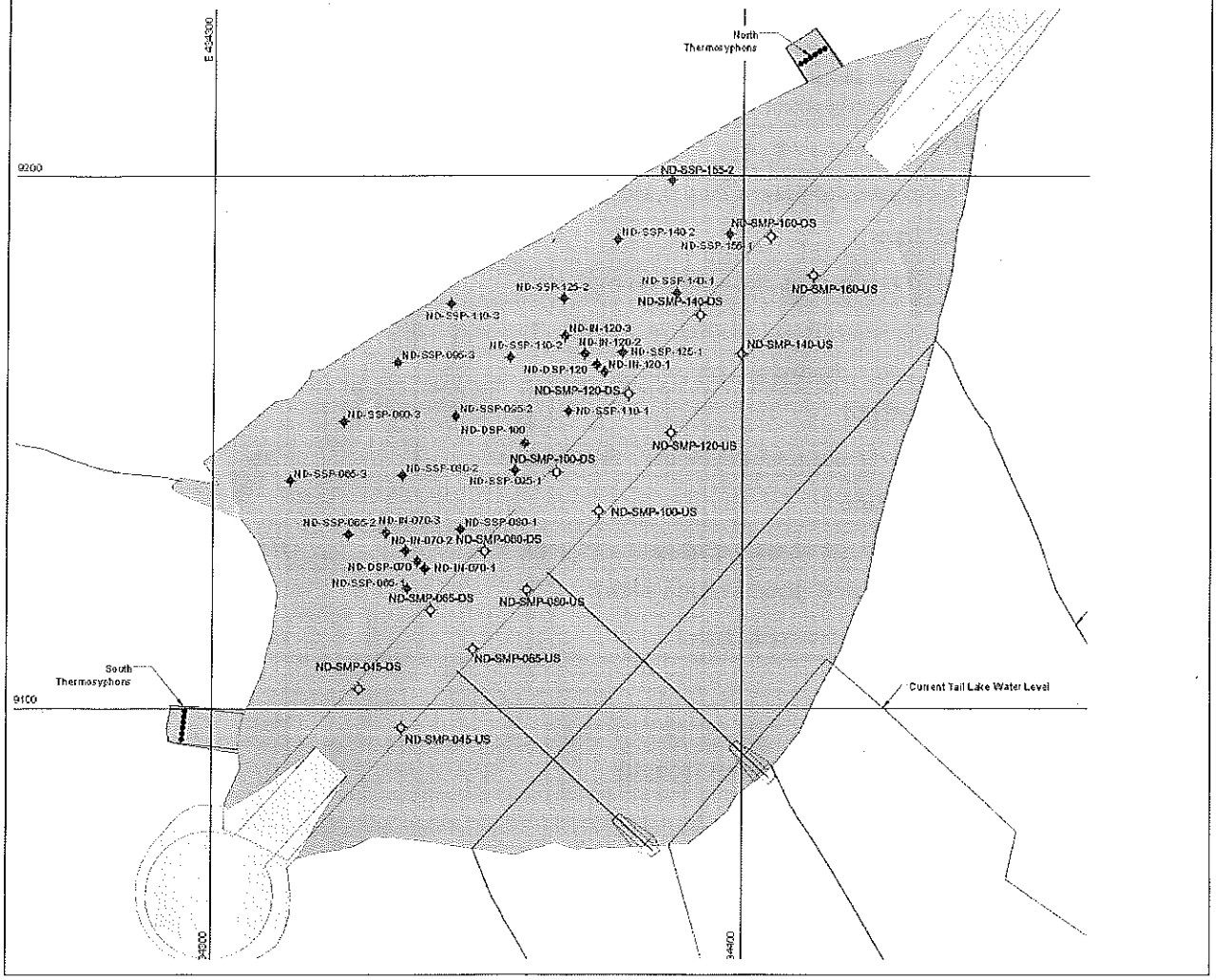
Visual Inspection:

This weekly walkover survey report is a means to track the condition on the North Dam, please provide details on changes that have developed since the previous inspection and/or any observations of particular concern. All photos are appreciated. Please send the completed form (scans are fine) and any photos to hopebaymonitoring@srk.com and pluedke@srk.com

Upstream Side of Dam Minor Surface cracking Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Downstream Side of Dam Any visible concerns? (cracks, depressions, erosion, seepage, etc.) Snow Cover	Yes	(No)
Crest of Dam Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Thermosyphons South Side Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.) Minor rust	Yes	(No)
Instrumentation (on crest and downstream side) Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen) Any suspended sediment in Tail Lake?	Yes	(No)
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015) Melt water	(Yes)	No

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos:	
Photo from north end looking south along the dam	☑
Photo from south end looking north along the dam	☑
Other photos, please describe – Photos taken	









North Dam Weekly Walkover Survey Report

Date:	June 19, 2019.
Inspected By:	Josh F.S
Conditions:	(ie. snow on ground, clear)

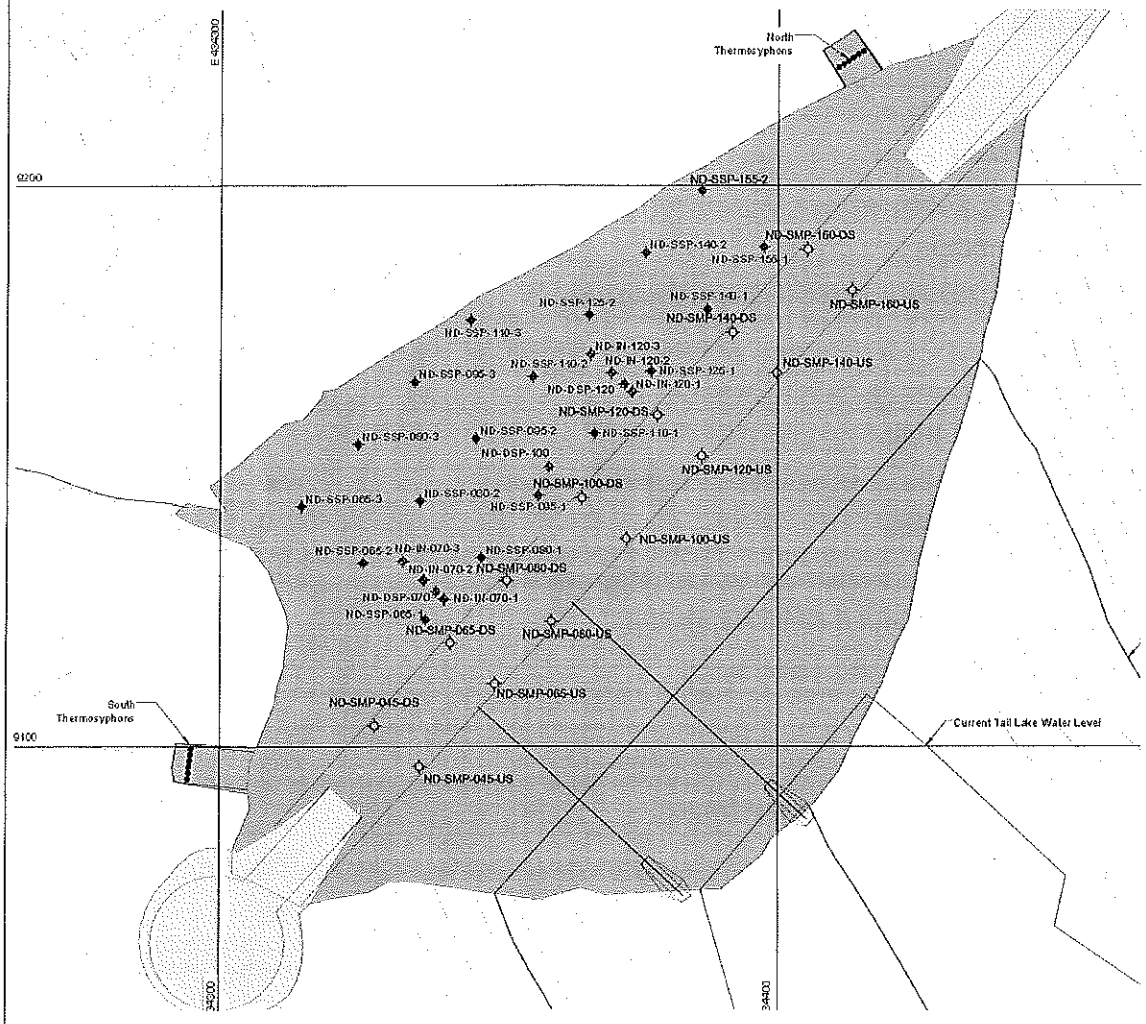
Visual Inspection:

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Upstream Side of Dam Surface cracks near discharge. Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Downstream Side of Dam Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	(No)
Crest of Dam Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Thermosyphons South Side Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Instrumentation (on crest and downstream side) Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen) Any suspended sediment in Tail Lake?	Yes	(No)
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015) Melt	(Yes)	No

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos: Photo from north end looking south along the dam Photo from south end looking north along the dam	☑ ☑
Other photos, please describe – Photos taken Up stream cracking.	







North Dam Weekly Walkover Survey Report

Date:	June 29. 2019
Inspected By:	MIKE TAMASA
Conditions:	(ie. snow on ground, clear)

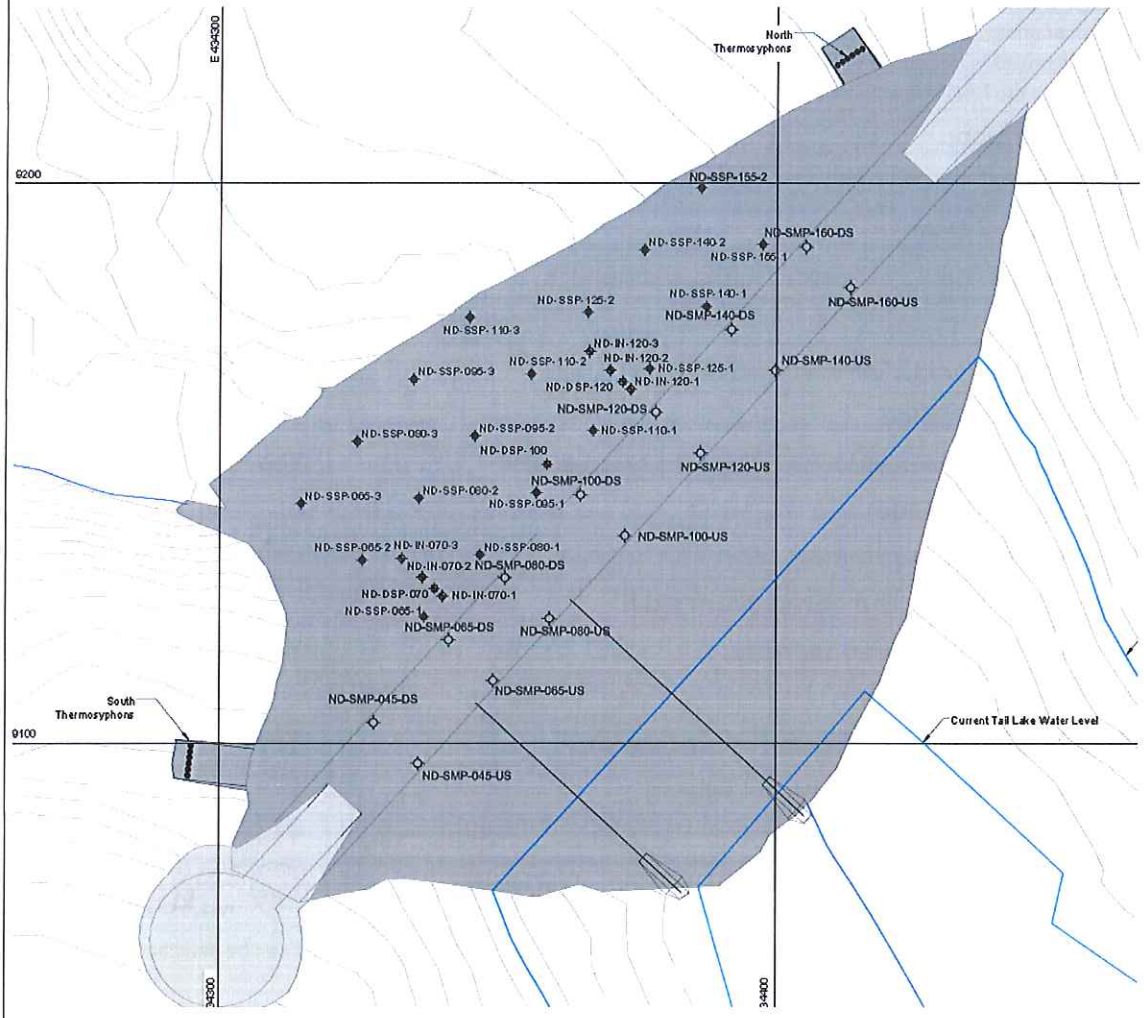
Visual Inspection:

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Upstream Side of Dam Any visible concerns? (cracks, depressions, erosion, etc.) Insignificant Cracks near discharge	Yes	(No)
Downstream Side of Dam Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	(No)
Crest of Dam Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Thermosyphons South Side Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Instrumentation (on crest and downstream side) Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen) Any suspended sediment in Tail Lake?	Yes	(No)
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	(Yes) due to melting ice	No

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos: Photo from north end looking south along the dam Photo from south end looking north along the dam	☑ ☑
Other photos, please describe – Photos taken Discharg point north side cracks. Water South side of the toe due to melting ice.	









North Dam Weekly Walkover Survey Report

Date:	JULY 09, 2019
Inspected By:	MIKE TAMASI
Conditions:	(ie. snow on ground, clear) CLEAR, DRY

Visual Inspection:

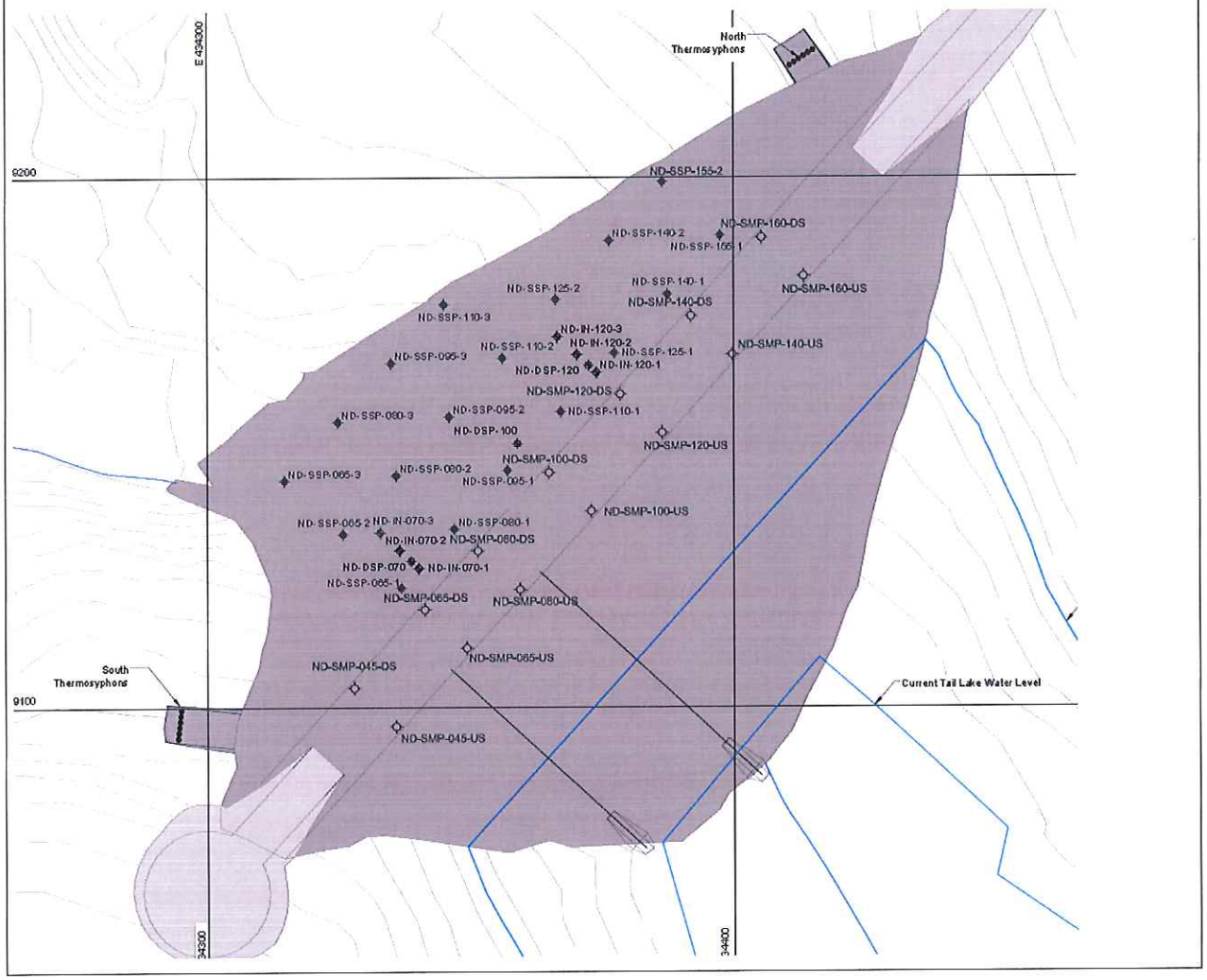
This weekly walkover survey report is a means to track the condition on the North Dam, please provide details on changes that have developed since the previous inspection and/or any observations of particular concern. All photos are appreciated. Please send the completed form (scans are fine) and any photos to hopebaymonitoring@srk.com and pluedke@srk.com

Upstream Side of Dam Any visible concerns? (cracks, depressions, erosion, etc.)	(Yes)	No
Downstream Side of Dam Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	(No)
Crest of Dam Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Thermosyphons South Side Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Instrumentation (on crest and downstream side) Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen) Any suspended sediment in Tail Lake?	Yes	(No)
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	(No)

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

Minor depression on Southern side near the water level.

Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos: Photo from north end looking south along the dam Photo from south end looking north along the dam	☑ ☑
Other photos, please describe – Photos taken Minor depression near water contact on South side.	







North Dam Weekly Walkover Survey Report

Date:	July 17, 2019.
Inspected By:	Josh Friis
Conditions:	(ie. snow on ground, clear) Clear.

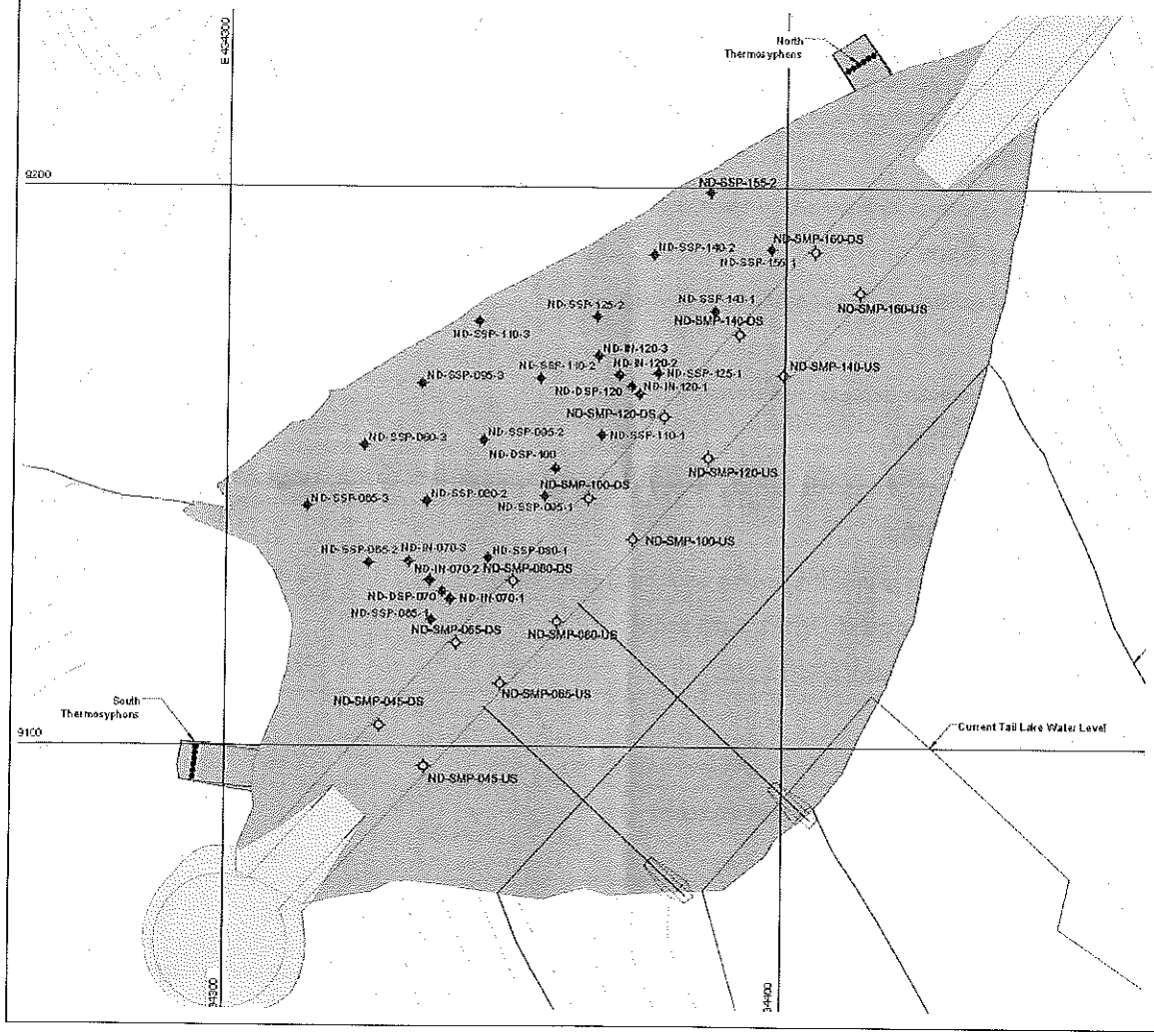
Visual Inspection:

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Upstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Downstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	(No)
Crest of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Thermosyphons South Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Instrumentation (on crest and downstream side)		
Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers		
Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen)		
Any suspended sediment in Tail Lake?	Yes	(No)
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	(No)

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos: Photo from north end looking south along the dam Photo from south end looking north along the dam	☑ ☑
Other photos, please describe – Photos taken	





North Dam Weekly Walkover Survey Report

Date:	July 24, 2019
Inspected By:	Josh Fraser
Conditions:	(ie. snow on ground, clear)

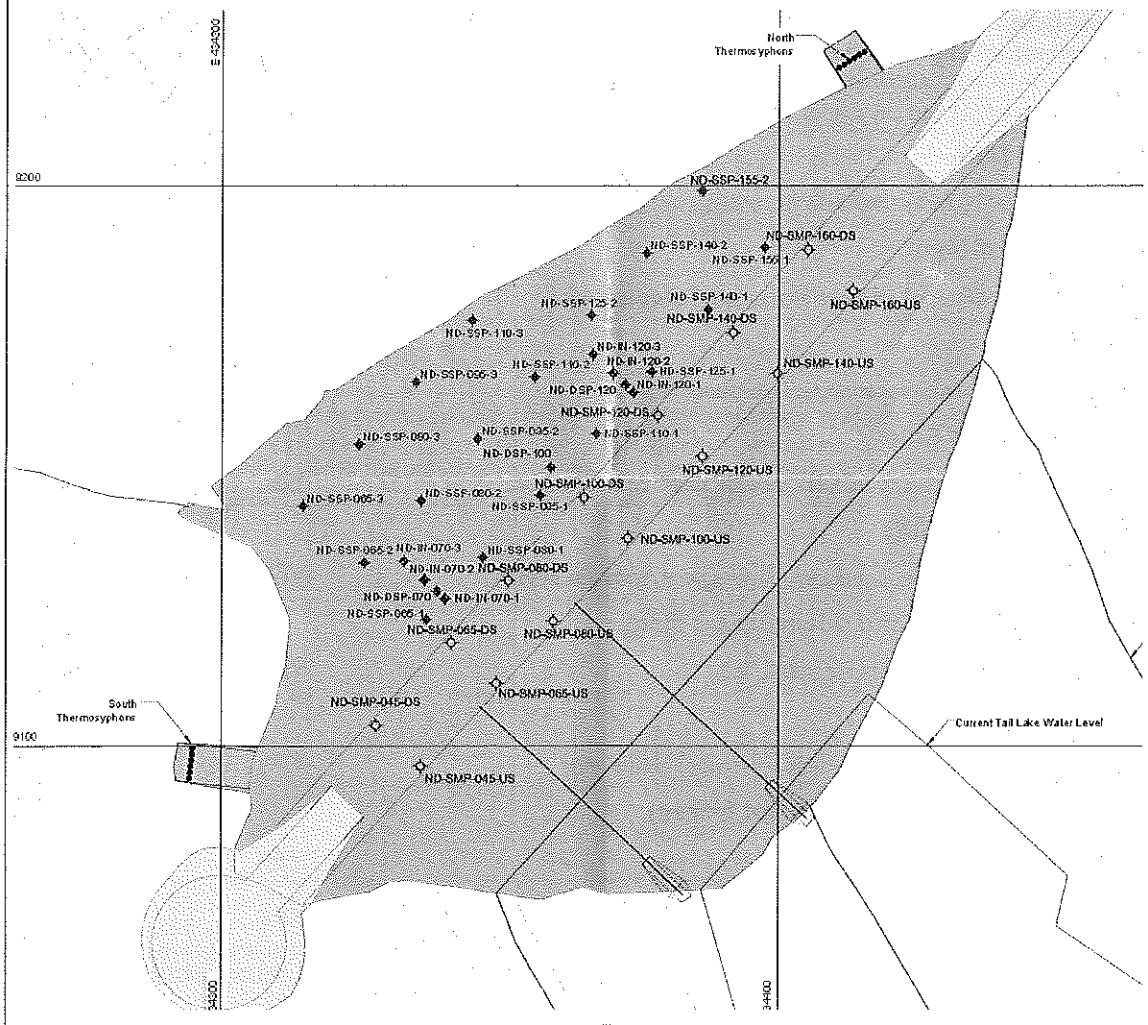
Visual Inspection:

This weekly walkover survey report is a means to track the condition on the North Dam, please provide details on changes that have developed since the previous inspection and/or any observations of particular concern. All photos are appreciated. Please send the completed form (scans are fine) and any photos to hopebaymonitoring@srk.com and pluedke@srk.com

Upstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Downstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	(No)
Crest of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Thermosyphons South Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Instrumentation (on crest and downstream side)		
Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers		
Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen)		
Any suspended sediment in Tail Lake?	Yes	(No)
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015) Minor standing water	Yes	(No)

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos:	
Photo from north end looking south along the dam	☐
Photo from south end looking north along the dam	☐
Other photos, please describe – Photos taken	





North Dam Weekly Walkover Survey Report

Date:	July 31, 2019
Inspected By:	Josh Foss
Conditions:	(ie. snow on ground, clear) Clear.

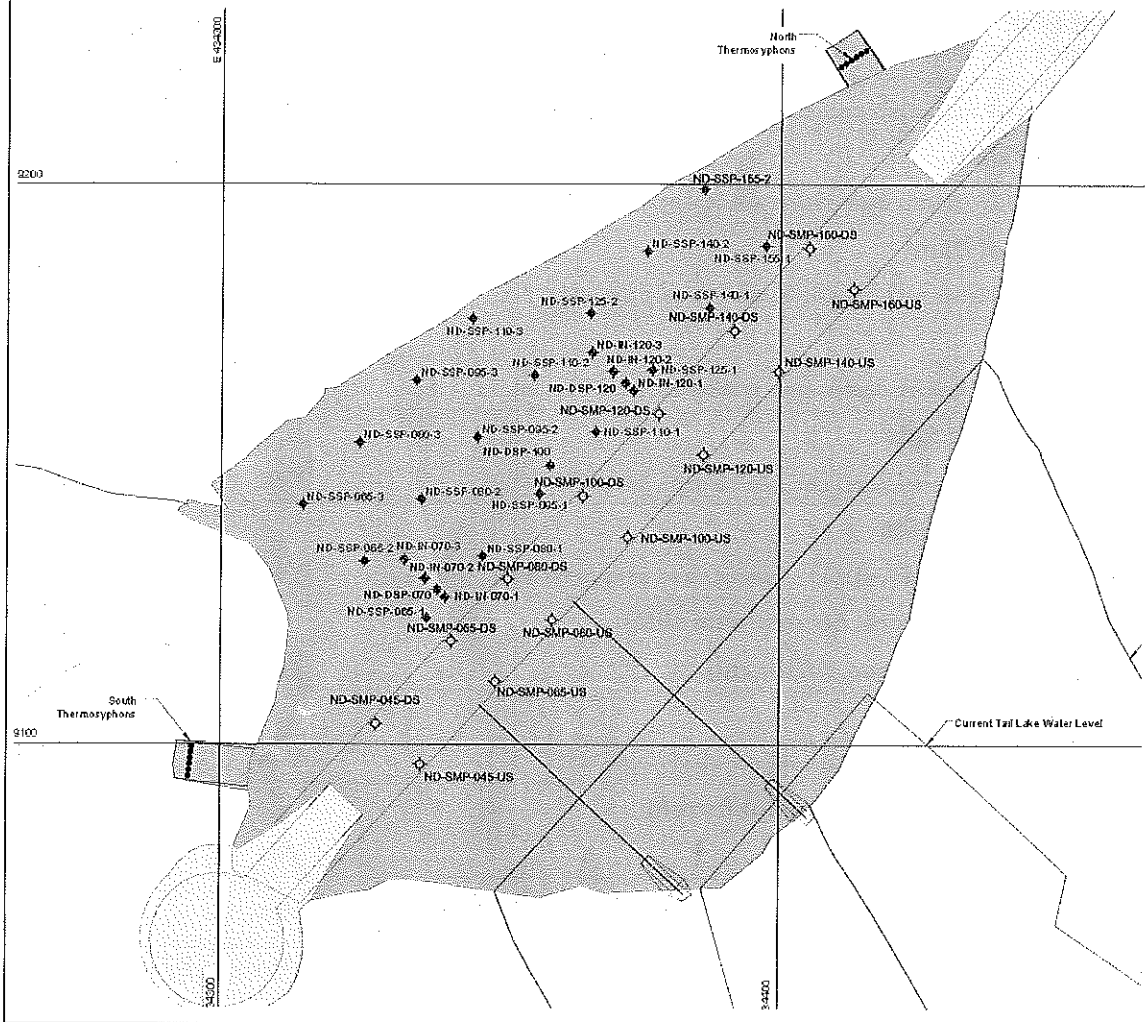
Visual Inspection:

This weekly walkover survey report is a means to track the condition on the North Dam, please provide details on changes that have developed since the previous inspection and/or any observations of particular concern. All photos are appreciated. Please send the completed form (scans are fine) and any photos to hopebaymonitoring@srk.com and pluedke@srk.com

Upstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Downstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	(No)
Crest of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Thermosyphons South Side Minor Rust		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Instrumentation (on crest and downstream side)		
Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers		
Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen)		
Any suspended sediment in Tail Lake?	Yes	(No)
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	(No)

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos: Photo from north end looking south along the dam Photo from south end looking north along the dam	☑ ☑
Other photos, please describe – Photos taken	





North Dam Weekly Walkover Survey Report

Date:	Mike Tamasa August 04. 2019
Inspected By:	
Conditions:	(ie. snow on ground, clear)

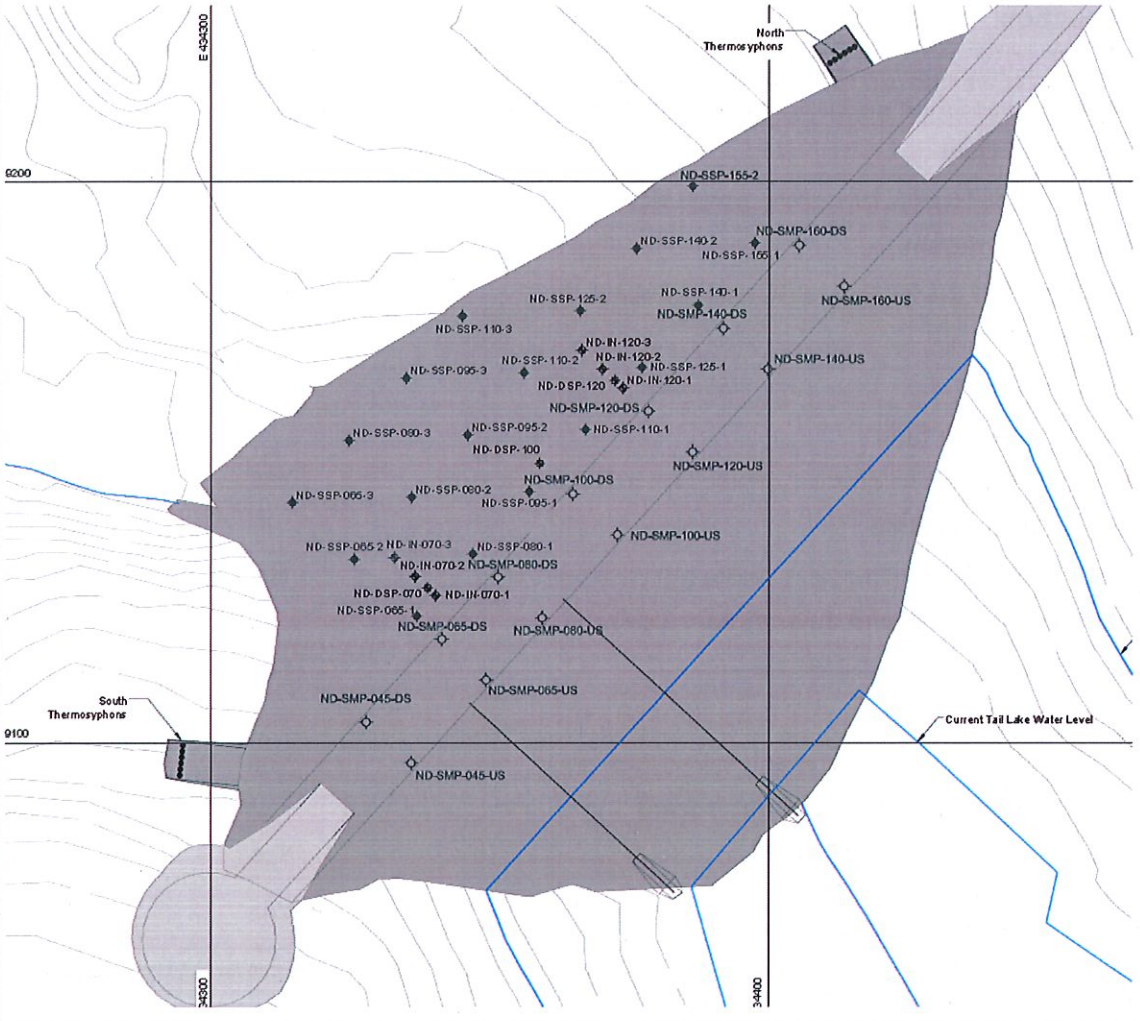
Visual Inspection:

This weekly walkover survey report is a means to track the condition on the North Dam, please provide details on changes that have developed since the previous inspection and/or any observations of particular concern. All photos are appreciated. Please send the completed form (scans are fine) and any photos to hopebaymonitoring@srk.com and pluedke@srk.com

Upstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	~~No~~
Downstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	~~No~~
Crest of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	~~No~~
Thermosyphons North Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	~~No~~
Thermosyphons South Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	~~No~~
Instrumentation (on crest and downstream side)		
Any visible concerns? (bent, rusted, cracked, etc.)	Yes	~~No~~
Thermistors and Dataloggers		
Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	~~No~~
Suspended Sediment in TIA (When not frozen)		
Any suspended sediment in Tail Lake?	Yes	~~No~~
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	~~No~~

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos: Photo from north end looking south along the dam Photo from south end looking north along the dam	☐ ☐
Other photos, please describe – Photos taken	

North Dam Weekly Walkover Survey Report

Date:	AUG. 10. 2019
Inspected By:	MIKE TAMASI
Conditions:	(ie. snow on ground, clear)

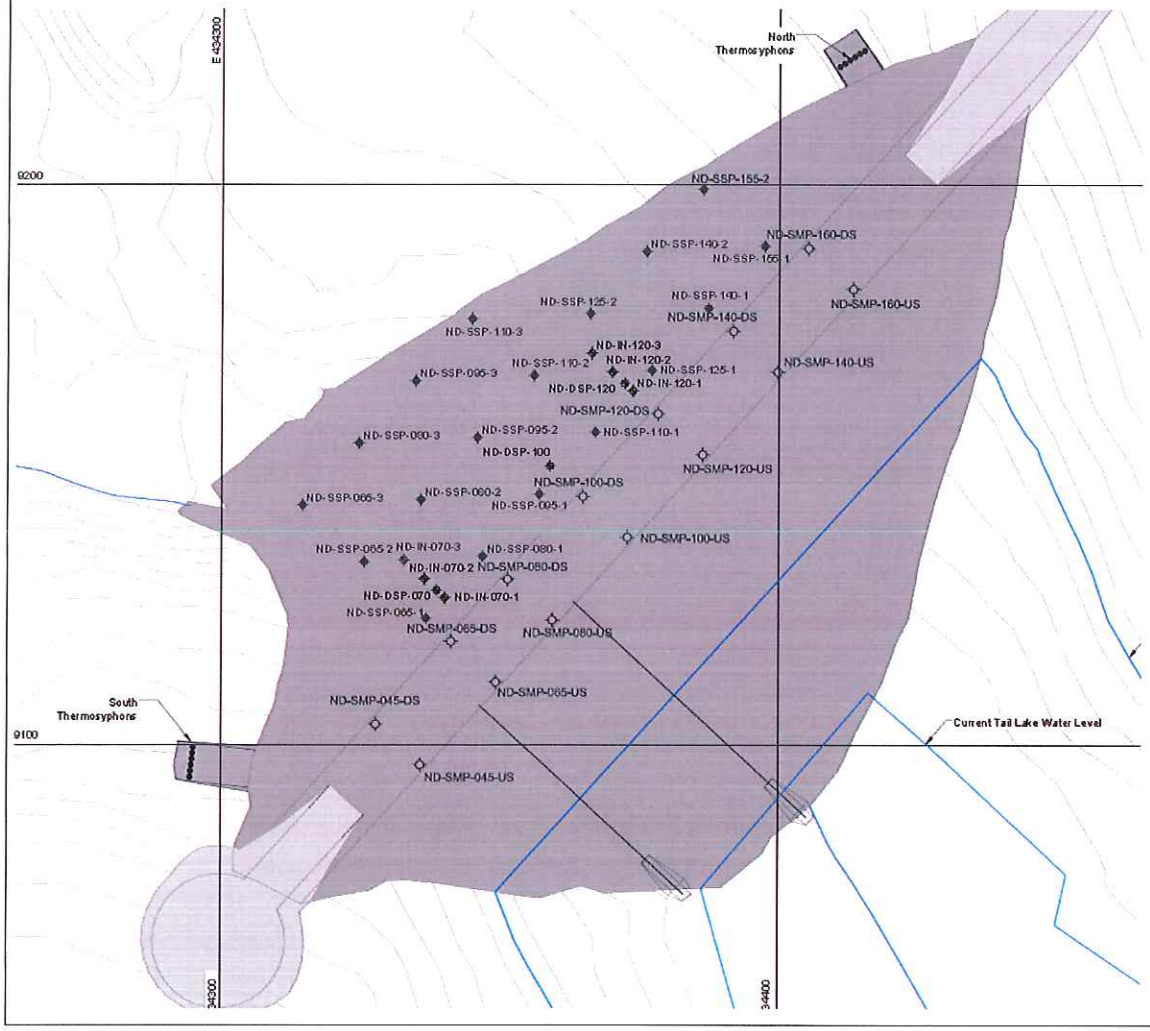
Visual Inspection:

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Upstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Downstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	(No)
Crest of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Thermosyphons South Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Instrumentation (on crest and downstream side)		
Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers		
Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen)		
Any suspended sediment in Tail Lake?	Yes	(No)
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	(No)

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos: Photo from north end looking south along the dam Photo from south end looking north along the dam	☐ ☐
Other photos, please describe – Photos taken	





North Dam Weekly Walkover Survey Report

Date:	August 21st 2019
Inspected By:	MIKE TANIASA
Conditions:	(ie. snow on ground, clear) CLEAR

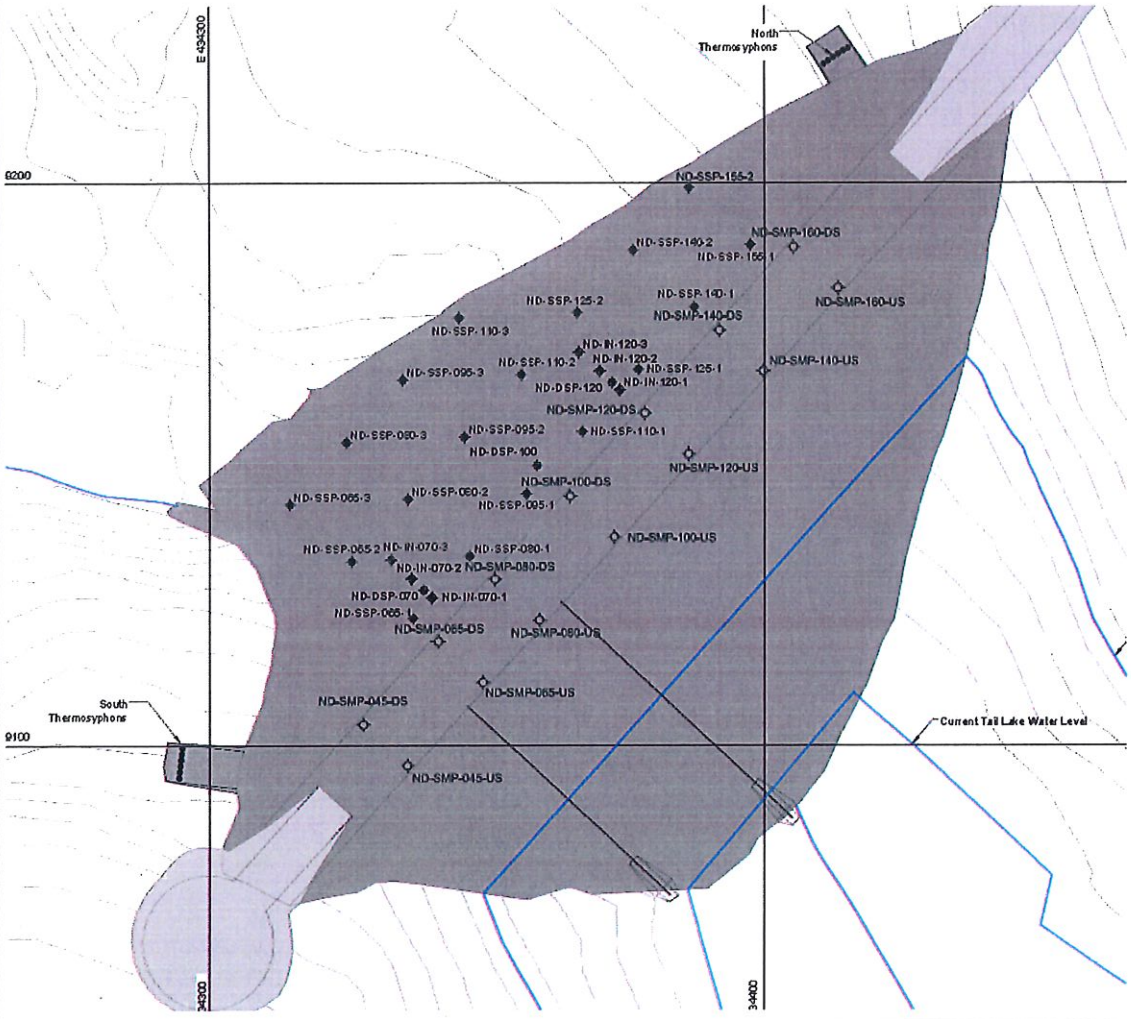
Visual Inspection:

This weekly walkover survey report is a means to track the condition on the North Dam, please provide details on changes that have developed since the previous inspection and/or any observations of particular concern. All photos are appreciated. Please send the completed form (scans are fine) and any photos to hopebaymonitoring@srk.com and pluedke@srk.com

Upstream Side of Dam Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	~~No~~
Downstream Side of Dam Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	~~No~~
Crest of Dam Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	~~No~~
Thermosyphons North Side Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	~~No~~
Thermosyphons South Side Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	~~No~~
Instrumentation (on crest and downstream side) Any visible concerns? (bent, rusted, cracked, etc.)	Yes	~~No~~
Thermistors and Dataloggers Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	~~No~~
Suspended Sediment in TIA (When not frozen) Any suspended sediment in Tail Lake?	Yes	~~No~~
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	~~No~~

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos: Photo from north end looking south along the dam Photo from south end looking north along the dam
Other photos, please describe – Photos taken





North Dam Weekly Walkover Survey Report

Date:	Aug 28. 2019
Inspected By:	Josh Fass
Conditions:	(ie. snow on ground, clear)

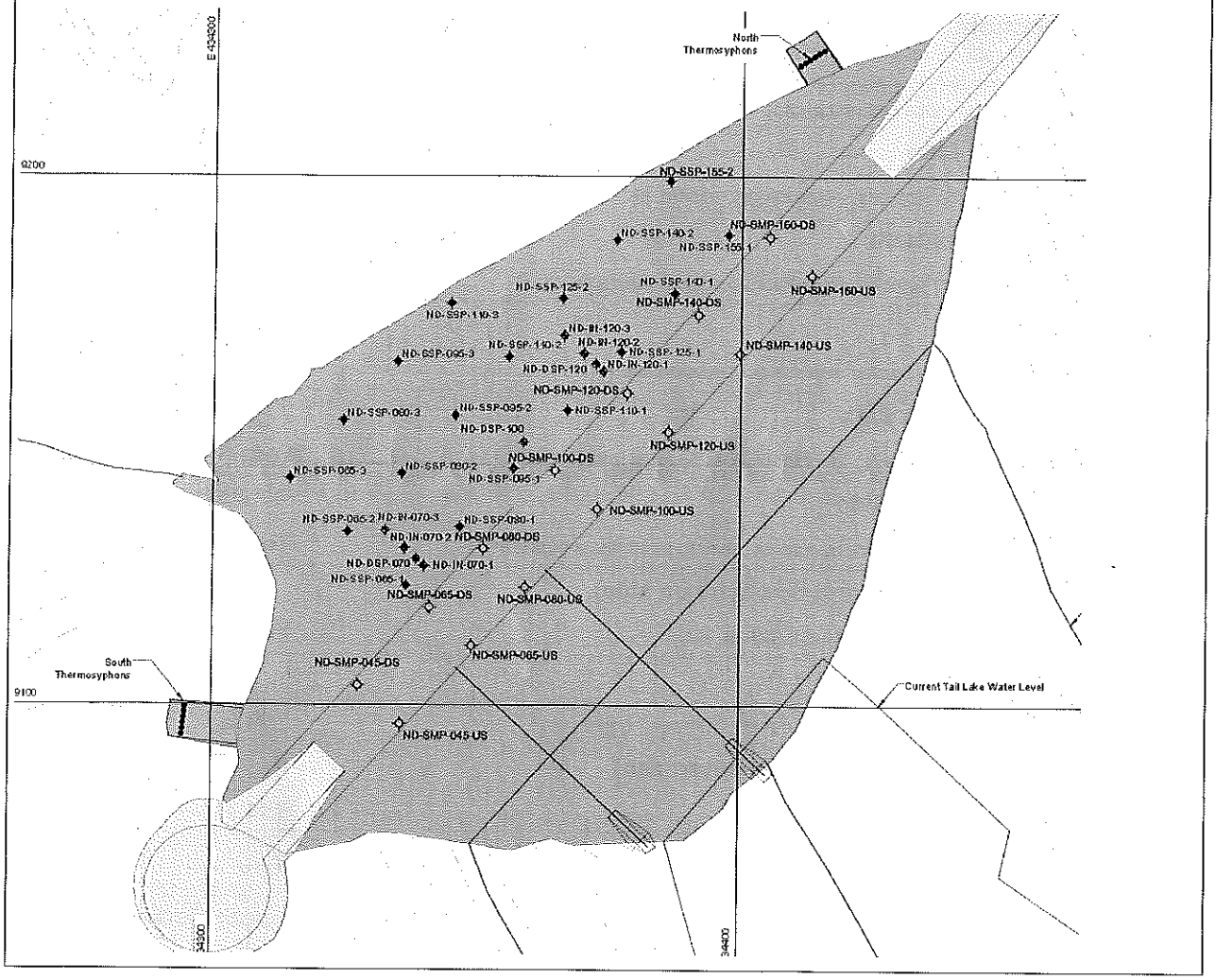
Visual Inspection:

This weekly walkover survey report is a means to track the condition on the North Dam, please provide details on changes that have developed since the previous inspection and/or any observations of particular concern. All photos are appreciated. Please send the completed form (scans are fine) and any photos to hopebaymonitoring@srk.com and pluedke@srk.com

Upstream Side of Dam Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Downstream Side of Dam Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	(No)
Crest of Dam Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Thermosyphons South Side Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Instrumentation (on crest and downstream side) Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen) Any suspended sediment in Tail Lake?	Yes	(No)
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	(No)

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos:	
Photo from north end looking south along the dam	☑
Photo from south end looking north along the dam	☑
Other photos, please describe – Photos taken	





North Dam Weekly Walkover Survey Report

Date:	Sept 4, 2019
Inspected By:	Josh Fris
Conditions:	(ie. snow on ground, clear)

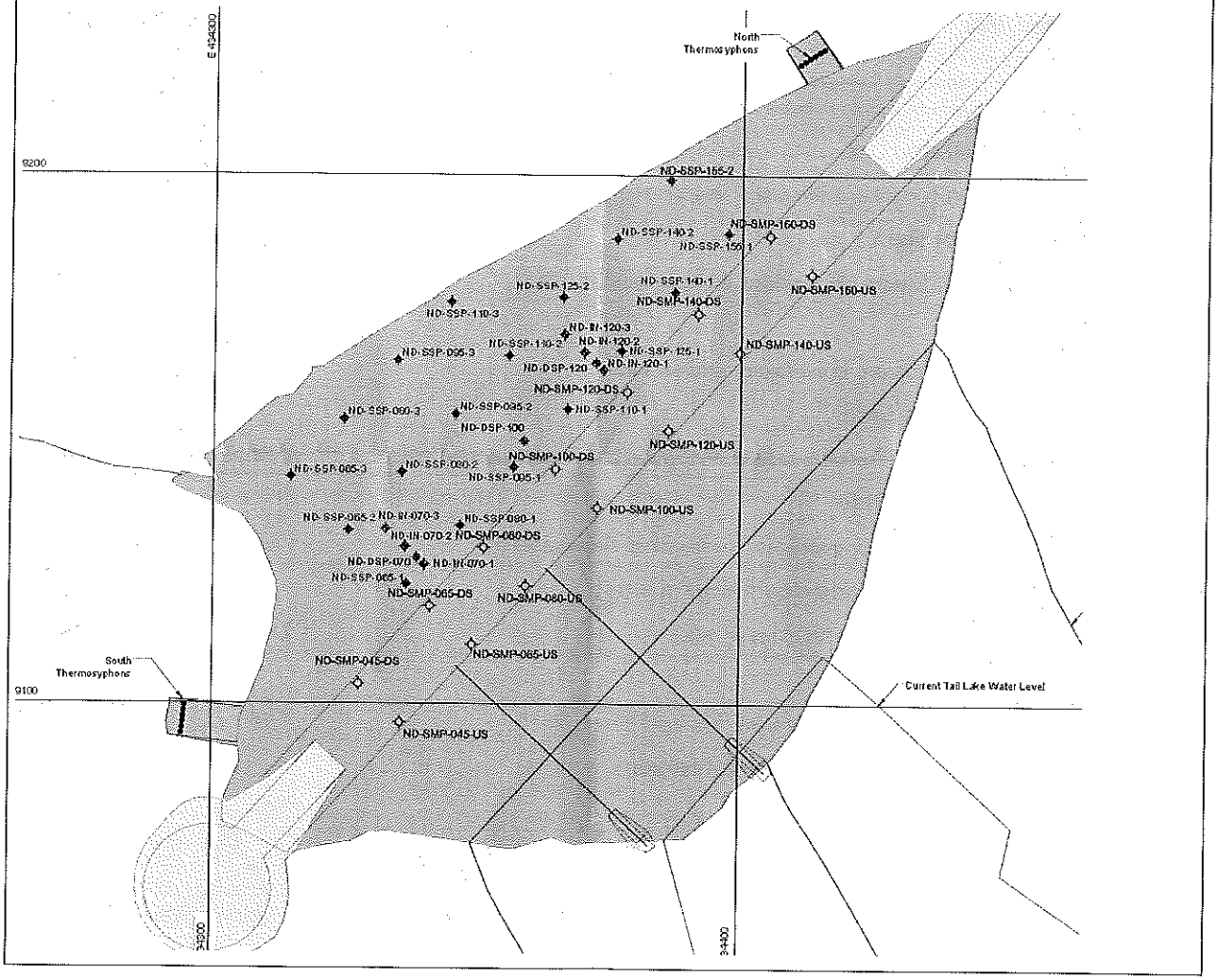
Visual Inspection:

This weekly walkover survey report is a means to track the condition on the North Dam, please provide details on changes that have developed since the previous inspection and/or any observations of particular concern. All photos are appreciated. Please send the completed form (scans are fine) and any photos to hopebaymonitoring@srk.com and pluedke@srk.com

Upstream Side of Dam Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Downstream Side of Dam Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	(No)
Crest of Dam Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Thermosyphons South Side Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Instrumentation (on crest and downstream side) Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen) Any suspended sediment in Tail Lake?	Yes	(No)
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	(No)

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

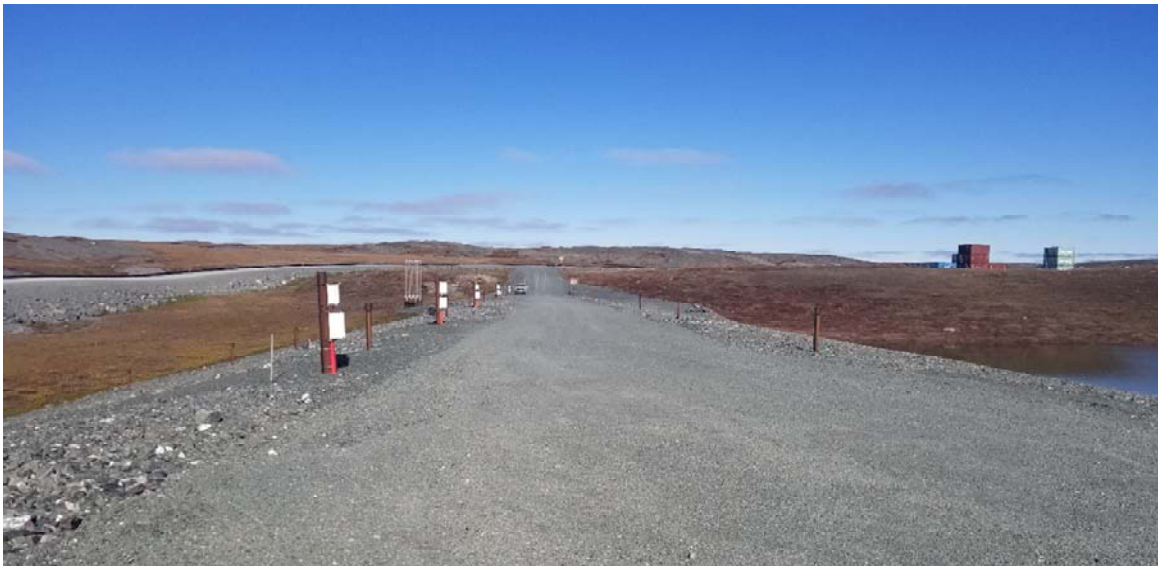
Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos: Photo from north end looking south along the dam Photo from south end looking north along the dam	☑ ☑
Other photos, please describe – Photos taken	





North Dam Weekly Walkover Survey Report

Date:	Sept 18, 2019
Inspected By:	Josh Fris
Conditions:	(ie. snow on ground, clear) Clear.

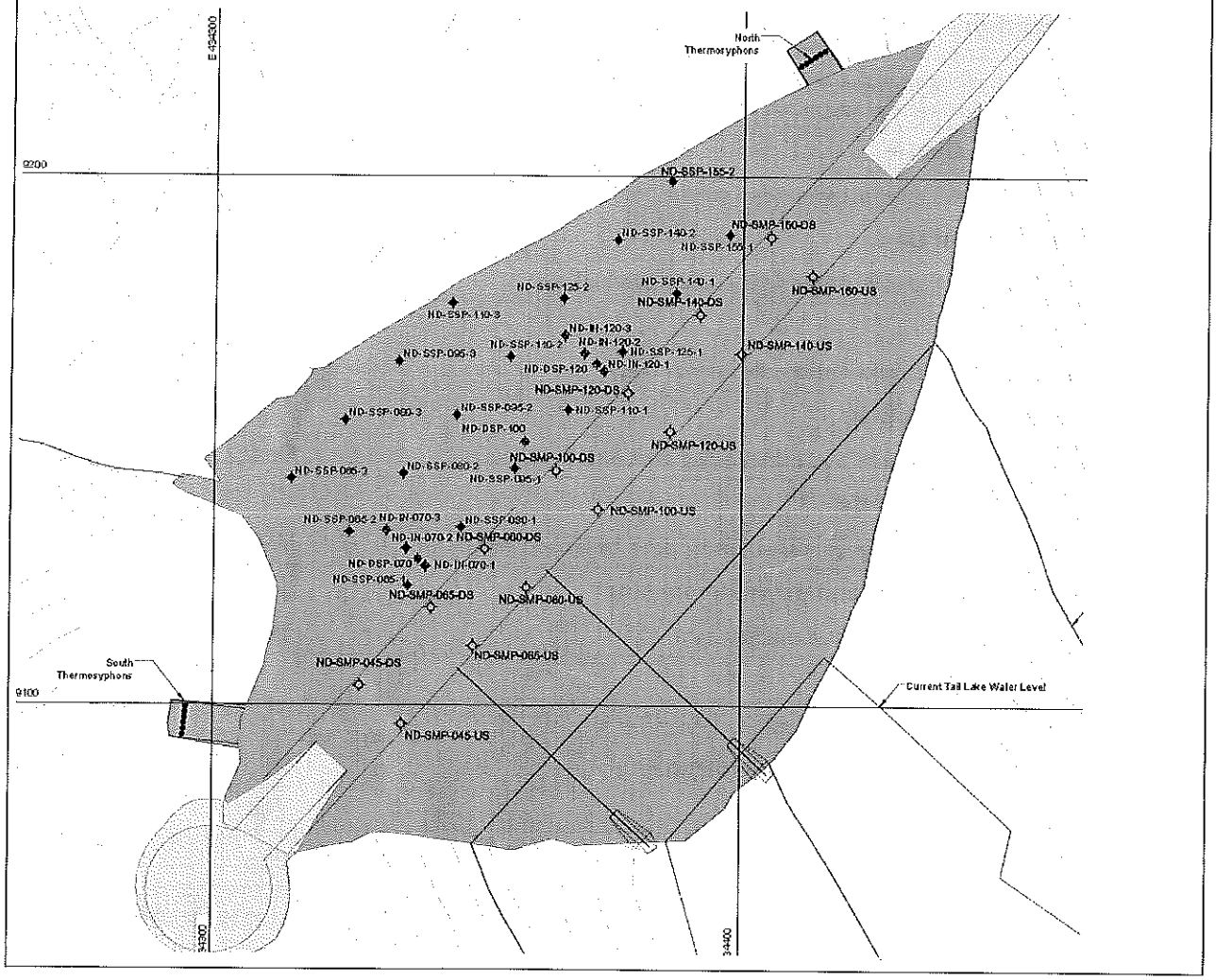
Visual Inspection:

This weekly walkover survey report is a means to track the condition on the North Dam, please provide details on changes that have developed since the previous inspection and/or any observations of particular concern. All photos are appreciated. Please send the completed form (scans are fine) and any photos to hopebaymonitoring@srk.com and pluedke@srk.com

Upstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Downstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	(No)
Crest of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Thermosyphons South Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Instrumentation (on crest and downstream side)		
Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers		
Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen)		
Any suspended sediment in Tail Lake?	Yes	(No)
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	(No)

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos: Photo from north end looking south along the dam Photo from south end looking north along the dam	☑ ☑
Other photos, please describe – Photos taken	





North Dam Weekly Walkover Survey Report

Date:	Sept 18, 2019
Inspected By:	Josh Fr.s
Conditions:	(ie. snow on ground, clear) Clear.

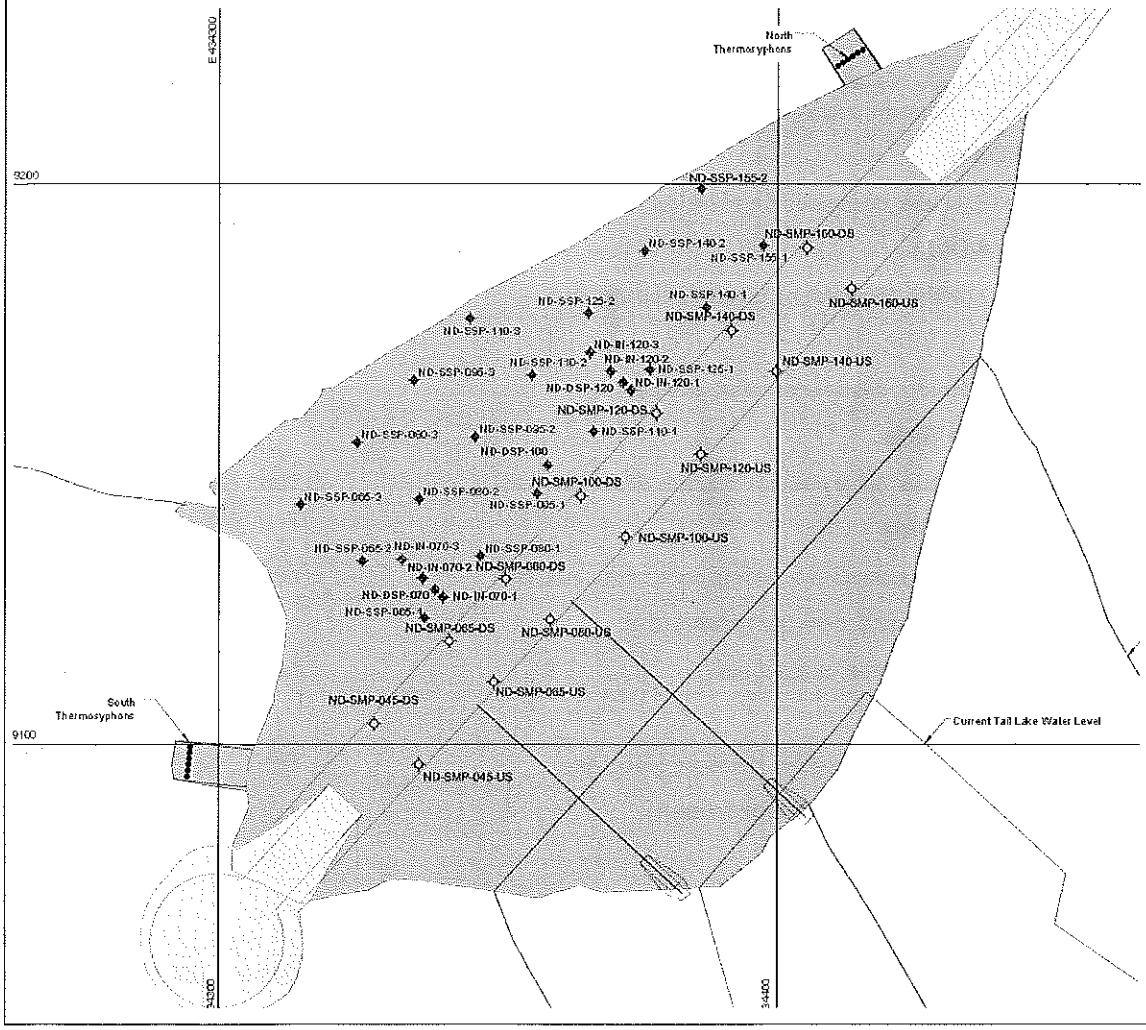
Visual Inspection:

This weekly walkover survey report is a means to track the condition on the North Dam, please provide details on changes that have developed since the previous inspection and/or any observations of particular concern. All photos are appreciated. Please send the completed form (scans are fine) and any photos to hopebaymonitoring@srk.com and pluedke@srk.com

Upstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Downstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	(No)
Crest of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Thermosyphons South Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Instrumentation (on crest and downstream side)		
Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers		
Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen)		
Any suspended sediment in Tail Lake?	Yes	(No)
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	(No)

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

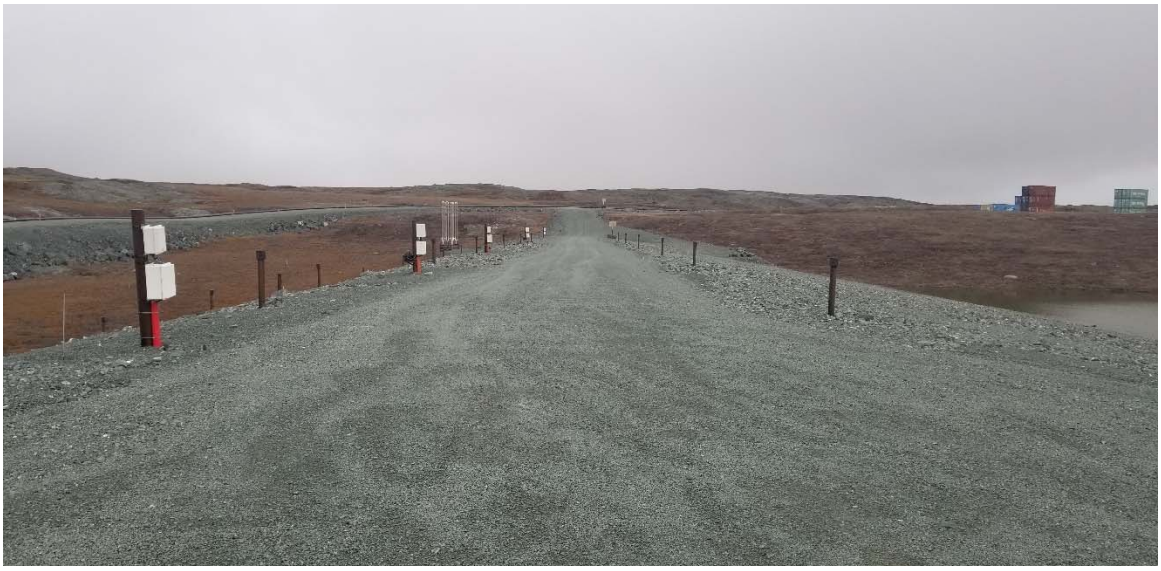
Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos: Photo from north end looking south along the dam Photo from south end looking north along the dam	☑ ☑
Other photos, please describe – Photos taken	





North Dam Weekly Walkover Survey Report

Date:	September 28, 2019
Inspected By:	MIKE TATHAM
Conditions:	(ie. snow on ground, clear) CLEAR DAY

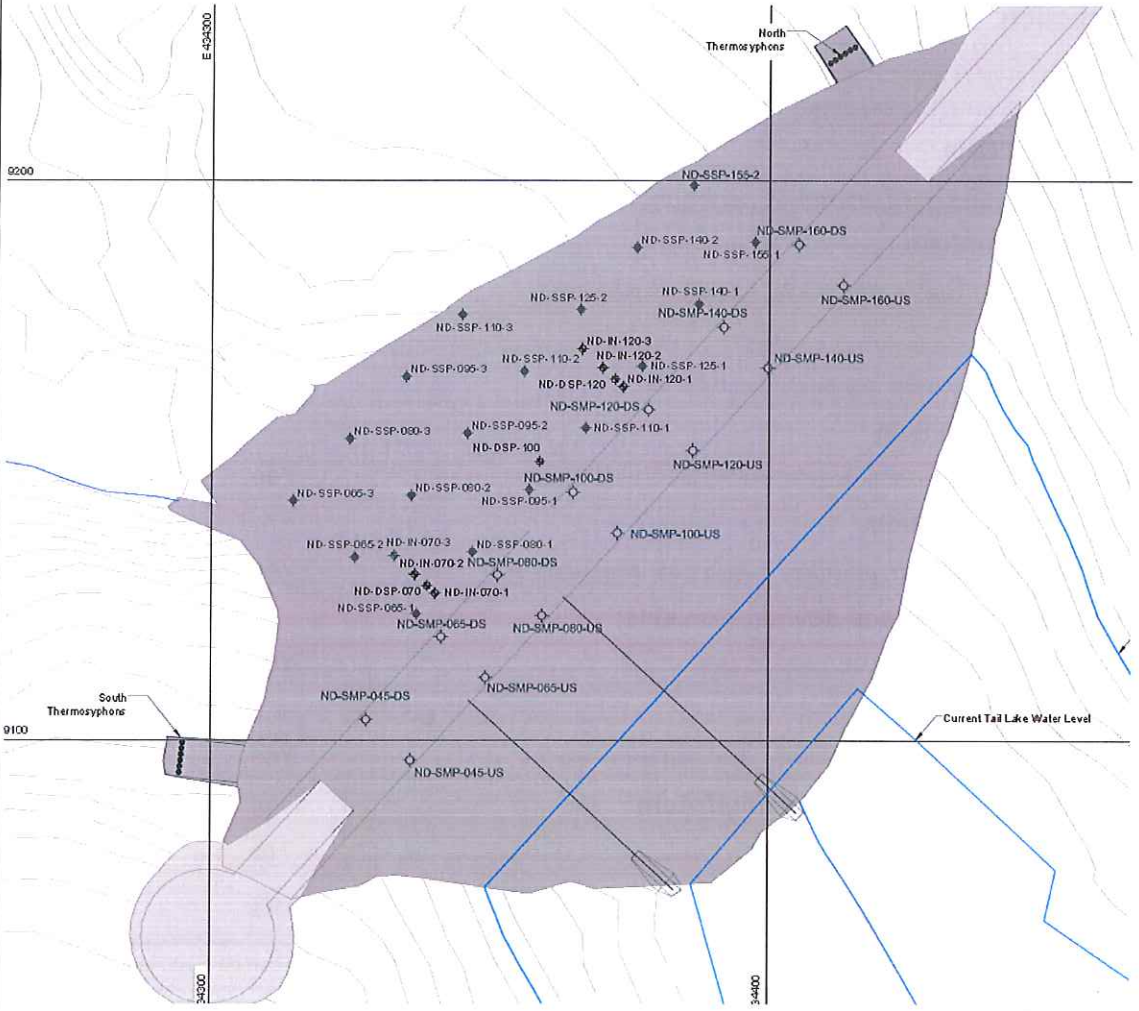
Visual Inspection:

This weekly walkover survey report is a means to track the condition on the North Dam, please provide details on changes that have developed since the previous inspection and/or any observations of particular concern. All photos are appreciated. Please send the completed form (scans are fine) and any photos to hopebaymonitoring@srk.com and pluedke@srk.com

Upstream Side of Dam Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Downstream Side of Dam Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	(No)
Crest of Dam Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Thermosyphons South Side Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Instrumentation (on crest and downstream side) Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen) Any suspended sediment in Tail Lake?	Yes	(No)
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	(No)

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos: Photo from north end looking south along the dam Photo from south end looking north along the dam	☑ ☑
Other photos, please describe – Photos taken	





North Dam Weekly Walkover Survey Report

Date:	Oct. 04. 2019
Inspected By:	MIKE TAMASA
Conditions:	(ie. snow on ground, clear) CLEAR

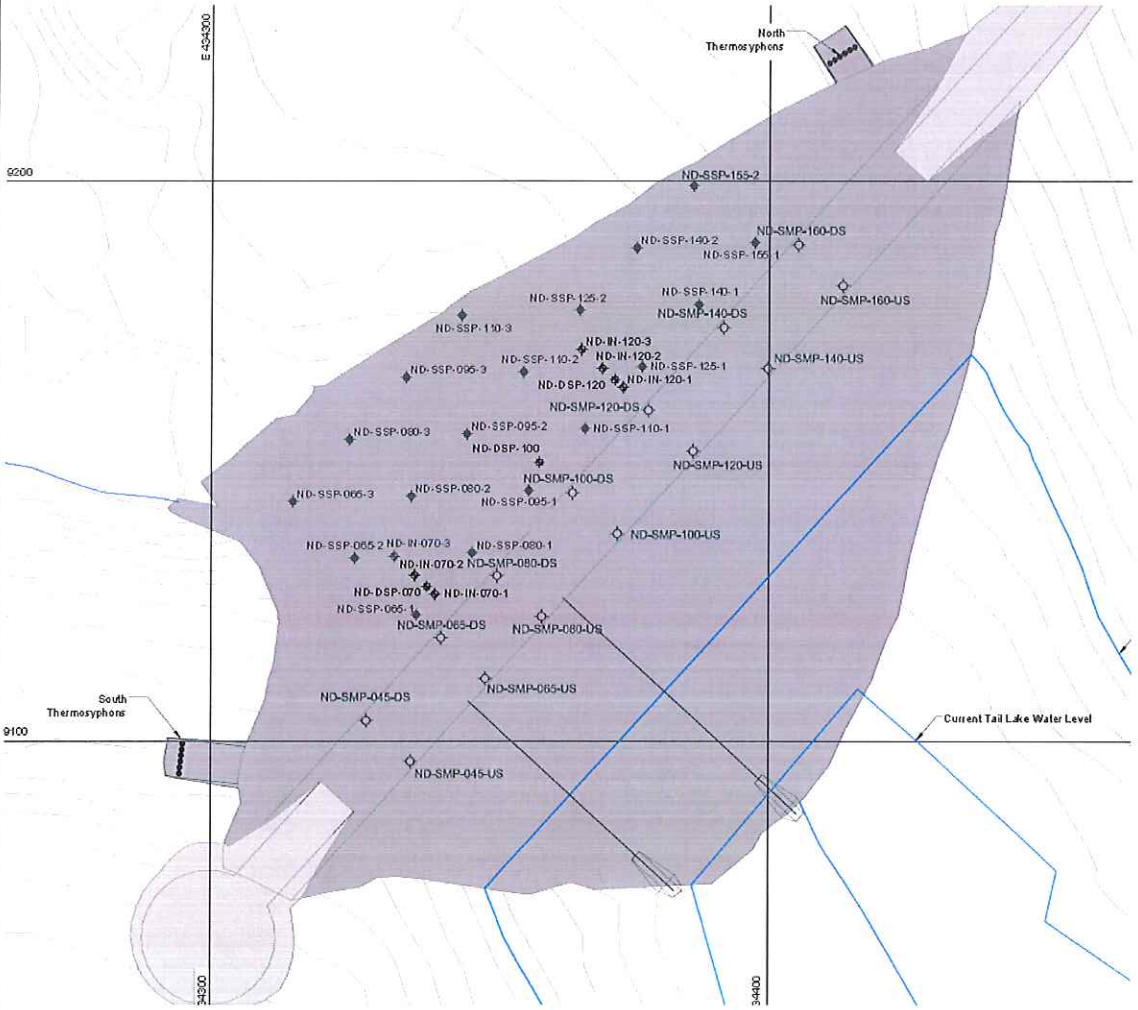
Visual Inspection:

This weekly walkover survey report is a means to track the condition on the North Dam, please provide details on changes that have developed since the previous inspection and/or any observations of particular concern. All photos are appreciated. Please send the completed form (scans are fine) and any photos to hopebaymonitoring@srk.com and pluedke@srk.com

Upstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Downstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	(No)
Crest of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Thermosyphons South Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Instrumentation (on crest and downstream side)		
Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers		
Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen)		
Any suspended sediment in Tail Lake?	Yes	(No)
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	(No)

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos:	
Photo from north end looking south along the dam	☑
Photo from south end looking north along the dam	☐
Other photos, please describe – Photos taken	





North Dam Weekly Walkover Survey Report

Date:	Oct 13, 2019
Inspected By:	MIKE TANASA
Conditions:	(ie. snow on ground, clear) SNOW

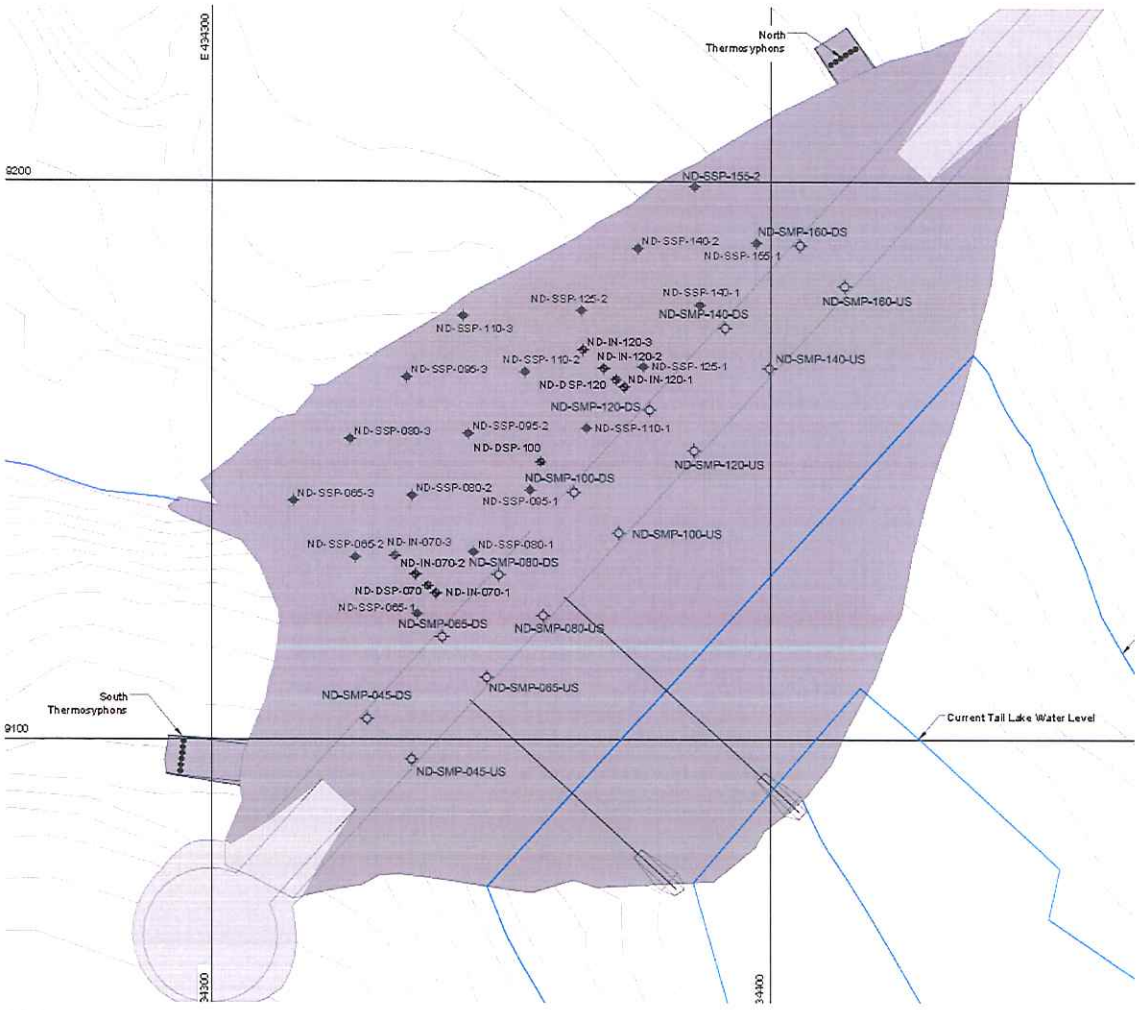
Visual Inspection:

This weekly walkover survey report is a means to track the condition on the North Dam, please provide details on changes that have developed since the previous inspection and/or any observations of particular concern. All photos are appreciated. Please send the completed form (scans are fine) and any photos to hopebaymonitoring@srk.com and pluedke@srk.com

Upstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Downstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	(No)
Crest of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Thermosyphons South Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Instrumentation (on crest and downstream side)		
Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers		
Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen)		
Any suspended sediment in Tail Lake?	Yes	(No)
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	(No)

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos: Photo from north end looking south along the dam Photo from south end looking north along the dam
Other photos, please describe – Photos taken





North Dam Weekly Walkover Survey Report

Date:	Oct 16, 2019
Inspected By:	Sarah Ross
Conditions:	(ie. snow on ground, clear) Snow.

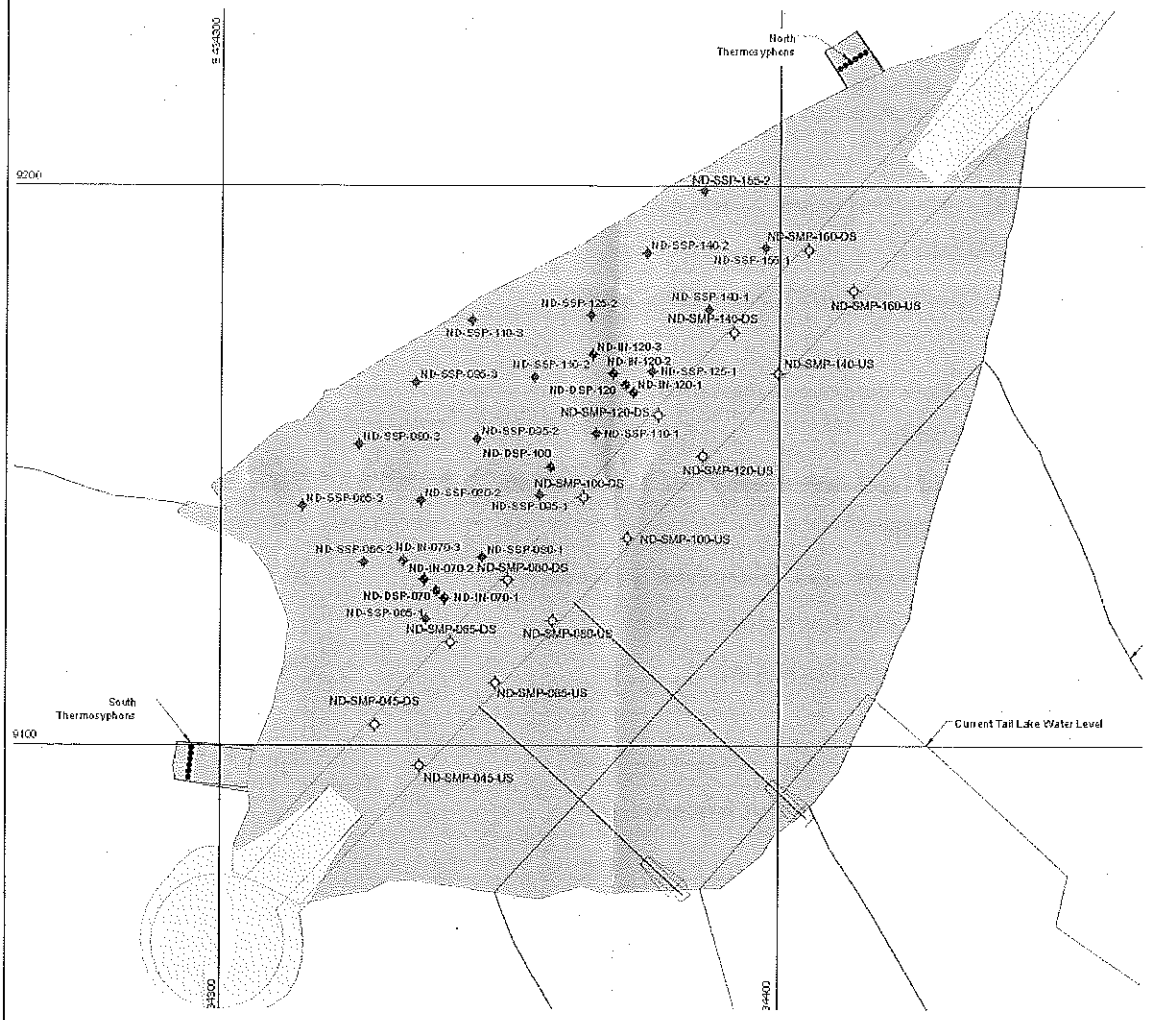
Visual Inspection:

This weekly walkover survey report is a means to track the condition on the North Dam, please provide details on changes that have developed since the previous inspection and/or any observations of particular concern. All photos are appreciated. Please send the completed form (scans are fine) and any photos to hopebaymonitoring@srk.com and pluedke@srk.com

Upstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Downstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	(No)
Crest of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Thermosyphons South Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Instrumentation (on crest and downstream side)		
Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers		
Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen)		
Any suspended sediment in Tail Lake?	Yes	(No)
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	(No)

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos: Photo from north end looking south along the dam Photo from south end looking north along the dam	☑ ☑
Other photos, please describe – Photos taken	





North Dam Weekly Walkover Survey Report

Date:	Oct 23, 2019
Inspected By:	Josh Fyvie
Conditions:	(ie. snow on ground, clear) Snow

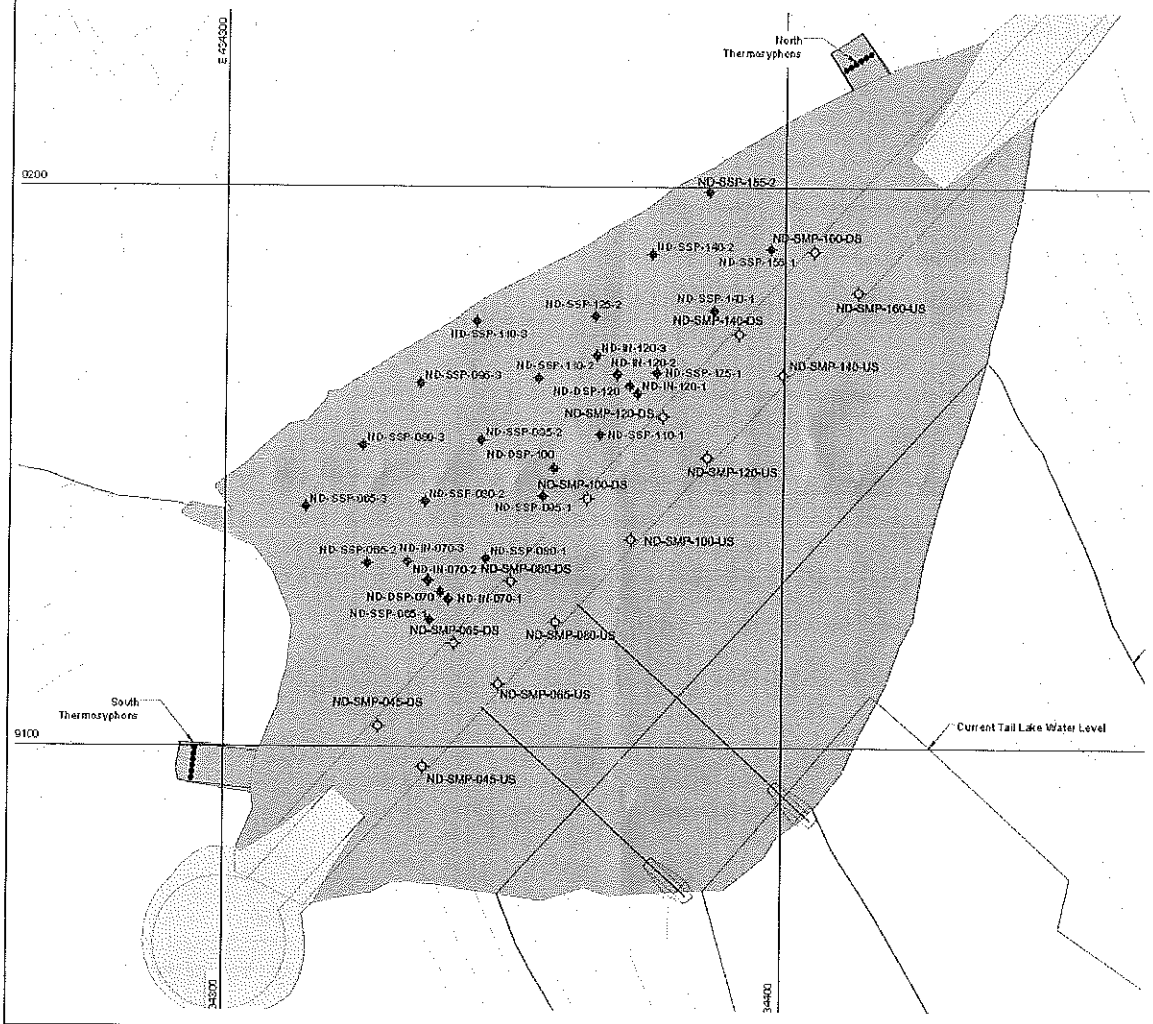
Visual Inspection:

This weekly walkover survey report is a means to track the condition on the North Dam, please provide details on changes that have developed since the previous inspection and/or any observations of particular concern. All photos are appreciated. Please send the completed form (scans are fine) and any photos to hopebaymonitoring@srk.com and pluedke@srk.com

Upstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Downstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	(No)
Crest of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Thermosyphons South Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Instrumentation (on crest and downstream side)		
Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers		
Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen)		
Any suspended sediment in Tail Lake?	Yes	(No)
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	(No)

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos: Photo from north end looking south along the dam Photo from south end looking north along the dam	☑ ☑
Other photos, please describe – Photos taken	





North Dam Weekly Walkover Survey Report

Date:	Oct 31, 2019
Inspected By:	Josh F.S
Conditions:	(ie. snow on ground, clear) Snow

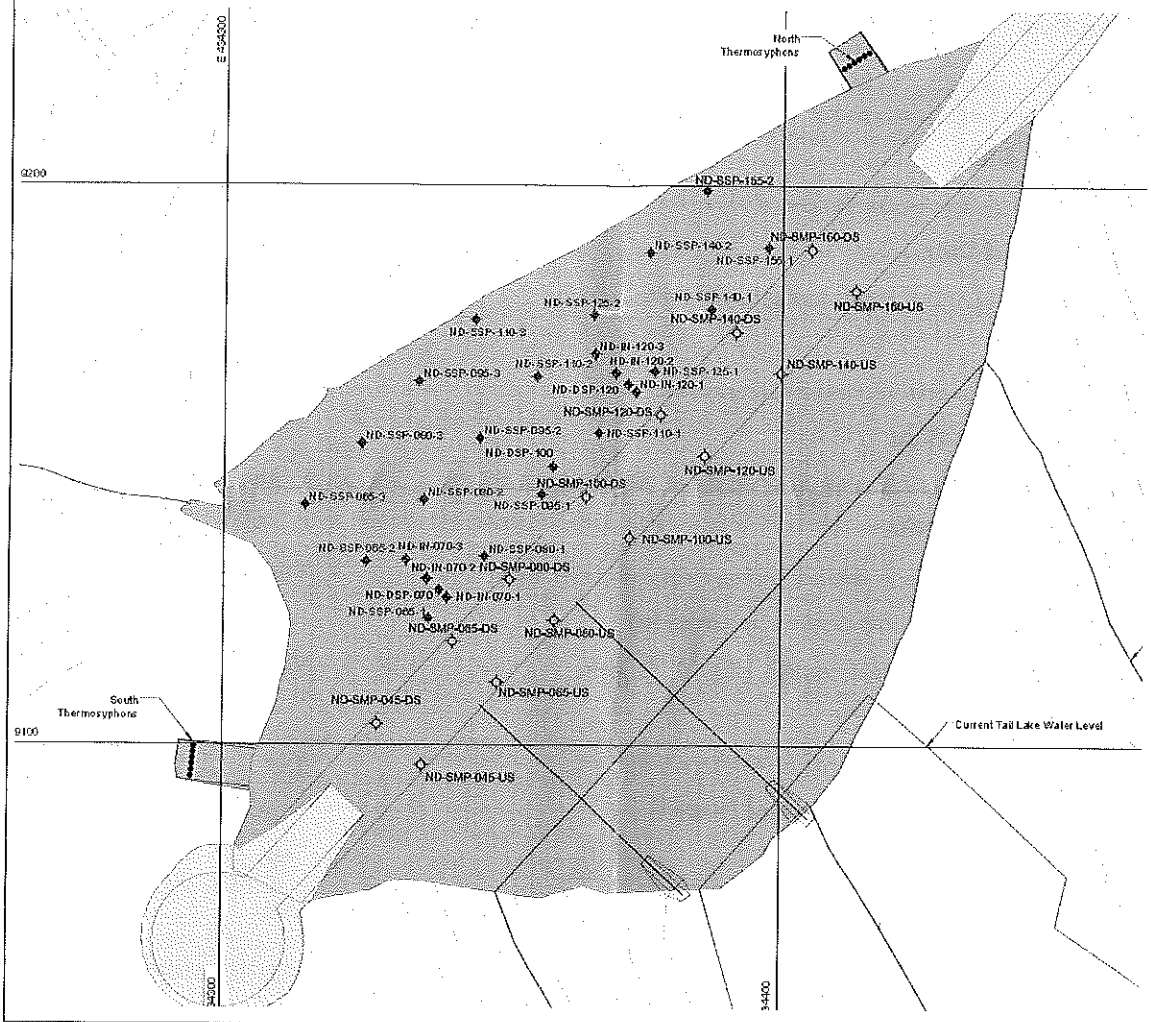
Visual Inspection:

This weekly walkover survey report is a means to track the condition on the North Dam, please provide details on changes that have developed since the previous inspection and/or any observations of particular concern. All photos are appreciated. Please send the completed form (scans are fine) and any photos to hopebaymonitoring@srk.com and pluedke@srk.com

Upstream Side of Dam Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Downstream Side of Dam Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	(No)
Crest of Dam Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Thermosyphons South Side Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Instrumentation (on crest and downstream side) Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen) Any suspended sediment in Tail Lake?	Yes	(No)
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	(No)

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos:	
Photo from north end looking south along the dam	☑
Photo from south end looking north along the dam	☑
Other photos, please describe – Photos taken	





North Dam Weekly Walkover Survey Report

Date:	November 8, 2019
Inspected By:	MIKE TAMASA
Conditions:	(ie. snow on ground, clear) SNOW

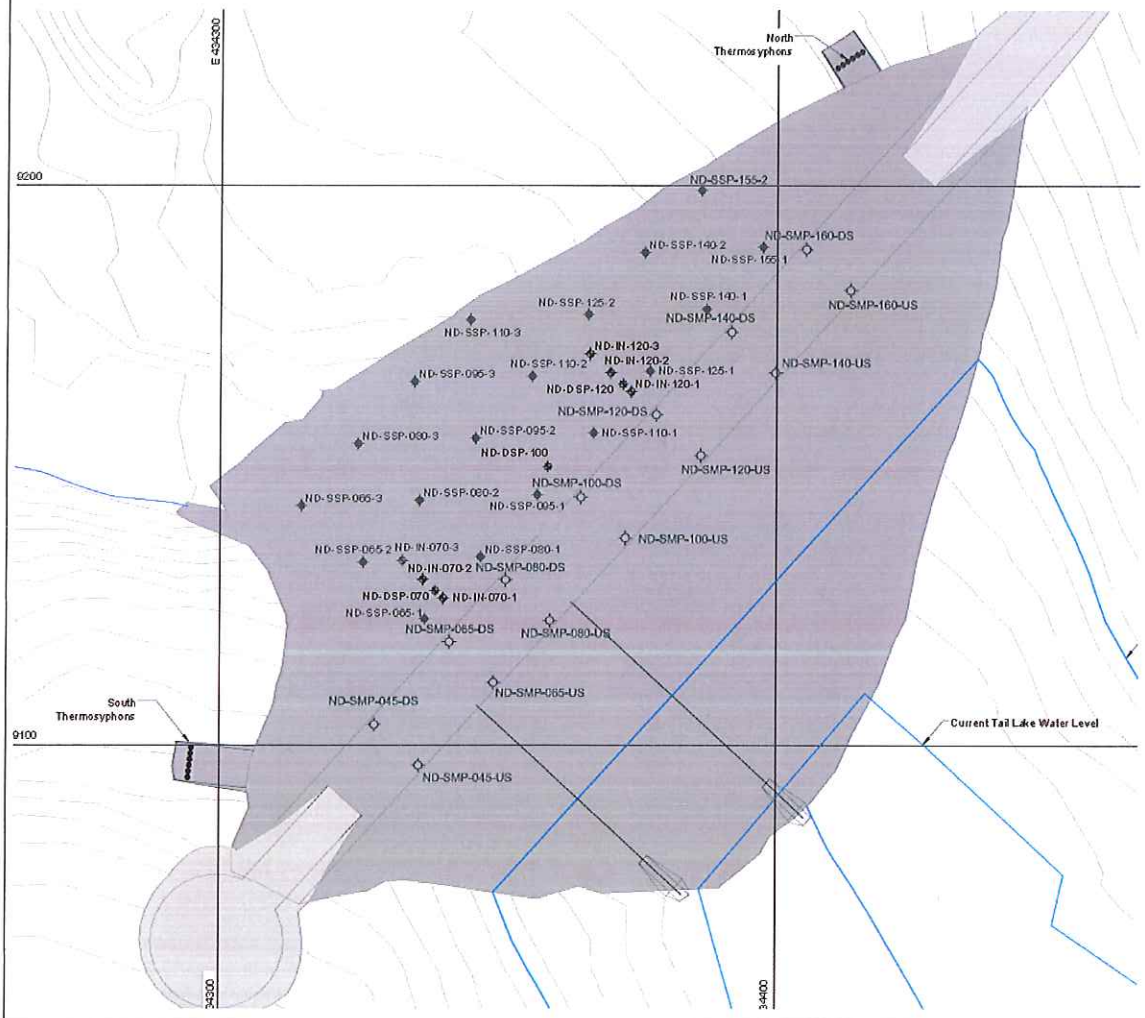
Visual Inspection:

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Upstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Downstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	(No)
Crest of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Thermosyphons South Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Instrumentation (on crest and downstream side)		
Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers		
Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen)		
Any suspended sediment in Tail Lake?	Yes	(No)
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	(No)

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figure provided on the next page. If seepage has been noted please estimate the flow.

Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos: Photo from north end looking south along the dam Photo from south end looking north along the dam	☑ ☑
Other photos, please describe – Photos taken	





North Dam Weekly Walkover Survey Report

Date:	NOV. 15 2019
Inspected By:	MIKE TANASA
Conditions:	(ie. snow on ground, clear) SNOW

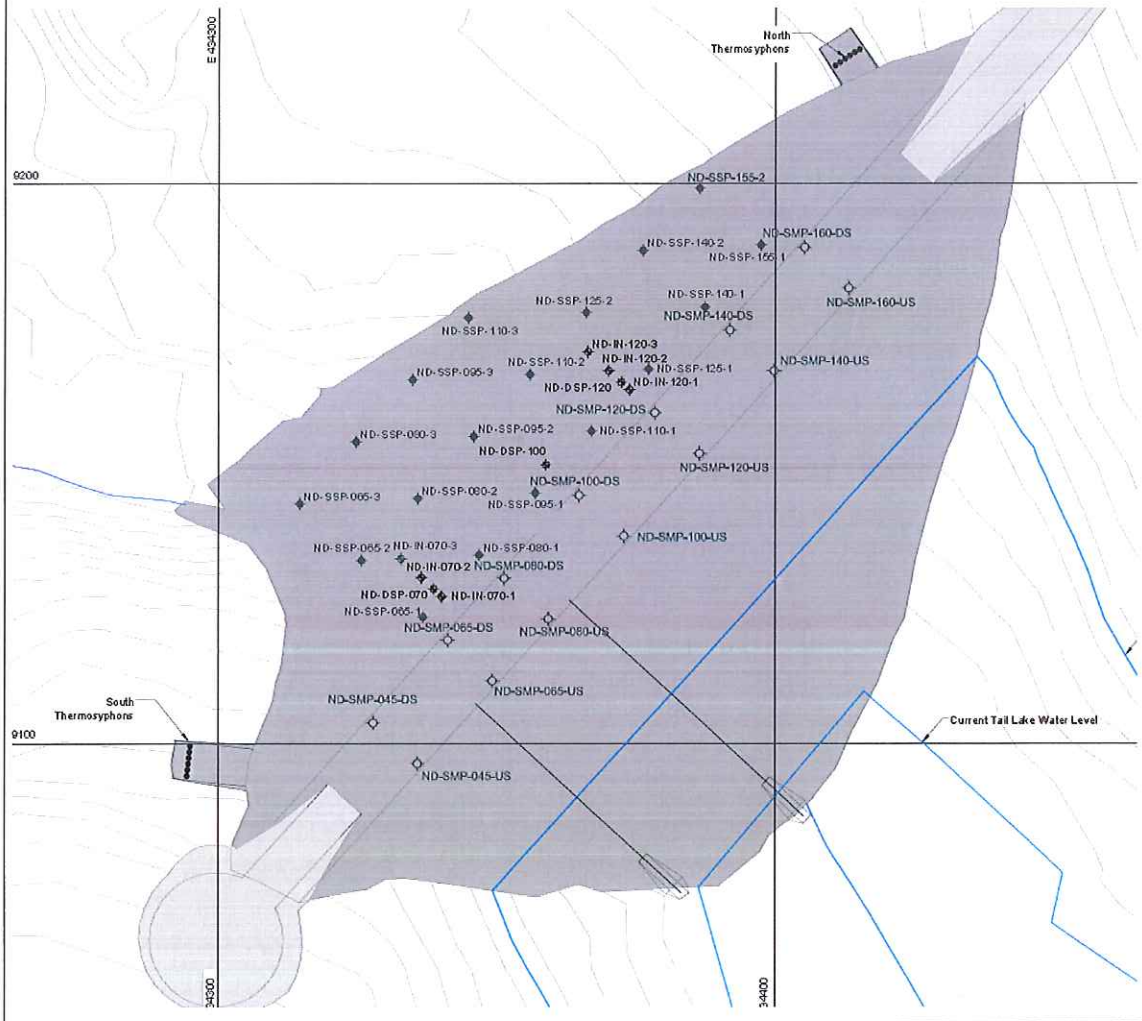
Visual Inspection:

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Photos:

Please collect the following photos: Photo from north end looking south along the dam Photo from south end looking north along the dam	☑ ☑
Other photos, please describe – Photos taken	





North Dam Weekly Walkover Survey Report

Date:	NOV. 24. 2019
Inspected By:	MIKE TANASH
Conditions:	(ie. snow on ground, clear) SNOW - COOLD AS IN THE ARCTIC !

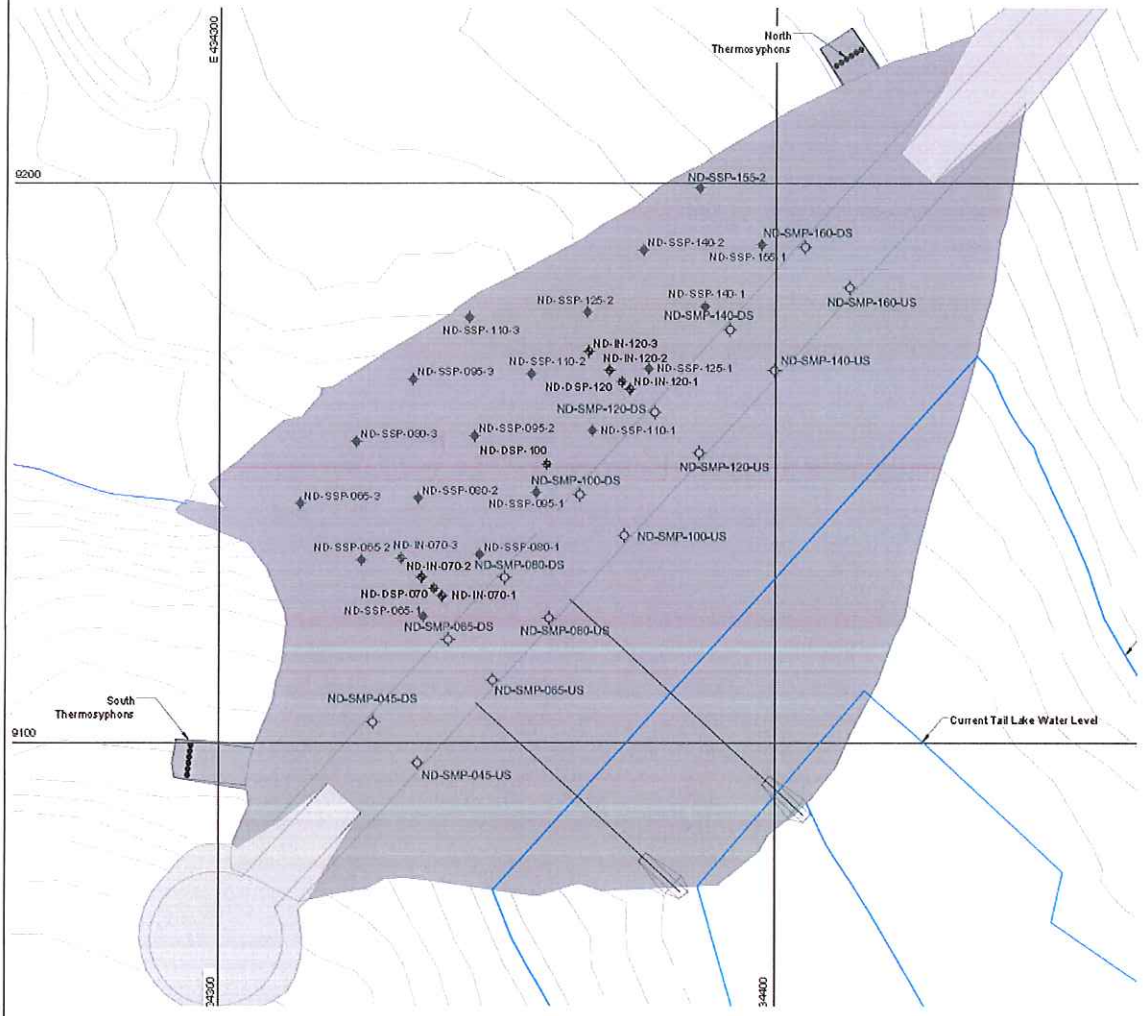
Visual Inspection:

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Any suspended sediment in Tail Lake?	Yes	(No)
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2015)	Yes	(No)

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Please provide any other observations you have made or items that did not fit in the space above



Photos:

Please collect the following photos: Photo from north end looking south along the dam Photo from south end looking north along the dam	☐ ☐
Other photos, please describe – Photos taken	

North Dam Weekly Walkover Survey Report

Date:	Dec 4, 2019
Inspected By:	Josh Fris
Conditions:	(ie. snow on ground, clear) Snow

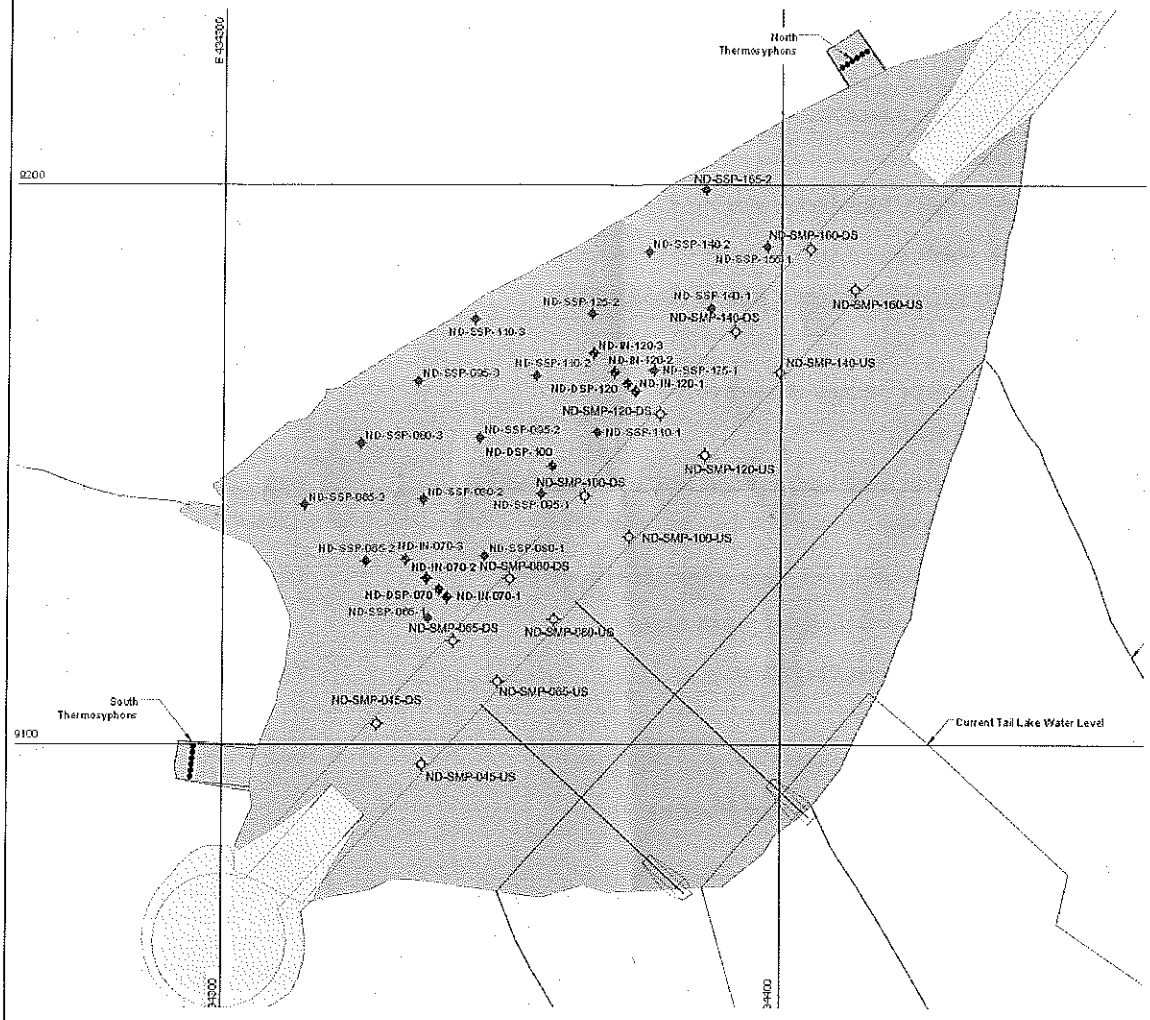
Visual Inspection:

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Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
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Any suspended sediment in Tail Lake?	Yes	(No)
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Photos:

Please collect the following photos: Photo from north end looking south along the dam Photo from south end looking north along the dam	☑ ☑
Other photos, please describe – Photos taken	





North Dam Weekly Walkover Survey Report

Date:	Dec. 25. 2019
Inspected By:	MIKE TAHASA
Conditions:	(ie. snow on ground, clear) SNOW

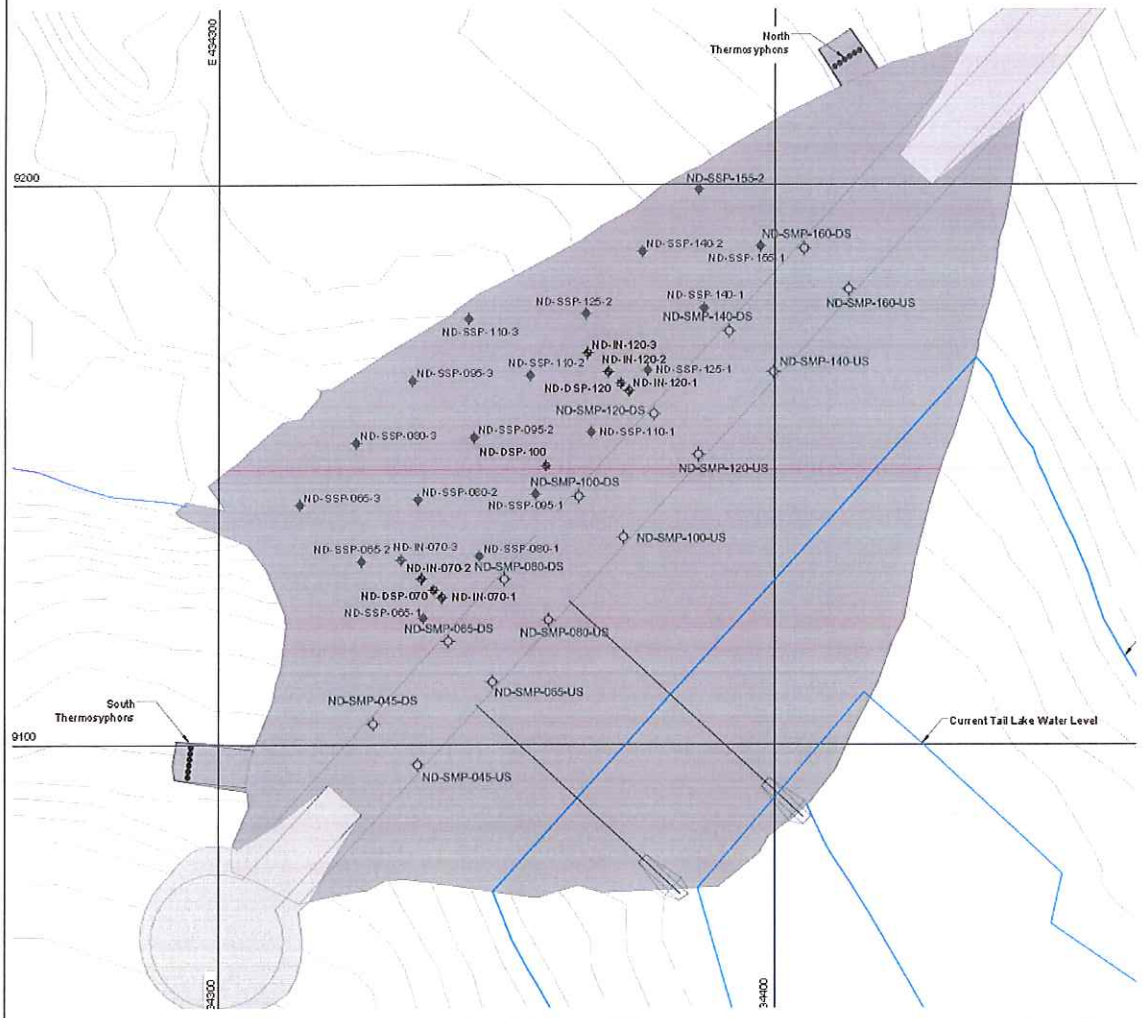
Visual Inspection:

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Any suspended sediment in Tail Lake?	Yes	(No)
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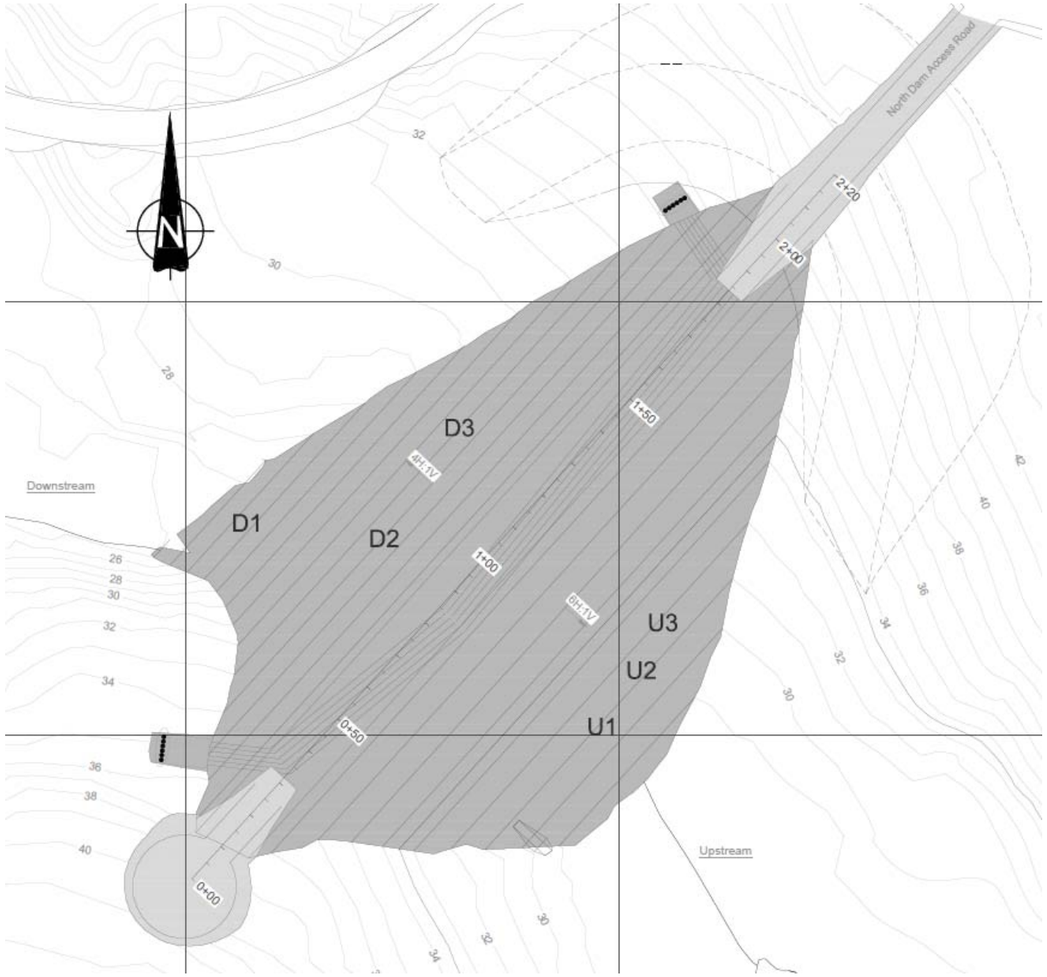
Photos:

Please collect the following photos: Photo from north end looking south along the dam Photo from south end looking north along the dam	☑ ☑
Other photos, please describe – Photos taken	





Appendix H – Depression Monitoring



DEPRESSION TRACKING

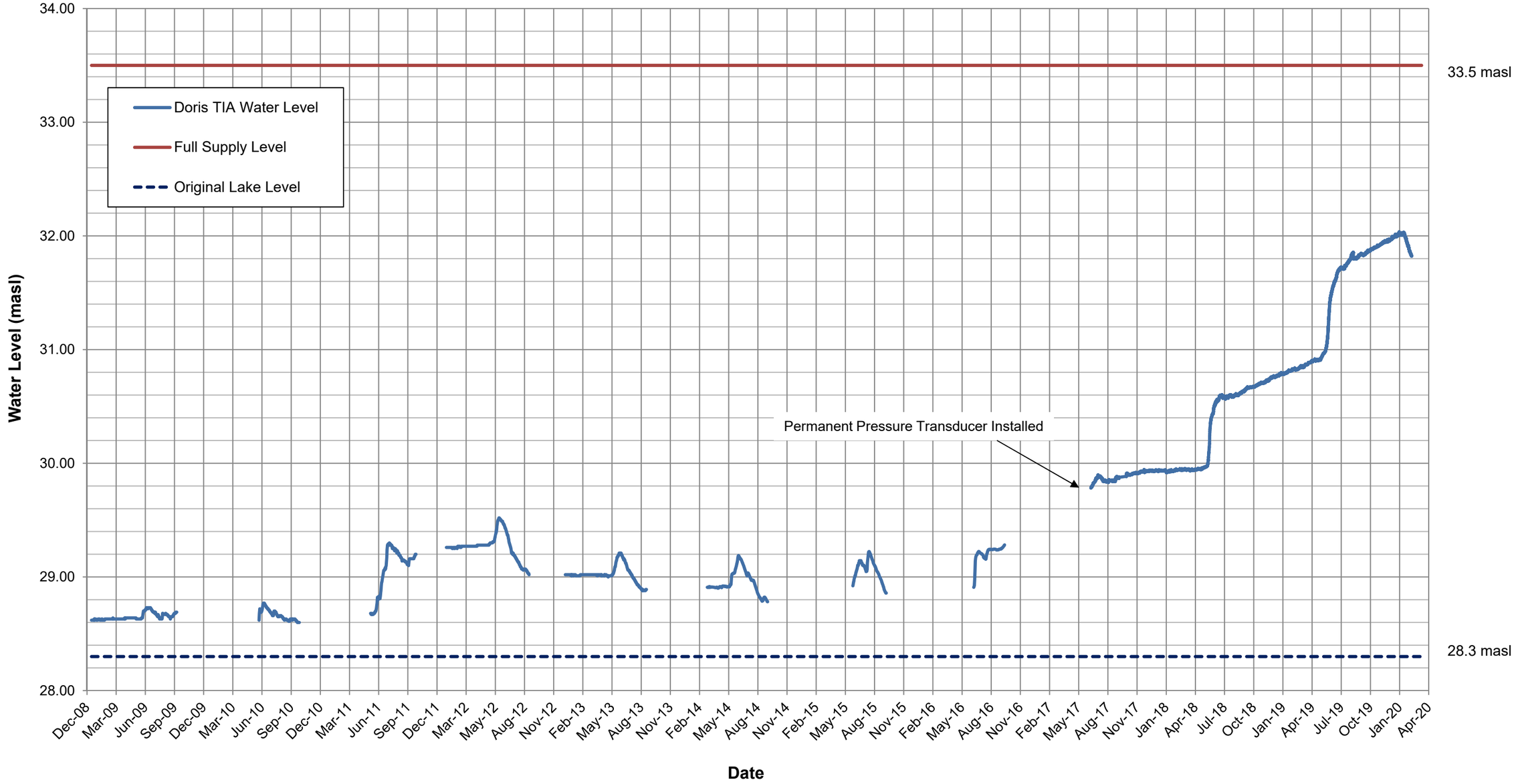
ID	Location	Comments	Northing	Easting
U1	Upstream	First noted June 2014	7559104	434393
		Boundaries spray painted and ID given July 2014		
		No substantial changes from previous inspection		
U2	Upstream	First noted June 2014	7559117	434402
		Boundaries spray painted and ID given July 2014		
		No substantial changes from previous inspection		
U3	Upstream	First noted June 2014	7559128	434407
		Boundaries spray painted and ID given July 2014		
		July 4, 2015 - Expanding toward U2		
		No substantial changes from previous inspection		
D1	Downstream	Identified during 2014 annual geotechnical inspection, spray painted and given ID.	7559151	434311
		September 1, 2014 - expanded towards the south		
		September 20, 2014 - TMAC ESR noted the depression looks to have expanded, paint mark updated.		
		July 4, 2015 - Slight expansion toward the crest was noted in the daily report		
		No substantial changes from previous inspection		
D2	Downstream	First noted in 2013 Annual Geotechnical Inspection	7559147	434344
		September 14, 2014 - TMAC ESR noted that the depression may have expanded slightly		
		No substantial changes from previous inspection		
D3	Downstream	First noted in 2013 Annual Geotechnical Inspection	7559173	434360
		August 10, 2014 - larger area marked		
		No substantial changes from previous inspection		

Notes:

1. Depression locations are based on hand held GPS measurements, accuracy is at best +/- 4 m.
2. Other small depressions were removed from the tracking system in 2016. Only significant depression were carried forward from the 2016 Annual Inspection.

srk consulting	TMAC RESOURCES	2019 AGI - North Dam
		Historic Depression Summary
Job No: 1CT022.038 Filename: AppH_ND_AGI_DepressionTracking.pptx	DORIS TIA	Date: Mar. 2020 / Approved: PDL / Figure: **H.1**

Appendix I – TIA Water Levels



Notes:

- Water level collected by permanent pressure transducer installed Summer 2017

srk consulting	TMAC RESOURCES	2019 AGI
Job No: 1CT022.038 Filename: AppendixI_WaterLevel.pptx	DORIS TIA	**TIA Reclaim Pond Water Level** Date: Feb. 2020 · Approved: AB · Figure: **I.1**

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

T: +1.604.681.4196
F: +1.604.687.5532
vancouver@srk.com
www.srk.com

Memo

To:	Oliver Curran, Vice-President Environment Ashley Mathai, Environmental Engineer	**Client:**	TMAC Resources Inc.
From:	Andrea Bowie, PEng John Kurylo, PEng	**Project No:**	1CT022.045
Cc:	Cameron Hore, PEng	**Date:**	August 16, 2019
Subject:	Hope Bay – Doris TIA 2020 Water Level Targets		

1 Introduction

The Doris Tailings Impoundment Area (TIA) is the primary water management facility at the Hope Bay Project. The TIA is the sole reservoir available for long term storage of tailings, as well as contact and mine water (if / as needed). The Doris TIA is impounded by two dams; North Dam and South Dam. A key operating criterion of the TIA is the water level. This memo provides the operating maximum target water level targets for 2020. These targets are continuously reviewed by the Engineer of Record (John Kurylo) and may be updated at any time. If changes are made, they will be formally communicated to TMAC in similar form (memo or formal email).

As discussed in Section 4, the TIA is not expected to have an operational discharge system until October 2019 or later. Therefore, water level targets have not been set for 2019, as there is no mechanism to control the water level.

SRK developed an operational water balance for the TIA which is described in a separate dedicated memorandum (SRK 2019). This operational water balance has been utilized to assess various scenarios and forecasts which in turn were used to set the operating targets for 2020.

Details of the water management strategy for the site are provided in the approved water management plan (SRK 2017).

2 Water Level Targets

The following levels are considered maximum operational water levels for the TIA in 2020:

- ***May 31, 2020 (Pre-freshet): 31.5 m***
- ***September 30, 2020 (Pre-freeze-up): 31.0 m***

The water level targets for the TIA are set for two key annual points;

- **Pre-freshet (considered as the end of May)**
  - The majority of inflow occurs during freshet and therefore it is important to have the TIA water level prior to freshet sufficiently low such that the water level rise during freshet will not adversely impact the facility.
- **Pre-freeze-up (considered as the end of September)**
  - The primary discharge period is the open water season from June to September. It is important to effectively utilize this period of discharge to prepare for the winter where discharge is not anticipated to be required. This target is set based on prediction over the winter and for the following freshet, such that no pre-freshet discharge is required. In other words, this target is aimed to have the water level such that without winter discharge, the pre-freshet water level for the following year should be met.

These targets are continuously reviewed and may be updated at any time. At a minimum annual frequency, TMAC will be updated on the target water levels.

3 TIA Operating Criteria

The operating criteria for the TIA are detailed in the Operations, Maintenance and Surveillance (OMS) Manual (SRK 2017).

The key criteria which are relevant to setting the operating water level targets are provided below. The operating water level targets are set to minimise the risk of ever exceeding these criteria.

- **Full Supply Level (FSL) of 33.5 m**
  - The FSL is the maximum permissible operating water level for the TIA and is governed by the North Dam. Above this level the TIA is out of compliance with the Canadian Dam Association (CAD) guidelines. The FSL will also be reviewed (at least annually) to check that the existing volume of deposited tailings has not impacted the elevation required to be available to store the design storm event (as set by the CDA guidelines).
- **South Dam beach length of 100 m**
  - The South Dam is designed and constructed as a tailings retaining dam not a water retaining dam and as such has a minimum required tailings beach length, from the upstream dam slope to the TIA pond, that must be maintained. The current beach slope of the tailings is approximately 1% and therefore this criterion can be approximated by ensuring the water level is at least 1 m lower than the minimum beach elevation at the South Dam.

    Based on the current beach level at the South Dam (33 m) the water level must currently be maintained below 32 m.

    The current water level is expected to reach 32 m towards the end of 2019 which is why it is imperative that the deposition continues from the South Dam to further develop the

tailings beach to as high an elevation as possible. Note that once freeze-up / winter conditions result on site the tailings discharge was planned to be moved to one location that will be used all winter. This one location would be use, and not moved around, to limit ice entrainment in the TIA. Additional details and the preferred winter tailings deposition location will be provided in September 2019 (before freeze-up). The expected winter tailings deposition location will also be discussed on site with the mill personnel as part of the 2019 TIA Annual Geotechnical Inspection (AGI).

In addition to the above noted key criteria, it is important to note that water in the TIA places thermal and pressure loading on the frozen core of the North Dam. The higher the water level in the TIA the higher these loadings are. This leads to increased deformation and degradation of the frozen core and ultimately reduces the service life of the structure. Therefore, where practical water levels should be minimised to increase the service life of the North Dam. This is why the target operating levels are defined as maximums. Operating below these levels, within practical limits, is recommended.

4 Current (July 2019) Scenario and Assumptions

The following points summarise the current scenario and assumptions for the TIA (as of the end of July 2019):

- The measured TIA water level is 31.7 m.
- The Roberts Bay Discharge System (RBDS) is not installed or operational; therefore, no discharge is currently possible.
  - The RBDS is planned to be operational in October 2019 for both Mine Water direct from the Doris Mine to Roberts Bay and for discharge of TIA water from the reclaim pond.
  - For forecasting purposes SRK have considered the full RBDS to be operational at 80% availability from January 1, 2020 onwards or, for comparison purposes, from June 2020 onwards.
- After 2020 all years are considered to discharge only during open water season (June-September).
- The tailings beach at the South Dam is at approximately 33 m and the tailings beach is at approximately 1%. Deposition is occurring from the South Dam now (in the ice-free months).
- Mine Water is being discharged to the TIA at a rate of approximately 880 m^3/day[1] with an increasing trend.
- A Mine Water TSS treatment plant has been procured and is planned to be operational in October 2019. This is intended to enable direct discharge of Mine Water to Roberts Bay within the MDMER limits. During periods of mine water discharge, for conservatism in the

[1] June 2019 daily average provided in monthly reporting from TMAC

scenario assessment it is assumed that 10% of the mine water is directed to the TIA and 90% is discharged directly to Roberts Bay.

- The Doris Process Plant has a throughput of approximately 2,400 tonnes per day.

5 Operating Water Balance Scenarios

The following key scenarios have been analysed using the Operational Water Balance, to aid in setting the operating target water levels and to asses the required actions to meet the targets. Details (the control panel) for each scenario are provided in Attachment 2 for reference.

The scenarios considered three variables:

- When the Mine water first commences discharge to Roberts Bay, January 2020 or June 2020
- When the TIA discharge first goes to Roberts Bay, January 2020 or June 2020
- The climate - either average conditions or 1:100 wet conditions (applied to all years)

The range of scenarios assessed and presented is provided in Table 1.

Table 1: Operating Water Balance Scenarios Presented

Scenario	Mine Water to Roberts Bay from:	TIA Discharge to Roberts Bay from:	Climate
1	January 2020	January 2020	average
2	June 2020	June 2020	average
3	January 2020	June 2020	average
4	June 2020	January 2020	average
5	January 2020	January 2020	wet
6	June 2020	June 2020	wet
7	January 2020	June 2020	wet
8	June 2020	January 2020	wet

For example:

- *Scenario 1* considers the full system to become operational in January 2020. Both Mine Water and TIA water are discharged to Roberts Bay from January 2020. Mine Water is then continuously discharged to Roberts Bay with 10% reporting to the TIA for upset conditions. TIA water is discharged from January to September in 2020 and then each open water season (June – September) for each following year. All years are considered to have average climatic conditions.
- *Scenario 7* considers the Mine Water discharge system to become operational in January 2020 and the TIA discharge system to become operational in June 2020. Mine Water is then continuously discharged to Roberts Bay with 10% reporting to the TIA for upset conditions.

TIA water is discharged from June to September in 2020 and then each open water season (June – September) for each following year. All years are considered to have wet (1:100) climatic conditions.

The water level plots (for the scenarios outlined in Table 1) are presented in Attachment 1. Plot 1 presents the four scenarios with average climatic conditions (Scenarios 1-4). Plot 2 presents the same scenarios for wet climatic conditions (Scenarios 5-8).

5.1 Discussion

To reach the defined operating target levels the RBDS must be operational in January 2020, with both Mine Water and TIA discharge commencing in January 2020 as shown on Plot 1 (Scenario 1) - considering average climatic conditions.

If TIA discharge does not commence until June 2020 the TIA operating criteria will be exceeded and the integrity of the South Dam will be at risk as shown on Plot 1 (Scenarios 2 and 3) – considering average climatic conditions.

Plot 2 demonstrates that under wet climatic conditions the TIA operating criteria will be exceeded, and the integrity of the South Dam will be at risk for all scenarios. Under these conditions it is even more critical that the RBDS be operational in January 2020, with both Mine Water and TIA discharge commencing in January 2020.

6 Conclusions

Based on the current beach level at the South Dam (33 m) the water level must be maintained below 32 m. This is the current governing water level criteria to protect the integrity of the South Dam.

The following levels are considered maximum water levels for the TIA in 2020:

- May 31, 2020 (Pre-freshet): 31.5 m
- September 30, 2020 (Pre-freeze-up): 31.0 m

To reach the defined operating target levels the RBDS must be operational in January 2020; with both Mine Water and TIA discharge commencing in January 2020.

If the RBDS is not operational in January 2020, additional mitigation measures to protect the integrity of the South Dam will be required.

7 References

SRK Consulting Canada Inc (SRK). 2019. Doris Mine Annual Water and Load Balance Assessment – 2018 Calendar Year. Memo prepared for TMAC Resources. March 19, 2019.

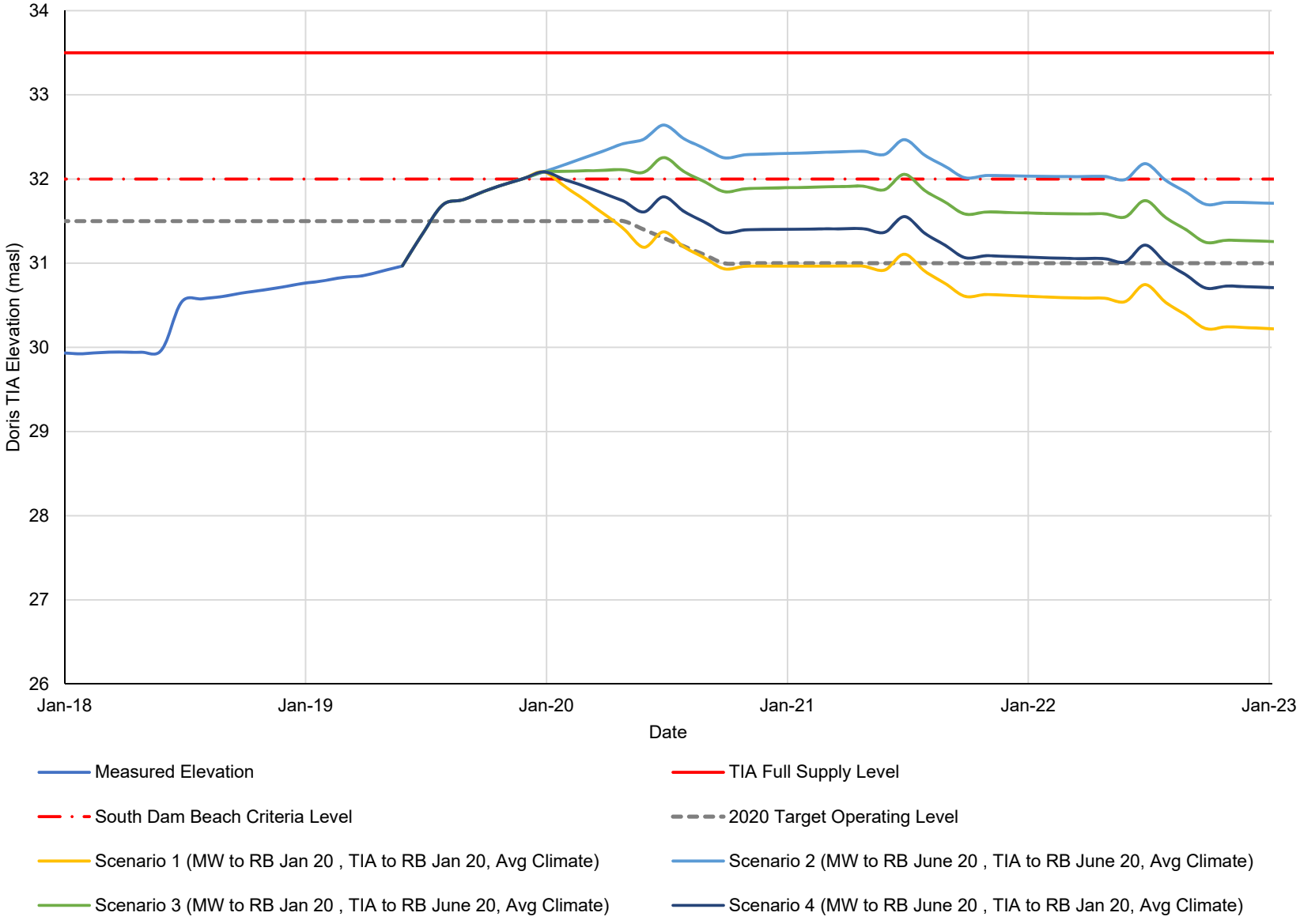
SRK Consulting Canada Inc (SRK). 2017. Operations, Maintenance and Surveillance Manual: Hope Bay Project, Phase 2, Doris Tailings Impoundment Area. Manual prepared for TMAC Resources. November 2017.

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

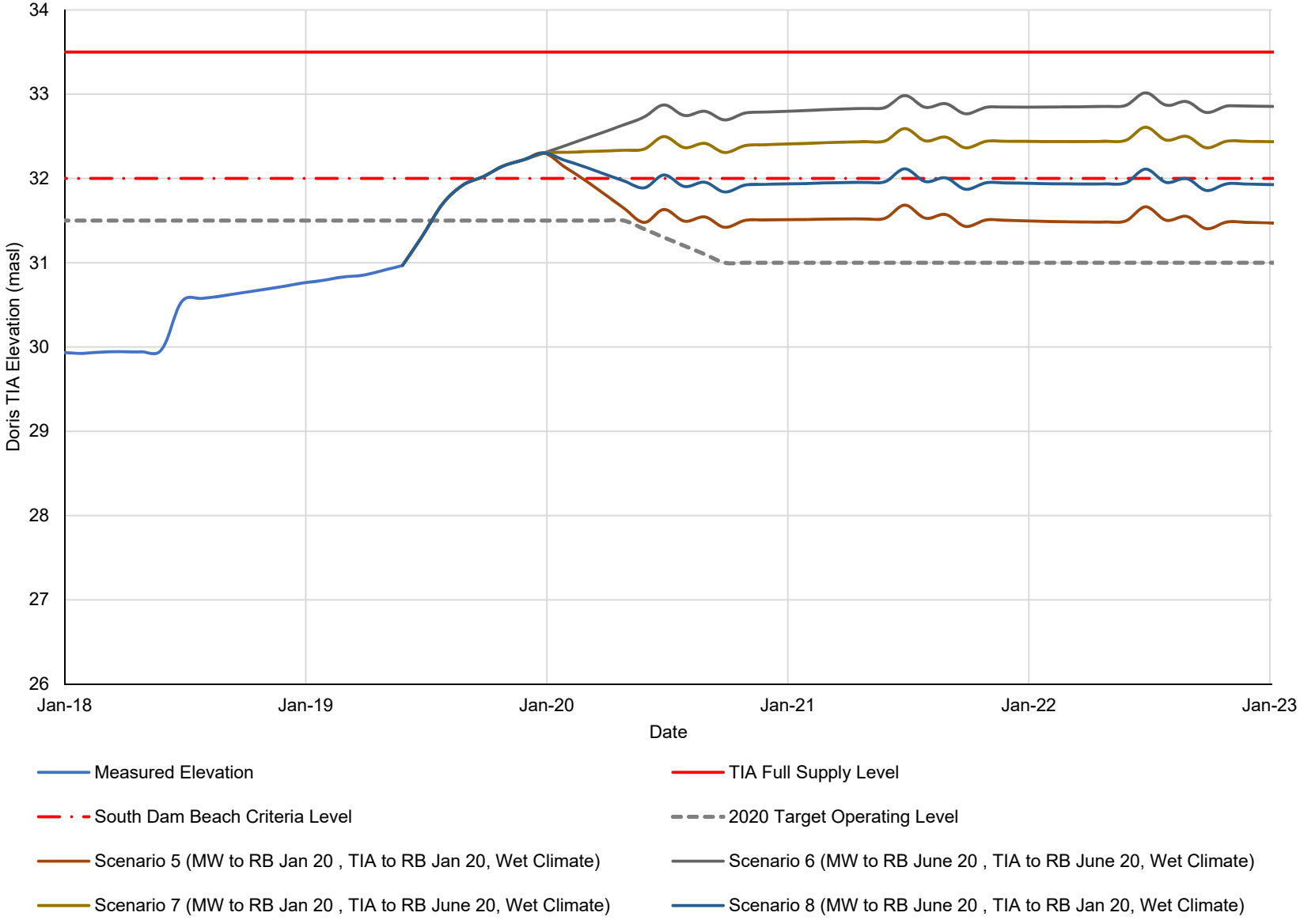
The opinions expressed in this report have been based on the information available to SRK at the time of preparation. SRK has exercised all due care in reviewing information supplied by others for use on this project. Whilst SRK has compared key supplied data with expected values, the accuracy of the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

Attachment 1 – Water Level Plots

Plot 1 - TIA Water levels for Scenarios 1-4



Plot 2 - TIA Water levels for Scenarios 1-8



Attachment 2 – Operating Water Balance Scenarios

Project Hope Bay
Project Nu 1CT022-036
Task Control Panel
Note: ***green = input cells, black = calculated cells for the model***
Sections numbers are linked back to the Hope Bay Mine Operational Water Balance Summary Memo dated April 5, 2018

Section 2.4.1 Hydrology
Action: Select Annual Return Period for green cells

Year	Return Period
2016	Average
2017	Average
2018	Average
2019	Average
2020	Average
2021	Average
2022	Average
2023	Average

Section 2.5.1 Load Balance
Action: Select Predictive Source Term
Source Term: Base Case

Source Term Options

Upper Case
Base Case

Section 2.4.2 Mine Water
Action: Select the future mine water curves

Options	Description
1	Groundwater Model Curve
2	Adjusted Groundwater Curve to Start from todays observed flows
3	User Input

Action: None, list option for selecting where Mine Water will be directed

Options	Description
1	Doris TIA
2	Roberts Bay

Table M.3 Volume of Mine Water pumped to Doris TIA (via SCP/pumpbox) (m^3/month)
Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	40,300	8,990	7,831	7,332	3,491	3,649
2	47,600	8,410	6,776	6,650	3,186	3,419
3	65,100	8,990	7,499	7,400	3,553	3,652
4	75,000	9,006	6,345	7,173	3,468	3,534
5	77,500	9,337	7,006	7,425	3,602	3,652
6	75,000	9,078	6,411	2,571	3,498	3,534
7	372,000	9,415	6,792	2,868	3,621	3,652
8	40,300	8,820	6,938	3,019	3,636	3,655
9	51,000	8,553	6,807	3,051	3,522	3,537
10	65,100	8,246	7,121	3,271	3,646	3,652
11	75,000	8,043	6,978	3,255	3,531	3,531
12	86,800	7,812	7,276	3,432	3,655	3,643

Table M.1 Volume of Doris Mine Water pumped to Surface (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1	1,300	2,900	2,400	1,700		
2	1,700	2,900	2,300	1,700		
3	2,100	2,900	2,300	1,700		
4	2,500	3,000	2,000	1,700		
5	2,500	3,000	2,000	1,700		
6	2,500	3,000	1,700			
7	12,000	3,000	1,700			
8	1,300	2,800	1,700			
9	1,700	2,800	1,700			
10	2,100	2,600	1,700			
11	2,500	2,600	1,700			
12	2,800	2,400	1,700			

Table M.4 Volume of Madrid North Mine Water pumped to Surface (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1			126	665	1,126	1,177
2			120	675	1,138	1,179
3			119	687	1,146	1,178
4		2	115	691	1,156	1,178
5		12	260	695	1,162	1,178
6		26	437	857	1,166	1,178
7		37	491	925	1,168	1,178
8		45	538	974	1,173	1,179
9		51	569	1,017	1,174	1,179
10		60	597	1,055	1,176	1,178
11		81	626	1,085	1,177	1,177
12		120	647	1,107	1,179	1,175

Table M.6 Volume of Madrid South Mine Water pumped to Surface (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Table M.2 Directs Doris mine water to the Doris TIA (the rest goes to Robert's Bay directly)
Action: Define percentage of Mine Water directed to the Doris TIA

Month	2019	2020	2021	2022	2023	2024
1	100%	10%	10%	10%	10%	10%
2	100%	10%	10%	10%	10%	10%
3	100%	10%	10%	10%	10%	10%
4	100%	10%	10%	10%	10%	10%
5	100%	10%	10%	10%	10%	10%
6	100%	10%	10%	10%	10%	10%
7	100%	10%	10%	10%	10%	10%
8	100%	10%	10%	10%	10%	10%
9	100%	10%	10%	10%	10%	10%
10	100%	10%	10%	10%	10%	10%
11	100%	10%	10%	10%	10%	10%
12	100%	10%	10%	10%	10%	10%

Table M.5 Directs Madrid North mine water to the Doris TIA (the rest goes to Robert's Bay direc
Action: Define percentage of Mine Water directed to the Doris TIA

Month	2019	2020	2021	2022	2023	2024
1	100%	10%	10%	10%	10%	10%
2	100%	10%	10%	10%	10%	10%
3	100%	10%	10%	10%	10%	10%
4	100%	10%	10%	10%	10%	10%
5	100%	10%	10%	10%	10%	10%
6	100%	10%	10%	10%	10%	10%
7	100%	10%	10%	10%	10%	10%
8	100%	10%	10%	10%	10%	10%
9	100%	10%	10%	10%	10%	10%
10	100%	10%	10%	10%	10%	10%
11	100%	10%	10%	10%	10%	10%
12	100%	10%	10%	10%	10%	10%

Table M.7 Directs Madrid South mine water to the Doris TIA (the rest goes to Robert's Bay directly)
Action: Define percentage of Mine Water directed to the Doris TIA

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Section 2.4.3 Ore Processing and Tailings Deposition
Note Assumes ore = total tailings = flotation tails + detoxified tails
Assumptions:

Tailings thickener underflow solids:	45%	solids	*Roughly average percent solids (August - November 2018)*
Plant Effluent:	1.50	m^3/tonne o	*Value set to all water into mill*
End of pipe tailings solids content	27%		
Tailings Specific Gravity	2.8		
Deposited Dry Density Slurried Tailings	1.3	tonnes/m^3	
Flotation Tails (% of total tails to TIA)	95%	solids	
Density of Water	1.0	tonnes/m^3	
Tailings Void ratio	1.2		

Table T.1 Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1	2,000	2,400	2,400	2,400	2,400	2,400
2	2,000	2,400	2,400	2,400	2,400	2,400
3	2,000	2,400	2,400	2,400	2,400	2,400
4	2,000	2,400	2,400	2,400	2,400	2,400
5	2,000	2,400	2,400	2,400	2,400	2,400
6	2,000	2,400	2,400	2,400	2,400	2,400
7	2,400	2,400	2,400	2,400	2,400	2,400
8	2,400	2,400	2,400	2,400	2,400	2,400
9	2,400	2,400	2,400	2,400	2,400	2,400
10	2,400	2,400	2,400	2,400	2,400	2,400
11	2,400	2,400	2,400	2,400	2,400	2,400
12	2,400	2,400	2,400	2,400	2,400	2,400

Table T.3 Total Tailings Solids to TIA (tonnes/month)
Table Calculates the total tailings solids input to the TIA from the process plant in tonnes/month

Month	2019	2020	2021	2022	2023	2024
1	58,900	70,680	70,680	70,680	70,680	70,680
2	53,200	66,120	63,840	63,840	63,840	66,120
3	58,900	70,680	70,680	70,680	70,680	70,680
4	57,000	68,400	68,400	68,400	68,400	68,400
5	58,900	70,680	70,680	70,680	70,680	70,680
6	57,000	68,400	68,400	68,400	68,400	68,400
7	70,680	70,680	70,680	70,680	70,680	70,680
8	70,680	70,680	70,680	70,680	70,680	70,680
9	68,400	68,400	68,400	68,400	68,400	68,400
10	70,680	70,680	70,680	70,680	70,680	70,680
11	68,400	68,400	68,400	68,400	68,400	68,400
12	70,680	70,680	70,680	70,680	70,680	70,680

Table T.2 Total Volume of water to TIA (m^3/month)
Table Calculates the total water input to the TIA from the process plant in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	93,000	111,600	111,600	111,600	111,600	111,600
2	84,000	104,400	100,800	100,800	100,800	104,400
3	93,000	111,600	111,600	111,600	111,600	111,600
4	90,000	108,000	108,000	108,000	108,000	108,000
5	93,000	111,600	111,600	111,600	111,600	111,600
6	90,000	108,000	108,000	108,000	108,000	108,000
7	111,600	111,600	111,600	111,600	111,600	111,600
8	111,600	111,600	111,600	111,600	111,600	111,600
9	108,000	108,000	108,000	108,000	108,000	108,000
10	111,600	111,600	111,600	111,600	111,600	111,600
11	108,000	108,000	108,000	108,000	108,000	108,000
12	111,600	111,600	111,600	111,600	111,600	111,600

Table T.1a Doris Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1	2,000					
2	2,000					
3	2,000					
4	2,000					
5	2,000					
6	2,000					
7	2,400					
8	2,400					
9	2,400					
10	2,400					
11	2,400					
12	2,400					

Table T.1 b Madrid North Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1		2,400	2,400	2,400	2,400	2,400
2		2,400	2,400	2,400	2,400	2,400
3		2,400	2,400	2,400	2,400	2,400
4		2,400	2,400	2,400	2,400	2,400
5		2,400	2,400	2,400	2,400	2,400
6		2,400	2,400	2,400	2,400	2,400
7		2,400	2,400	2,400	2,400	2,400
8		2,400	2,400	2,400	2,400	2,400
9		2,400	2,400	2,400	2,400	2,400
10		2,400	2,400	2,400	2,400	2,400
11		2,400	2,400	2,400	2,400	2,400
12		2,400	2,400	2,400	2,400	2,400

Table T.1 c Madrid South Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Table T.1d Boston Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

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Note: ***green = input cells, black = calculated cells for the model***
Sections numbers are linked back to the Hope Bay Mine Operational Water Balance Summary Memo dated April 5, 2018

Section 2.4.4 Process Plant Reclaim

Note *Update the water use values based on the hourly process flow breakdown*

0.7	To process water tank (m^3/tonne)	Based on average July to Dec 2018
0.8	To raw water tank (m^3/tonne)	Based on average July to Dec 2018

Note: *Defines the source of raw water to the process plant*

Option 1	Doris TIA	results in no change in net water to Doris TIA
Options 2	Doris Lake	results in net water addition to Doris TIA
Options 3	-	results in no model action when selected

Section 2.4.5 Sewage Treatment Plant Effluent

Note *Table below shows relevant averages from historic data*

0.16	Average rate since operations (m^3/person/day)
-	

Table R.1 Process Water to Process Plant (m^3/day)

Action: Calculates reclaim for process water from the Doris TIA case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1	1,400	1,680	1,680	1,680	1,680	1,680
2	1,400	1,680	1,680	1,680	1,680	1,680
3	1,400	1,680	1,680	1,680	1,680	1,680
4	1,400	1,680	1,680	1,680	1,680	1,680
5	1,400	1,680	1,680	1,680	1,680	1,680
6	1,400	1,680	1,680	1,680	1,680	1,680
7	1,680	1,680	1,680	1,680	1,680	1,680
8	1,680	1,680	1,680	1,680	1,680	1,680
9	1,680	1,680	1,680	1,680	1,680	1,680
10	1,680	1,680	1,680	1,680	1,680	1,680
11	1,680	1,680	1,680	1,680	1,680	1,680
12	1,680	1,680	1,680	1,680	1,680	1,680

Table R.2 Raw Water to Process Plant (m^3/day)

Action: Calculates reclaim for raw water (location selected in table to the right) in m^3/day

Month	2019	2020	2021	2022	2023	2024
1	1,600	1,920	1,920	1,920	1,920	1,920
2	1,600	1,920	1,920	1,920	1,920	1,920
3	1,600	1,920	1,920	1,920	1,920	1,920
4	1,600	1,920	1,920	1,920	1,920	1,920
5	1,600	1,920	1,920	1,920	1,920	1,920
6	1,600	1,920	1,920	1,920	1,920	1,920
7	1,920	1,920	1,920	1,920	1,920	1,920
8	1,920	1,920	1,920	1,920	1,920	1,920
9	1,920	1,920	1,920	1,920	1,920	1,920
10	1,920	1,920	1,920	1,920	1,920	1,920
11	1,920	1,920	1,920	1,920	1,920	1,920
12	1,920	1,920	1,920	1,920	1,920	1,920

Table S.1 - Average number of people at the camp each month

Action: Input the average number of people at camp

Month	2019	2020	2021	2022	2023	2024
1		300	300	300	300	300
2		300	300	300	300	300
3		300	300	300	300	300
4		300	300	300	300	300
5	300	300	300	300	300	300
6	300	300	300	300	300	300
7	300	300	300	300	300	300
8	300	300	300	300	300	300
9	300	300	300	300	300	300
10	300	300	300	300	300	300
11	300	300	300	300	300	300
12	300	300	300	300	300	300

Table S.2 - Percent of sewage treatment plant effluent directed to the TIA (the rest reports to the tundra)

Action: Define percent sewage to the Doris TIA

Month	2019	2020	2021	2022	2023	2024
1		100%	100%	100%	100%	100%
2		100%	100%	100%	100%	100%
3		100%	100%	100%	100%	100%
4		100%	100%	100%	100%	100%
5		100%	100%	100%	100%	100%
6		100%	100%	100%	100%	100%
7		100%	100%	100%	100%	100%
8		100%	100%	100%	100%	100%
9	100%	100%	100%	100%	100%	100%
10	100%	100%	100%	100%	100%	100%
11	100%	100%	100%	100%	100%	100%
12	100%	100%	100%	100%	100%	100%

Table R.3 Source of Raw Water

Action: Select the source of Raw water to the Doris Process Plant from the drop-down list

Month	2019	2020	2021	2022	2023	2024
1	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
2	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
3	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
4	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
5	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
6	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
7	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
8	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
9	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
10	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
11	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
12	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA

Table R.4 Total Reclaim Volume from the Doris TIA (m^3/month)

Table Calculates the reclaim water demand from the Doris TIA in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	93,000	111,600	111,600	111,600	111,600	111,600
2	84,000	104,400	100,800	100,800	100,800	104,400
3	93,000	111,600	111,600	111,600	111,600	111,600
4	90,000	108,000	108,000	108,000	108,000	108,000
5	93,000	111,600	111,600	111,600	111,600	111,600
6	90,000	108,000	108,000	108,000	108,000	108,000
7	111,600	111,600	111,600	111,600	111,600	111,600
8	111,600	111,600	111,600	111,600	111,600	111,600
9	108,000	108,000	108,000	108,000	108,000	108,000
10	111,600	111,600	111,600	111,600	111,600	111,600
11	108,000	108,000	108,000	108,000	108,000	108,000
12	111,600	111,600	111,600	111,600	111,600	111,600

Table S.3 - Calculates the volume of sewage treatment effluent pumped to the Doris TIA

Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	0	1,484	1,484	1,484	1,484	1,484
2	0	1,388	1,340	1,340	1,340	1,388
3	0	1,484	1,484	1,484	1,484	1,484
4	0	1,436	1,436	1,436	1,436	1,436
5	0	1,484	1,484	1,484	1,484	1,484
6	0	1,436	1,436	1,436	1,436	1,436
7	0	1,484	1,484	1,484	1,484	1,484
8	0	1,484	1,484	1,484	1,484	1,484
9	1,436	1,436	1,436	1,436	1,436	1,436
10	1,484	1,484	1,484	1,484	1,484	1,484
11	1,436	1,436	1,436	1,436	1,436	1,436
12	1,484	1,484	1,484	1,484	1,484	1,484

Section 2.4.6 Sediment Control Pond (SCP) to Doris TIA

Note *Table below shows relevant averages from historic data (m^3/day)*

391	2018 June Data
222	2018 July Data
700	2018 August Data

Section 2.4.7 Doris TIA Discharge to Roberts Bay

Pump Capacity	7,200	m^3/day	For Reference Design Capacity of System = 7,200 m^3/day
Pump Availability	80%		

Section 2.4.8 Madrid North Contact Water Pond (CWP) to Doris TIA

Note *Assumes the same as the Doris SCP*

391	2018 June Data
222	2018 July Data
700	2018 August Data

Table C.1 Volume from SCP to Doris TIA - does not include mine water flows (m^3/day)

Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6	391	391	391	391	391	391
7	222	222	222	222	222	222
8	700	700	700	700	700	700
9						
10						
11						
12						

Table D.1 Doris TIA Discharge Pump Utilization (days/month)

Action: Fill in the number of days in a month the pump is active

Month	2019	2020	2021	2022	2023	2024
1		31				
2		28				
3		31				
4		30				
5		31				
6		30	30	30	30	30
7		31	31	31	31	31
8		31	31	31	31	31
9		30	30	30	30	30
10						
11						
12						

Table W.1 Volume from MN CWP to Doris TIA - does not include mine water flows (m^3/day)

Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6		391	391	391	391	391
7		222	222	222	222	222
8		700	700	700	700	700
9						
10						
11						
12						

Table C.2 Volume from SCP to Doris TIA - does not include mine water flows (m^3/month)

Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	11,725	11,725	11,725	11,725	11,725	11,725
7	6,876	6,876	6,876	6,876	6,876	6,876
8	21,700	21,700	21,700	21,700	21,700	21,700
9	0	0	0	0	0	0
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0

Table D.2 Doris TIA Discharge Pumping Rate (m^3/month)

Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	0	178,560	0	0	0	0
2	0	161,280	0	0	0	0
3	0	178,560	0	0	0	0
4	0	172,800	0	0	0	0
5	0	178,560	0	0	0	0
6	0	172,800	172,800	172,800	172,800	172,800
7	0	178,560	178,560	178,560	178,560	178,560
8	0	178,560	178,560	178,560	178,560	178,560
9	0	172,800	172,800	172,800	172,800	172,800
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0

Table W.2 Volume from MN CWP to Doris TIA - does not include mine water flows (m^3/month)

Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	11,725	11,725	11,725	11,725	11,725
7	0	6,876	6,876	6,876	6,876	6,876
8	0	21,700	21,700	21,700	21,700	21,700
9	0	0	0	0	0	0
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0

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Note: ***green = input cells, black = calculated cells for the model***
Sections numbers are linked back to the Hope Bay Mine Operational Water Balance Summary Memo dated April 5, 2018

Section 2.4.1 Hydrology
Action: Select Annual Return Period for green cells

Year	Return Period
2016	Average
2017	Average
2018	Average
2019	Average
2020	Average
2021	Average
2022	Average
2023	Average

Section 2.5.1 Load Balance
Action: Select Predictive Source Term
Source Term: Base Case

Source Term Options

Upper Case
Base Case

Section 2.4.2 Mine Water
Action: Select the future mine water curves

Options	Description
1	Groundwater Model Curve
2	Adjusted Groundwater Curve to Start from todays observed flows
3	User Input

Action: None, list option for selecting where Mine Water will be directed

Options	Description
1	Doris TIA
2	Roberts Bay

Table M.3 Volume of Mine Water pumped to Doris TIA (via SCP/pumpbox) (m^3/month)
Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	40,300	89,900	7,831	7,332	3,491	3,649
2	47,600	84,100	6,776	6,650	3,186	3,419
3	65,100	89,900	7,499	7,400	3,553	3,652
4	75,000	90,006	6,345	7,173	3,468	3,534
5	77,500	93,037	7,006	7,425	3,602	3,652
6	75,000	9,078	6,411	2,571	3,498	3,534
7	372,000	9,415	6,792	2,868	3,621	3,652
8	40,300	8,820	6,938	3,019	3,636	3,655
9	51,000	8,553	6,807	3,051	3,522	3,537
10	65,100	8,246	7,121	3,271	3,646	3,652
11	75,000	8,043	6,978	3,255	3,531	3,531
12	86,800	7,812	7,276	3,432	3,655	3,643

Table M.1 Volume of Doris Mine Water pumped to Surface (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1	1,300	2,900	2,400	1,700		
2	1,700	2,900	2,300	1,700		
3	2,100	2,900	2,300	1,700		
4	2,500	3,000	2,000	1,700		
5	2,500	3,000	2,000	1,700		
6	2,500	3,000	1,700			
7	12,000	3,000	1,700			
8	1,300	2,800	1,700			
9	1,700	2,800	1,700			
10	2,100	2,600	1,700			
11	2,500	2,600	1,700			
12	2,800	2,400	1,700			

Table M.4 Volume of Madrid North Mine Water pumped to Surface (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1			126	665	1,126	1,177
2			120	675	1,138	1,179
3			119	687	1,146	1,178
4		2	115	691	1,156	1,178
5		12	260	695	1,162	1,178
6		26	437	857	1,166	1,178
7		37	491	925	1,168	1,178
8		45	538	974	1,173	1,179
9		51	569	1,017	1,174	1,179
10		60	597	1,055	1,176	1,178
11		81	626	1,085	1,177	1,177
12		120	647	1,107	1,179	1,175

Table M.6 Volume of Madrid South Mine Water pumped to Surface (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Table M.2 Directs Doris mine water to the Doris TIA (the rest goes to Robert's Bay directly)
Action: Define percentage of Mine Water directed to the Doris TIA

Month	2019	2020	2021	2022	2023	2024
1	100%	100%	10%	10%	10%	10%
2	100%	100%	10%	10%	10%	10%
3	100%	100%	10%	10%	10%	10%
4	100%	100%	10%	10%	10%	10%
5	100%	100%	10%	10%	10%	10%
6	100%	10%	10%	10%	10%	10%
7	100%	10%	10%	10%	10%	10%
8	100%	10%	10%	10%	10%	10%
9	100%	10%	10%	10%	10%	10%
10	100%	10%	10%	10%	10%	10%
11	100%	10%	10%	10%	10%	10%
12	100%	10%	10%	10%	10%	10%

Table M.5 Directs Madrid North mine water to the Doris TIA (the rest goes to Robert's Bay direc
Action: Define percentage of Mine Water directed to the Doris TIA

Month	2019	2020	2021	2022	2023	2024
1	100%	10%	10%	10%	10%	10%
2	100%	10%	10%	10%	10%	10%
3	100%	10%	10%	10%	10%	10%
4	100%	10%	10%	10%	10%	10%
5	100%	10%	10%	10%	10%	10%
6	100%	10%	10%	10%	10%	10%
7	100%	10%	10%	10%	10%	10%
8	100%	10%	10%	10%	10%	10%
9	100%	10%	10%	10%	10%	10%
10	100%	10%	10%	10%	10%	10%
11	100%	10%	10%	10%	10%	10%
12	100%	10%	10%	10%	10%	10%

Table M.7 Directs Madrid South mine water to the Doris TIA (the rest goes to Robert's Bay directly)
Action: Define percentage of Mine Water directed to the Doris TIA

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Section 2.4.3 Ore Processing and Tailings Deposition
Note Assumes ore = total tailings = flotation tails + detoxified tails
Assumptions:

Tailings thickener underflow solids:	45%	solids	*Roughly average percent solids (August - November 2018)*
Plant Effluent:	1.50	m^3/tonne o	*Value set to all water into mill*
End of pipe tailings solids content	27%		
Tailings Specific Gravity	2.8		
Deposited Dry Density Slurried Tailings	1.3	tonnes/m^3	
Flotation Tails (% of total tails to TIA)	95%	solids	
Density of Water	1.0	tonnes/m^3	
Tailings Void ratio	1.2		

Table T.1 Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1	2,000	2,400	2,400	2,400	2,400	2,400
2	2,000	2,400	2,400	2,400	2,400	2,400
3	2,000	2,400	2,400	2,400	2,400	2,400
4	2,000	2,400	2,400	2,400	2,400	2,400
5	2,000	2,400	2,400	2,400	2,400	2,400
6	2,000	2,400	2,400	2,400	2,400	2,400
7	2,400	2,400	2,400	2,400	2,400	2,400
8	2,400	2,400	2,400	2,400	2,400	2,400
9	2,400	2,400	2,400	2,400	2,400	2,400
10	2,400	2,400	2,400	2,400	2,400	2,400
11	2,400	2,400	2,400	2,400	2,400	2,400
12	2,400	2,400	2,400	2,400	2,400	2,400

Table T.3 Total Tailings Solids to TIA (tonnes/month)
Table Calculates the total tailings solids input to the TIA from the process plant in tonnes/month

Month	2019	2020	2021	2022	2023	2024
1	58,900	70,680	70,680	70,680	70,680	70,680
2	53,200	66,120	63,840	63,840	63,840	66,120
3	58,900	70,680	70,680	70,680	70,680	70,680
4	57,000	68,400	68,400	68,400	68,400	68,400
5	58,900	70,680	70,680	70,680	70,680	70,680
6	57,000	68,400	68,400	68,400	68,400	68,400
7	70,680	70,680	70,680	70,680	70,680	70,680
8	70,680	70,680	70,680	70,680	70,680	70,680
9	68,400	68,400	68,400	68,400	68,400	68,400
10	70,680	70,680	70,680	70,680	70,680	70,680
11	68,400	68,400	68,400	68,400	68,400	68,400
12	70,680	70,680	70,680	70,680	70,680	70,680

Table T.2 Total Volume of water to TIA (m^3/month)
Table Calculates the total water input to the TIA from the process plant in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	93,000	111,600	111,600	111,600	111,600	111,600
2	84,000	104,400	100,800	100,800	100,800	104,400
3	93,000	111,600	111,600	111,600	111,600	111,600
4	90,000	108,000	108,000	108,000	108,000	108,000
5	93,000	111,600	111,600	111,600	111,600	111,600
6	90,000	108,000	108,000	108,000	108,000	108,000
7	111,600	111,600	111,600	111,600	111,600	111,600
8	111,600	111,600	111,600	111,600	111,600	111,600
9	108,000	108,000	108,000	108,000	108,000	108,000
10	111,600	111,600	111,600	111,600	111,600	111,600
11	108,000	108,000	108,000	108,000	108,000	108,000
12	111,600	111,600	111,600	111,600	111,600	111,600

Table T.1a Doris Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1	2,000					
2	2,000					
3	2,000					
4	2,000					
5	2,000					
6	2,000					
7	2,400					
8	2,400					
9	2,400					
10	2,400					
11	2,400					
12	2,400					

Table T.1 b Madrid North Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1		2,400	2,400	2,400	2,400	2,400
2		2,400	2,400	2,400	2,400	2,400
3		2,400	2,400	2,400	2,400	2,400
4		2,400	2,400	2,400	2,400	2,400
5		2,400	2,400	2,400	2,400	2,400
6		2,400	2,400	2,400	2,400	2,400
7		2,400	2,400	2,400	2,400	2,400
8		2,400	2,400	2,400	2,400	2,400
9		2,400	2,400	2,400	2,400	2,400
10		2,400	2,400	2,400	2,400	2,400
11		2,400	2,400	2,400	2,400	2,400
12		2,400	2,400	2,400	2,400	2,400

Table T.1 c Madrid South Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Table T.1d Boston Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

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Note: ***green = input cells, black = calculated cells for the model***
Sections numbers are linked back to the Hope Bay Mine Operational Water Balance Summary Memo dated April 5, 2018

Section 2.4.4 Process Plant Reclaim

Note *Update the water use values based on the hourly process flow breakdown*

0.7	To process water tank (m^3/tonne)	Based on average July to Dec 2018
0.8	To raw water tank (m^3/tonne)	Based on average July to Dec 2018

Note: *Defines the source of raw water to the process plant*

Option 1	Doris TIA	results in no change in net water to Doris TIA
Options 2	Doris Lake	results in net water addition to Doris TIA
Options 3	-	results in no model action when selected

Section 2.4.5 Sewage Treatment Plant Effluent

Note *Table below shows relevant averages from historic data*

0.16	Average rate since operations (m^3/person/day)
-	

Table R.1 Process Water to Process Plant (m^3/day)
Action: Calculates reclaim for process water from the Doris TIA case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1	1,400	1,680	1,680	1,680	1,680	1,680
2	1,400	1,680	1,680	1,680	1,680	1,680
3	1,400	1,680	1,680	1,680	1,680	1,680
4	1,400	1,680	1,680	1,680	1,680	1,680
5	1,400	1,680	1,680	1,680	1,680	1,680
6	1,400	1,680	1,680	1,680	1,680	1,680
7	1,680	1,680	1,680	1,680	1,680	1,680
8	1,680	1,680	1,680	1,680	1,680	1,680
9	1,680	1,680	1,680	1,680	1,680	1,680
10	1,680	1,680	1,680	1,680	1,680	1,680
11	1,680	1,680	1,680	1,680	1,680	1,680
12	1,680	1,680	1,680	1,680	1,680	1,680

Table R.2 Raw Water to Process Plant (m^3/day)
Action: Calculates reclaim for raw water (location selected in table to the right) in m^3/day

Month	2019	2020	2021	2022	2023	2024
1	1,600	1,920	1,920	1,920	1,920	1,920
2	1,600	1,920	1,920	1,920	1,920	1,920
3	1,600	1,920	1,920	1,920	1,920	1,920
4	1,600	1,920	1,920	1,920	1,920	1,920
5	1,600	1,920	1,920	1,920	1,920	1,920
6	1,600	1,920	1,920	1,920	1,920	1,920
7	1,920	1,920	1,920	1,920	1,920	1,920
8	1,920	1,920	1,920	1,920	1,920	1,920
9	1,920	1,920	1,920	1,920	1,920	1,920
10	1,920	1,920	1,920	1,920	1,920	1,920
11	1,920	1,920	1,920	1,920	1,920	1,920
12	1,920	1,920	1,920	1,920	1,920	1,920

Table S.1 - Average number of people at the camp each month
Action: Input the average number of people at camp

Month	2019	2020	2021	2022	2023	2024
1		300	300	300	300	300
2		300	300	300	300	300
3		300	300	300	300	300
4		300	300	300	300	300
5	300	300	300	300	300	300
6	300	300	300	300	300	300
7	300	300	300	300	300	300
8	300	300	300	300	300	300
9	300	300	300	300	300	300
10	300	300	300	300	300	300
11	300	300	300	300	300	300
12	300	300	300	300	300	300

Table S.2 - Percent of sewage treatment plant effluent directed to the TIA (the rest reports to the tundra)
Action: Define percent sewage to the Doris TIA

Month	2019	2020	2021	2022	2023	2024
1		100%	100%	100%	100%	100%
2		100%	100%	100%	100%	100%
3		100%	100%	100%	100%	100%
4		100%	100%	100%	100%	100%
5		100%	100%	100%	100%	100%
6		100%	100%	100%	100%	100%
7		100%	100%	100%	100%	100%
8		100%	100%	100%	100%	100%
9	100%	100%	100%	100%	100%	100%
10	100%	100%	100%	100%	100%	100%
11	100%	100%	100%	100%	100%	100%
12	100%	100%	100%	100%	100%	100%

Table R.3 Source of Raw Water
Action: Select the source of Raw water to the Doris Process Plant from the drop-down list

Month	2019	2020	2021	2022	2023	2024
1	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
2	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
3	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
4	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
5	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
6	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
7	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
8	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
9	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
10	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
11	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
12	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA

Table R.4 Total Reclaim Volume from the Doris TIA (m^3/month)
Table Calculates the reclaim water demand from the Doris TIA in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	93,000	111,600	111,600	111,600	111,600	111,600
2	84,000	104,400	100,800	100,800	100,800	104,400
3	93,000	111,600	111,600	111,600	111,600	111,600
4	90,000	108,000	108,000	108,000	108,000	108,000
5	93,000	111,600	111,600	111,600	111,600	111,600
6	90,000	108,000	108,000	108,000	108,000	108,000
7	111,600	111,600	111,600	111,600	111,600	111,600
8	111,600	111,600	111,600	111,600	111,600	111,600
9	108,000	108,000	108,000	108,000	108,000	108,000
10	111,600	111,600	111,600	111,600	111,600	111,600
11	108,000	108,000	108,000	108,000	108,000	108,000
12	111,600	111,600	111,600	111,600	111,600	111,600

Table S.3 - Calculates the volume of sewage treatment effluent pumped to the Doris TIA
Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	0	1,484	1,484	1,484	1,484	1,484
2	0	1,388	1,340	1,340	1,340	1,388
3	0	1,484	1,484	1,484	1,484	1,484
4	0	1,436	1,436	1,436	1,436	1,436
5	0	1,484	1,484	1,484	1,484	1,484
6	0	1,436	1,436	1,436	1,436	1,436
7	0	1,484	1,484	1,484	1,484	1,484
8	0	1,484	1,484	1,484	1,484	1,484
9	1,436	1,436	1,436	1,436	1,436	1,436
10	1,484	1,484	1,484	1,484	1,484	1,484
11	1,436	1,436	1,436	1,436	1,436	1,436
12	1,484	1,484	1,484	1,484	1,484	1,484

Section 2.4.6 Sediment Control Pond (SCP) to Doris TIA

Note *Table below shows relevant averages from historic data (m^3/day)*

391	2018 June Data
222	2018 July Data
700	2018 August Data

Section 2.4.7 Doris TIA Discharge to Roberts Bay

Pump Capacity 7,200 m^3/day For Reference Design Capacity of System = 7,200 m^3/day
Pump Availability 80%

Section 2.4.8 Madrid North Contact Water Pond (CWP) to Doris TIA

Note *Assumes the same as the Doris SCP*

391	2018 June Data
222	2018 July Data
700	2018 August Data

Table C.1 Volume from SCP to Doris TIA - does not include mine water flows (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6	391	391	391	391	391	391
7	222	222	222	222	222	222
8	700	700	700	700	700	700
9						
10						
11						
12						

Table D.1 Doris TIA Discharge Pump Utilization (days/month)
Action: Fill in the number of days in a month the pump is active

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6		30	30	30	30	30
7		31	31	31	31	31
8		31	31	31	31	31
9		30	30	30	30	30
10						
11						
12						

Table W.1 Volume from MN CWP to Doris TIA - does not include mine water flows (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6		391	391	391	391	391
7		222	222	222	222	222
8		700	700	700	700	700
9						
10						
11						
12						

Table C.2 Volume from SCP to Doris TIA - does not include mine water flows (m^3/month)
Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	11,725	11,725	11,725	11,725	11,725	11,725
7	6,876	6,876	6,876	6,876	6,876	6,876
8	21,700	21,700	21,700	21,700	21,700	21,700
9	0	0	0	0	0	0
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0

Table D.2 Doris TIA Discharge Pumping Rate (m^3/month)
Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	172,800	172,800	172,800	172,800	172,800
7	0	178,560	178,560	178,560	178,560	178,560
8	0	178,560	178,560	178,560	178,560	178,560
9	0	172,800	172,800	172,800	172,800	172,800
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0

Table W.2 Volume from MN CWP to Doris TIA - does not include mine water flows (m^3/month)
Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	11,725	11,725	11,725	11,725	11,725
7	0	6,876	6,876	6,876	6,876	6,876
8	0	21,700	21,700	21,700	21,700	21,700
9	0	0	0	0	0	0
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0

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Task Control Panel
Note: ***green = input cells, black = calculated cells for the model***
Sections numbers are linked back to the Hope Bay Mine Operational Water Balance Summary Memo dated April 5, 2018

Section 2.4.1 Hydrology
Action: Select Annual Return Period for green cells

Year	Return Period
2016	Average
2017	Average
2018	Average
2019	Average
2020	Average
2021	Average
2022	Average
2023	Average

Section 2.5.1 Load Balance
Action: Select Predictive Source Term
Source Term: Base Case

Source Term Options

Upper Case
Base Case

Section 2.4.2 Mine Water
Action: Select the future mine water curves

Options	Description
1	Groundwater Model Curve
2	Adjusted Groundwater Curve to Start from todays observed flows
3	User Input

Action: None, list option for selecting where Mine Water will be directed

Options	Description
1	Doris TIA
2	Roberts Bay

Table M.3 Volume of Mine Water pumped to Doris TIA (via SCP/pumpbox) (m^3/month)
Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	40,300	8,990	7,831	7,332	3,491	3,649
2	47,600	8,410	6,776	6,650	3,186	3,419
3	65,100	8,990	7,499	7,400	3,553	3,652
4	75,000	9,006	6,345	7,173	3,468	3,534
5	77,500	9,337	7,006	7,425	3,602	3,652
6	75,000	9,078	6,411	2,571	3,498	3,534
7	372,000	9,415	6,792	2,868	3,621	3,652
8	40,300	8,820	6,938	3,019	3,636	3,655
9	51,000	8,553	6,807	3,051	3,522	3,537
10	65,100	8,246	7,121	3,271	3,646	3,652
11	75,000	8,043	6,978	3,255	3,531	3,531
12	86,800	7,812	7,276	3,432	3,655	3,643

Table M.1 Volume of Doris Mine Water pumped to Surface (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1	1,300	2,900	2,400	1,700		
2	1,700	2,900	2,300	1,700		
3	2,100	2,900	2,300	1,700		
4	2,500	3,000	2,000	1,700		
5	2,500	3,000	2,000	1,700		
6	2,500	3,000	1,700			
7	12,000	3,000	1,700			
8	1,300	2,800	1,700			
9	1,700	2,800	1,700			
10	2,100	2,600	1,700			
11	2,500	2,600	1,700			
12	2,800	2,400	1,700			

Table M.4 Volume of Madrid North Mine Water pumped to Surface (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1			126	665	1,126	1,177
2			120	675	1,138	1,179
3			119	687	1,146	1,178
4		2	115	691	1,156	1,178
5		12	260	695	1,162	1,178
6		26	437	857	1,166	1,178
7		37	491	925	1,168	1,178
8		45	538	974	1,173	1,179
9		51	569	1,017	1,174	1,179
10		60	597	1,055	1,176	1,178
11		81	626	1,085	1,177	1,177
12		120	647	1,107	1,179	1,175

Table M.6 Volume of Madrid South Mine Water pumped to Surface (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Table M.2 Directs Doris mine water to the Doris TIA (the rest goes to Robert's Bay directly)
Action: Define percentage of Mine Water directed to the Doris TIA

Month	2019	2020	2021	2022	2023	2024
1	100%	10%	10%	10%	10%	10%
2	100%	10%	10%	10%	10%	10%
3	100%	10%	10%	10%	10%	10%
4	100%	10%	10%	10%	10%	10%
5	100%	10%	10%	10%	10%	10%
6	100%	10%	10%	10%	10%	10%
7	100%	10%	10%	10%	10%	10%
8	100%	10%	10%	10%	10%	10%
9	100%	10%	10%	10%	10%	10%
10	100%	10%	10%	10%	10%	10%
11	100%	10%	10%	10%	10%	10%
12	100%	10%	10%	10%	10%	10%

Table M.5 Directs Madrid North mine water to the Doris TIA (the rest goes to Robert's Bay direc
Action: Define percentage of Mine Water directed to the Doris TIA

Month	2019	2020	2021	2022	2023	2024
1	100%	10%	10%	10%	10%	10%
2	100%	10%	10%	10%	10%	10%
3	100%	10%	10%	10%	10%	10%
4	100%	10%	10%	10%	10%	10%
5	100%	10%	10%	10%	10%	10%
6	100%	10%	10%	10%	10%	10%
7	100%	10%	10%	10%	10%	10%
8	100%	10%	10%	10%	10%	10%
9	100%	10%	10%	10%	10%	10%
10	100%	10%	10%	10%	10%	10%
11	100%	10%	10%	10%	10%	10%
12	100%	10%	10%	10%	10%	10%

Table M.7 Directs Madrid South mine water to the Doris TIA (the rest goes to Robert's Bay directly)
Action: Define percentage of Mine Water directed to the Doris TIA

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Section 2.4.3 Ore Processing and Tailings Deposition
Note Assumes ore = total tailings = flotation tails + detoxified tails
Assumptions:

Tailings thickener underflow solids:	45%	solids	*Roughly average percent solids (August - November 2018)*
Plant Effluent:	1.50	m^3/tonne o	*Value set to all water into mill*
End of pipe tailings solids content	27%		
Tailings Specific Gravity	2.8		
Deposited Dry Density Slurried Tailings	1.3	tonnes/m^3	
Flotation Tails (% of total tails to TIA)	95%	solids	
Density of Water	1.0	tonnes/m^3	
Tailings Void ratio	1.2		

Table T.1 Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1	2,000	2,400	2,400	2,400	2,400	2,400
2	2,000	2,400	2,400	2,400	2,400	2,400
3	2,000	2,400	2,400	2,400	2,400	2,400
4	2,000	2,400	2,400	2,400	2,400	2,400
5	2,000	2,400	2,400	2,400	2,400	2,400
6	2,000	2,400	2,400	2,400	2,400	2,400
7	2,400	2,400	2,400	2,400	2,400	2,400
8	2,400	2,400	2,400	2,400	2,400	2,400
9	2,400	2,400	2,400	2,400	2,400	2,400
10	2,400	2,400	2,400	2,400	2,400	2,400
11	2,400	2,400	2,400	2,400	2,400	2,400
12	2,400	2,400	2,400	2,400	2,400	2,400

Table T.3 Total Tailings Solids to TIA (tonnes/month)
Table Calculates the total tailings solids input to the TIA from the process plant in tonnes/month

Month	2019	2020	2021	2022	2023	2024
1	58,900	70,680	70,680	70,680	70,680	70,680
2	53,200	66,120	63,840	63,840	63,840	66,120
3	58,900	70,680	70,680	70,680	70,680	70,680
4	57,000	68,400	68,400	68,400	68,400	68,400
5	58,900	70,680	70,680	70,680	70,680	70,680
6	57,000	68,400	68,400	68,400	68,400	68,400
7	70,680	70,680	70,680	70,680	70,680	70,680
8	70,680	70,680	70,680	70,680	70,680	70,680
9	68,400	68,400	68,400	68,400	68,400	68,400
10	70,680	70,680	70,680	70,680	70,680	70,680
11	68,400	68,400	68,400	68,400	68,400	68,400
12	70,680	70,680	70,680	70,680	70,680	70,680

Table T.2 Total Volume of water to TIA (m^3/month)
Table Calculates the total water input to the TIA from the process plant in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	93,000	111,600	111,600	111,600	111,600	111,600
2	84,000	104,400	100,800	100,800	100,800	104,400
3	93,000	111,600	111,600	111,600	111,600	111,600
4	90,000	108,000	108,000	108,000	108,000	108,000
5	93,000	111,600	111,600	111,600	111,600	111,600
6	90,000	108,000	108,000	108,000	108,000	108,000
7	111,600	111,600	111,600	111,600	111,600	111,600
8	111,600	111,600	111,600	111,600	111,600	111,600
9	108,000	108,000	108,000	108,000	108,000	108,000
10	111,600	111,600	111,600	111,600	111,600	111,600
11	108,000	108,000	108,000	108,000	108,000	108,000
12	111,600	111,600	111,600	111,600	111,600	111,600

Table T.1a Doris Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1	2,000					
2	2,000					
3	2,000					
4	2,000					
5	2,000					
6	2,000					
7	2,400					
8	2,400					
9	2,400					
10	2,400					
11	2,400					
12	2,400					

Table T.1 b Madrid North Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1		2,400	2,400	2,400	2,400	2,400
2		2,400	2,400	2,400	2,400	2,400
3		2,400	2,400	2,400	2,400	2,400
4		2,400	2,400	2,400	2,400	2,400
5		2,400	2,400	2,400	2,400	2,400
6		2,400	2,400	2,400	2,400	2,400
7		2,400	2,400	2,400	2,400	2,400
8		2,400	2,400	2,400	2,400	2,400
9		2,400	2,400	2,400	2,400	2,400
10		2,400	2,400	2,400	2,400	2,400
11		2,400	2,400	2,400	2,400	2,400
12		2,400	2,400	2,400	2,400	2,400

Table T.1 c Madrid South Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Table T.1d Boston Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

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Note: ***green = input cells, black = calculated cells for the model***
Sections numbers are linked back to the Hope Bay Mine Operational Water Balance Summary Memo dated April 5, 2018

Section 2.4.4 Process Plant Reclaim

Note *Update the water use values based on the hourly process flow breakdown*

0.7	To process water tank (m^3/tonne)	Based on average July to Dec 2018
0.8	To raw water tank (m^3/tonne)	Based on average July to Dec 2018

Note: *Defines the source of raw water to the process plant*

Option 1	Doris TIA	results in no change in net water to Doris TIA
Options 2	Doris Lake	results in net water addition to Doris TIA
Options 3	-	results in no model action when selected

Section 2.4.5 Sewage Treatment Plant Effluent

Note *Table below shows relevant averages from historic data*

0.16	Average rate since operations (m^3/person/day)
-	

Table R.1 Process Water to Process Plant (m^3/day)
Action: Calculates reclaim for process water from the Doris TIA case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1	1,400	1,680	1,680	1,680	1,680	1,680
2	1,400	1,680	1,680	1,680	1,680	1,680
3	1,400	1,680	1,680	1,680	1,680	1,680
4	1,400	1,680	1,680	1,680	1,680	1,680
5	1,400	1,680	1,680	1,680	1,680	1,680
6	1,400	1,680	1,680	1,680	1,680	1,680
7	1,680	1,680	1,680	1,680	1,680	1,680
8	1,680	1,680	1,680	1,680	1,680	1,680
9	1,680	1,680	1,680	1,680	1,680	1,680
10	1,680	1,680	1,680	1,680	1,680	1,680
11	1,680	1,680	1,680	1,680	1,680	1,680
12	1,680	1,680	1,680	1,680	1,680	1,680

Table R.2 Raw Water to Process Plant (m^3/day)
Action: Calculates reclaim for raw water (location selected in table to the right) in m^3/day

Month	2019	2020	2021	2022	2023	2024
1	1,600	1,920	1,920	1,920	1,920	1,920
2	1,600	1,920	1,920	1,920	1,920	1,920
3	1,600	1,920	1,920	1,920	1,920	1,920
4	1,600	1,920	1,920	1,920	1,920	1,920
5	1,600	1,920	1,920	1,920	1,920	1,920
6	1,600	1,920	1,920	1,920	1,920	1,920
7	1,920	1,920	1,920	1,920	1,920	1,920
8	1,920	1,920	1,920	1,920	1,920	1,920
9	1,920	1,920	1,920	1,920	1,920	1,920
10	1,920	1,920	1,920	1,920	1,920	1,920
11	1,920	1,920	1,920	1,920	1,920	1,920
12	1,920	1,920	1,920	1,920	1,920	1,920

Table S.1 - Average number of people at the camp each month
Action: Input the average number of people at camp

Month	2019	2020	2021	2022	2023	2024
1		300	300	300	300	300
2		300	300	300	300	300
3		300	300	300	300	300
4		300	300	300	300	300
5	300	300	300	300	300	300
6	300	300	300	300	300	300
7	300	300	300	300	300	300
8	300	300	300	300	300	300
9	300	300	300	300	300	300
10	300	300	300	300	300	300
11	300	300	300	300	300	300
12	300	300	300	300	300	300

Table S.2 - Percent of sewage treatment plant effluent directed to the TIA (the rest reports to the tundra)
Action: Define percent sewage to the Doris TIA

Month	2019	2020	2021	2022	2023	2024
1		100%	100%	100%	100%	100%
2		100%	100%	100%	100%	100%
3		100%	100%	100%	100%	100%
4		100%	100%	100%	100%	100%
5		100%	100%	100%	100%	100%
6		100%	100%	100%	100%	100%
7		100%	100%	100%	100%	100%
8		100%	100%	100%	100%	100%
9	100%	100%	100%	100%	100%	100%
10	100%	100%	100%	100%	100%	100%
11	100%	100%	100%	100%	100%	100%
12	100%	100%	100%	100%	100%	100%

Table R.3 Source of Raw Water
Action: Select the source of Raw water to the Doris Process Plant from the drop-down list

Month	2019	2020	2021	2022	2023	2024
1	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
2	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
3	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
4	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
5	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
6	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
7	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
8	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
9	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
10	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
11	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
12	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA

Table R.4 Total Reclaim Volume from the Doris TIA (m^3/month)
Table Calculates the reclaim water demand from the Doris TIA in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	93,000	111,600	111,600	111,600	111,600	111,600
2	84,000	104,400	100,800	100,800	100,800	104,400
3	93,000	111,600	111,600	111,600	111,600	111,600
4	90,000	108,000	108,000	108,000	108,000	108,000
5	93,000	111,600	111,600	111,600	111,600	111,600
6	90,000	108,000	108,000	108,000	108,000	108,000
7	111,600	111,600	111,600	111,600	111,600	111,600
8	111,600	111,600	111,600	111,600	111,600	111,600
9	108,000	108,000	108,000	108,000	108,000	108,000
10	111,600	111,600	111,600	111,600	111,600	111,600
11	108,000	108,000	108,000	108,000	108,000	108,000
12	111,600	111,600	111,600	111,600	111,600	111,600

Table S.3 - Calculates the volume of sewage treatment effluent pumped to the Doris TIA
Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	0	1,484	1,484	1,484	1,484	1,484
2	0	1,388	1,340	1,340	1,340	1,388
3	0	1,484	1,484	1,484	1,484	1,484
4	0	1,436	1,436	1,436	1,436	1,436
5	0	1,484	1,484	1,484	1,484	1,484
6	0	1,436	1,436	1,436	1,436	1,436
7	0	1,484	1,484	1,484	1,484	1,484
8	0	1,484	1,484	1,484	1,484	1,484
9	1,436	1,436	1,436	1,436	1,436	1,436
10	1,484	1,484	1,484	1,484	1,484	1,484
11	1,436	1,436	1,436	1,436	1,436	1,436
12	1,484	1,484	1,484	1,484	1,484	1,484

Section 2.4.6 Sediment Control Pond (SCP) to Doris TIA

Note *Table below shows relevant averages from historic data (m^3/day)*

391	2018 June Data
222	2018 July Data
700	2018 August Data

Section 2.4.7 Doris TIA Discharge to Roberts Bay

Pump Capacity 7,200 m^3/day For Reference Design Capacity of System = 7,200 m^3/day
Pump Availability 80%

Section 2.4.8 Madrid North Contact Water Pond (CWP) to Doris TIA

Note *Assumes the same as the Doris SCP*

391	2018 June Data
222	2018 July Data
700	2018 August Data

Table C.1 Volume from SCP to Doris TIA - does not include mine water flows (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6	391	391	391	391	391	391
7	222	222	222	222	222	222
8	700	700	700	700	700	700
9						
10						
11						
12						

Table D.1 Doris TIA Discharge Pump Utilization (days/month)
Action: Fill in the number of days in a month the pump is active

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6		30	30	30	30	30
7		31	31	31	31	31
8		31	31	31	31	31
9		30	30	30	30	30
10						
11						
12						

Table W.1 Volume from MN CWP to Doris TIA - does not include mine water flows (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6		391	391	391	391	391
7		222	222	222	222	222
8		700	700	700	700	700
9						
10						
11						
12						

Table C.2 Volume from SCP to Doris TIA - does not include mine water flows (m^3/month)
Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	11,725	11,725	11,725	11,725	11,725	11,725
7	6,876	6,876	6,876	6,876	6,876	6,876
8	21,700	21,700	21,700	21,700	21,700	21,700
9	0	0	0	0	0	0
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0

Table D.2 Doris TIA Discharge Pumping Rate (m^3/month)
Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	172,800	172,800	172,800	172,800	172,800
7	0	178,560	178,560	178,560	178,560	178,560
8	0	178,560	178,560	178,560	178,560	178,560
9	0	172,800	172,800	172,800	172,800	172,800
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0

Table W.2 Volume from MN CWP to Doris TIA - does not include mine water flows (m^3/month)
Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	11,725	11,725	11,725	11,725	11,725
7	0	6,876	6,876	6,876	6,876	6,876
8	0	21,700	21,700	21,700	21,700	21,700
9	0	0	0	0	0	0
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0

Project Hope Bay
Project No 1CT022-036
Task Control Panel
Note: ***green = input cells, black = calculated cells for the model***
Sections numbers are linked back to the Hope Bay Mine Operational Water Balance Summary Memo dated April 5, 2018

Section 2.4.1 Hydrology
Action: Select Annual Return Period for green cells

Year	Return Period
2016	Average
2017	Average
2018	Average
2019	Average
2020	Average
2021	Average
2022	Average
2023	Average

Section 2.5.1 Load Balance
Action: Select Predictive Source Term
Source Term: Base Case

Source Term Options

Upper Case
Base Case

Section 2.4.2 Mine Water
Action: Select the future mine water curves

Options	Description
1	Groundwater Model Curve
2	Adjusted Groundwater Curve to Start from todays observed flows
3	User Input

Action: None, list option for selecting where Mine Water will be directed

Options	Description
1	Doris TIA
2	Roberts Bay

Table M.3 Volume of Mine Water pumped to Doris TIA (via SCP/pumpbox) (m^3/month)
Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	40,300	89,900	7,831	7,332	3,491	3,649
2	47,600	84,100	6,776	6,650	3,186	3,419
3	65,100	89,900	7,499	7,400	3,553	3,652
4	75,000	90,006	6,345	7,173	3,468	3,534
5	77,500	93,037	7,006	7,425	3,602	3,652
6	75,000	9,078	6,411	2,571	3,498	3,534
7	372,000	9,415	6,792	2,868	3,621	3,652
8	40,300	8,820	6,938	3,019	3,636	3,655
9	51,000	8,553	6,807	3,051	3,522	3,537
10	65,100	8,246	7,121	3,271	3,646	3,652
11	75,000	8,043	6,978	3,255	3,531	3,531
12	86,800	7,812	7,276	3,432	3,655	3,643

Table M.1 Volume of Doris Mine Water pumped to Surface (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1	1,300	2,900	2,400	1,700		
2	1,700	2,900	2,300	1,700		
3	2,100	2,900	2,300	1,700		
4	2,500	3,000	2,000	1,700		
5	2,500	3,000	2,000	1,700		
6	2,500	3,000	1,700			
7	12,000	3,000	1,700			
8	1,300	2,800	1,700			
9	1,700	2,800	1,700			
10	2,100	2,600	1,700			
11	2,500	2,600	1,700			
12	2,800	2,400	1,700			

Table M.4 Volume of Madrid North Mine Water pumped to Surface (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1			126	665	1,126	1,177
2			120	675	1,138	1,179
3			119	687	1,146	1,178
4		2	115	691	1,156	1,178
5		12	260	695	1,162	1,178
6		26	437	857	1,166	1,178
7		37	491	925	1,168	1,178
8		45	538	974	1,173	1,179
9		51	569	1,017	1,174	1,179
10		60	597	1,055	1,176	1,178
11		81	626	1,085	1,177	1,177
12		120	647	1,107	1,179	1,175

Table M.6 Volume of Madrid South Mine Water pumped to Surface (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Table M.2 Directs Doris mine water to the Doris TIA (the rest goes to Robert's Bay directly)
Action: Define percentage of Mine Water directed to the Doris TIA

Month	2019	2020	2021	2022	2023	2024
1	100%	100%	10%	10%	10%	10%
2	100%	100%	10%	10%	10%	10%
3	100%	100%	10%	10%	10%	10%
4	100%	100%	10%	10%	10%	10%
5	100%	100%	10%	10%	10%	10%
6	100%	10%	10%	10%	10%	10%
7	100%	10%	10%	10%	10%	10%
8	100%	10%	10%	10%	10%	10%
9	100%	10%	10%	10%	10%	10%
10	100%	10%	10%	10%	10%	10%
11	100%	10%	10%	10%	10%	10%
12	100%	10%	10%	10%	10%	10%

Table M.5 Directs Madrid North mine water to the Doris TIA (the rest goes to Robert's Bay direc
Action: Define percentage of Mine Water directed to the Doris TIA

Month	2019	2020	2021	2022	2023	2024
1	100%	10%	10%	10%	10%	10%
2	100%	10%	10%	10%	10%	10%
3	100%	10%	10%	10%	10%	10%
4	100%	10%	10%	10%	10%	10%
5	100%	10%	10%	10%	10%	10%
6	100%	10%	10%	10%	10%	10%
7	100%	10%	10%	10%	10%	10%
8	100%	10%	10%	10%	10%	10%
9	100%	10%	10%	10%	10%	10%
10	100%	10%	10%	10%	10%	10%
11	100%	10%	10%	10%	10%	10%
12	100%	10%	10%	10%	10%	10%

Table M.7 Directs Madrid South mine water to the Doris TIA (the rest goes to Robert's Bay directly)
Action: Define percentage of Mine Water directed to the Doris TIA

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Section 2.4.3 Ore Processing and Tailings Deposition
Note Assumes ore = total tailings = flotation tails + detoxified tails
Assumptions:

Tailings thickener underflow solids:	45%	solids	*Roughly average percent solids (August - November 2018)*
Plant Effluent:	1.50	m^3/tonne o	*Value set to all water into mill*
End of pipe tailings solids content	27%		
Tailings Specific Gravity	2.8		
Deposited Dry Density Slurried Tailings	1.3	tonnes/m^3	
Flotation Tails (% of total tails to TIA)	95%	solids	
Density of Water	1.0	tonnes/m^3	
Tailings Void ratio	1.2		

Table T.1 Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1	2,000	2,400	2,400	2,400	2,400	2,400
2	2,000	2,400	2,400	2,400	2,400	2,400
3	2,000	2,400	2,400	2,400	2,400	2,400
4	2,000	2,400	2,400	2,400	2,400	2,400
5	2,000	2,400	2,400	2,400	2,400	2,400
6	2,000	2,400	2,400	2,400	2,400	2,400
7	2,400	2,400	2,400	2,400	2,400	2,400
8	2,400	2,400	2,400	2,400	2,400	2,400
9	2,400	2,400	2,400	2,400	2,400	2,400
10	2,400	2,400	2,400	2,400	2,400	2,400
11	2,400	2,400	2,400	2,400	2,400	2,400
12	2,400	2,400	2,400	2,400	2,400	2,400

Table T.3 Total Tailings Solids to TIA (tonnes/month)
Table Calculates the total tailings solids input to the TIA from the process plant in tonnes/month

Month	2019	2020	2021	2022	2023	2024
1	58,900	70,680	70,680	70,680	70,680	70,680
2	53,200	66,120	63,840	63,840	63,840	66,120
3	58,900	70,680	70,680	70,680	70,680	70,680
4	57,000	68,400	68,400	68,400	68,400	68,400
5	58,900	70,680	70,680	70,680	70,680	70,680
6	57,000	68,400	68,400	68,400	68,400	68,400
7	70,680	70,680	70,680	70,680	70,680	70,680
8	70,680	70,680	70,680	70,680	70,680	70,680
9	68,400	68,400	68,400	68,400	68,400	68,400
10	70,680	70,680	70,680	70,680	70,680	70,680
11	68,400	68,400	68,400	68,400	68,400	68,400
12	70,680	70,680	70,680	70,680	70,680	70,680

Table T.2 Total Volume of water to TIA (m^3/month)
Table Calculates the total water input to the TIA from the process plant in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	93,000	111,600	111,600	111,600	111,600	111,600
2	84,000	104,400	100,800	100,800	100,800	104,400
3	93,000	111,600	111,600	111,600	111,600	111,600
4	90,000	108,000	108,000	108,000	108,000	108,000
5	93,000	111,600	111,600	111,600	111,600	111,600
6	90,000	108,000	108,000	108,000	108,000	108,000
7	111,600	111,600	111,600	111,600	111,600	111,600
8	111,600	111,600	111,600	111,600	111,600	111,600
9	108,000	108,000	108,000	108,000	108,000	108,000
10	111,600	111,600	111,600	111,600	111,600	111,600
11	108,000	108,000	108,000	108,000	108,000	108,000
12	111,600	111,600	111,600	111,600	111,600	111,600

Table T.1a Doris Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1	2,000					
2	2,000					
3	2,000					
4	2,000					
5	2,000					
6	2,000					
7	2,400					
8	2,400					
9	2,400					
10	2,400					
11	2,400					
12	2,400					

Table T.1 b Madrid North Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1		2,400	2,400	2,400	2,400	2,400
2		2,400	2,400	2,400	2,400	2,400
3		2,400	2,400	2,400	2,400	2,400
4		2,400	2,400	2,400	2,400	2,400
5		2,400	2,400	2,400	2,400	2,400
6		2,400	2,400	2,400	2,400	2,400
7		2,400	2,400	2,400	2,400	2,400
8		2,400	2,400	2,400	2,400	2,400
9		2,400	2,400	2,400	2,400	2,400
10		2,400	2,400	2,400	2,400	2,400
11		2,400	2,400	2,400	2,400	2,400
12		2,400	2,400	2,400	2,400	2,400

Table T.1 c Madrid South Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Table T.1d Boston Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Project Hope Bay
Project No 1CT022-036
Task Control Panel
Note: ***green = input cells, black = calculated cells for the model***
Sections numbers are linked back to the Hope Bay Mine Operational Water Balance Summary Memo dated April 5, 2018

Section 2.4.4 Process Plant Reclaim

Note *Update the water use values based on the hourly process flow breakdown*

0.7	To process water tank (m^3/tonne)	Based on average July to Dec 2018
0.8	To raw water tank (m^3/tonne)	Based on average July to Dec 2018

Note: *Defines the source of raw water to the process plant*

Option 1	Doris TIA	results in no change in net water to Doris TIA
Options 2	Doris Lake	results in net water addition to Doris TIA
Options 3	-	results in no model action when selected

Section 2.4.5 Sewage Treatment Plant Effluent

Note *Table below shows relevant averages from historic data*

0.16	Average rate since operations (m^3/person/day)
-	

Table R.1 Process Water to Process Plant (m^3/day)

Action: Calculates reclaim for process water from the Doris TIA case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1	1,400	1,680	1,680	1,680	1,680	1,680
2	1,400	1,680	1,680	1,680	1,680	1,680
3	1,400	1,680	1,680	1,680	1,680	1,680
4	1,400	1,680	1,680	1,680	1,680	1,680
5	1,400	1,680	1,680	1,680	1,680	1,680
6	1,400	1,680	1,680	1,680	1,680	1,680
7	1,680	1,680	1,680	1,680	1,680	1,680
8	1,680	1,680	1,680	1,680	1,680	1,680
9	1,680	1,680	1,680	1,680	1,680	1,680
10	1,680	1,680	1,680	1,680	1,680	1,680
11	1,680	1,680	1,680	1,680	1,680	1,680
12	1,680	1,680	1,680	1,680	1,680	1,680

Table R.2 Raw Water to Process Plant (m^3/day)

Action: Calculates reclaim for raw water (location selected in table to the right) in m^3/day

Month	2019	2020	2021	2022	2023	2024
1	1,600	1,920	1,920	1,920	1,920	1,920
2	1,600	1,920	1,920	1,920	1,920	1,920
3	1,600	1,920	1,920	1,920	1,920	1,920
4	1,600	1,920	1,920	1,920	1,920	1,920
5	1,600	1,920	1,920	1,920	1,920	1,920
6	1,600	1,920	1,920	1,920	1,920	1,920
7	1,920	1,920	1,920	1,920	1,920	1,920
8	1,920	1,920	1,920	1,920	1,920	1,920
9	1,920	1,920	1,920	1,920	1,920	1,920
10	1,920	1,920	1,920	1,920	1,920	1,920
11	1,920	1,920	1,920	1,920	1,920	1,920
12	1,920	1,920	1,920	1,920	1,920	1,920

Table S.1 - Average number of people at the camp each month

Action: Input the average number of people at camp

Month	2019	2020	2021	2022	2023	2024
1		300	300	300	300	300
2		300	300	300	300	300
3		300	300	300	300	300
4		300	300	300	300	300
5	300	300	300	300	300	300
6	300	300	300	300	300	300
7	300	300	300	300	300	300
8	300	300	300	300	300	300
9	300	300	300	300	300	300
10	300	300	300	300	300	300
11	300	300	300	300	300	300
12	300	300	300	300	300	300

Table S.2 - Percent of sewage treatment plant effluent directed to the TIA (the rest reports to the tundra)

Action: Define percent sewage to the Doris TIA

Month	2019	2020	2021	2022	2023	2024
1		100%	100%	100%	100%	100%
2		100%	100%	100%	100%	100%
3		100%	100%	100%	100%	100%
4		100%	100%	100%	100%	100%
5		100%	100%	100%	100%	100%
6		100%	100%	100%	100%	100%
7		100%	100%	100%	100%	100%
8		100%	100%	100%	100%	100%
9	100%	100%	100%	100%	100%	100%
10	100%	100%	100%	100%	100%	100%
11	100%	100%	100%	100%	100%	100%
12	100%	100%	100%	100%	100%	100%

Table R.3 Source of Raw Water

Action: Select the source of Raw water to the Doris Process Plant from the drop-down list

Month	2019	2020	2021	2022	2023	2024
1	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
2	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
3	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
4	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
5	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
6	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
7	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
8	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
9	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
10	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
11	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
12	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA

Table R.4 Total Reclaim Volume from the Doris TIA (m^3/month)

Table Calculates the reclaim water demand from the Doris TIA in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	93,000	111,600	111,600	111,600	111,600	111,600
2	84,000	104,400	100,800	100,800	100,800	104,400
3	93,000	111,600	111,600	111,600	111,600	111,600
4	90,000	108,000	108,000	108,000	108,000	108,000
5	93,000	111,600	111,600	111,600	111,600	111,600
6	90,000	108,000	108,000	108,000	108,000	108,000
7	111,600	111,600	111,600	111,600	111,600	111,600
8	111,600	111,600	111,600	111,600	111,600	111,600
9	108,000	108,000	108,000	108,000	108,000	108,000
10	111,600	111,600	111,600	111,600	111,600	111,600
11	108,000	108,000	108,000	108,000	108,000	108,000
12	111,600	111,600	111,600	111,600	111,600	111,600

Table S.3 - Calculates the volume of sewage treatment effluent pumped to the Doris TIA

Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	0	1,484	1,484	1,484	1,484	1,484
2	0	1,388	1,340	1,340	1,340	1,388
3	0	1,484	1,484	1,484	1,484	1,484
4	0	1,436	1,436	1,436	1,436	1,436
5	0	1,484	1,484	1,484	1,484	1,484
6	0	1,436	1,436	1,436	1,436	1,436
7	0	1,484	1,484	1,484	1,484	1,484
8	0	1,484	1,484	1,484	1,484	1,484
9	1,436	1,436	1,436	1,436	1,436	1,436
10	1,484	1,484	1,484	1,484	1,484	1,484
11	1,436	1,436	1,436	1,436	1,436	1,436
12	1,484	1,484	1,484	1,484	1,484	1,484

Section 2.4.6 Sediment Control Pond (SCP) to Doris TIA

Note *Table below shows relevant averages from historic data (m^3/day)*

391	2018 June Data
222	2018 July Data
700	2018 August Data

Section 2.4.7 Doris TIA Discharge to Roberts Bay

Pump Capacity	7,200	m^3/day	For Reference Design Capacity of System = 7,200 m^3/day
Pump Availability	80%		

Section 2.4.8 Madrid North Contact Water Pond (CWP) to Doris TIA

Note *Assumes the same as the Doris SCP*

391	2018 June Data
222	2018 July Data
700	2018 August Data

Table C.1 Volume from SCP to Doris TIA - does not include mine water flows (m^3/day)

Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6	391	391	391	391	391	391
7	222	222	222	222	222	222
8	700	700	700	700	700	700
9						
10						
11						
12						

Table D.1 Doris TIA Discharge Pump Utilization (days/month)

Action: Fill in the number of days in a month the pump is active

Month	2019	2020	2021	2022	2023	2024
1		31				
2		28				
3		31				
4		30				
5		31				
6		30	30	30	30	30
7		31	31	31	31	31
8		31	31	31	31	31
9		30	30	30	30	30
10						
11						
12						

Table W.1 Volume from MN CWP to Doris TIA - does not include mine water flows (m^3/day)

Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6		391	391	391	391	391
7		222	222	222	222	222
8		700	700	700	700	700
9						
10						
11						
12						

Table C.2 Volume from SCP to Doris TIA - does not include mine water flows (m^3/month)

Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	11,725	11,725	11,725	11,725	11,725	11,725
7	6,876	6,876	6,876	6,876	6,876	6,876
8	21,700	21,700	21,700	21,700	21,700	21,700
9	0	0	0	0	0	0
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0

Table D.2 Doris TIA Discharge Pumping Rate (m^3/month)

Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	0	178,560	0	0	0	0
2	0	161,280	0	0	0	0
3	0	178,560	0	0	0	0
4	0	172,800	0	0	0	0
5	0	178,560	0	0	0	0
6	0	172,800	172,800	172,800	172,800	172,800
7	0	178,560	178,560	178,560	178,560	178,560
8	0	178,560	178,560	178,560	178,560	178,560
9	0	172,800	172,800	172,800	172,800	172,800
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0

Table W.2 Volume from MN CWP to Doris TIA - does not include mine water flows (m^3/month)

Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	11,725	11,725	11,725	11,725	11,725
7	0	6,876	6,876	6,876	6,876	6,876
8	0	21,700	21,700	21,700	21,700	21,700
9	0	0	0	0	0	0
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0

Project Hope Bay
Project No 1CT022-036
Task Control Panel
Note: ***green = input cells, black = calculated cells for the model***
Sections numbers are linked back to the Hope Bay Mine Operational Water Balance Summary Memo dated April 5, 2018

Section 2.4.1 Hydrology
Action: Select Annual Return Period for green cells

Year	Return Period
2016	Average
2017	Average
2018	Average
2019	1 in 100 Wet
2020	1 in 100 Wet
2021	1 in 100 Wet
2022	1 in 100 Wet
2023	1 in 100 Wet

Section 2.5.1 Load Balance
Action: Select Predictive Source Term
Source Term: Base Case

Source Term Options

Upper Case
Base Case

Section 2.4.2 Mine Water
Action: Select the future mine water curves

Options	Description
1	Groundwater Model Curve
2	Adjusted Groundwater Curve to Start from todays observed flows
3	User Input

Action: None, list option for selecting where Mine Water will be directed

Options	Description
1	Doris TIA
2	Roberts Bay

Table M.3 Volume of Mine Water pumped to Doris TIA (via SCP/pumpbox) (m^3/month)
Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	40,300	8,990	7,831	7,332	3,491	3,649
2	47,600	8,410	6,776	6,650	3,186	3,419
3	65,100	8,990	7,499	7,400	3,553	3,652
4	75,000	9,006	6,345	7,173	3,468	3,534
5	77,500	9,337	7,006	7,425	3,602	3,652
6	75,000	9,078	6,411	2,571	3,498	3,534
7	372,000	9,415	6,792	2,868	3,621	3,652
8	40,300	8,820	6,938	3,019	3,636	3,655
9	51,000	8,553	6,807	3,051	3,522	3,537
10	65,100	8,246	7,121	3,271	3,646	3,652
11	75,000	8,043	6,978	3,255	3,531	3,531
12	86,800	7,812	7,276	3,432	3,655	3,643

Table M.1 Volume of Doris Mine Water pumped to Surface (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1	1,300	2,900	2,400	1,700		
2	1,700	2,900	2,300	1,700		
3	2,100	2,900	2,300	1,700		
4	2,500	3,000	2,000	1,700		
5	2,500	3,000	2,000	1,700		
6	2,500	3,000	1,700			
7	12,000	3,000	1,700			
8	1,300	2,800	1,700			
9	1,700	2,800	1,700			
10	2,100	2,600	1,700			
11	2,500	2,600	1,700			
12	2,800	2,400	1,700			

Table M.4 Volume of Madrid North Mine Water pumped to Surface (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1			126	665	1,126	1,177
2			120	675	1,138	1,179
3			119	687	1,146	1,178
4		2	115	691	1,156	1,178
5		12	260	695	1,162	1,178
6		26	437	857	1,166	1,178
7		37	491	925	1,168	1,178
8		45	538	974	1,173	1,179
9		51	569	1,017	1,174	1,179
10		60	597	1,055	1,176	1,178
11		81	626	1,085	1,177	1,177
12		120	647	1,107	1,179	1,175

Table M.6 Volume of Madrid South Mine Water pumped to Surface (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Table M.2 Directs Doris mine water to the Doris TIA (the rest goes to Robert's Bay directly)
Action: Define percentage of Mine Water directed to the Doris TIA

Month	2019	2020	2021	2022	2023	2024
1	100%	10%	10%	10%	10%	10%
2	100%	10%	10%	10%	10%	10%
3	100%	10%	10%	10%	10%	10%
4	100%	10%	10%	10%	10%	10%
5	100%	10%	10%	10%	10%	10%
6	100%	10%	10%	10%	10%	10%
7	100%	10%	10%	10%	10%	10%
8	100%	10%	10%	10%	10%	10%
9	100%	10%	10%	10%	10%	10%
10	100%	10%	10%	10%	10%	10%
11	100%	10%	10%	10%	10%	10%
12	100%	10%	10%	10%	10%	10%

Table M.5 Directs Madrid North mine water to the Doris TIA (the rest goes to Robert's Bay direc
Action: Define percentage of Mine Water directed to the Doris TIA

Month	2019	2020	2021	2022	2023	2024
1	100%	10%	10%	10%	10%	10%
2	100%	10%	10%	10%	10%	10%
3	100%	10%	10%	10%	10%	10%
4	100%	10%	10%	10%	10%	10%
5	100%	10%	10%	10%	10%	10%
6	100%	10%	10%	10%	10%	10%
7	100%	10%	10%	10%	10%	10%
8	100%	10%	10%	10%	10%	10%
9	100%	10%	10%	10%	10%	10%
10	100%	10%	10%	10%	10%	10%
11	100%	10%	10%	10%	10%	10%
12	100%	10%	10%	10%	10%	10%

Table M.7 Directs Madrid South mine water to the Doris TIA (the rest goes to Robert's Bay directly)
Action: Define percentage of Mine Water directed to the Doris TIA

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Section 2.4.3 Ore Processing and Tailings Deposition
Note Assumes ore = total tailings = flotation tails + detoxified tails
Assumptions:

Tailings thickener underflow solids:	45%	solids	*Roughly average percent solids (August - November 2018)*
Plant Effluent:	1.50	m^3/tonne o	*Value set to all water into mill*
End of pipe tailings solids content	27%		
Tailings Specific Gravity	2.8		
Deposited Dry Density Slurried Tailings	1.3	tonnes/m^3	
Flotation Tails (% of total tails to TIA)	95%	solids	
Density of Water	1.0	tonnes/m^3	
Tailings Void ratio	1.2		

Table T.1 Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1	2,000	2,400	2,400	2,400	2,400	2,400
2	2,000	2,400	2,400	2,400	2,400	2,400
3	2,000	2,400	2,400	2,400	2,400	2,400
4	2,000	2,400	2,400	2,400	2,400	2,400
5	2,000	2,400	2,400	2,400	2,400	2,400
6	2,000	2,400	2,400	2,400	2,400	2,400
7	2,400	2,400	2,400	2,400	2,400	2,400
8	2,400	2,400	2,400	2,400	2,400	2,400
9	2,400	2,400	2,400	2,400	2,400	2,400
10	2,400	2,400	2,400	2,400	2,400	2,400
11	2,400	2,400	2,400	2,400	2,400	2,400
12	2,400	2,400	2,400	2,400	2,400	2,400

Table T.3 Total Tailings Solids to TIA (tonnes/month)
Table Calculates the total tailings solids input to the TIA from the process plant in tonnes/month

Month	2019	2020	2021	2022	2023	2024
1	58,900	70,680	70,680	70,680	70,680	70,680
2	53,200	66,120	63,840	63,840	63,840	66,120
3	58,900	70,680	70,680	70,680	70,680	70,680
4	57,000	68,400	68,400	68,400	68,400	68,400
5	58,900	70,680	70,680	70,680	70,680	70,680
6	57,000	68,400	68,400	68,400	68,400	68,400
7	70,680	70,680	70,680	70,680	70,680	70,680
8	70,680	70,680	70,680	70,680	70,680	70,680
9	68,400	68,400	68,400	68,400	68,400	68,400
10	70,680	70,680	70,680	70,680	70,680	70,680
11	68,400	68,400	68,400	68,400	68,400	68,400
12	70,680	70,680	70,680	70,680	70,680	70,680

Table T.2 Total Volume of water to TIA (m^3/month)
Table Calculates the total water input to the TIA from the process plant in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	93,000	111,600	111,600	111,600	111,600	111,600
2	84,000	104,400	100,800	100,800	100,800	104,400
3	93,000	111,600	111,600	111,600	111,600	111,600
4	90,000	108,000	108,000	108,000	108,000	108,000
5	93,000	111,600	111,600	111,600	111,600	111,600
6	90,000	108,000	108,000	108,000	108,000	108,000
7	111,600	111,600	111,600	111,600	111,600	111,600
8	111,600	111,600	111,600	111,600	111,600	111,600
9	108,000	108,000	108,000	108,000	108,000	108,000
10	111,600	111,600	111,600	111,600	111,600	111,600
11	108,000	108,000	108,000	108,000	108,000	108,000
12	111,600	111,600	111,600	111,600	111,600	111,600

Table T.1a Doris Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1	2,000					
2	2,000					
3	2,000					
4	2,000					
5	2,000					
6	2,000					
7	2,400					
8	2,400					
9	2,400					
10	2,400					
11	2,400					
12	2,400					

Table T.1 b Madrid North Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1		2,400	2,400	2,400	2,400	2,400
2		2,400	2,400	2,400	2,400	2,400
3		2,400	2,400	2,400	2,400	2,400
4		2,400	2,400	2,400	2,400	2,400
5		2,400	2,400	2,400	2,400	2,400
6		2,400	2,400	2,400	2,400	2,400
7		2,400	2,400	2,400	2,400	2,400
8		2,400	2,400	2,400	2,400	2,400
9		2,400	2,400	2,400	2,400	2,400
10		2,400	2,400	2,400	2,400	2,400
11		2,400	2,400	2,400	2,400	2,400
12		2,400	2,400	2,400	2,400	2,400

Table T.1 c Madrid South Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Table T.1d Boston Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Project Hope Bay
Project No 1CT022-036
Task Control Panel
Note: ***green = input cells, black = calculated cells for the model***
Sections numbers are linked back to the Hope Bay Mine Operational Water Balance Summary Memo dated April 5, 2018

Section 2.4.4 Process Plant Reclaim

Note *Update the water use values based on the hourly process flow breakdown*

0.7	To process water tank (m^3/tonne)	Based on average July to Dec 2018
0.8	To raw water tank (m^3/tonne)	Based on average July to Dec 2018

Note: *Defines the source of raw water to the process plant*

Option 1	Doris TIA	results in no change in net water to Doris TIA
Options 2	Doris Lake	results in net water addition to Doris TIA
Options 3	-	results in no model action when selected

Section 2.4.5 Sewage Treatment Plant Effluent

Note *Table below shows relevant averages from historic data*

0.16	Average rate since operations (m^3/person/day)
-	

Table R.1 Process Water to Process Plant (m^3/day)

Action: Calculates reclaim for process water from the Doris TIA case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1	1,400	1,680	1,680	1,680	1,680	1,680
2	1,400	1,680	1,680	1,680	1,680	1,680
3	1,400	1,680	1,680	1,680	1,680	1,680
4	1,400	1,680	1,680	1,680	1,680	1,680
5	1,400	1,680	1,680	1,680	1,680	1,680
6	1,400	1,680	1,680	1,680	1,680	1,680
7	1,680	1,680	1,680	1,680	1,680	1,680
8	1,680	1,680	1,680	1,680	1,680	1,680
9	1,680	1,680	1,680	1,680	1,680	1,680
10	1,680	1,680	1,680	1,680	1,680	1,680
11	1,680	1,680	1,680	1,680	1,680	1,680
12	1,680	1,680	1,680	1,680	1,680	1,680

Table R.2 Raw Water to Process Plant (m^3/day)

Action: Calculates reclaim for raw water (location selected in table to the right) in m^3/day

Month	2019	2020	2021	2022	2023	2024
1	1,600	1,920	1,920	1,920	1,920	1,920
2	1,600	1,920	1,920	1,920	1,920	1,920
3	1,600	1,920	1,920	1,920	1,920	1,920
4	1,600	1,920	1,920	1,920	1,920	1,920
5	1,600	1,920	1,920	1,920	1,920	1,920
6	1,600	1,920	1,920	1,920	1,920	1,920
7	1,920	1,920	1,920	1,920	1,920	1,920
8	1,920	1,920	1,920	1,920	1,920	1,920
9	1,920	1,920	1,920	1,920	1,920	1,920
10	1,920	1,920	1,920	1,920	1,920	1,920
11	1,920	1,920	1,920	1,920	1,920	1,920
12	1,920	1,920	1,920	1,920	1,920	1,920

Table S.1 - Average number of people at the camp each month

Action: Input the average number of people at camp

Month	2019	2020	2021	2022	2023	2024
1		300	300	300	300	300
2		300	300	300	300	300
3		300	300	300	300	300
4		300	300	300	300	300
5	300	300	300	300	300	300
6	300	300	300	300	300	300
7	300	300	300	300	300	300
8	300	300	300	300	300	300
9	300	300	300	300	300	300
10	300	300	300	300	300	300
11	300	300	300	300	300	300
12	300	300	300	300	300	300

Table S.2 - Percent of sewage treatment plant effluent directed to the TIA (the rest reports to the tundra)

Action: Define percent sewage to the Doris TIA

Month	2019	2020	2021	2022	2023	2024
1		100%	100%	100%	100%	100%
2		100%	100%	100%	100%	100%
3		100%	100%	100%	100%	100%
4		100%	100%	100%	100%	100%
5		100%	100%	100%	100%	100%
6		100%	100%	100%	100%	100%
7		100%	100%	100%	100%	100%
8		100%	100%	100%	100%	100%
9	100%	100%	100%	100%	100%	100%
10	100%	100%	100%	100%	100%	100%
11	100%	100%	100%	100%	100%	100%
12	100%	100%	100%	100%	100%	100%

Table R.3 Source of Raw Water

Action: Select the source of Raw water to the Doris Process Plant from the drop-down list

Month	2019	2020	2021	2022	2023	2024
1	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
2	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
3	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
4	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
5	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
6	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
7	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
8	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
9	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
10	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
11	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
12	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA

Table R.4 Total Reclaim Volume from the Doris TIA (m^3/month)

Table Calculates the reclaim water demand from the Doris TIA in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	93,000	111,600	111,600	111,600	111,600	111,600
2	84,000	104,400	100,800	100,800	100,800	104,400
3	93,000	111,600	111,600	111,600	111,600	111,600
4	90,000	108,000	108,000	108,000	108,000	108,000
5	93,000	111,600	111,600	111,600	111,600	111,600
6	90,000	108,000	108,000	108,000	108,000	108,000
7	111,600	111,600	111,600	111,600	111,600	111,600
8	111,600	111,600	111,600	111,600	111,600	111,600
9	108,000	108,000	108,000	108,000	108,000	108,000
10	111,600	111,600	111,600	111,600	111,600	111,600
11	108,000	108,000	108,000	108,000	108,000	108,000
12	111,600	111,600	111,600	111,600	111,600	111,600

Table S.3 - Calculates the volume of sewage treatment effluent pumped to the Doris TIA

Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	0	1,484	1,484	1,484	1,484	1,484
2	0	1,388	1,340	1,340	1,340	1,388
3	0	1,484	1,484	1,484	1,484	1,484
4	0	1,436	1,436	1,436	1,436	1,436
5	0	1,484	1,484	1,484	1,484	1,484
6	0	1,436	1,436	1,436	1,436	1,436
7	0	1,484	1,484	1,484	1,484	1,484
8	0	1,484	1,484	1,484	1,484	1,484
9	1,436	1,436	1,436	1,436	1,436	1,436
10	1,484	1,484	1,484	1,484	1,484	1,484
11	1,436	1,436	1,436	1,436	1,436	1,436
12	1,484	1,484	1,484	1,484	1,484	1,484

Section 2.4.6 Sediment Control Pond (SCP) to Doris TIA

Note *Table below shows relevant averages from historic data (m^3/day)*

391	2018 June Data
222	2018 July Data
700	2018 August Data

Section 2.4.7 Doris TIA Discharge to Roberts Bay

Pump Capacity	7,200	m^3/day	For Reference Design Capacity of System = 7,200 m^3/day
Pump Availability	80%		

Section 2.4.8 Madrid North Contact Water Pond (CWP) to Doris TIA

Note *Assumes the same as the Doris SCP*

391	2018 June Data
222	2018 July Data
700	2018 August Data

Table C.1 Volume from SCP to Doris TIA - does not include mine water flows (m^3/day)

Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6	391	391	391	391	391	391
7	222	222	222	222	222	222
8	700	700	700	700	700	700
9						
10						
11						
12						

Table D.1 Doris TIA Discharge Pump Utilization (days/month)

Action: Fill in the number of days in a month the pump is active

Month	2019	2020	2021	2022	2023	2024
1		31				
2		28				
3		31				
4		30				
5		31				
6		30	30	30	30	30
7		31	31	31	31	31
8		31	31	31	31	31
9		30	30	30	30	30
10						
11						
12						

Table W.1 Volume from MN CWP to Doris TIA - does not include mine water flows (m^3/day)

Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6		391	391	391	391	391
7		222	222	222	222	222
8		700	700	700	700	700
9						
10						
11						
12						

Table C.2 Volume from SCP to Doris TIA - does not include mine water flows (m^3/month)

Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	11,725	11,725	11,725	11,725	11,725	11,725
7	6,876	6,876	6,876	6,876	6,876	6,876
8	21,700	21,700	21,700	21,700	21,700	21,700
9	0	0	0	0	0	0
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0

Table D.2 Doris TIA Discharge Pumping Rate (m^3/month)

Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	0	178,560	0	0	0	0
2	0	161,280	0	0	0	0
3	0	178,560	0	0	0	0
4	0	172,800	0	0	0	0
5	0	178,560	0	0	0	0
6	0	172,800	172,800	172,800	172,800	172,800
7	0	178,560	178,560	178,560	178,560	178,560
8	0	178,560	178,560	178,560	178,560	178,560
9	0	172,800	172,800	172,800	172,800	172,800
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0

Table W.2 Volume from MN CWP to Doris TIA - does not include mine water flows (m^3/month)

Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	11,725	11,725	11,725	11,725	11,725
7	0	6,876	6,876	6,876	6,876	6,876
8	0	21,700	21,700	21,700	21,700	21,700
9	0	0	0	0	0	0
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0

Project Hope Bay
Project No 1CT022-036
Task Control Panel
Note: ***green = input cells, black = calculated cells for the model***
Sections numbers are linked back to the Hope Bay Mine Operational Water Balance Summary Memo dated April 5, 2018

Section 2.4.1 Hydrology
Action: Select Annual Return Period for green cells

Year	Return Period
2016	Average
2017	Average
2018	Average
2019	1 in 100 Wet
2020	1 in 100 Wet
2021	1 in 100 Wet
2022	1 in 100 Wet
2023	1 in 100 Wet

Section 2.5.1 Load Balance
Action: Select Predictive Source Term
Source Term: Base Case

Source Term Options

Upper Case
Base Case

Section 2.4.2 Mine Water
Action: Select the future mine water curves

Options	Description
1	Groundwater Model Curve
2	Adjusted Groundwater Curve to Start from todays observed flows
3	User Input

Action: None, list option for selecting where Mine Water will be directed

Options	Description
1	Doris TIA
2	Roberts Bay

Table M.3 Volume of Mine Water pumped to Doris TIA (via SCP/pumpbox) (m^3/month)
Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	40,300	89,900	7,831	7,332	3,491	3,649
2	47,600	84,100	6,776	6,650	3,186	3,419
3	65,100	89,900	7,499	7,400	3,553	3,652
4	75,000	90,006	6,345	7,173	3,468	3,534
5	77,500	93,037	7,006	7,425	3,602	3,652
6	75,000	9,078	6,411	2,571	3,498	3,534
7	372,000	9,415	6,792	2,868	3,621	3,652
8	40,300	8,820	6,938	3,019	3,636	3,655
9	51,000	8,553	6,807	3,051	3,522	3,537
10	65,100	8,246	7,121	3,271	3,646	3,652
11	75,000	8,043	6,978	3,255	3,531	3,531
12	86,800	7,812	7,276	3,432	3,655	3,643

Table M.1 Volume of Doris Mine Water pumped to Surface (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1	1,300	2,900	2,400	1,700		
2	1,700	2,900	2,300	1,700		
3	2,100	2,900	2,300	1,700		
4	2,500	3,000	2,000	1,700		
5	2,500	3,000	2,000	1,700		
6	2,500	3,000	1,700			
7	12,000	3,000	1,700			
8	1,300	2,800	1,700			
9	1,700	2,800	1,700			
10	2,100	2,600	1,700			
11	2,500	2,600	1,700			
12	2,800	2,400	1,700			

Table M.4 Volume of Madrid North Mine Water pumped to Surface (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1			126	665	1,126	1,177
2			120	675	1,138	1,179
3			119	687	1,146	1,178
4		2	115	691	1,156	1,178
5		12	260	695	1,162	1,178
6		26	437	857	1,166	1,178
7		37	491	925	1,168	1,178
8		45	538	974	1,173	1,179
9		51	569	1,017	1,174	1,179
10		60	597	1,055	1,176	1,178
11		81	626	1,085	1,177	1,177
12		120	647	1,107	1,179	1,175

Table M.6 Volume of Madrid South Mine Water pumped to Surface (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Table M.2 Directs Doris mine water to the Doris TIA (the rest goes to Robert's Bay directly)
Action: Define percentage of Mine Water directed to the Doris TIA

Month	2019	2020	2021	2022	2023	2024
1	100%	100%	10%	10%	10%	10%
2	100%	100%	10%	10%	10%	10%
3	100%	100%	10%	10%	10%	10%
4	100%	100%	10%	10%	10%	10%
5	100%	100%	10%	10%	10%	10%
6	100%	10%	10%	10%	10%	10%
7	100%	10%	10%	10%	10%	10%
8	100%	10%	10%	10%	10%	10%
9	100%	10%	10%	10%	10%	10%
10	100%	10%	10%	10%	10%	10%
11	100%	10%	10%	10%	10%	10%
12	100%	10%	10%	10%	10%	10%

Table M.5 Directs Madrid North mine water to the Doris TIA (the rest goes to Robert's Bay direc
Action: Define percentage of Mine Water directed to the Doris TIA

Month	2019	2020	2021	2022	2023	2024
1	100%	10%	10%	10%	10%	10%
2	100%	10%	10%	10%	10%	10%
3	100%	10%	10%	10%	10%	10%
4	100%	10%	10%	10%	10%	10%
5	100%	10%	10%	10%	10%	10%
6	100%	10%	10%	10%	10%	10%
7	100%	10%	10%	10%	10%	10%
8	100%	10%	10%	10%	10%	10%
9	100%	10%	10%	10%	10%	10%
10	100%	10%	10%	10%	10%	10%
11	100%	10%	10%	10%	10%	10%
12	100%	10%	10%	10%	10%	10%

Table M.7 Directs Madrid South mine water to the Doris TIA (the rest goes to Robert's Bay directly)
Action: Define percentage of Mine Water directed to the Doris TIA

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Section 2.4.3 Ore Processing and Tailings Deposition
Note Assumes ore = total tailings = flotation tails + detoxified tails
Assumptions:

Tailings thickener underflow solids:	45%	solids	*Roughly average percent solids (August - November 2018)*
Plant Effluent:	1.50	m^3/tonne o	*Value set to all water into mill*
End of pipe tailings solids content	27%		
Tailings Specific Gravity	2.8		
Deposited Dry Density Slurried Tailings	1.3	tonnes/m^3	
Flotation Tails (% of total tails to TIA)	95%	solids	
Density of Water	1.0	tonnes/m^3	
Tailings Void ratio	1.2		

Table T.1 Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1	2,000	2,400	2,400	2,400	2,400	2,400
2	2,000	2,400	2,400	2,400	2,400	2,400
3	2,000	2,400	2,400	2,400	2,400	2,400
4	2,000	2,400	2,400	2,400	2,400	2,400
5	2,000	2,400	2,400	2,400	2,400	2,400
6	2,000	2,400	2,400	2,400	2,400	2,400
7	2,400	2,400	2,400	2,400	2,400	2,400
8	2,400	2,400	2,400	2,400	2,400	2,400
9	2,400	2,400	2,400	2,400	2,400	2,400
10	2,400	2,400	2,400	2,400	2,400	2,400
11	2,400	2,400	2,400	2,400	2,400	2,400
12	2,400	2,400	2,400	2,400	2,400	2,400

Table T.3 Total Tailings Solids to TIA (tonnes/month)
Table Calculates the total tailings solids input to the TIA from the process plant in tonnes/month

Month	2019	2020	2021	2022	2023	2024
1	58,900	70,680	70,680	70,680	70,680	70,680
2	53,200	66,120	63,840	63,840	63,840	66,120
3	58,900	70,680	70,680	70,680	70,680	70,680
4	57,000	68,400	68,400	68,400	68,400	68,400
5	58,900	70,680	70,680	70,680	70,680	70,680
6	57,000	68,400	68,400	68,400	68,400	68,400
7	70,680	70,680	70,680	70,680	70,680	70,680
8	70,680	70,680	70,680	70,680	70,680	70,680
9	68,400	68,400	68,400	68,400	68,400	68,400
10	70,680	70,680	70,680	70,680	70,680	70,680
11	68,400	68,400	68,400	68,400	68,400	68,400
12	70,680	70,680	70,680	70,680	70,680	70,680

Table T.2 Total Volume of water to TIA (m^3/month)
Table Calculates the total water input to the TIA from the process plant in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	93,000	111,600	111,600	111,600	111,600	111,600
2	84,000	104,400	100,800	100,800	100,800	104,400
3	93,000	111,600	111,600	111,600	111,600	111,600
4	90,000	108,000	108,000	108,000	108,000	108,000
5	93,000	111,600	111,600	111,600	111,600	111,600
6	90,000	108,000	108,000	108,000	108,000	108,000
7	111,600	111,600	111,600	111,600	111,600	111,600
8	111,600	111,600	111,600	111,600	111,600	111,600
9	108,000	108,000	108,000	108,000	108,000	108,000
10	111,600	111,600	111,600	111,600	111,600	111,600
11	108,000	108,000	108,000	108,000	108,000	108,000
12	111,600	111,600	111,600	111,600	111,600	111,600

Table T.1a Doris Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1	2,000					
2	2,000					
3	2,000					
4	2,000					
5	2,000					
6	2,000					
7	2,400					
8	2,400					
9	2,400					
10	2,400					
11	2,400					
12	2,400					

Table T.1 b Madrid North Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1		2,400	2,400	2,400	2,400	2,400
2		2,400	2,400	2,400	2,400	2,400
3		2,400	2,400	2,400	2,400	2,400
4		2,400	2,400	2,400	2,400	2,400
5		2,400	2,400	2,400	2,400	2,400
6		2,400	2,400	2,400	2,400	2,400
7		2,400	2,400	2,400	2,400	2,400
8		2,400	2,400	2,400	2,400	2,400
9		2,400	2,400	2,400	2,400	2,400
10		2,400	2,400	2,400	2,400	2,400
11		2,400	2,400	2,400	2,400	2,400
12		2,400	2,400	2,400	2,400	2,400

Table T.1 c Madrid South Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Table T.1d Boston Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Project Hope Bay
Project No 1CT022-036
Task Control Panel
Note: ***green = input cells, black = calculated cells for the model***
Sections numbers are linked back to the Hope Bay Mine Operational Water Balance Summary Memo dated April 5, 2018

Section 2.4.4 Process Plant Reclaim

Note *Update the water use values based on the hourly process flow breakdown*

0.7	To process water tank (m^3/tonne)	Based on average July to Dec 2018
0.8	To raw water tank (m^3/tonne)	Based on average July to Dec 2018

Note: *Defines the source of raw water to the process plant*

Option 1	Doris TIA	results in no change in net water to Doris TIA
Options 2	Doris Lake	results in net water addition to Doris TIA
Options 3	-	results in no model action when selected

Section 2.4.5 Sewage Treatment Plant Effluent

Note *Table below shows relevant averages from historic data*

0.16	Average rate since operations (m^3/person/day)
-	

Table R.1 Process Water to Process Plant (m^3/day)
Action: Calculates reclaim for process water from the Doris TIA case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1	1,400	1,680	1,680	1,680	1,680	1,680
2	1,400	1,680	1,680	1,680	1,680	1,680
3	1,400	1,680	1,680	1,680	1,680	1,680
4	1,400	1,680	1,680	1,680	1,680	1,680
5	1,400	1,680	1,680	1,680	1,680	1,680
6	1,400	1,680	1,680	1,680	1,680	1,680
7	1,680	1,680	1,680	1,680	1,680	1,680
8	1,680	1,680	1,680	1,680	1,680	1,680
9	1,680	1,680	1,680	1,680	1,680	1,680
10	1,680	1,680	1,680	1,680	1,680	1,680
11	1,680	1,680	1,680	1,680	1,680	1,680
12	1,680	1,680	1,680	1,680	1,680	1,680

Table R.2 Raw Water to Process Plant (m^3/day)
Action: Calculates reclaim for raw water (location selected in table to the right) in m^3/day

Month	2019	2020	2021	2022	2023	2024
1	1,600	1,920	1,920	1,920	1,920	1,920
2	1,600	1,920	1,920	1,920	1,920	1,920
3	1,600	1,920	1,920	1,920	1,920	1,920
4	1,600	1,920	1,920	1,920	1,920	1,920
5	1,600	1,920	1,920	1,920	1,920	1,920
6	1,600	1,920	1,920	1,920	1,920	1,920
7	1,920	1,920	1,920	1,920	1,920	1,920
8	1,920	1,920	1,920	1,920	1,920	1,920
9	1,920	1,920	1,920	1,920	1,920	1,920
10	1,920	1,920	1,920	1,920	1,920	1,920
11	1,920	1,920	1,920	1,920	1,920	1,920
12	1,920	1,920	1,920	1,920	1,920	1,920

Table S.1 - Average number of people at the camp each month
Action: Input the average number of people at camp

Month	2019	2020	2021	2022	2023	2024
1		300	300	300	300	300
2		300	300	300	300	300
3		300	300	300	300	300
4		300	300	300	300	300
5	300	300	300	300	300	300
6	300	300	300	300	300	300
7	300	300	300	300	300	300
8	300	300	300	300	300	300
9	300	300	300	300	300	300
10	300	300	300	300	300	300
11	300	300	300	300	300	300
12	300	300	300	300	300	300

Table S.2 - Percent of sewage treatment plant effluent directed to the TIA (the rest reports to the tundra)
Action: Define percent sewage to the Doris TIA

Month	2019	2020	2021	2022	2023	2024
1		100%	100%	100%	100%	100%
2		100%	100%	100%	100%	100%
3		100%	100%	100%	100%	100%
4		100%	100%	100%	100%	100%
5		100%	100%	100%	100%	100%
6		100%	100%	100%	100%	100%
7		100%	100%	100%	100%	100%
8		100%	100%	100%	100%	100%
9	100%	100%	100%	100%	100%	100%
10	100%	100%	100%	100%	100%	100%
11	100%	100%	100%	100%	100%	100%
12	100%	100%	100%	100%	100%	100%

Table R.3 Source of Raw Water
Action: Select the source of Raw water to the Doris Process Plant from the drop-down list

Month	2019	2020	2021	2022	2023	2024
1	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
2	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
3	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
4	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
5	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
6	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
7	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
8	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
9	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
10	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
11	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
12	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA

Table R.4 Total Reclaim Volume from the Doris TIA (m^3/month)
Table Calculates the reclaim water demand from the Doris TIA in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	93,000	111,600	111,600	111,600	111,600	111,600
2	84,000	104,400	100,800	100,800	100,800	104,400
3	93,000	111,600	111,600	111,600	111,600	111,600
4	90,000	108,000	108,000	108,000	108,000	108,000
5	93,000	111,600	111,600	111,600	111,600	111,600
6	90,000	108,000	108,000	108,000	108,000	108,000
7	111,600	111,600	111,600	111,600	111,600	111,600
8	111,600	111,600	111,600	111,600	111,600	111,600
9	108,000	108,000	108,000	108,000	108,000	108,000
10	111,600	111,600	111,600	111,600	111,600	111,600
11	108,000	108,000	108,000	108,000	108,000	108,000
12	111,600	111,600	111,600	111,600	111,600	111,600

Table S.3 - Calculates the volume of sewage treatment effluent pumped to the Doris TIA
Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	0	1,484	1,484	1,484	1,484	1,484
2	0	1,388	1,340	1,340	1,340	1,388
3	0	1,484	1,484	1,484	1,484	1,484
4	0	1,436	1,436	1,436	1,436	1,436
5	0	1,484	1,484	1,484	1,484	1,484
6	0	1,436	1,436	1,436	1,436	1,436
7	0	1,484	1,484	1,484	1,484	1,484
8	0	1,484	1,484	1,484	1,484	1,484
9	1,436	1,436	1,436	1,436	1,436	1,436
10	1,484	1,484	1,484	1,484	1,484	1,484
11	1,436	1,436	1,436	1,436	1,436	1,436
12	1,484	1,484	1,484	1,484	1,484	1,484

Section 2.4.6 Sediment Control Pond (SCP) to Doris TIA

Note *Table below shows relevant averages from historic data (m^3/day)*

391	2018 June Data
222	2018 July Data
700	2018 August Data

Section 2.4.7 Doris TIA Discharge to Roberts Bay

Pump Capacity 7,200 m^3/day For Reference Design Capacity of System = 7,200 m^3/day
Pump Availability 80%

Section 2.4.8 Madrid North Contact Water Pond (CWP) to Doris TIA

Note *Assumes the same as the Doris SCP*

391	2018 June Data
222	2018 July Data
700	2018 August Data

Table C.1 Volume from SCP to Doris TIA - does not include mine water flows (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6	391	391	391	391	391	391
7	222	222	222	222	222	222
8	700	700	700	700	700	700
9						
10						
11						
12						

Table D.1 Doris TIA Discharge Pump Utilization (days/month)
Action: Fill in the number of days in a month the pump is active

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6		30	30	30	30	30
7		31	31	31	31	31
8		31	31	31	31	31
9		30	30	30	30	30
10						
11						
12						

Table W.1 Volume from MN CWP to Doris TIA - does not include mine water flows (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6		391	391	391	391	391
7		222	222	222	222	222
8		700	700	700	700	700
9						
10						
11						
12						

Table C.2 Volume from SCP to Doris TIA - does not include mine water flows (m^3/month)
Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	11,725	11,725	11,725	11,725	11,725	11,725
7	6,876	6,876	6,876	6,876	6,876	6,876
8	21,700	21,700	21,700	21,700	21,700	21,700
9	0	0	0	0	0	0
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0

Table D.2 Doris TIA Discharge Pumping Rate (m^3/month)
Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	172,800	172,800	172,800	172,800	172,800
7	0	178,560	178,560	178,560	178,560	178,560
8	0	178,560	178,560	178,560	178,560	178,560
9	0	172,800	172,800	172,800	172,800	172,800
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0

Table W.2 Volume from MN CWP to Doris TIA - does not include mine water flows (m^3/month)
Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	11,725	11,725	11,725	11,725	11,725
7	0	6,876	6,876	6,876	6,876	6,876
8	0	21,700	21,700	21,700	21,700	21,700
9	0	0	0	0	0	0
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0

Project Hope Bay
Project No 1CT022-036
Task Control Panel
Note: ***green = input cells, black = calculated cells for the model***
Sections numbers are linked back to the Hope Bay Mine Operational Water Balance Summary Memo dated April 5, 2018

Section 2.4.1 Hydrology
Action: Select Annual Return Period for green cells

Year	Return Period
2016	Average
2017	Average
2018	Average
2019	1 in 100 Wet
2020	1 in 100 Wet
2021	1 in 100 Wet
2022	1 in 100 Wet
2023	1 in 100 Wet

Section 2.5.1 Load Balance
Action: Select Predictive Source Term
Source Term: Base Case

Source Term Options

Upper Case
Base Case

Section 2.4.2 Mine Water
Action: Select the future mine water curves

Options	Description
1	Groundwater Model Curve
2	Adjusted Groundwater Curve to Start from todays observed flows
3	User Input

Action: None, list option for selecting where Mine Water will be directed

Options	Description
1	Doris TIA
2	Roberts Bay

Table M.3 Volume of Mine Water pumped to Doris TIA (via SCP/pumpbox) (m^3/month)
Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	40,300	8,990	7,831	7,332	3,491	3,649
2	47,600	8,410	6,776	6,650	3,186	3,419
3	65,100	8,990	7,499	7,400	3,553	3,652
4	75,000	9,006	6,345	7,173	3,468	3,534
5	77,500	9,337	7,006	7,425	3,602	3,652
6	75,000	9,078	6,411	2,571	3,498	3,534
7	372,000	9,415	6,792	2,868	3,621	3,652
8	40,300	8,820	6,938	3,019	3,636	3,655
9	51,000	8,553	6,807	3,051	3,522	3,537
10	65,100	8,246	7,121	3,271	3,646	3,652
11	75,000	8,043	6,978	3,255	3,531	3,531
12	86,800	7,812	7,276	3,432	3,655	3,643

Table M.1 Volume of Doris Mine Water pumped to Surface (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1	1,300	2,900	2,400	1,700		
2	1,700	2,900	2,300	1,700		
3	2,100	2,900	2,300	1,700		
4	2,500	3,000	2,000	1,700		
5	2,500	3,000	2,000	1,700		
6	2,500	3,000	1,700			
7	12,000	3,000	1,700			
8	1,300	2,800	1,700			
9	1,700	2,800	1,700			
10	2,100	2,600	1,700			
11	2,500	2,600	1,700			
12	2,800	2,400	1,700			

Table M.4 Volume of Madrid North Mine Water pumped to Surface (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1			126	665	1,126	1,177
2			120	675	1,138	1,179
3			119	687	1,146	1,178
4		2	115	691	1,156	1,178
5		12	260	695	1,162	1,178
6		26	437	857	1,166	1,178
7		37	491	925	1,168	1,178
8		45	538	974	1,173	1,179
9		51	569	1,017	1,174	1,179
10		60	597	1,055	1,176	1,178
11		81	626	1,085	1,177	1,177
12		120	647	1,107	1,179	1,175

Table M.6 Volume of Madrid South Mine Water pumped to Surface (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Table M.2 Directs Doris mine water to the Doris TIA (the rest goes to Robert's Bay directly)
Action: Define percentage of Mine Water directed to the Doris TIA

Month	2019	2020	2021	2022	2023	2024
1	100%	10%	10%	10%	10%	10%
2	100%	10%	10%	10%	10%	10%
3	100%	10%	10%	10%	10%	10%
4	100%	10%	10%	10%	10%	10%
5	100%	10%	10%	10%	10%	10%
6	100%	10%	10%	10%	10%	10%
7	100%	10%	10%	10%	10%	10%
8	100%	10%	10%	10%	10%	10%
9	100%	10%	10%	10%	10%	10%
10	100%	10%	10%	10%	10%	10%
11	100%	10%	10%	10%	10%	10%
12	100%	10%	10%	10%	10%	10%

Table M.5 Directs Madrid North mine water to the Doris TIA (the rest goes to Robert's Bay direc
Action: Define percentage of Mine Water directed to the Doris TIA

Month	2019	2020	2021	2022	2023	2024
1	100%	10%	10%	10%	10%	10%
2	100%	10%	10%	10%	10%	10%
3	100%	10%	10%	10%	10%	10%
4	100%	10%	10%	10%	10%	10%
5	100%	10%	10%	10%	10%	10%
6	100%	10%	10%	10%	10%	10%
7	100%	10%	10%	10%	10%	10%
8	100%	10%	10%	10%	10%	10%
9	100%	10%	10%	10%	10%	10%
10	100%	10%	10%	10%	10%	10%
11	100%	10%	10%	10%	10%	10%
12	100%	10%	10%	10%	10%	10%

Table M.7 Directs Madrid South mine water to the Doris TIA (the rest goes to Robert's Bay directly)
Action: Define percentage of Mine Water directed to the Doris TIA

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Section 2.4.3 Ore Processing and Tailings Deposition
Note Assumes ore = total tailings = flotation tails + detoxified tails
Assumptions:

Tailings thickener underflow solids:	45%	solids	*Roughly average percent solids (August - November 2018)*
Plant Effluent:	1.50	m^3/tonne o	*Value set to all water into mill*
End of pipe tailings solids content	27%		
Tailings Specific Gravity	2.8		
Deposited Dry Density Slurried Tailings	1.3	tonnes/m^3	
Flotation Tails (% of total tails to TIA)	95%	solids	
Density of Water	1.0	tonnes/m^3	
Tailings Void ratio	1.2		

Table T.1 Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1	2,000	2,400	2,400	2,400	2,400	2,400
2	2,000	2,400	2,400	2,400	2,400	2,400
3	2,000	2,400	2,400	2,400	2,400	2,400
4	2,000	2,400	2,400	2,400	2,400	2,400
5	2,000	2,400	2,400	2,400	2,400	2,400
6	2,000	2,400	2,400	2,400	2,400	2,400
7	2,400	2,400	2,400	2,400	2,400	2,400
8	2,400	2,400	2,400	2,400	2,400	2,400
9	2,400	2,400	2,400	2,400	2,400	2,400
10	2,400	2,400	2,400	2,400	2,400	2,400
11	2,400	2,400	2,400	2,400	2,400	2,400
12	2,400	2,400	2,400	2,400	2,400	2,400

Table T.3 Total Tailings Solids to TIA (tonnes/month)
Table Calculates the total tailings solids input to the TIA from the process plant in tonnes/month

Month	2019	2020	2021	2022	2023	2024
1	58,900	70,680	70,680	70,680	70,680	70,680
2	53,200	66,120	63,840	63,840	63,840	66,120
3	58,900	70,680	70,680	70,680	70,680	70,680
4	57,000	68,400	68,400	68,400	68,400	68,400
5	58,900	70,680	70,680	70,680	70,680	70,680
6	57,000	68,400	68,400	68,400	68,400	68,400
7	70,680	70,680	70,680	70,680	70,680	70,680
8	70,680	70,680	70,680	70,680	70,680	70,680
9	68,400	68,400	68,400	68,400	68,400	68,400
10	70,680	70,680	70,680	70,680	70,680	70,680
11	68,400	68,400	68,400	68,400	68,400	68,400
12	70,680	70,680	70,680	70,680	70,680	70,680

Table T.2 Total Volume of water to TIA (m^3/month)
Table Calculates the total water input to the TIA from the process plant in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	93,000	111,600	111,600	111,600	111,600	111,600
2	84,000	104,400	100,800	100,800	100,800	104,400
3	93,000	111,600	111,600	111,600	111,600	111,600
4	90,000	108,000	108,000	108,000	108,000	108,000
5	93,000	111,600	111,600	111,600	111,600	111,600
6	90,000	108,000	108,000	108,000	108,000	108,000
7	111,600	111,600	111,600	111,600	111,600	111,600
8	111,600	111,600	111,600	111,600	111,600	111,600
9	108,000	108,000	108,000	108,000	108,000	108,000
10	111,600	111,600	111,600	111,600	111,600	111,600
11	108,000	108,000	108,000	108,000	108,000	108,000
12	111,600	111,600	111,600	111,600	111,600	111,600

Table T.1a Doris Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1	2,000					
2	2,000					
3	2,000					
4	2,000					
5	2,000					
6	2,000					
7	2,400					
8	2,400					
9	2,400					
10	2,400					
11	2,400					
12	2,400					

Table T.1 b Madrid North Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1		2,400	2,400	2,400	2,400	2,400
2		2,400	2,400	2,400	2,400	2,400
3		2,400	2,400	2,400	2,400	2,400
4		2,400	2,400	2,400	2,400	2,400
5		2,400	2,400	2,400	2,400	2,400
6		2,400	2,400	2,400	2,400	2,400
7		2,400	2,400	2,400	2,400	2,400
8		2,400	2,400	2,400	2,400	2,400
9		2,400	2,400	2,400	2,400	2,400
10		2,400	2,400	2,400	2,400	2,400
11		2,400	2,400	2,400	2,400	2,400
12		2,400	2,400	2,400	2,400	2,400

Table T.1 c Madrid South Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Table T.1d Boston Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Project Hope Bay
Project No 1CT022-036
Task Control Panel
Note: ***green = input cells, black = calculated cells for the model***
Sections numbers are linked back to the Hope Bay Mine Operational Water Balance Summary Memo dated April 5, 2018

Section 2.4.4 Process Plant Reclaim

Note *Update the water use values based on the hourly process flow breakdown*

0.7	To process water tank (m^3/tonne)	Based on average July to Dec 2018
0.8	To raw water tank (m^3/tonne)	Based on average July to Dec 2018

Note: *Defines the source of raw water to the process plant*

Option 1	Doris TIA	results in no change in net water to Doris TIA
Options 2	Doris Lake	results in net water addition to Doris TIA
Options 3	-	results in no model action when selected

Section 2.4.5 Sewage Treatment Plant Effluent

Note *Table below shows relevant averages from historic data*

0.16	Average rate since operations (m^3/person/day)
-	

Table R.1 Process Water to Process Plant (m^3/day)
Action: Calculates reclaim for process water from the Doris TIA case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1	1,400	1,680	1,680	1,680	1,680	1,680
2	1,400	1,680	1,680	1,680	1,680	1,680
3	1,400	1,680	1,680	1,680	1,680	1,680
4	1,400	1,680	1,680	1,680	1,680	1,680
5	1,400	1,680	1,680	1,680	1,680	1,680
6	1,400	1,680	1,680	1,680	1,680	1,680
7	1,680	1,680	1,680	1,680	1,680	1,680
8	1,680	1,680	1,680	1,680	1,680	1,680
9	1,680	1,680	1,680	1,680	1,680	1,680
10	1,680	1,680	1,680	1,680	1,680	1,680
11	1,680	1,680	1,680	1,680	1,680	1,680
12	1,680	1,680	1,680	1,680	1,680	1,680

Table R.2 Raw Water to Process Plant (m^3/day)
Action: Calculates reclaim for raw water (location selected in table to the right) in m^3/day

Month	2019	2020	2021	2022	2023	2024
1	1,600	1,920	1,920	1,920	1,920	1,920
2	1,600	1,920	1,920	1,920	1,920	1,920
3	1,600	1,920	1,920	1,920	1,920	1,920
4	1,600	1,920	1,920	1,920	1,920	1,920
5	1,600	1,920	1,920	1,920	1,920	1,920
6	1,600	1,920	1,920	1,920	1,920	1,920
7	1,920	1,920	1,920	1,920	1,920	1,920
8	1,920	1,920	1,920	1,920	1,920	1,920
9	1,920	1,920	1,920	1,920	1,920	1,920
10	1,920	1,920	1,920	1,920	1,920	1,920
11	1,920	1,920	1,920	1,920	1,920	1,920
12	1,920	1,920	1,920	1,920	1,920	1,920

Table S.1 - Average number of people at the camp each month
Action: Input the average number of people at camp

Month	2019	2020	2021	2022	2023	2024
1		300	300	300	300	300
2		300	300	300	300	300
3		300	300	300	300	300
4		300	300	300	300	300
5	300	300	300	300	300	300
6	300	300	300	300	300	300
7	300	300	300	300	300	300
8	300	300	300	300	300	300
9	300	300	300	300	300	300
10	300	300	300	300	300	300
11	300	300	300	300	300	300
12	300	300	300	300	300	300

Table S.2 - Percent of sewage treatment plant effluent directed to the TIA (the rest reports to the tundra)
Action: Define percent sewage to the Doris TIA

Month	2019	2020	2021	2022	2023	2024
1		100%	100%	100%	100%	100%
2		100%	100%	100%	100%	100%
3		100%	100%	100%	100%	100%
4		100%	100%	100%	100%	100%
5		100%	100%	100%	100%	100%
6		100%	100%	100%	100%	100%
7		100%	100%	100%	100%	100%
8		100%	100%	100%	100%	100%
9	100%	100%	100%	100%	100%	100%
10	100%	100%	100%	100%	100%	100%
11	100%	100%	100%	100%	100%	100%
12	100%	100%	100%	100%	100%	100%

Table R.3 Source of Raw Water
Action: Select the source of Raw water to the Doris Process Plant from the drop-down list

Month	2019	2020	2021	2022	2023	2024
1	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
2	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
3	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
4	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
5	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
6	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
7	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
8	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
9	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
10	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
11	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
12	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA

Table R.4 Total Reclaim Volume from the Doris TIA (m^3/month)
Table Calculates the reclaim water demand from the Doris TIA in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	93,000	111,600	111,600	111,600	111,600	111,600
2	84,000	104,400	100,800	100,800	100,800	104,400
3	93,000	111,600	111,600	111,600	111,600	111,600
4	90,000	108,000	108,000	108,000	108,000	108,000
5	93,000	111,600	111,600	111,600	111,600	111,600
6	90,000	108,000	108,000	108,000	108,000	108,000
7	111,600	111,600	111,600	111,600	111,600	111,600
8	111,600	111,600	111,600	111,600	111,600	111,600
9	108,000	108,000	108,000	108,000	108,000	108,000
10	111,600	111,600	111,600	111,600	111,600	111,600
11	108,000	108,000	108,000	108,000	108,000	108,000
12	111,600	111,600	111,600	111,600	111,600	111,600

Table S.3 - Calculates the volume of sewage treatment effluent pumped to the Doris TIA
Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	0	1,484	1,484	1,484	1,484	1,484
2	0	1,388	1,340	1,340	1,340	1,388
3	0	1,484	1,484	1,484	1,484	1,484
4	0	1,436	1,436	1,436	1,436	1,436
5	0	1,484	1,484	1,484	1,484	1,484
6	0	1,436	1,436	1,436	1,436	1,436
7	0	1,484	1,484	1,484	1,484	1,484
8	0	1,484	1,484	1,484	1,484	1,484
9	1,436	1,436	1,436	1,436	1,436	1,436
10	1,484	1,484	1,484	1,484	1,484	1,484
11	1,436	1,436	1,436	1,436	1,436	1,436
12	1,484	1,484	1,484	1,484	1,484	1,484

Section 2.4.6 Sediment Control Pond (SCP) to Doris TIA

Note *Table below shows relevant averages from historic data (m^3/day)*

391	2018 June Data
222	2018 July Data
700	2018 August Data

Section 2.4.7 Doris TIA Discharge to Roberts Bay

Pump Capacity 7,200 m^3/day For Reference Design Capacity of System = 7,200 m^3/day
Pump Availability 80%

Section 2.4.8 Madrid North Contact Water Pond (CWP) to Doris TIA

Note *Assumes the same as the Doris SCP*

391	2018 June Data
222	2018 July Data
700	2018 August Data

Table C.1 Volume from SCP to Doris TIA - does not include mine water flows (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6	391	391	391	391	391	391
7	222	222	222	222	222	222
8	700	700	700	700	700	700
9						
10						
11						
12						

Table D.1 Doris TIA Discharge Pump Utilization (days/month)
Action: Fill in the number of days in a month the pump is active

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6		30	30	30	30	30
7		31	31	31	31	31
8		31	31	31	31	31
9		30	30	30	30	30
10						
11						
12						

Table W.1 Volume from MN CWP to Doris TIA - does not include mine water flows (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6		391	391	391	391	391
7		222	222	222	222	222
8		700	700	700	700	700
9						
10						
11						
12						

Table C.2 Volume from SCP to Doris TIA - does not include mine water flows (m^3/month)
Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	11,725	11,725	11,725	11,725	11,725	11,725
7	6,876	6,876	6,876	6,876	6,876	6,876
8	21,700	21,700	21,700	21,700	21,700	21,700
9	0	0	0	0	0	0
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0

Table D.2 Doris TIA Discharge Pumping Rate (m^3/month)
Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	172,800	172,800	172,800	172,800	172,800
7	0	178,560	178,560	178,560	178,560	178,560
8	0	178,560	178,560	178,560	178,560	178,560
9	0	172,800	172,800	172,800	172,800	172,800
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0

Table W.2 Volume from MN CWP to Doris TIA - does not include mine water flows (m^3/month)
Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	11,725	11,725	11,725	11,725	11,725
7	0	6,876	6,876	6,876	6,876	6,876
8	0	21,700	21,700	21,700	21,700	21,700
9	0	0	0	0	0	0
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0

Project Hope Bay
Project No 1CT022-036
Task Control Panel
Note: ***green = input cells, black = calculated cells for the model***
Sections numbers are linked back to the Hope Bay Mine Operational Water Balance Summary Memo dated April 5, 2018

Section 2.4.1 Hydrology
Action: Select Annual Return Period for green cells

Year	Return Period
2016	Average
2017	Average
2018	Average
2019	1 in 100 Wet
2020	1 in 100 Wet
2021	1 in 100 Wet
2022	1 in 100 Wet
2023	1 in 100 Wet

Section 2.5.1 Load Balance
Action: Select Predictive Source Term
Source Term: Base Case

Source Term Options

Upper Case
Base Case

Section 2.4.2 Mine Water
Action: Select the future mine water curves

Options	Description
1	Groundwater Model Curve
2	Adjusted Groundwater Curve to Start from todays observed flows
3	User Input

Action: None, list option for selecting where Mine Water will be directed

Options	Description
1	Doris TIA
2	Roberts Bay

Table M.3 Volume of Mine Water pumped to Doris TIA (via SCP/pumpbox) (m^3/month)
Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	40,300	89,900	7,831	7,332	3,491	3,649
2	47,600	84,100	6,776	6,650	3,186	3,419
3	65,100	89,900	7,499	7,400	3,553	3,652
4	75,000	90,006	6,345	7,173	3,468	3,534
5	77,500	93,037	7,006	7,425	3,602	3,652
6	75,000	9,078	6,411	2,571	3,498	3,534
7	372,000	9,415	6,792	2,868	3,621	3,652
8	40,300	8,820	6,938	3,019	3,636	3,655
9	51,000	8,553	6,807	3,051	3,522	3,537
10	65,100	8,246	7,121	3,271	3,646	3,652
11	75,000	8,043	6,978	3,255	3,531	3,531
12	86,800	7,812	7,276	3,432	3,655	3,643

Table M.1 Volume of Doris Mine Water pumped to Surface (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1	1,300	2,900	2,400	1,700		
2	1,700	2,900	2,300	1,700		
3	2,100	2,900	2,300	1,700		
4	2,500	3,000	2,000	1,700		
5	2,500	3,000	2,000	1,700		
6	2,500	3,000	1,700			
7	12,000	3,000	1,700			
8	1,300	2,800	1,700			
9	1,700	2,800	1,700			
10	2,100	2,600	1,700			
11	2,500	2,600	1,700			
12	2,800	2,400	1,700			

Table M.4 Volume of Madrid North Mine Water pumped to Surface (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1			126	665	1,126	1,177
2			120	675	1,138	1,179
3			119	687	1,146	1,178
4		2	115	691	1,156	1,178
5		12	260	695	1,162	1,178
6		26	437	857	1,166	1,178
7		37	491	925	1,168	1,178
8		45	538	974	1,173	1,179
9		51	569	1,017	1,174	1,179
10		60	597	1,055	1,176	1,178
11		81	626	1,085	1,177	1,177
12		120	647	1,107	1,179	1,175

Table M.6 Volume of Madrid South Mine Water pumped to Surface (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Table M.2 Directs Doris mine water to the Doris TIA (the rest goes to Robert's Bay directly)
Action: Define percentage of Mine Water directed to the Doris TIA

Month	2019	2020	2021	2022	2023	2024
1	100%	100%	10%	10%	10%	10%
2	100%	100%	10%	10%	10%	10%
3	100%	100%	10%	10%	10%	10%
4	100%	100%	10%	10%	10%	10%
5	100%	100%	10%	10%	10%	10%
6	100%	10%	10%	10%	10%	10%
7	100%	10%	10%	10%	10%	10%
8	100%	10%	10%	10%	10%	10%
9	100%	10%	10%	10%	10%	10%
10	100%	10%	10%	10%	10%	10%
11	100%	10%	10%	10%	10%	10%
12	100%	10%	10%	10%	10%	10%

Table M.5 Directs Madrid North mine water to the Doris TIA (the rest goes to Robert's Bay direc
Action: Define percentage of Mine Water directed to the Doris TIA

Month	2019	2020	2021	2022	2023	2024
1	100%	10%	10%	10%	10%	10%
2	100%	10%	10%	10%	10%	10%
3	100%	10%	10%	10%	10%	10%
4	100%	10%	10%	10%	10%	10%
5	100%	10%	10%	10%	10%	10%
6	100%	10%	10%	10%	10%	10%
7	100%	10%	10%	10%	10%	10%
8	100%	10%	10%	10%	10%	10%
9	100%	10%	10%	10%	10%	10%
10	100%	10%	10%	10%	10%	10%
11	100%	10%	10%	10%	10%	10%
12	100%	10%	10%	10%	10%	10%

Table M.7 Directs Madrid South mine water to the Doris TIA (the rest goes to Robert's Bay directly)
Action: Define percentage of Mine Water directed to the Doris TIA

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Section 2.4.3 Ore Processing and Tailings Deposition
Note Assumes ore = total tailings = flotation tails + detoxified tails
Assumptions:

Tailings thickener underflow solids:	45%	solids	*Roughly average percent solids (August - November 2018)*
Plant Effluent:	1.50	m^3/tonne o	*Value set to all water into mill*
End of pipe tailings solids content	27%		
Tailings Specific Gravity	2.8		
Deposited Dry Density Slurried Tailings	1.3	tonnes/m^3	
Flotation Tails (% of total tails to TIA)	95%	solids	
Density of Water	1.0	tonnes/m^3	
Tailings Void ratio	1.2		

Table T.1 Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1	2,000	2,400	2,400	2,400	2,400	2,400
2	2,000	2,400	2,400	2,400	2,400	2,400
3	2,000	2,400	2,400	2,400	2,400	2,400
4	2,000	2,400	2,400	2,400	2,400	2,400
5	2,000	2,400	2,400	2,400	2,400	2,400
6	2,000	2,400	2,400	2,400	2,400	2,400
7	2,400	2,400	2,400	2,400	2,400	2,400
8	2,400	2,400	2,400	2,400	2,400	2,400
9	2,400	2,400	2,400	2,400	2,400	2,400
10	2,400	2,400	2,400	2,400	2,400	2,400
11	2,400	2,400	2,400	2,400	2,400	2,400
12	2,400	2,400	2,400	2,400	2,400	2,400

Table T.3 Total Tailings Solids to TIA (tonnes/month)
Table Calculates the total tailings solids input to the TIA from the process plant in tonnes/month

Month	2019	2020	2021	2022	2023	2024
1	58,900	70,680	70,680	70,680	70,680	70,680
2	53,200	66,120	63,840	63,840	63,840	66,120
3	58,900	70,680	70,680	70,680	70,680	70,680
4	57,000	68,400	68,400	68,400	68,400	68,400
5	58,900	70,680	70,680	70,680	70,680	70,680
6	57,000	68,400	68,400	68,400	68,400	68,400
7	70,680	70,680	70,680	70,680	70,680	70,680
8	70,680	70,680	70,680	70,680	70,680	70,680
9	68,400	68,400	68,400	68,400	68,400	68,400
10	70,680	70,680	70,680	70,680	70,680	70,680
11	68,400	68,400	68,400	68,400	68,400	68,400
12	70,680	70,680	70,680	70,680	70,680	70,680

Table T.2 Total Volume of water to TIA (m^3/month)
Table Calculates the total water input to the TIA from the process plant in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	93,000	111,600	111,600	111,600	111,600	111,600
2	84,000	104,400	100,800	100,800	100,800	104,400
3	93,000	111,600	111,600	111,600	111,600	111,600
4	90,000	108,000	108,000	108,000	108,000	108,000
5	93,000	111,600	111,600	111,600	111,600	111,600
6	90,000	108,000	108,000	108,000	108,000	108,000
7	111,600	111,600	111,600	111,600	111,600	111,600
8	111,600	111,600	111,600	111,600	111,600	111,600
9	108,000	108,000	108,000	108,000	108,000	108,000
10	111,600	111,600	111,600	111,600	111,600	111,600
11	108,000	108,000	108,000	108,000	108,000	108,000
12	111,600	111,600	111,600	111,600	111,600	111,600

Table T.1a Doris Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1	2,000					
2	2,000					
3	2,000					
4	2,000					
5	2,000					
6	2,000					
7	2,400					
8	2,400					
9	2,400					
10	2,400					
11	2,400					
12	2,400					

Table T.1 b Madrid North Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1		2,400	2,400	2,400	2,400	2,400
2		2,400	2,400	2,400	2,400	2,400
3		2,400	2,400	2,400	2,400	2,400
4		2,400	2,400	2,400	2,400	2,400
5		2,400	2,400	2,400	2,400	2,400
6		2,400	2,400	2,400	2,400	2,400
7		2,400	2,400	2,400	2,400	2,400
8		2,400	2,400	2,400	2,400	2,400
9		2,400	2,400	2,400	2,400	2,400
10		2,400	2,400	2,400	2,400	2,400
11		2,400	2,400	2,400	2,400	2,400
12		2,400	2,400	2,400	2,400	2,400

Table T.1 c Madrid South Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Table T.1d Boston Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Project Hope Bay
Project No 1CT022-036
Task Control Panel
Note: ***green = input cells, black = calculated cells for the model***
Sections numbers are linked back to the Hope Bay Mine Operational Water Balance Summary Memo dated April 5, 2018

Section 2.4.4 Process Plant Reclaim

Note *Update the water use values based on the hourly process flow breakdown*

0.7	To process water tank (m^3/tonne)	Based on average July to Dec 2018
0.8	To raw water tank (m^3/tonne)	Based on average July to Dec 2018

Note: *Defines the source of raw water to the process plant*

Option 1	Doris TIA	results in no change in net water to Doris TIA
Options 2	Doris Lake	results in net water addition to Doris TIA
Options 3	-	results in no model action when selected

Section 2.4.5 Sewage Treatment Plant Effluent

Note *Table below shows relevant averages from historic data*

0.16	Average rate since operations (m^3/person/day)
-	

Table R.1 Process Water to Process Plant (m^3/day)

Action: Calculates reclaim for process water from the Doris TIA case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1	1,400	1,680	1,680	1,680	1,680	1,680
2	1,400	1,680	1,680	1,680	1,680	1,680
3	1,400	1,680	1,680	1,680	1,680	1,680
4	1,400	1,680	1,680	1,680	1,680	1,680
5	1,400	1,680	1,680	1,680	1,680	1,680
6	1,400	1,680	1,680	1,680	1,680	1,680
7	1,680	1,680	1,680	1,680	1,680	1,680
8	1,680	1,680	1,680	1,680	1,680	1,680
9	1,680	1,680	1,680	1,680	1,680	1,680
10	1,680	1,680	1,680	1,680	1,680	1,680
11	1,680	1,680	1,680	1,680	1,680	1,680
12	1,680	1,680	1,680	1,680	1,680	1,680

Table R.2 Raw Water to Process Plant (m^3/day)

Action: Calculates reclaim for raw water (location selected in table to the right) in m^3/day

Month	2019	2020	2021	2022	2023	2024
1	1,600	1,920	1,920	1,920	1,920	1,920
2	1,600	1,920	1,920	1,920	1,920	1,920
3	1,600	1,920	1,920	1,920	1,920	1,920
4	1,600	1,920	1,920	1,920	1,920	1,920
5	1,600	1,920	1,920	1,920	1,920	1,920
6	1,600	1,920	1,920	1,920	1,920	1,920
7	1,920	1,920	1,920	1,920	1,920	1,920
8	1,920	1,920	1,920	1,920	1,920	1,920
9	1,920	1,920	1,920	1,920	1,920	1,920
10	1,920	1,920	1,920	1,920	1,920	1,920
11	1,920	1,920	1,920	1,920	1,920	1,920
12	1,920	1,920	1,920	1,920	1,920	1,920

Table S.1 - Average number of people at the camp each month

Action: Input the average number of people at camp

Month	2019	2020	2021	2022	2023	2024
1		300	300	300	300	300
2		300	300	300	300	300
3		300	300	300	300	300
4		300	300	300	300	300
5	300	300	300	300	300	300
6	300	300	300	300	300	300
7	300	300	300	300	300	300
8	300	300	300	300	300	300
9	300	300	300	300	300	300
10	300	300	300	300	300	300
11	300	300	300	300	300	300
12	300	300	300	300	300	300

Table S.2 - Percent of sewage treatment plant effluent directed to the TIA (the rest reports to the tundra)

Action: Define percent sewage to the Doris TIA

Month	2019	2020	2021	2022	2023	2024
1		100%	100%	100%	100%	100%
2		100%	100%	100%	100%	100%
3		100%	100%	100%	100%	100%
4		100%	100%	100%	100%	100%
5		100%	100%	100%	100%	100%
6		100%	100%	100%	100%	100%
7		100%	100%	100%	100%	100%
8		100%	100%	100%	100%	100%
9	100%	100%	100%	100%	100%	100%
10	100%	100%	100%	100%	100%	100%
11	100%	100%	100%	100%	100%	100%
12	100%	100%	100%	100%	100%	100%

Table R.3 Source of Raw Water

Action: Select the source of Raw water to the Doris Process Plant from the drop-down list

Month	2019	2020	2021	2022	2023	2024
1	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
2	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
3	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
4	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
5	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
6	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
7	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
8	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
9	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
10	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
11	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
12	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA

Table R.4 Total Reclaim Volume from the Doris TIA (m^3/month)

Table Calculates the reclaim water demand from the Doris TIA in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	93,000	111,600	111,600	111,600	111,600	111,600
2	84,000	104,400	100,800	100,800	100,800	104,400
3	93,000	111,600	111,600	111,600	111,600	111,600
4	90,000	108,000	108,000	108,000	108,000	108,000
5	93,000	111,600	111,600	111,600	111,600	111,600
6	90,000	108,000	108,000	108,000	108,000	108,000
7	111,600	111,600	111,600	111,600	111,600	111,600
8	111,600	111,600	111,600	111,600	111,600	111,600
9	108,000	108,000	108,000	108,000	108,000	108,000
10	111,600	111,600	111,600	111,600	111,600	111,600
11	108,000	108,000	108,000	108,000	108,000	108,000
12	111,600	111,600	111,600	111,600	111,600	111,600

Table S.3 - Calculates the volume of sewage treatment effluent pumped to the Doris TIA

Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	0	1,484	1,484	1,484	1,484	1,484
2	0	1,388	1,340	1,340	1,340	1,388
3	0	1,484	1,484	1,484	1,484	1,484
4	0	1,436	1,436	1,436	1,436	1,436
5	0	1,484	1,484	1,484	1,484	1,484
6	0	1,436	1,436	1,436	1,436	1,436
7	0	1,484	1,484	1,484	1,484	1,484
8	0	1,484	1,484	1,484	1,484	1,484
9	1,436	1,436	1,436	1,436	1,436	1,436
10	1,484	1,484	1,484	1,484	1,484	1,484
11	1,436	1,436	1,436	1,436	1,436	1,436
12	1,484	1,484	1,484	1,484	1,484	1,484

Section 2.4.6 Sediment Control Pond (SCP) to Doris TIA

Note *Table below shows relevant averages from historic data (m^3/day)*

391	2018 June Data
222	2018 July Data
700	2018 August Data

Section 2.4.7 Doris TIA Discharge to Roberts Bay

Pump Capacity	7,200	m^3/day	For Reference Design Capacity of System = 7,200 m^3/day
Pump Availability	80%		

Section 2.4.8 Madrid North Contact Water Pond (CWP) to Doris TIA

Note *Assumes the same as the Doris SCP*

391	2018 June Data
222	2018 July Data
700	2018 August Data

Table C.1 Volume from SCP to Doris TIA - does not include mine water flows (m^3/day)

Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6	391	391	391	391	391	391
7	222	222	222	222	222	222
8	700	700	700	700	700	700
9						
10						
11						
12						

Table D.1 Doris TIA Discharge Pump Utilization (days/month)

Action: Fill in the number of days in a month the pump is active

Month	2019	2020	2021	2022	2023	2024
1		31				
2		28				
3		31				
4		30				
5		31				
6		30	30	30	30	30
7		31	31	31	31	31
8		31	31	31	31	31
9		30	30	30	30	30
10						
11						
12						

Table W.1 Volume from MN CWP to Doris TIA - does not include mine water flows (m^3/day)

Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6		391	391	391	391	391
7		222	222	222	222	222
8		700	700	700	700	700
9						
10						
11						
12						

Table C.2 Volume from SCP to Doris TIA - does not include mine water flows (m^3/month)

Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	11,725	11,725	11,725	11,725	11,725	11,725
7	6,876	6,876	6,876	6,876	6,876	6,876
8	21,700	21,700	21,700	21,700	21,700	21,700
9	0	0	0	0	0	0
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0

Table D.2 Doris TIA Discharge Pumping Rate (m^3/month)

Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	0	178,560	0	0	0	0
2	0	161,280	0	0	0	0
3	0	178,560	0	0	0	0
4	0	172,800	0	0	0	0
5	0	178,560	0	0	0	0
6	0	172,800	172,800	172,800	172,800	172,800
7	0	178,560	178,560	178,560	178,560	178,560
8	0	178,560	178,560	178,560	178,560	178,560
9	0	172,800	172,800	172,800	172,800	172,800
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0

Table W.2 Volume from MN CWP to Doris TIA - does not include mine water flows (m^3/month)

Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	11,725	11,725	11,725	11,725	11,725
7	0	6,876	6,876	6,876	6,876	6,876
8	0	21,700	21,700	21,700	21,700	21,700
9	0	0	0	0	0	0
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0

Project Hope Bay
Project Nu 1CT022-036
Task Control Panel
Note: ***green = input cells, black = calculated cells for the model***
Sections numbers are linked back to the Hope Bay Mine Operational Water Balance Summary Memo dated April 5, 2018

Section 2.4.1 Hydrology
Action: Select Annual Return Period for green cells

Year	Return Period
2016	Average
2017	Average
2018	Average
2019	Average
2020	Average
2021	Average
2022	Average
2023	Average

Section 2.5.1 Load Balance
Action: Select Predictive Source Term
Source Term: Base Case

Source Term Options

Upper Case
Base Case

Section 2.4.2 Mine Water
Action: Select the future mine water curves

Options	Description
1	Groundwater Model Curve
2	Adjusted Groundwater Curve to Start from todays observed flows
3	User Input

Action: None, list option for selecting where Mine Water will be directed

Options	Description
1	Doris TIA
2	Roberts Bay

Table M.3 Volume of Mine Water pumped to Doris TIA (via SCP/pumpbox) (m^3/month)
Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	40,300	89,900	78,306	73,315	34,906	36,487
2	47,600	84,100	67,760	66,500	31,864	34,191
3	65,100	89,900	74,989	73,997	35,526	36,518
4	75,000	90,060	63,450	71,730	34,680	35,340
5	77,500	93,372	70,060	74,245	36,022	36,518
6	75,000	90,780	64,110	25,710	34,980	35,340
7	372,000	94,147	67,921	28,675	36,208	36,518
8	40,300	88,195	69,378	30,194	36,363	36,549
9	51,000	85,530	68,070	30,510	35,220	35,370
10	65,100	82,460	71,207	32,705	36,456	36,518
11	75,000	80,430	69,780	32,550	35,310	35,310
12	86,800	78,120	72,757	34,317	36,549	36,425

Table M.1 Volume of Doris Mine Water pumped to Surface (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1	1,300	2,900	2,400	1,700		
2	1,700	2,900	2,300	1,700		
3	2,100	2,900	2,300	1,700		
4	2,500	3,000	2,000	1,700		
5	2,500	3,000	2,000	1,700		
6	2,500	3,000	1,700			
7	12,000	3,000	1,700			
8	1,300	2,800	1,700			
9	1,700	2,800	1,700			
10	2,100	2,600	1,700			
11	2,500	2,600	1,700			
12	2,800	2,400	1,700			

Table M.4 Volume of Madrid North Mine Water pumped to Surface (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1			126	665	1,126	1,177
2			120	675	1,138	1,179
3			119	687	1,146	1,178
4		2	115	691	1,156	1,178
5		12	260	695	1,162	1,178
6		26	437	857	1,166	1,178
7		37	491	925	1,168	1,178
8		45	538	974	1,173	1,179
9		51	569	1,017	1,174	1,179
10		60	597	1,055	1,176	1,178
11		81	626	1,085	1,177	1,177
12		120	647	1,107	1,179	1,175

Table M.6 Volume of Madrid South Mine Water pumped to Surface (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Table M.2 Directs Doris mine water to the Doris TIA (the rest goes to Robert's Bay directly)
Action: Define percentage of Mine Water directed to the Doris TIA

Month	2019	2020	2021	2022	2023	2024
1	100%	100%	100%	100%	100%	100%
2	100%	100%	100%	100%	100%	100%
3	100%	100%	100%	100%	100%	100%
4	100%	100%	100%	100%	100%	100%
5	100%	100%	100%	100%	100%	100%
6	100%	100%	100%	100%	100%	100%
7	100%	100%	100%	100%	100%	100%
8	100%	100%	100%	100%	100%	100%
9	100%	100%	100%	100%	100%	100%
10	100%	100%	100%	100%	100%	100%
11	100%	100%	100%	100%	100%	100%
12	100%	100%	100%	100%	100%	100%

Table M.5 Directs Madrid North mine water to the Doris TIA (the rest goes to Robert's Bay direc
Action: Define percentage of Mine Water directed to the Doris TIA

Month	2019	2020	2021	2022	2023	2024
1	100%	100%	100%	100%	100%	100%
2	100%	100%	100%	100%	100%	100%
3	100%	100%	100%	100%	100%	100%
4	100%	100%	100%	100%	100%	100%
5	100%	100%	100%	100%	100%	100%
6	100%	100%	100%	100%	100%	100%
7	100%	100%	100%	100%	100%	100%
8	100%	100%	100%	100%	100%	100%
9	100%	100%	100%	100%	100%	100%
10	100%	100%	100%	100%	100%	100%
11	100%	100%	100%	100%	100%	100%
12	100%	100%	100%	100%	100%	100%

Table M.7 Directs Madrid South mine water to the Doris TIA (the rest goes to Robert's Bay directly)
Action: Define percentage of Mine Water directed to the Doris TIA

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Section 2.4.3 Ore Processing and Tailings Deposition
Note Assumes ore = total tailings = flotation tails + detoxified tails
Assumptions:

Tailings thickener underflow solids:	45%	solids	*Roughly average percent solids (August - November 2018)*
Plant Effluent:	1.50	m^3/tonne o	*Value set to all water into mill*
End of pipe tailings solids content	27%		
Tailings Specific Gravity	2.8		
Deposited Dry Density Slurried Tailings	1.3	tonnes/m^3	
Flotation Tails (% of total tails to TIA)	95%	solids	
Density of Water	1.0	tonnes/m^3	
Tailings Void ratio	1.2		

Table T.1 Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1	2,000	2,400	2,400	2,400	2,400	2,400
2	2,000	2,400	2,400	2,400	2,400	2,400
3	2,000	2,400	2,400	2,400	2,400	2,400
4	2,000	2,400	2,400	2,400	2,400	2,400
5	2,000	2,400	2,400	2,400	2,400	2,400
6	2,000	2,400	2,400	2,400	2,400	2,400
7	2,400	2,400	2,400	2,400	2,400	2,400
8	2,400	2,400	2,400	2,400	2,400	2,400
9	2,400	2,400	2,400	2,400	2,400	2,400
10	2,400	2,400	2,400	2,400	2,400	2,400
11	2,400	2,400	2,400	2,400	2,400	2,400
12	2,400	2,400	2,400	2,400	2,400	2,400

Table T.3 Total Tailings Solids to TIA (tonnes/month)
Table Calculates the total tailings solids input to the TIA from the process plant in tonnes/month

Month	2019	2020	2021	2022	2023	2024
1	58,900	70,680	70,680	70,680	70,680	70,680
2	53,200	66,120	63,840	63,840	63,840	66,120
3	58,900	70,680	70,680	70,680	70,680	70,680
4	57,000	68,400	68,400	68,400	68,400	68,400
5	58,900	70,680	70,680	70,680	70,680	70,680
6	57,000	68,400	68,400	68,400	68,400	68,400
7	70,680	70,680	70,680	70,680	70,680	70,680
8	70,680	70,680	70,680	70,680	70,680	70,680
9	68,400	68,400	68,400	68,400	68,400	68,400
10	70,680	70,680	70,680	70,680	70,680	70,680
11	68,400	68,400	68,400	68,400	68,400	68,400
12	70,680	70,680	70,680	70,680	70,680	70,680

Table T.2 Total Volume of water to TIA (m^3/month)
Table Calculates the total water input to the TIA from the process plant in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	93,000	111,600	111,600	111,600	111,600	111,600
2	84,000	104,400	100,800	100,800	100,800	104,400
3	93,000	111,600	111,600	111,600	111,600	111,600
4	90,000	108,000	108,000	108,000	108,000	108,000
5	93,000	111,600	111,600	111,600	111,600	111,600
6	90,000	108,000	108,000	108,000	108,000	108,000
7	111,600	111,600	111,600	111,600	111,600	111,600
8	111,600	111,600	111,600	111,600	111,600	111,600
9	108,000	108,000	108,000	108,000	108,000	108,000
10	111,600	111,600	111,600	111,600	111,600	111,600
11	108,000	108,000	108,000	108,000	108,000	108,000
12	111,600	111,600	111,600	111,600	111,600	111,600

Table T.1a Doris Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1	2,000					
2	2,000					
3	2,000					
4	2,000					
5	2,000					
6	2,000					
7	2,400					
8	2,400					
9	2,400					
10	2,400					
11	2,400					
12	2,400					

Table T.1 b Madrid North Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1		2,400	2,400	2,400	2,400	2,400
2		2,400	2,400	2,400	2,400	2,400
3		2,400	2,400	2,400	2,400	2,400
4		2,400	2,400	2,400	2,400	2,400
5		2,400	2,400	2,400	2,400	2,400
6		2,400	2,400	2,400	2,400	2,400
7		2,400	2,400	2,400	2,400	2,400
8		2,400	2,400	2,400	2,400	2,400
9		2,400	2,400	2,400	2,400	2,400
10		2,400	2,400	2,400	2,400	2,400
11		2,400	2,400	2,400	2,400	2,400
12		2,400	2,400	2,400	2,400	2,400

Table T.1 c Madrid South Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Table T.1d Boston Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Project Hope Bay
Project No 1CT022-036
Task Control Panel
Note: ***green = input cells, black = calculated cells for the model***
Sections numbers are linked back to the Hope Bay Mine Operational Water Balance Summary Memo dated April 5, 2018

Section 2.4.4 Process Plant Reclaim

Note *Update the water use values based on the hourly process flow breakdown*

0.7	To process water tank (m^3/tonne)	Based on average July to Dec 2018
0.8	To raw water tank (m^3/tonne)	Based on average July to Dec 2018

Note: *Defines the source of raw water to the process plant*

Option 1	Doris TIA	results in no change in net water to Doris TIA
Options 2	Doris Lake	results in net water addition to Doris TIA
Options 3	-	results in no model action when selected

Section 2.4.5 Sewage Treatment Plant Effluent

Note *Table below shows relevant averages from historic data*

0.16	Average rate since operations (m^3/person/day)
-	

Table R.1 Process Water to Process Plant (m^3/day)
Action: Calculates reclaim for process water from the Doris TIA case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1	1,400	1,680	1,680	1,680	1,680	1,680
2	1,400	1,680	1,680	1,680	1,680	1,680
3	1,400	1,680	1,680	1,680	1,680	1,680
4	1,400	1,680	1,680	1,680	1,680	1,680
5	1,400	1,680	1,680	1,680	1,680	1,680
6	1,400	1,680	1,680	1,680	1,680	1,680
7	1,680	1,680	1,680	1,680	1,680	1,680
8	1,680	1,680	1,680	1,680	1,680	1,680
9	1,680	1,680	1,680	1,680	1,680	1,680
10	1,680	1,680	1,680	1,680	1,680	1,680
11	1,680	1,680	1,680	1,680	1,680	1,680
12	1,680	1,680	1,680	1,680	1,680	1,680

Table R.2 Raw Water to Process Plant (m^3/day)
Action: Calculates reclaim for raw water (location selected in table to the right) in m^3/day

Month	2019	2020	2021	2022	2023	2024
1	1,600	1,920	1,920	1,920	1,920	1,920
2	1,600	1,920	1,920	1,920	1,920	1,920
3	1,600	1,920	1,920	1,920	1,920	1,920
4	1,600	1,920	1,920	1,920	1,920	1,920
5	1,600	1,920	1,920	1,920	1,920	1,920
6	1,600	1,920	1,920	1,920	1,920	1,920
7	1,920	1,920	1,920	1,920	1,920	1,920
8	1,920	1,920	1,920	1,920	1,920	1,920
9	1,920	1,920	1,920	1,920	1,920	1,920
10	1,920	1,920	1,920	1,920	1,920	1,920
11	1,920	1,920	1,920	1,920	1,920	1,920
12	1,920	1,920	1,920	1,920	1,920	1,920

Table S.1 - Average number of people at the camp each month
Action: Input the average number of people at camp

Month	2019	2020	2021	2022	2023	2024
1		300	300	300	300	300
2		300	300	300	300	300
3		300	300	300	300	300
4		300	300	300	300	300
5	300	300	300	300	300	300
6	300	300	300	300	300	300
7	300	300	300	300	300	300
8	300	300	300	300	300	300
9	300	300	300	300	300	300
10	300	300	300	300	300	300
11	300	300	300	300	300	300
12	300	300	300	300	300	300

Table S.2 - Percent of sewage treatment plant effluent directed to the TIA (the rest reports to the tundra)
Action: Define percent sewage to the Doris TIA

Month	2019	2020	2021	2022	2023	2024
1		100%	100%	100%	100%	100%
2		100%	100%	100%	100%	100%
3		100%	100%	100%	100%	100%
4		100%	100%	100%	100%	100%
5		100%	100%	100%	100%	100%
6		100%	100%	100%	100%	100%
7		100%	100%	100%	100%	100%
8		100%	100%	100%	100%	100%
9	100%	100%	100%	100%	100%	100%
10	100%	100%	100%	100%	100%	100%
11	100%	100%	100%	100%	100%	100%
12	100%	100%	100%	100%	100%	100%

Table R.3 Source of Raw Water
Action: Select the source of Raw water to the Doris Process Plant from the drop-down list

Month	2019	2020	2021	2022	2023	2024
1	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
2	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
3	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
4	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
5	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
6	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
7	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
8	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
9	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
10	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
11	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
12	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA

Table R.4 Total Reclaim Volume from the Doris TIA (m^3/month)
Table Calculates the reclaim water demand from the Doris TIA in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	93,000	111,600	111,600	111,600	111,600	111,600
2	84,000	104,400	100,800	100,800	100,800	104,400
3	93,000	111,600	111,600	111,600	111,600	111,600
4	90,000	108,000	108,000	108,000	108,000	108,000
5	93,000	111,600	111,600	111,600	111,600	111,600
6	90,000	108,000	108,000	108,000	108,000	108,000
7	111,600	111,600	111,600	111,600	111,600	111,600
8	111,600	111,600	111,600	111,600	111,600	111,600
9	108,000	108,000	108,000	108,000	108,000	108,000
10	111,600	111,600	111,600	111,600	111,600	111,600
11	108,000	108,000	108,000	108,000	108,000	108,000
12	111,600	111,600	111,600	111,600	111,600	111,600

Table S.3 - Calculates the volume of sewage treatment effluent pumped to the Doris TIA
Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	0	1,484	1,484	1,484	1,484	1,484
2	0	1,388	1,340	1,340	1,340	1,388
3	0	1,484	1,484	1,484	1,484	1,484
4	0	1,436	1,436	1,436	1,436	1,436
5	0	1,484	1,484	1,484	1,484	1,484
6	0	1,436	1,436	1,436	1,436	1,436
7	0	1,484	1,484	1,484	1,484	1,484
8	0	1,484	1,484	1,484	1,484	1,484
9	1,436	1,436	1,436	1,436	1,436	1,436
10	1,484	1,484	1,484	1,484	1,484	1,484
11	1,436	1,436	1,436	1,436	1,436	1,436
12	1,484	1,484	1,484	1,484	1,484	1,484

Section 2.4.6 Sediment Control Pond (SCP) to Doris TIA

Note *Table below shows relevant averages from historic data (m^3/day)*

391	2018 June Data
222	2018 July Data
700	2018 August Data

Section 2.4.7 Doris TIA Discharge to Roberts Bay

Pump Capacity 7,200 m^3/day For Reference Design Capacity of System = 7,200 m^3/day
Pump Availability 80%

Section 2.4.8 Madrid North Contact Water Pond (CWP) to Doris TIA

Note *Assumes the same as the Doris SCP*

391	2018 June Data
222	2018 July Data
700	2018 August Data

Table C.1 Volume from SCP to Doris TIA - does not include mine water flows (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6	391	391	391	391	391	391
7	222	222	222	222	222	222
8	700	700	700	700	700	700
9						
10						
11						
12						

Table D.1 Doris TIA Discharge Pump Utilization (days/month)
Action: Fill in the number of days in a month the pump is active

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6		30	30	30	30	30
7		31	31	31	31	31
8		31	31	31	31	31
9		30	30	30	30	30
10						
11						
12						

Table W.1 Volume from MN CWP to Doris TIA - does not include mine water flows (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6		391	391	391	391	391
7		222	222	222	222	222
8		700	700	700	700	700
9						
10						
11						
12						

Table C.2 Volume from SCP to Doris TIA - does not include mine water flows (m^3/month)
Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	11,725	11,725	11,725	11,725	11,725	11,725
7	6,876	6,876	6,876	6,876	6,876	6,876
8	21,700	21,700	21,700	21,700	21,700	21,700
9	0	0	0	0	0	0
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0

Table D.2 Doris TIA Discharge Pumping Rate (m^3/month)
Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	172,800	172,800	172,800	172,800	172,800
7	0	178,560	178,560	178,560	178,560	178,560
8	0	178,560	178,560	178,560	178,560	178,560
9	0	172,800	172,800	172,800	172,800	172,800
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0

Table W.2 Volume from MN CWP to Doris TIA - does not include mine water flows (m^3/month)
Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	11,725	11,725	11,725	11,725	11,725
7	0	6,876	6,876	6,876	6,876	6,876
8	0	21,700	21,700	21,700	21,700	21,700
9	0	0	0	0	0	0
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0

Project Hope Bay
Project No 1CT022-036
Task Control Panel
Note: ***green = input cells, black = calculated cells for the model***
Sections numbers are linked back to the Hope Bay Mine Operational Water Balance Summary Memo dated April 5, 2018

Section 2.4.1 Hydrology
Action: Select Annual Return Period for green cells

Year	Return Period
2016	Average
2017	Average
2018	Average
2019	1 in 100 Wet
2020	1 in 100 Wet
2021	1 in 100 Wet
2022	1 in 100 Wet
2023	1 in 100 Wet

Section 2.5.1 Load Balance
Action: Select Predictive Source Term
Source Term: Base Case

Source Term Options

Upper Case
Base Case

Section 2.4.2 Mine Water
Action: Select the future mine water curves

Options	Description
1	Groundwater Model Curve
2	Adjusted Groundwater Curve to Start from todays observed flows
3	User Input

Action: None, list option for selecting where Mine Water will be directed

Options	Description
1	Doris TIA
2	Roberts Bay

Table M.3 Volume of Mine Water pumped to Doris TIA (via SCP/pumpbox) (m^3/month)
Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	40,300	89,900	78,306	73,315	34,906	36,487
2	47,600	84,100	67,760	66,500	31,864	34,191
3	65,100	89,900	74,989	73,997	35,526	36,518
4	75,000	90,060	63,450	71,730	34,680	35,340
5	77,500	93,372	70,060	74,245	36,022	36,518
6	75,000	90,780	64,110	25,710	34,980	35,340
7	372,000	94,147	67,921	28,675	36,208	36,518
8	40,300	88,195	69,378	30,194	36,363	36,549
9	51,000	85,530	68,070	30,510	35,220	35,370
10	65,100	82,460	71,207	32,705	36,456	36,518
11	75,000	80,430	69,780	32,550	35,310	35,310
12	86,800	78,120	72,757	34,317	36,549	36,425

Table M.1 Volume of Doris Mine Water pumped to Surface (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1	1,300	2,900	2,400	1,700		
2	1,700	2,900	2,300	1,700		
3	2,100	2,900	2,300	1,700		
4	2,500	3,000	2,000	1,700		
5	2,500	3,000	2,000	1,700		
6	2,500	3,000	1,700			
7	12,000	3,000	1,700			
8	1,300	2,800	1,700			
9	1,700	2,800	1,700			
10	2,100	2,600	1,700			
11	2,500	2,600	1,700			
12	2,800	2,400	1,700			

Table M.4 Volume of Madrid North Mine Water pumped to Surface (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1			126	665	1,126	1,177
2			120	675	1,138	1,179
3			119	687	1,146	1,178
4		2	115	691	1,156	1,178
5		12	260	695	1,162	1,178
6		26	437	857	1,166	1,178
7		37	491	925	1,168	1,178
8		45	538	974	1,173	1,179
9		51	569	1,017	1,174	1,179
10		60	597	1,055	1,176	1,178
11		81	626	1,085	1,177	1,177
12		120	647	1,107	1,179	1,175

Table M.6 Volume of Madrid South Mine Water pumped to Surface (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Table M.2 Directs Doris mine water to the Doris TIA (the rest goes to Robert's Bay directly)
Action: Define percentage of Mine Water directed to the Doris TIA

Month	2019	2020	2021	2022	2023	2024
1	100%	100%	100%	100%	100%	100%
2	100%	100%	100%	100%	100%	100%
3	100%	100%	100%	100%	100%	100%
4	100%	100%	100%	100%	100%	100%
5	100%	100%	100%	100%	100%	100%
6	100%	100%	100%	100%	100%	100%
7	100%	100%	100%	100%	100%	100%
8	100%	100%	100%	100%	100%	100%
9	100%	100%	100%	100%	100%	100%
10	100%	100%	100%	100%	100%	100%
11	100%	100%	100%	100%	100%	100%
12	100%	100%	100%	100%	100%	100%

Table M.5 Directs Madrid North mine water to the Doris TIA (the rest goes to Robert's Bay direc
Action: Define percentage of Mine Water directed to the Doris TIA

Month	2019	2020	2021	2022	2023	2024
1	100%	100%	100%	100%	100%	100%
2	100%	100%	100%	100%	100%	100%
3	100%	100%	100%	100%	100%	100%
4	100%	100%	100%	100%	100%	100%
5	100%	100%	100%	100%	100%	100%
6	100%	100%	100%	100%	100%	100%
7	100%	100%	100%	100%	100%	100%
8	100%	100%	100%	100%	100%	100%
9	100%	100%	100%	100%	100%	100%
10	100%	100%	100%	100%	100%	100%
11	100%	100%	100%	100%	100%	100%
12	100%	100%	100%	100%	100%	100%

Table M.7 Directs Madrid South mine water to the Doris TIA (the rest goes to Robert's Bay directly)
Action: Define percentage of Mine Water directed to the Doris TIA

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Section 2.4.3 Ore Processing and Tailings Deposition
Note Assumes ore = total tailings = flotation tails + detoxified tails
Assumptions:

Tailings thickener underflow solids:	45%	solids	*Roughly average percent solids (August - November 2018)*
Plant Effluent:	1.50	m^3/tonne o	*Value set to all water into mill*
End of pipe tailings solids content	27%		
Tailings Specific Gravity	2.8		
Deposited Dry Density Slurried Tailings	1.3	tonnes/m^3	
Flotation Tails (% of total tails to TIA)	95%	solids	
Density of Water	1.0	tonnes/m^3	
Tailings Void ratio	1.2		

Table T.1 Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1	2,000	2,400	2,400	2,400	2,400	2,400
2	2,000	2,400	2,400	2,400	2,400	2,400
3	2,000	2,400	2,400	2,400	2,400	2,400
4	2,000	2,400	2,400	2,400	2,400	2,400
5	2,000	2,400	2,400	2,400	2,400	2,400
6	2,000	2,400	2,400	2,400	2,400	2,400
7	2,400	2,400	2,400	2,400	2,400	2,400
8	2,400	2,400	2,400	2,400	2,400	2,400
9	2,400	2,400	2,400	2,400	2,400	2,400
10	2,400	2,400	2,400	2,400	2,400	2,400
11	2,400	2,400	2,400	2,400	2,400	2,400
12	2,400	2,400	2,400	2,400	2,400	2,400

Table T.3 Total Tailings Solids to TIA (tonnes/month)
Table Calculates the total tailings solids input to the TIA from the process plant in tonnes/month

Month	2019	2020	2021	2022	2023	2024
1	58,900	70,680	70,680	70,680	70,680	70,680
2	53,200	66,120	63,840	63,840	63,840	66,120
3	58,900	70,680	70,680	70,680	70,680	70,680
4	57,000	68,400	68,400	68,400	68,400	68,400
5	58,900	70,680	70,680	70,680	70,680	70,680
6	57,000	68,400	68,400	68,400	68,400	68,400
7	70,680	70,680	70,680	70,680	70,680	70,680
8	70,680	70,680	70,680	70,680	70,680	70,680
9	68,400	68,400	68,400	68,400	68,400	68,400
10	70,680	70,680	70,680	70,680	70,680	70,680
11	68,400	68,400	68,400	68,400	68,400	68,400
12	70,680	70,680	70,680	70,680	70,680	70,680

Table T.2 Total Volume of water to TIA (m^3/month)
Table Calculates the total water input to the TIA from the process plant in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	93,000	111,600	111,600	111,600	111,600	111,600
2	84,000	104,400	100,800	100,800	100,800	104,400
3	93,000	111,600	111,600	111,600	111,600	111,600
4	90,000	108,000	108,000	108,000	108,000	108,000
5	93,000	111,600	111,600	111,600	111,600	111,600
6	90,000	108,000	108,000	108,000	108,000	108,000
7	111,600	111,600	111,600	111,600	111,600	111,600
8	111,600	111,600	111,600	111,600	111,600	111,600
9	108,000	108,000	108,000	108,000	108,000	108,000
10	111,600	111,600	111,600	111,600	111,600	111,600
11	108,000	108,000	108,000	108,000	108,000	108,000
12	111,600	111,600	111,600	111,600	111,600	111,600

Table T.1a Doris Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1	2,000					
2	2,000					
3	2,000					
4	2,000					
5	2,000					
6	2,000					
7	2,400					
8	2,400					
9	2,400					
10	2,400					
11	2,400					
12	2,400					

Table T.1 b Madrid North Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1		2,400	2,400	2,400	2,400	2,400
2		2,400	2,400	2,400	2,400	2,400
3		2,400	2,400	2,400	2,400	2,400
4		2,400	2,400	2,400	2,400	2,400
5		2,400	2,400	2,400	2,400	2,400
6		2,400	2,400	2,400	2,400	2,400
7		2,400	2,400	2,400	2,400	2,400
8		2,400	2,400	2,400	2,400	2,400
9		2,400	2,400	2,400	2,400	2,400
10		2,400	2,400	2,400	2,400	2,400
11		2,400	2,400	2,400	2,400	2,400
12		2,400	2,400	2,400	2,400	2,400

Table T.1 c Madrid South Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Table T.1d Boston Ore Processing Rate (tpd)
Action: Input the user defined processing rate in tpd of ore

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Project Hope Bay
Project No 1CT022-036
Task Control Panel
Note: ***green = input cells, black = calculated cells for the model***
Sections numbers are linked back to the Hope Bay Mine Operational Water Balance Summary Memo dated April 5, 2018

Section 2.4.4 Process Plant Reclaim

Note *Update the water use values based on the hourly process flow breakdown*

0.7	To process water tank (m^3/tonne)	Based on average July to Dec 2018
0.8	To raw water tank (m^3/tonne)	Based on average July to Dec 2018

Note: *Defines the source of raw water to the process plant*

Option 1	Doris TIA	results in no change in net water to Doris TIA
Options 2	Doris Lake	results in net water addition to Doris TIA
Options 3	-	results in no model action when selected

Section 2.4.5 Sewage Treatment Plant Effluent

Note *Table below shows relevant averages from historic data*

0.16	Average rate since operations (m^3/person/day)
-	

Table R.1 Process Water to Process Plant (m^3/day)
Action: Calculates reclaim for process water from the Doris TIA case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1	1,400	1,680	1,680	1,680	1,680	1,680
2	1,400	1,680	1,680	1,680	1,680	1,680
3	1,400	1,680	1,680	1,680	1,680	1,680
4	1,400	1,680	1,680	1,680	1,680	1,680
5	1,400	1,680	1,680	1,680	1,680	1,680
6	1,400	1,680	1,680	1,680	1,680	1,680
7	1,680	1,680	1,680	1,680	1,680	1,680
8	1,680	1,680	1,680	1,680	1,680	1,680
9	1,680	1,680	1,680	1,680	1,680	1,680
10	1,680	1,680	1,680	1,680	1,680	1,680
11	1,680	1,680	1,680	1,680	1,680	1,680
12	1,680	1,680	1,680	1,680	1,680	1,680

Table R.2 Raw Water to Process Plant (m^3/day)
Action: Calculates reclaim for raw water (location selected in table to the right) in m^3/day

Month	2019	2020	2021	2022	2023	2024
1	1,600	1,920	1,920	1,920	1,920	1,920
2	1,600	1,920	1,920	1,920	1,920	1,920
3	1,600	1,920	1,920	1,920	1,920	1,920
4	1,600	1,920	1,920	1,920	1,920	1,920
5	1,600	1,920	1,920	1,920	1,920	1,920
6	1,600	1,920	1,920	1,920	1,920	1,920
7	1,920	1,920	1,920	1,920	1,920	1,920
8	1,920	1,920	1,920	1,920	1,920	1,920
9	1,920	1,920	1,920	1,920	1,920	1,920
10	1,920	1,920	1,920	1,920	1,920	1,920
11	1,920	1,920	1,920	1,920	1,920	1,920
12	1,920	1,920	1,920	1,920	1,920	1,920

Table S.1 - Average number of people at the camp each month
Action: Input the average number of people at camp

Month	2019	2020	2021	2022	2023	2024
1		300	300	300	300	300
2		300	300	300	300	300
3		300	300	300	300	300
4		300	300	300	300	300
5	300	300	300	300	300	300
6	300	300	300	300	300	300
7	300	300	300	300	300	300
8	300	300	300	300	300	300
9	300	300	300	300	300	300
10	300	300	300	300	300	300
11	300	300	300	300	300	300
12	300	300	300	300	300	300

Table S.2 - Percent of sewage treatment plant effluent directed to the TIA (the rest reports to the tundra)
Action: Define percent sewage to the Doris TIA

Month	2019	2020	2021	2022	2023	2024
1		100%	100%	100%	100%	100%
2		100%	100%	100%	100%	100%
3		100%	100%	100%	100%	100%
4		100%	100%	100%	100%	100%
5		100%	100%	100%	100%	100%
6		100%	100%	100%	100%	100%
7		100%	100%	100%	100%	100%
8		100%	100%	100%	100%	100%
9	100%	100%	100%	100%	100%	100%
10	100%	100%	100%	100%	100%	100%
11	100%	100%	100%	100%	100%	100%
12	100%	100%	100%	100%	100%	100%

Table R.3 Source of Raw Water
Action: Select the source of Raw water to the Doris Process Plant from the drop-down list

Month	2019	2020	2021	2022	2023	2024
1	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
2	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
3	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
4	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
5	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
6	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
7	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
8	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
9	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
10	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
11	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA
12	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA	Doris TIA

Table R.4 Total Reclaim Volume from the Doris TIA (m^3/month)
Table Calculates the reclaim water demand from the Doris TIA in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	93,000	111,600	111,600	111,600	111,600	111,600
2	84,000	104,400	100,800	100,800	100,800	104,400
3	93,000	111,600	111,600	111,600	111,600	111,600
4	90,000	108,000	108,000	108,000	108,000	108,000
5	93,000	111,600	111,600	111,600	111,600	111,600
6	90,000	108,000	108,000	108,000	108,000	108,000
7	111,600	111,600	111,600	111,600	111,600	111,600
8	111,600	111,600	111,600	111,600	111,600	111,600
9	108,000	108,000	108,000	108,000	108,000	108,000
10	111,600	111,600	111,600	111,600	111,600	111,600
11	108,000	108,000	108,000	108,000	108,000	108,000
12	111,600	111,600	111,600	111,600	111,600	111,600

Table S.3 - Calculates the volume of sewage treatment effluent pumped to the Doris TIA
Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	0	1,484	1,484	1,484	1,484	1,484
2	0	1,388	1,340	1,340	1,340	1,388
3	0	1,484	1,484	1,484	1,484	1,484
4	0	1,436	1,436	1,436	1,436	1,436
5	0	1,484	1,484	1,484	1,484	1,484
6	0	1,436	1,436	1,436	1,436	1,436
7	0	1,484	1,484	1,484	1,484	1,484
8	0	1,484	1,484	1,484	1,484	1,484
9	1,436	1,436	1,436	1,436	1,436	1,436
10	1,484	1,484	1,484	1,484	1,484	1,484
11	1,436	1,436	1,436	1,436	1,436	1,436
12	1,484	1,484	1,484	1,484	1,484	1,484

Section 2.4.6 Sediment Control Pond (SCP) to Doris TIA

Note *Table below shows relevant averages from historic data (m^3/day)*

391	2018 June Data
222	2018 July Data
700	2018 August Data

Section 2.4.7 Doris TIA Discharge to Roberts Bay

Pump Capacity 7,200 m^3/day For Reference Design Capacity of System = 7,200 m^3/day
Pump Availability 80%

Section 2.4.8 Madrid North Contact Water Pond (CWP) to Doris TIA

Note *Assumes the same as the Doris SCP*

391	2018 June Data
222	2018 July Data
700	2018 August Data

Table C.1 Volume from SCP to Doris TIA - does not include mine water flows (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6	391	391	391	391	391	391
7	222	222	222	222	222	222
8	700	700	700	700	700	700
9						
10						
11						
12						

Table D.1 Doris TIA Discharge Pump Utilization (days/month)
Action: Fill in the number of days in a month the pump is active

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6		30	30	30	30	30
7		31	31	31	31	31
8		31	31	31	31	31
9		30	30	30	30	30
10						
11						
12						

Table W.1 Volume from MN CWP to Doris TIA - does not include mine water flows (m^3/day)
Action: Input the user defined case in m^3/day

Month	2019	2020	2021	2022	2023	2024
1						
2						
3						
4						
5						
6		391	391	391	391	391
7		222	222	222	222	222
8		700	700	700	700	700
9						
10						
11						
12						

Table C.2 Volume from SCP to Doris TIA - does not include mine water flows (m^3/month)
Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	11,725	11,725	11,725	11,725	11,725	11,725
7	6,876	6,876	6,876	6,876	6,876	6,876
8	21,700	21,700	21,700	21,700	21,700	21,700
9	0	0	0	0	0	0
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0

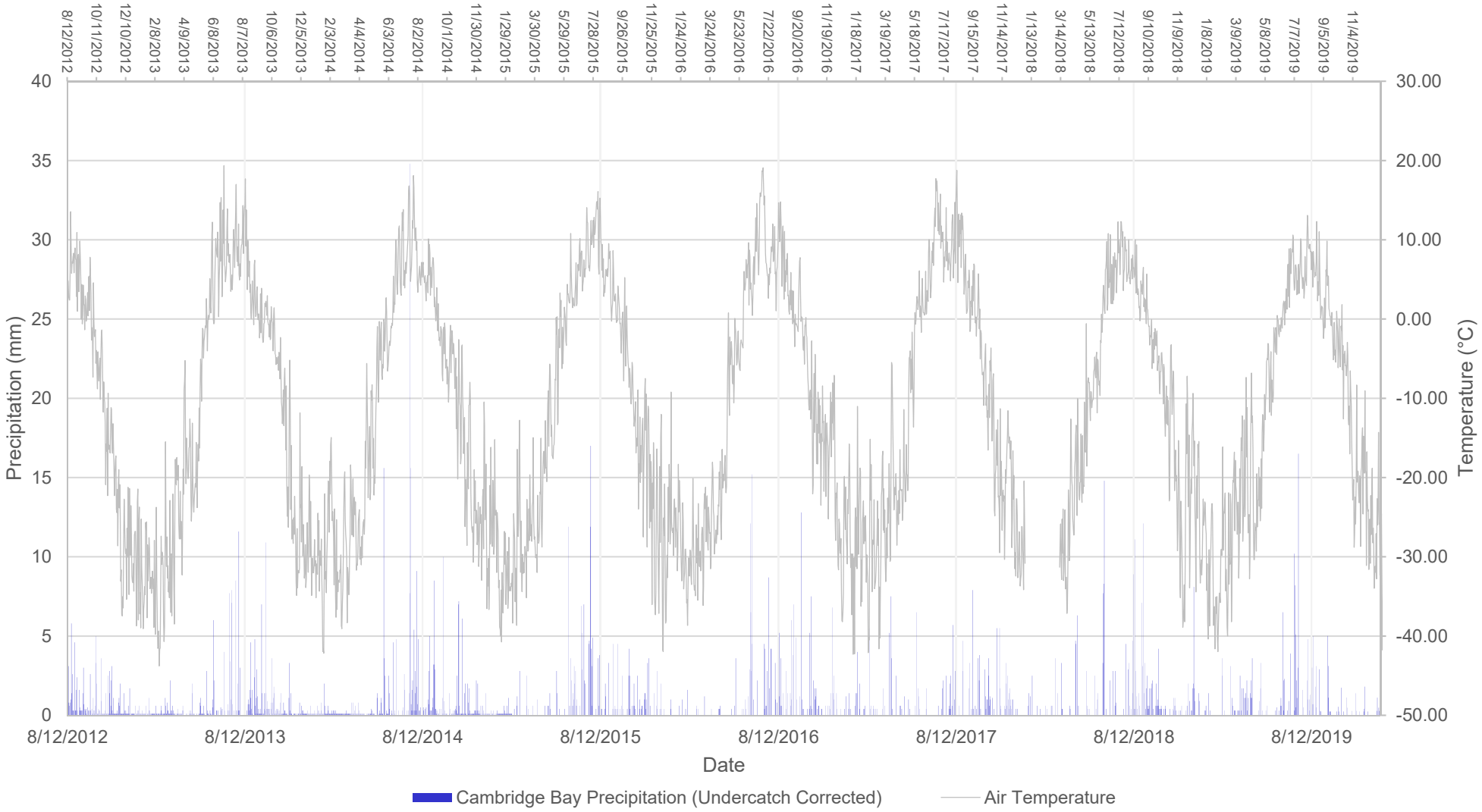
Table D.2 Doris TIA Discharge Pumping Rate (m^3/month)
Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	172,800	172,800	172,800	172,800	172,800
7	0	178,560	178,560	178,560	178,560	178,560
8	0	178,560	178,560	178,560	178,560	178,560
9	0	172,800	172,800	172,800	172,800	172,800
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0

Table W.2 Volume from MN CWP to Doris TIA - does not include mine water flows (m^3/month)
Table Calculates the model input based on selection in m^3/month

Month	2019	2020	2021	2022	2023	2024
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	11,725	11,725	11,725	11,725	11,725
7	0	6,876	6,876	6,876	6,876	6,876
8	0	21,700	21,700	21,700	21,700	21,700
9	0	0	0	0	0	0
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0

Appendix J – Climate Data



Notes:

- This data is intended for reference use in this report.

srk consulting	TMAC RESOURCES	2019 AGI
		Climate Data
Job No: 1CT022.038 Filename: AppendixJ_ClimateData.pptx	**DORIS TIA**	Date: Mar. 2020 / Approved: PDL / Figure: **J.1**

Appendix K – 2019 Seepage Review

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Memo

To:	John Kurylo, PEng, EOR Christopher Stevens, PhD Peter Luedke, EIT	**Client:**	TMAC Resources Inc.
From:	Andrea Bowie, PEng Derrick Midwinter, PGeo	**Project No:**	1CT022.037
Reviewed By:	Lisa Barazzuol, PGeo	**Date:**	July 3, 2020
Subject:	2019 North and South Dam Seepage Water Quality Investigation, Hope Bay Project		

1 Background

The North Dam forms the northern boundary of the Doris TIA, within a narrow natural valley blocking the original Tail Lake outlet to Doris Lake. The structure impounds the Reclaim Pond and was designed as a water retaining structure. The dam has a central frozen core with a secondary upstream Geosynthetic Clay Liner (GCL). The dam is constructed from local quarry rock and consists of processed fines for the core, 150 mm nominal sized transition material, and a run of quarry (ROQ) outer shell. To ensure maintenance of frozen foundation conditions, the key trench of the dam is equipped with 12 horizontal thermosyphon evaporators. Seepage of water has been observed along the downstream toe of the dam near the former outlet of Tail Lake since after the first winter of dam construction in 2011.

The South Dam is located at the southern end of the Doris TIA, on the watercourse to Ogama Lake. The South Dam is designed as a frozen foundation dam consisting of a compacted rock fill dam (sourced from a local quarry) with a GCL keyed into the permafrost overburden foundation for seepage control. The dam is designed to retain beached tailings as opposed to water. The dam is to be constructed in two phases, incorporating a single downstream raise. Construction of the first phase began in January 2018 and construction was completed in June 2018.

Key dates for North and South Dam construction and tailings impoundment area (TIA) operations are as follows:

- February 2011 – Initiation of North Dam construction (over two winter seasons),
- April 2012 – Completion of North Dam construction,
- February 2017 – Effective start of tailings discharge from a temporary berm within the TIA,
- January 2018 – Initiation of South Dam construction,
- February 2018 – Mine water discharged to the Doris TIA
- June 2018 – Completion of South Dam construction, deposition from the South Dam began in the same timeframe.

In 2017, based on a recommendation from the Engineer or Record (EOR), TMAC Resources Inc. initiated a monitoring program of North Dam seepage (SRK 2018a). After completion of the South Dam, a similar seepage monitoring program was initiated (SRK 2019a, 2019b).

Monitoring includes seepage inspections for the North and South dams, and water quality sampling and analysis of toe seepage when observed. The monitoring program also includes TIA Reclaim Pond water at surveillance network program (SNP) stations TL-1 and TL-5. Furthermore, at the recommendation of the EOR, three samples of TIA pond at the tailings slurry discharge points at the South Dam were sampled in August 2019 to quantify pond water chemistry and freezing point depression of the TIA tailings as the chemical composition of porewater within the tailings beach will directly impact heat transfer and freeze-back of the tailings over time (SRK 2020a). Delayed freezeback of the tailings beach could limit heat loss from the South Dam foundation immediately below the upstream toe.

The water quality assessment makes use of samples from SNP stations TL-1 and TL-5 that are monitored as part of and in compliance with Water Licence 2AM-DOH1335 Amendment No. 2 (Nunavut Water Board 2018). However, the North Dam seepage monitoring program and associated data analysis presented herein is not a compliance requirement and is the context of the North and South Dams monitoring program and at the request of the EOR. This memo documents a geochemical data review of the aforementioned stations with the following objectives:

- Document the results of the 2019 North and South Dam seepage monitoring programs;
- Understand the potential source of the North Dam toe seep; and
- Assess the major ion chemistry of water quality monitoring stations, including TIA pond water upstream of the South Dam.

2 Methods

2.1 2019 North Dam Toe Seepage Survey and Sampling Program

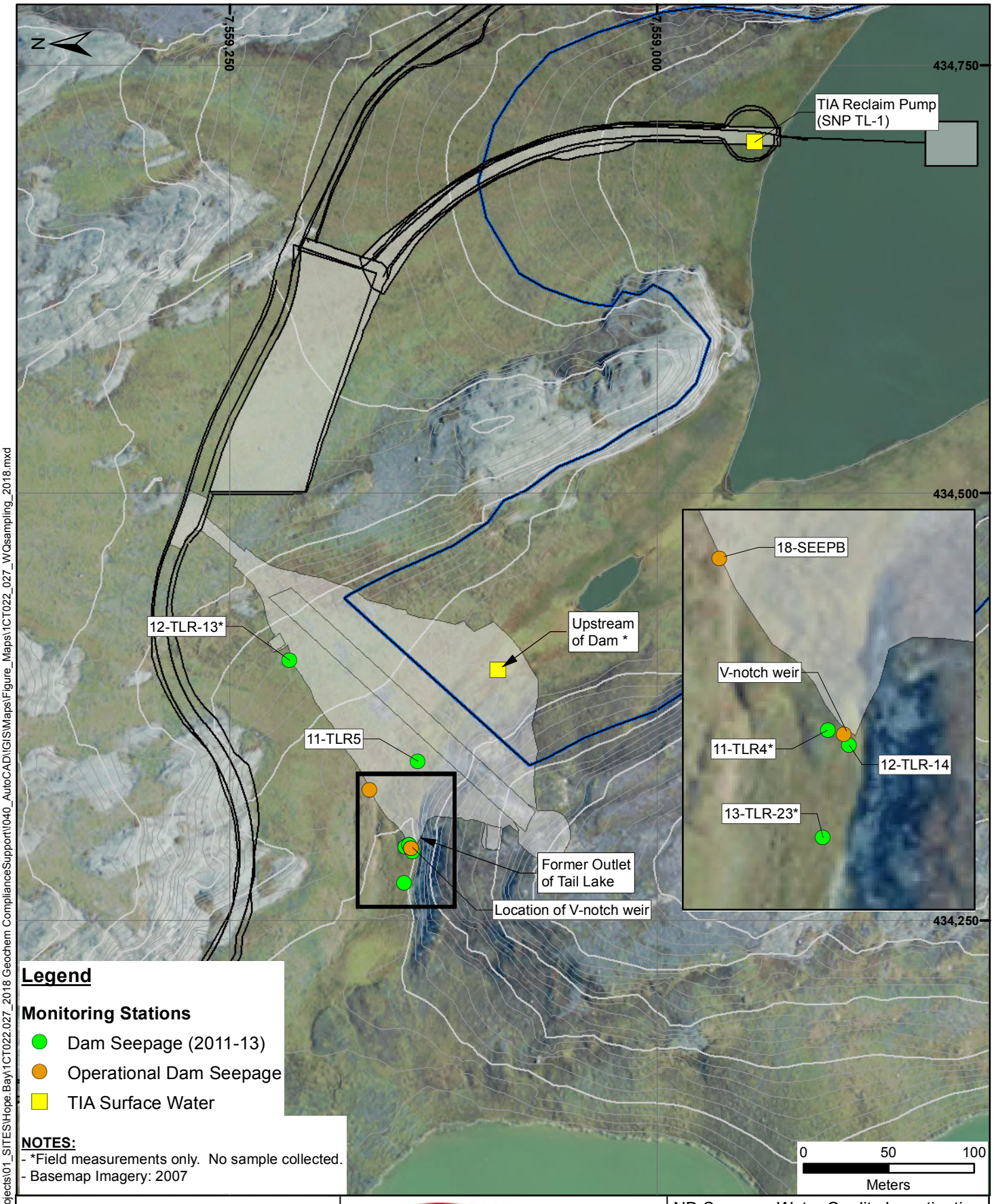
SRK Consulting (Canada) Inc. (2018a) outlines the North Dam toe seepage inspection and water quality monitoring program. In summary, TMAC conducts weekly inspections of the dam toe. If seepage is observed flowing at the dam toe, TMAC collects the following samples at a maximum frequency of once per week (Figure 2-1):

- North Dam toe seepage: field parameters and water quality samples for laboratory analysis are collected at all observed locations of seepage flow,
- TL-1 (reclaim pump): field parameters and water quality samples for laboratory analysis, and
- TIA Reclaim Pond water at upstream face of North Dam: field parameters only.

TMAC shipped samples to ALS Environmental in Burnaby, BC for the analysis of pH, electrical conductivity (EC), total alkalinity, sulphate, chloride, nutrients (ammonia, nitrate and nitrite), total cyanide, free cyanide, cyanate, and dissolved trace elements. At the time of sample collection, TMAC measured the following field parameters: pH, EC, oxidation-reduction potential (ORP), temperature, chloride and flow rate.

In 2019, TMAC collected 12 samples of seepage at the toe of the North Dam and TL-1 over a 13-week period between July 1 and September 23, 2019. On September 9, lab analysis did not include EC, alkalinity, sulphate and dissolved metals. Prior to July 1 and after September 23 seepage at the dam toe was frozen. At TL-1, monitoring occurs year-round. Field measurements of TIA Reclaim Pond water were collected for all of the sampling events, except on August 5, 2019.

The sampling methods for supernatant solution (TL-5) are detailed in SRK (2020) and briefly summarized herein. TMAC collected monthly samples (12 samples collected in 2019) of the process plant tailings supernatant (TL-5) from the flotation tailings thickener tank. The filtrate from the detox filter press (where detoxified tailings are dewatered) is pumped to the flotation tailings thickener tank prior to discharge to the TIA.



Legend

Monitoring Stations

- Dam Seepage (2011-13)
- Operational Dam Seepage
- TIA Surface Water

NOTES:

- *Field measurements only. No sample collected.
- Basemap Imagery: 2007

srk consulting

TMAC RESOURCES

ND Seepage Water Quality Investigation

Seepage Monitoring Sampling Locations

Job No: 1CT022.037 Filename: 1CT022_037_WQsampling_2019	Doris TIA	Date: Mar 2020	Approved: LB	Figure: 2-1

Path: \\srk.ad\dfs\na\van\Projects\01_SITES\Hope.Bay\1CT022.027_2018 Geochem ComplianceSupport\1040_AutoCAD\GIS\Maps\Figure_Maps\1CT022_027_WQsampling_2018.mxd

2.2 2019 South Dam Toe Seepage Survey and Sampling Program

SRK (2019a) outlines the South Dam toe seepage inspection and water quality monitoring program. Similar to the North Dam program, TMAC conducts weekly inspections of the dam toe. If seepage is observed flowing at the dam toe, TMAC collects the following samples at a maximum frequency of once per week:

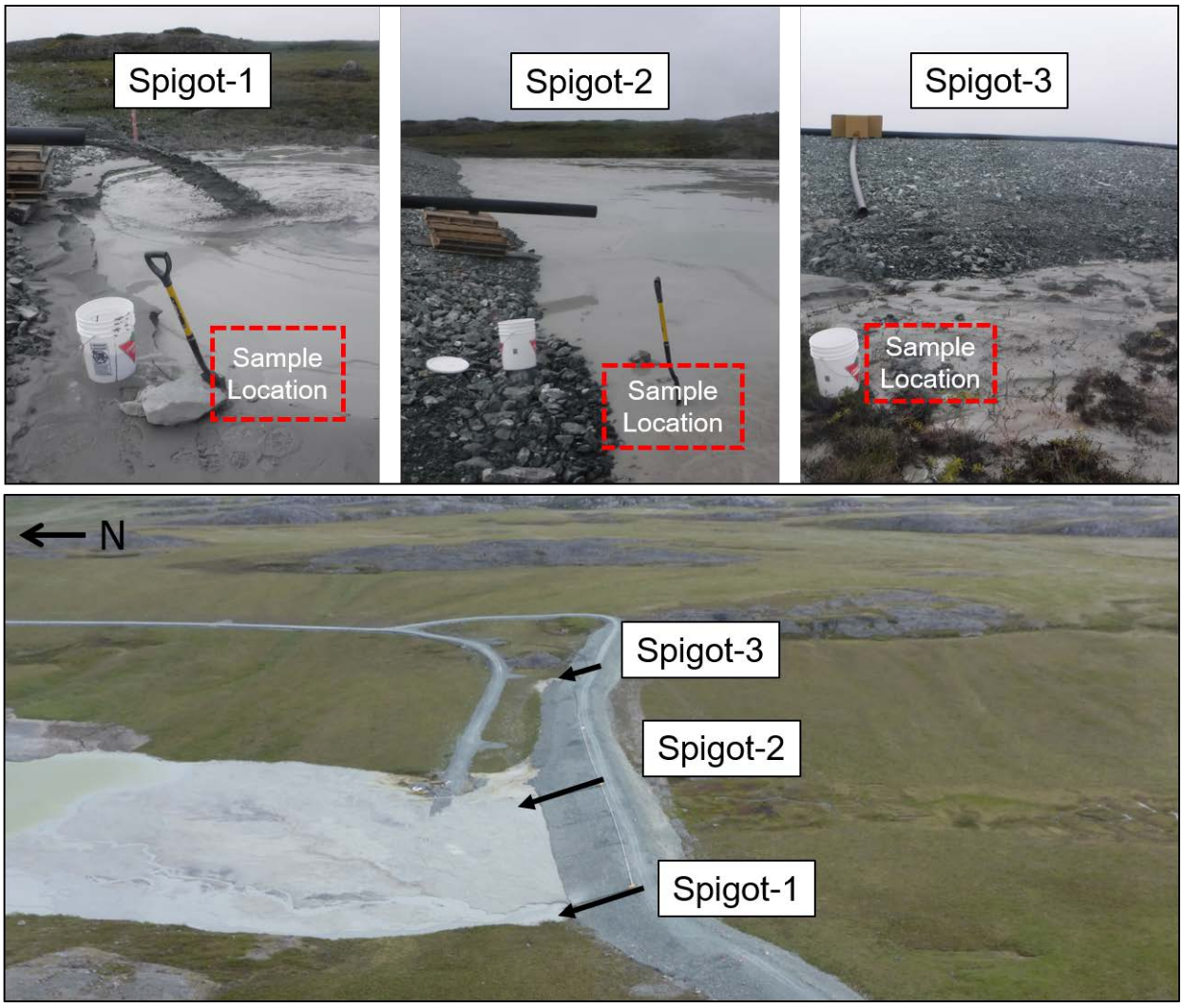
- South Dam toe seepage: field parameters and water quality samples for laboratory analysis are collected at all observed locations of seepage flow,
- TL-5 (tailings supernatant discharge from the mill): field parameters and water quality samples for laboratory analysis, and
- TIA Reclaim Pond water at upstream face of South Dam: field parameters only.

The recommended lab analyses and field parameters are the same as listed in Section 2.1. Seepage was not observed flowing from toe of the South Dam in 2019 and accordingly, samples were not collected.

2.3 TIA Pond Samples Upstream of South Dam

SRK collected one sample of tailings slurry from the upstream face of the south dam on August 4, 2019 near each of the three tailings discharge spigots (Figure 2-2). Prior to sampling, it had rained for several consecutive days. During sample collection, the top 10 cm of tailings were removed using a shovel to remove any meteoric water prior to sampling. In between samples, the shovel was cleaned using distilled water and a stiff brush. For each sample, approximately 10 to 20 kg of tailings slurry was collected in clean 20 L plastic buckets, with the volume of supernatant ranging from 2 to 4 L. At the time of sampling, tailings were being discharged from Spigot-1, with the tailings beach present between Spigot-1 and Spigot-2. The tailings sampled at Spigot-3 were from a tailings area that was not contiguous with the beach at Spigot-1 and Spigot-2 (Figure 2-2).

TMAC shipped samples to Global ARD Testing Service in Burnaby, BC. Global ARD collected samples of supernatant from each bucket for analysis of pH, electrical conductivity (EC), total alkalinity, sulphate, chloride, nutrients (ammonia, nitrate and nitrite), TSS, total cyanide, free cyanide, cyanate, and total and dissolved major and trace elements. It was not possible to measure field pH and EC because of the solids content in the samples.



Source: \\srk.ad\dfs\na\van\Projects\01_SITES\Hope.Bay\1CT022.037_2019 Geochem Compliance\!080_Deliverables\202003_TIA Dam Seepage\Figures\Figure2.3_SpigotPhotos.png

Figure 2-2: Photos of South Dam Spigots and TIA Pond Samples

2.4 Water Quality Database Compilation

SRK compiled data provided by TMAC for the North Dam toe seepage assessment, with stations presented in Figure 2-1 and described in Table 2-1. An overview of additional water quality sampling data included in this assessment is described as follows:

- North Dam seepage:
  - 2011 to 2014: opportunistic seepage survey along the downstream toe of the dam (SRK 2012 to 2014), and
  - 2017 to 2018: seepage and monitoring program conducted as part of the North Dam seepage monitoring program (SRK 2018b). In 2017, all seepage samples were collected from the location of the v-notch weir;
- TL-1: samples collected as part of the SNP monitoring of TIA Reclaim Pond water, collected at the reclaim pump; and

- TL-5: tailings supernatant samples collected within the mill prior to discharge to the TIA and as part of the SNP monitoring program.

SRK previously conducted data QA/QC of these data, as documented in SRK (2019). A summary of data QA/QC of the 2019 monitoring data is presented in Section 2.3.

Table 2-1: Data Sources

Station ID	Station Description	Years	Reference
North Dam seepage	Downstream toe	2011 to 2014; 2017 to 2018	SRK (2012, 2013, 2014, 2018b)
TIA Reclaim Pond water	Upstream face of North Dam	2017 to 2018	SRK (2018b)
TL-1	Reclaim Pump	2011 to 2018	SNP monitoring program
TL-5	Tailings supernatant discharge to TIA	2017 to 2018	SNP monitoring program

2.5 Quality Control for 2019 Analytical Data

SRK reviewed all 2019 water quality data and conducted a geochemical quality control (QC) program to validate the data. This is routine practice by SRK to ensure confidence in the analysis, through identifying any possible limitations of the data. The outcomes of the QC program are summarized in Table 2-2 (2019 North Dam seepage samples), Table 2-3 (TL-1), and Table 2-4 (South Dam tailings supernatant). The results of data QC for TL-5 are documented in SRK (2020b). SRK flagged the following QC issues that that are summarized as follows:

- North Dam Seepage:
  - Four samples had a greater than 30% RPD between field and lab chloride; TMAC stated that the discrepancy may be the result of instrument not functioning properly. The instrument has since been replaced.
- TL-1:
  - One sample had a greater than 20% RPD between total and dissolved potassium, with both values >10x DL. The data has been confirmed by re-analysis.

All data were deemed acceptable. SRK accepted all data as received.

Table 2-2: Summary of QA/QC Assessment of 2019 Data, North Dam Seepage Samples

QC Test	SRK QC Criteria	North Dam Seepage Results
Physical Test[1]		
Field Blank	Minimum criteria is <2X DL, will accept <5X DL	(n=2) All passed.
Method Blank	<2X DL	(n=14) for Conductivity, (n=13) for TSS, (n=2) for TDS All passed.
Field Duplicate	For samples >10X DL should be within +/-30% RPD	(n=2) All passed.
Lab Duplicate	For samples >10X DL should be within +/-20% RPD	(n=1) for TSS, (n=1) for Conductivity and (n=1) for pH All passed
Field pH vs. Lab pH	Difference should not be greater than 1 pH unit	(n=13) All passed.
Field EC vs Lab EC	For samples > 10X the detection limit (DL), % RPD should be within +/-30%	(n=12) All passed.
Standard Reference Materials	Within specified tolerance ranges.	(n=15) for pH, (n=14) for EC, (n=10) for TSS and (n=1) for ORP All passed.
Anions and Nutrients[2]		
Field Blank	Minimum criteria is <2X DL, will accept <5X DL	(n=2) All passed.
Method Blank	<2X DL	(n=13) for Total Ammonia (as N), (n=14) for Total Alkalinity, (n=14) for Cl, (n=14) for Nitrate (as N), (n=14) for Nitrite (as N), (n=3) for TKN, (n=15) for Total Nitrogen, (n=3) for Orthophosphate-Dissolved (as P), (n=3) for Phosphorus (P)-Total, (N=13) for SO4 All passed.
Field Duplicate	For samples >10X DL should be within +/-30% RPD	(n=2) All passed.
Lab Duplicate	For samples >10X DL should be within +/-20% RPD	(n=5) for Total N, (n=1) for Total Ammonia, (n=1) for Total Alkalinity All passed.
Ion Balance	EC>100 uS/cm, % difference should be within +/-10%	(n=12) All passed.
Standard Reference Materials	Within specified tolerance ranges.	(n=13) for Total Ammonia (as N), (n=14) for Total Alkalinity, (n=14) for Cl, (n=14) for Nitrate (as N), (n=14) for Nitrite (as N), (n=3) for TKN, (n=15) for Total Nitrogen, (n=3) for Orthophosphate-Dissolved (as P), (n=3) for Phosphorus (P)-Total, (N=13) for SO4 All passed.
Cyanides[3]		
Field Blank	Minimum criteria is <2X DL, will accept <5X DL	(n=2) All passed.
Method Blank	<2X DL	(n=14) for WAD CN, (n=18) for Total CN, (n=13) for Cyanate, (n=19) for free CN, (n=14) for Thiocyanate (SCN) All passed.
Field Duplicate	For samples >10X DL should be within +/-30% RPD	(n=2) All passed.
Lab Duplicate	For samples >10X DL should be within +/-20% RPD	(n=1) for Cyanate, (n=2) for SCN All passed.
Standard Reference Materials	Within specified tolerance ranges.	(n=14) for WAD CN, (n=18) for Total CN, (n=13) for Cyanate, (n=19) for free CN, (n=14) for Thiocyanate (SCN) All passed.
Trace Metals by ICP-MS		
Field Blank	Minimum criteria is <2X DL, will accept <5X DL	(n=2) All passed.

QC Test	SRK QC Criteria	North Dam Seepage Results
Method Blank	<2X DL	(n=14) for Total and (n=13) for Dissolved All passed.
Field Duplicate	For samples >10X DL should be within +/-30% RPD	(n=2) All passed.
Lab Duplicate	For samples >10X DL should be within +/-20% RPD	(n=3) for Total All passed.
Total vs Dissolved Metals	Total Metals>Dissolved metals. Total Metals should be greater than Dissolved Metals, if not the % difference should be within +/-20%. ALS would use 10X DL, Maxxam would use 5X DL	(n=12) All passed.
Standard Reference Materials	Within specified tolerance ranges.	(n=14) for Total and (n=11) Dissolved All passed.
Hg-CVAAS		
Field Blank	Minimum criteria is <2X DL, will accept <5X DL	(n=2) All passed.
Method Blank	<2X DL	(n=14) for Total and (n=8) for Dissolved All passed.
Field Duplicate	For samples >10X DL should be within +/-30% RPD	(n=2) All passed.
Lab Duplicate	For samples >10X DL should be within +/-20% RPD	(n=2) for Total and (n=3) for Dissolved All passed.
Standard Reference Materials	Within specified tolerance ranges.	(n=14) for Total and (n=8) for Dissolved All passed.

Source: \\VAN-SVR0\Projects\01_SITES\Hope.Bay\1CT022.037_2019 Geochem Compliance\!020_Project_Data\Lab\Dam Seepage\!Summary Table QAQC_1CT022.037_2019_NorthDam_mlt_Rev01.xls

Notes:

1 Conductivity, pH, Hardness (as CaCO3), Total Suspended Solids

2 Total Alkalinity, Total Ammonia, Unionized Ammonia, Cl, NO3, NO2, Total N, SO4

3 WAD CN, Total CN, Cyanate, SCN, Free CN

Table 2-3: Summary of QA/QC Assessment of 2019 Data, SNP Station TL-1

QC Test	SRK QC Criteria	TL-1 Results
Physical Test[1]		
Method Blank	<2X DL	(n=23) for Conductivity, (n=33) for TSS, (n=23) for TDS All passed.
Field Duplicate	For samples >10X DL should be within +/-30% RPD	(n=1) All passed.
Lab Duplicate	For samples >10X DL should be within +/-20% RPD	(n=13) for TSS, (n=6) for TDS, (n=13) for Conductivity, (n=1) for ORP and (n=2) for All passed.
Field pH vs. Lab pH	Difference should not be greater than 1 pH unit	(n=46) All passed.
Field EC vs Lab EC	For samples > 10X the detection limit (DL), % RPD should be within +/-30%	(n=22) All passed.
Field Cl vs Lab Cl	For samples > 10X the detection limit (DL), % RPD should be within +/-30%	(n=5) All passed.
Standard Reference Materials	Within specified tolerance ranges.	(n=25) for pH, (n=25) for EC, (n=34) for TSS and (n=23) for TDS All passed.
Anions and Nutrients[2]		
Method Blank	<2X DL	(n=23) for Total Ammonia (as N), (n=25) for Total Alkalinity, (n=14) for Cl, (n=14) for Nitrate (as N), (n=14) for Nitrite (as N), (n=3) for TKN, (n=15) for Total Nitrogen, (n=3) for Orthophosphate-Dissolved (as P), (n=3) for Phosphorus (P)-Total, (N=24) for SO4 All passed.
Field Duplicate	For samples >10X DL should be within +/-30% RPD	(n=1) All passed.
Lab Duplicate	For samples >10X DL should be within +/-20% RPD	(n=5) for Total N, (n=3) for Total Ammonia, (n=1) for Total Alkalinity, (n=1) for Orthophosphate-Dissolved (as P) All passed.
Ion Balance	EC>100 uS/cm, % difference should be within +/-10%	(n=18) All passed.
Standard Reference Materials	Within specified tolerance ranges.	(n=25) for Total Alkalinity, (n=23) for Total Ammonia, (n=14) for Cl, (n=14) for NO3, (n=14) for NO2, (n=16) for Total N, (n=24) for SO4, (n=3) for TKN, (n=1) for Orthophosphate-Dissolved (as P), (n=3) for Phosphorus (P)-Total All passed.
Cyanides[3]		
Method Blank	<2X DL	(n=23) for WAD CN, (n=27) for Total CN, (n=25) for Cyanate, (n=16) for free CN, (n=18) for Thiocyanate (SCN) All passed.
Field Duplicate	For samples >10X DL should be within +/-30% RPD	(n=1) All passed.
Lab Duplicate	For samples >10X DL should be within +/-20% RPD	(n=1) for Cyanate, (n=6) for SCN All passed.
Standard Reference Materials	Within specified tolerance ranges.	(n=24) for WAD CN, (n=27) for Total CN, (n=24) for Cyanate, (n=26) for SCN, (n=19) for Free CN, (n=3) for Cyanide All passed.

QC Test	SRK QC Criteria	TL-1 Results
Trace Metals by ICP-MS		
Method Blank	<2X DL	(n=31 for Total) and (n=34) for Dissolved All passed.
Field Duplicate	For samples >10X DL should be within +/-30% RPD	(n=1) All passed.
Lab Duplicate	For samples >10X DL should be within +/-20% RPD	(n=16) for Total and (n=14) for Dissolved All passed.
Total vs Dissolved Metals	Total Metals>Dissolved metals. Total Metals should be greater than Dissolved Metals, if not the % difference should be within +/-20%. ALS would use 10X DL, Maxxam would use 5X DL	(n=46) - L2387698 - Total and Dissolved K has 26% RPD and >10x DL. The data has been confirmed by re-analysis.
Standard Reference Materials	Within specified tolerance ranges.	(n=34) for Total and (n=30) Dissolved All passed.
Hg-CVAAS		
Method Blank	<2X DL	(n=34) for Total and (n=31) for Dissolved All passed.
Field Duplicate	For samples >10X DL should be within +/-30% RPD	(n=1) All passed.
Lab Duplicate	For samples >10X DL should be within +/-20% RPD	(n=23) for Total and (n=25) for Dissolved All passed.
Standard Reference Materials	Within specified tolerance ranges.	(n=34) for Total and (n=30) for Dissolved All passed.

Source: \\VAN-SVR0\Projects\01_SITES\Hope.Bay\1CT022.037_2019 Geochem Compliance\!020_Project_Data\Lab\Dam Seepage\!Summary Table QAQC_1CT022.037_2019_NorthDam_mlt_Rev01.xls

Notes:

1 Conductivity, pH, Hardness (as CaCO3), Total Suspended Solids

2 Total Alkalinity, Total Ammonia, Unionized Ammonia, Cl, NO_3, NO_2, Total N, SO_4

3 WAD CN, Total CN, Cyanate, SCN, Free CN

Table 2-4: Summary of QA/QC Assessment of 2019 Data, TIA Pond at South Dam

QC Test	SRK QC Criteria	Results
Physical Test[1]		
Split Duplicate (n=1) for pH	Within +/10% RPD	All passed.
Split Duplicate (n=1) for EC	For samples >10X DL should be within +/-30% RPD	All passed.
Anions and Nutrients[2]		
Method Blank (n=1) for SO4, (n=1) for Cl, (n=1) for NO3 (n=1) for NO2, (n=1) for NH4, (n=1) for Total N, (n=1) for TSS	<2X DL	All passed.
Split Duplicate (n=1) for Total Alkalinity, (n=1) for SO4, (n=1) for Cl, (n=1) for NO3 (n=1) for NO2, (n=1) for NH4, (n=1) for Total N, (n=1) for TSS	For samples >10X DL should be within +/-30% RPD	All passed.
Lab Duplicate (n=1) for SO4, Cl, NO3, NO2, NH4, Total N, TSS	For samples >10X DL should be within +/-20% RPD	All passed.
Ion Balance (n=3)	EC>100 uS/cm, % difference should be within +/-10%	All passed.
Cyanides Species[3]		
Split Duplicate (n=1) for Free CN, (n=1) for EDTA-CN, (n=1) for Thiocyanate, (n=1) for Cyanate	For samples >10X DL should be within +/-30% RPD	All passed.
Standard Reference Material (n=0)	Within specified tolerance ranges.	All passed.
Metals		
Method Blank (n=1) for Total and (n=1) for Dissolved	<2X DL	All passed.
Split Duplicate (n=1) for Total and (n=1) for Dissolved	For samples >10X DL should be within +/-30% RPD	All passed.
Lab Duplicate (n=1) for Total (n=1) for Dissolved	For samples >10X DL should be within +/-20% RPD	All passed.
Total vs Dissolved Metals (n=3)	Total Metals>Dissolved metals. Total Metals should be greater than Dissolved Metals, if not the % difference should be within +/-20%. ALS would use 10X DL, Maxxam would use 5X DL	All passed.

Source: \\srk.ad\dfs\na\van\Projects\01_SITES\Hope.Bay\1CT022.037_2019 Geochem Compliance\!020_Project_Data\Lab\Tailings\COA 3 SouthDam Monitoring Tailings Supernatant (rec'd 3-Sep19)_QAQC_mlt.xlsx]

Notes:

1 Conductivity, pH, Hardness (as CaCO3), Total Suspended Solids

2 Total Alkalinity, Total Ammonia, Unionized Ammonia, Cl, NO3, NO2, Total N, SO4

3 WAD CN, Total CN, Cyanate, SCN, Free CN

3 Results

3.1 North Dam Seepage Monitoring

North Dam seepage data from 2019 are summarized in Table 3-1 with full results presented in Attachment 1. Summary statistics for the North Dam Seepage, TL-1 and TL-5 is shown in Table 3-2 and Table 3-3. The scope of the water chemistry assessment is to determine if TIA Reclaim Pond water is present in seepage at the downstream toe of the North Dam. This section discusses a subset of the water quality data, specifically EC, ammonia, nitrite, chloride, sulphate, and other major ions, which were identified as geochemical tracers of TIA Reclaim Pond. For other parameters, there were no appreciable differences in concentration between toe seepage samples and TL-1.

Table 3-1: Summary of 2019 North Dam Seepage Monitoring Data

Location	Date[1]	pH	EC uS/cm	Total Alkalinity mg/L as $CaCO_3$	SO_4 mg/L	Cl mg/L	Total Ammonia mg/L as N	NO_3 mg/L as N	NO_2 mg/L as N	Ca mg/L	Mg mg/L	Na mg/L	Ka mg/L	As mg/L	Co mg/L	Cu mg/L	Mn mg/L	Mo mg/L	Ni mg/L	Zn mg/L
V-notch weir	01-Jul-19	8.2	280	110	21	15	0.0095	0.10	0.001	34	6.9	15	2	0.00056	0.0003	0.0069	0.006	0.001	0.001	0.005
	08-Jul-19	8.2	290	110	23	14	0.012	0.15	0.0011	35	7	16	2	0.00064	0.0003	0.0066	0.0036	0.001	0.001	0.005
	15-Jul-19	7.8	290	110	18	17	0.014	0.12	0.001	36	7.7	15	2	0.00054	0.0003	0.0076	0.004	0.001	0.001	0.005
	22-Jul-19	8.3	330	130	22	17	0.012	0.23	0.001	42	8	18	2	0.00056	0.0003	0.0073	0.004	0.001	0.001	0.005
	29-Jul-19	8.1	340	130	27	19	0.013	0.43	0.02	40	9.6	22	2	0.00056	0.0003	0.0081	0.0039	0.001	0.001	0.005
	05-Aug-19	8.3	350	130	26	17	0.014	0.3	0.0011	39	8.5	21	2	0.00062	0.0003	0.0079	0.0032	0.001	0.0011	0.005
	12-Aug-19	8.3	340	150	20	19	0.014	0.19	0.0015	39	9	19	2	0.00059	0.0003	0.0084	0.0042	0.001	0.0015	0.005
	19-Aug-19	8.3	360	140	17	20	0.012	0.19	0.001	42	9.5	19	2	0.00069	0.0003	0.0085	0.0041	0.001	0.0015	0.005
	26-Aug-19	8.3	340	130	16	20	0.013	0.16	0.001	40	9.6	18	2	0.00062	0.0003	0.0083	0.0039	0.001	0.0014	0.005
	02-Sep-19	8.4	350	140	14	23	0.018	0.15	0.001	41	10	19	2	0.00055	0.0003	0.0082	0.006	0.001	0.0015	0.005
	09-Sept-19	8.4	--	--	--	38	0.013	0.26	0.0012	--	--	--	--	--	--	--	--	--	--	--
	16-Sep-19	8	370	140	20	26	0.01	0.14	0.0013	43	9.5	20	2	0.0005	0.0003	0.007	0.0058	0.001	0.0013	0.005
	23-Sep-19	8.4	380	130	16	33	0.014	0.11	0.0014	46	11	22	2	0.00056	0.0003	0.0083	0.0083	0.001	0.0017	0.005

Source: \\srk.ad\dfs\na\van\Projects\01_SITES\Hope.Bay\1CT022.037_2019 Geochem Compliance\Task 145 - TIA Dam Seepage\Database Export\!TMAC_DMS_LinkedSpreadsheet_WQ_pivot_rtc.xlsx]

Notes:

Trace element for all samples is dissolved.

[1] For September 09, 2019, conductivity, alkalinity, sulphate and dissolved metals were not measured.

Table 3-2: Statistical Summary of Physical Parameters and Nutrients at North Dam Seepage, TL-1 and TL-5

Station	Year*	Statistic	pH		EC		Total Alkalinity mg/L as $CaCO_3$	SO_4 mg/L	Cl mg/L	Total Ammonia	NO_3	NO_2
			Field	Lab	Field	Lab						
					uS/cm					mg/L as N		
North Dam Seepage	2011	Min	7.9	8	180	--	230	190	690	29	82	--
		Median	7.9	8	1800	--	230	190	690	29	82	--
		Max	7.9	8	3500	--	230	190	690	29	82	--
		n	2	1	2	--	1	1	1	1	1	--
	2012	Min	7.3	8	140	370	150	9	30	0.72	0.73	0.021
		Median	7.5	8	270	370	150	9	30	0.72	0.73	0.021
		Max	7.6	8	410	370	150	9	30	0.72	0.73	0.021
		n	2	1	2	1	1	1	1	1	1	1
	2017-2018	Min	7.1	7.6	280	270	100	11	15	0.005	0.022	0.001
		Median	7.5	7.9	380	380	130	25	21	0.007	0.39	0.001
		Max	8.8	8.3	420	410	150	39	29	0.019	1.4	0.0021
		n	14	15	14	15	15	15	15	15	15	15
	2019	Min	7.6	7.8	290	280	110	14	14	0.0095	0.1	0.001
		Median	7.8	8.3	350	340	130	20	19	0.013	0.16	0.0011
		Max	8.7	8.4	400	380	150	27	38	0.018	0.43	0.02
		n	13	13	13	12	12	12	13	13	13	13
TL-1 (TIA Reclaim Pump)	2011-2016	Min	7.5	7.1	150	85	32	1	3.5	0.005	0.005	0.001
		Median	7.5	7.8	150	210	35	2.4	39	0.05	0.05	0.05
		Max	7.5	9	150	340	45	5.7	63	0.26	1.2	0.05
		n	1	84	1	43	10	49	84	84	84	84
	2017	Min	7.5	7.4	340	530	75	81	60	0.21	0.085	0.0017
		Median	7.9	7.9	540	530	75	81	70	1.1	0.67	0.023
		Max	8.6	8.1	790	530	75	81	92	1.9	1.6	0.12
		n	14	17	13	1	1	1	17	30	19	19
	2018	Min	7.3	7.6	1100	1900	82	260	110	0.92	0.61	0.02
		Median	7.9	8.2	1900	2200	93	300	380	2.7	1.1	0.2
		Max	10	9.2	2700	3100	110	380	660	9.8	2	0.3
		n	34	39	30	8	10	10	18	49	18	18
	2019	Min	7.2	7.7	39	3600	110	65	38	3.5	2.3	0.12
		Median	7.8	8.1	4700	4500	120	490	1100	4.9	2.7	0.19
		Max	8.7	8.7	8000	5900	170	660	1500	7.5	3.9	0.99
		n	50	46	50	22	18	19	21	46	19	19
TL-5 (Tailings Supernatant)	2017-2018	Min	--	7.7	--	--	--	6	--	11	0.1	0.02
		Median	--	8.2	--	--	--	1400	--	21	14	0.41
		Max	--	8.5	--	--	--	2800	--	61	40	18
		n	--	22	--	--	--	22	--	30	22	22
	2019	Min	6.1	6.2	7100	8100	66	1300	1200	13	6.7	0.29
		Median	8.2	8.2	8300	8500	290	2000	1500	31	11	0.54
		Max	8.4	8.4	10000	9300	350	2900	1800	38	25	0.8
		n	11	12	11	9	9	12	9	12	12	12

Source: \\srk.ad\dfs\na\van\Projects\01_SITES\Hope.Bay\1CT022.037_2019 Geochem Compliance\Task 125 - Tailings Monitoring\1. Working File\!DamSeepage_HistoricalWQ_Compilation_amd_lnb_knk_Rev07.xlsx

Note:

Trace element data for all other stations are dissolved.

*Tailings deposition in the TIA commenced in 2017.

Table 3-3: Statistical Summary of Dissolved Trace Element Data*, North Dam Seepage, TL-1 and TL-5

Station	Year**	Statistic	Ca mg/L	Mg mg/L	K mg/L	Na mg/L	As mg/L	Co mg/L	Cu mg/L	Mn mg/L	Mo mg/L	Ni mg/L	Zn mg/L
North Dam Seepage	2011	Min	73	62	34	460	0.0035	0.005	0.017	0.54	0.0053	0.0025	0.015
		Median	73	62	34	460	0.0035	0.005	0.017	0.54	0.0053	0.0025	0.015
		Max	73	62	34	460	0.0035	0.005	0.017	0.54	0.0053	0.0025	0.015
		n	1	1	1	1	1	1	1	1	1	1	1
	2012	Min	38	9.9	3.8	27	0.00041	0.00054	0.0038	0.14	0.00066	0.0015	0.0029
		Median	38	9.9	3.8	27	0.00041	0.00054	0.0038	0.14	0.00066	0.0015	0.0029
		Max	38	9.9	3.8	27	0.00041	0.00054	0.0038	0.14	0.00066	0.0015	0.0029
		n	1	1	1	1	1	1	1	1	1	1	1
	2017-2018	Min	27	7.4	1.3	20	0.00044	0.0001	0.007	0.0032	0.00045	0.00081	0.001
		Median	38	9	1.8	26	0.00052	0.00015	0.0083	0.0051	0.00072	0.0011	0.001
		Max	47	9.7	2.8	39	0.00062	0.0003	0.014	0.0081	0.001	0.0014	0.0067
		n	13	13	13	13	13	13	13	13	13	13	13
	2019	Min	34	6.9	2	15	0.0005	0.0003	0.0066	0.0032	0.001	0.001	0.005
		Median	40	9.1	2	19	0.00056	0.0003	0.0078	0.004	0.001	0.0012	0.005
		Max	43	10	2	22	0.00069	0.0003	0.0085	0.0067	0.001	0.0015	0.005
		n	12	12	12	12	12	12	12	12	12	12	12
TL-1 (TIA Reclaim Pump)	2011-2016	Min	5.8	1.3	1.3	12	0.00017	0.0001	0.00072	0.0033	0.00053	0.0005	0.0013
		Median	12	5.7	1.6	14	0.0004	0.002	0.0013	0.005	0.005	0.002	0.002
		Max	21	9.7	2.6	24	0.0004	0.002	0.0014	0.018	0.005	0.002	0.012
		n	47	47	13	13	6	6	6	6	6	6	3
	2017	Min	28	8.3	4.4	61	0.0004	0.0007	0.0067	0.054	0.00064	0.0016	0.0016
		Median	28	8.3	4.4	61	0.0004	0.0007	0.0067	0.054	0.00064	0.0016	0.0016
		Max	28	8.3	4.4	61	0.0004	0.0007	0.0067	0.054	0.00064	0.0016	0.0016
		n	1	1	1	1	1	1	1	1	1	1	1
	2018	Min	56	21	15	220	0.00054	0.0014	0.0076	0.16	0.0013	0.0039	0.001
		Median	67	30	18	300	0.00058	0.0015	0.013	0.31	0.0016	0.0042	0.002
		Max	100	50	27	510	0.00087	0.0027	0.029	0.4	0.0026	0.0081	0.005
		n	13	13	13	14	13	13	13	13	13	13	14
	2019	Min	12	6.4	3.1	6	0.00076	0.0028	0.024	0.36	0.0028	0.007	0.002
		Median	140	74	35	750	0.11	0.3	0.19	0.45	0.29	0.12	0.5
		Max	160	110	52	1100	0.97	0.45	0.56	0.62	0.37	0.96	0.5
		n	46	46	46	46	46	46	46	46	46	46	46
TL-5 (Tailings Supernatant)	2017-2018 (Total Metals)	Min	33	22	36	520	0.00088	0.0053	0.0057	0.063	0.0032	0.011	0.006
		Median	96	40	75	910	0.0042	0.012	0.11	0.17	0.0068	0.063	0.033
		Max	220	140	130	1800	0.11	0.089	0.9	0.88	0.012	0.14	0.87
		n	30	30	30	30	30	30	30	30	30	30	30
	2019 (Total Metals)	Min	110	65	53	1000	0.0015	0.0069	0.036	0.14	0.0093	0.016	0.015
		Median	140	86	85	1800	0.0041	0.022	0.53	0.21	0.026	0.095	0.023
		Max	160	120	99	2100	0.031	0.029	160	1.4	0.11	3.5	0.29
		n	12	12	12	12	12	12	12	12	12	12	12
	2019 (Dissolved Metals)	Min	110	76	62	1500	0.0014	0.007	0.0069	0.1	0.014	0.0069	0.005
		Median	130	89	79	1800	0.0021	0.01	0.2	0.18	0.042	0.077	0.005
		Max	160	110	100	2000	0.0063	0.025	150	1.3	0.11	3.5	0.26
		n	9	9	9	9	9	9	9	9	9	9	9

Source: \\srk.ad\dfs\na\van\Projects\01_SITES\Hope.Bay\1CT022.037_2019 Geochem Compliance\Task 125 - Tailings Monitoring\1. Working File\!DamSeepage_HistoricalWQ_Compilation_amd_lnb_knk_Rev07.xlsx

Note:

*All trace elements are dissolved except TL-5 monitoring data, as noted.

**Tailings deposition in the TIA commenced in 2017.

3.1.1 Comparison of TIA Surface Water Measurements

For each North Dam seepage sampling event, field measurements of EC and chloride are collected at TIA stations TL-1 and surface water immediately upstream of the North dam (Figure 2-1). Field measurements of field EC and chloride at TL-1 and upstream of the dam face are at near parity for the majority of samples, suggesting that TIA Reclaim Pond water is well mixed in this area and that samples collected at TL-1 are representative of pond chemistry at the upstream side of the North Dam. Samples with higher field EC and chloride at TL-1 were sampled in July.

Saline mine water from the underground is typically pumped to the process plan pumpbox in the mill and then discharged to the TIA with the tailings slurry. At the end of June, saline mine water was pumped to the Doris Sediment Control Pond and then to the reclaim pump station (TL-1) resulting in discharge of saline water to TL-1. Subsequent measurements of field EC at TL-1 (July 1, 8, 15, 2019) are elevated compared to TIA pond water upstream of the North Dam. For field Cl, only one sample was collected in July (July 1, 2019), and a similar trend of elevated concentrations at TL-1 was observed. The likely cause of this difference was the change of mine water input to the TIA. After July, samples were at near parity for field EC and Cl.

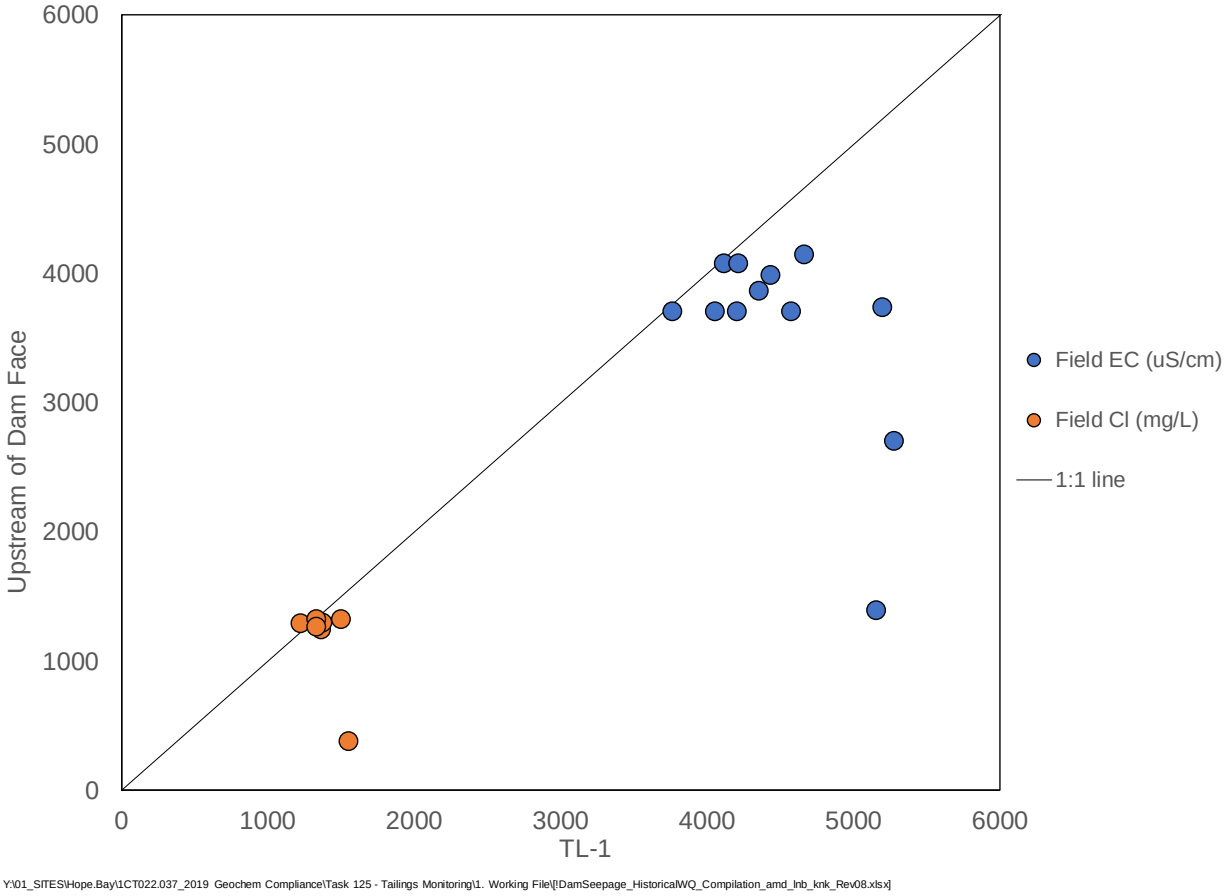


Figure 3-1: Comparison of Field EC and Chloride at TIA Surface Stations, 2019 Monitoring Data

3.1.2 pH and EC

The pH for North Dam seepage samples ranged from 7.6 to 8.7 in 2019 and has been stable since 2011 (Figure 3-2).

EC data are summarized as follows:

- TL-5: EC was relatively stable ranging from 8,130 to 9,310 µS/cm in 2019 and was not previously monitored at this station.
- TL-1: Since 2017, EC at TL-1 has exhibited an increasing trend up to 5,480 µS/cm on June 3, 2019, after which values decreased to a minimum of 4,020 µS/cm during the open water season and then increased again at the end of the year to a maximum value of 5,850 µS/cm on December 12, 2019.
- North Dam toe seepage: EC levels in 2019 ranged from 288 to 377 µS/cm, with levels at TL-1 15 to 20 times higher than toe seep samples. EC levels have consistently been <500 µS/cm since 2011, except for 12-TLR-13. Seep sample 12-TLR-13 was collected from the apron of the dam after the first year of construction and had an anomalously high EC of ~3,500 µS/cm.

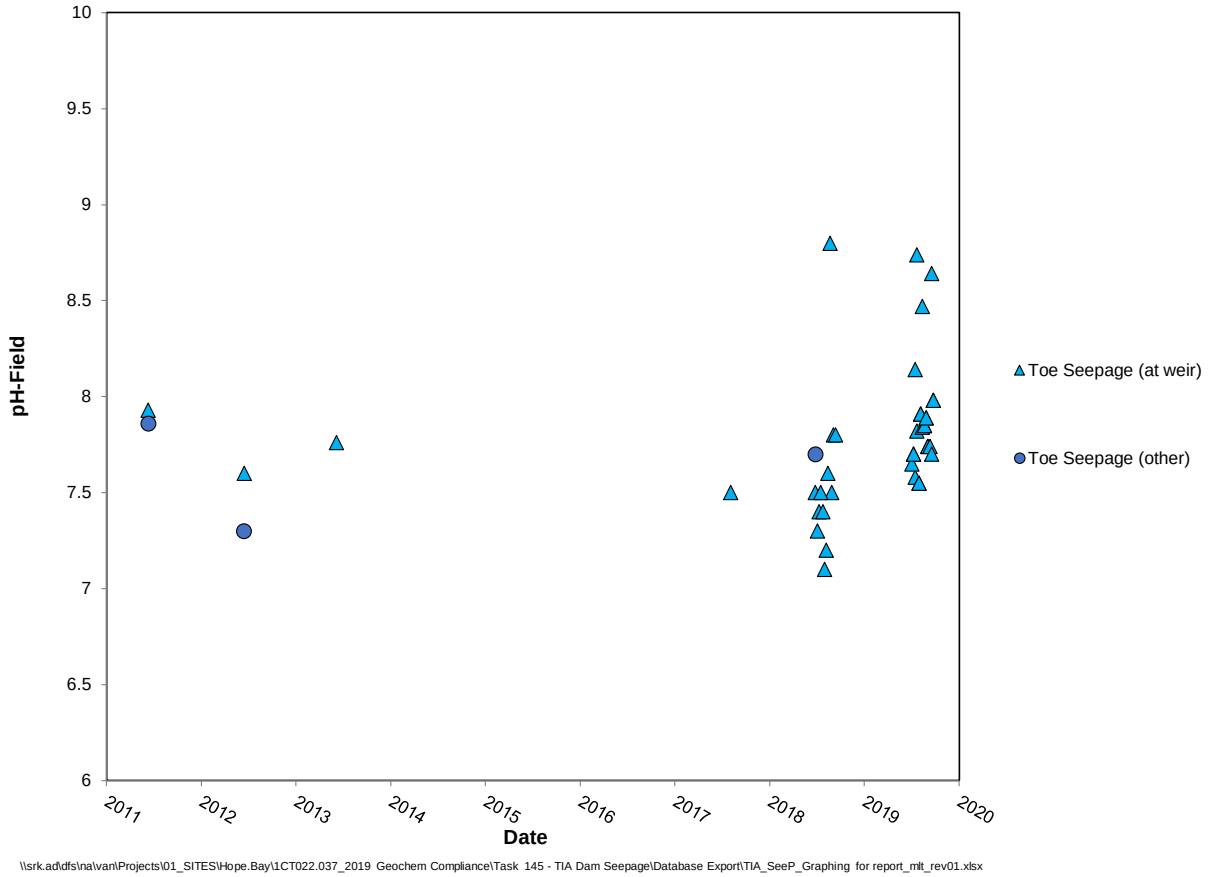


Figure 3-2: pH Monitoring Data

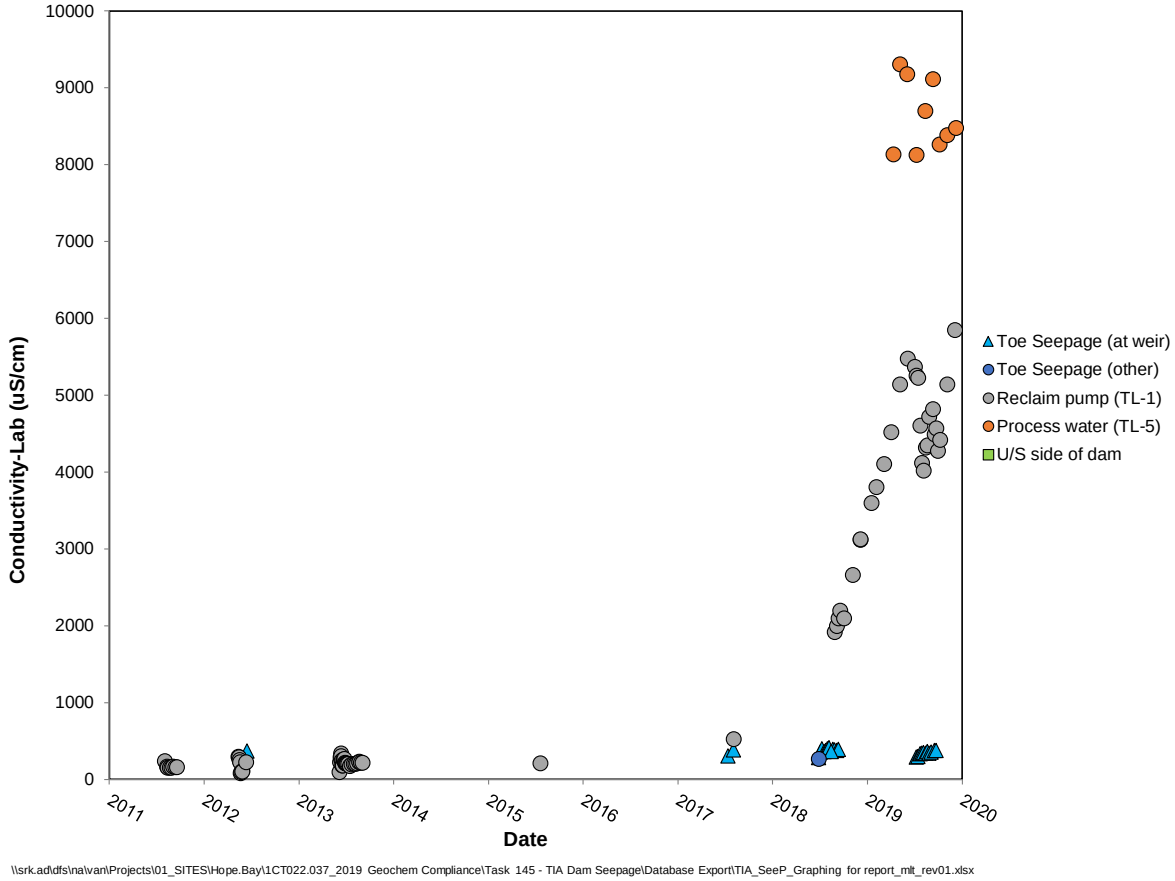


Figure 3-3: EC Monitoring Data

3.1.3 Ammonia and Nitrite

Sources of ammonia and nitrite introduced to the TIA by tailings include i) ore and waste rock containing blasting residues ii) process water containing the cyanide destruction supernatant and iii) biological degradation in the TIA of cyanate and thiocyanate, which are produced as a by-product of the cyanide destruction circuit in the mill. Ammonia from the process plant represents approximately 80% of source loads to the TIA.

Ammonia data are summarized as follows (Figure 3-4):

- TL-5: ammonia concentrations in 2019 ranged from 13 to 38 mg/L as N and are showing a increasing trend since 2017. Concentrations at TL-5 were consistently higher than TL-1 by at least threefold.
- TL-1: ammonia concentrations in 2019 ranged from 3.5 to 7.5 g/L as N. Since 2017, ammonia concentrations have been exhibiting an increasing trend with biologically-mediated seasonal fluctuations, where maximum concentrations are exhibited in winter and minimum concentrations in summer.

- North Dam toe seepage: ammonia concentrations in 2019 ranged from 0.0095 to 0.018 mg/L as N, with levels at TL-1 at least 190 times higher than toe seep samples. Ammonia concentrations for seepage in 2019 were on the same order of magnitude as those observed in 2017 and 2018 and lower than samples from 2011 and 2012 (29 and 0.72 mg/L as N, respectively). However, all measured concentrations in 2019 were greater than those measured in 2018, except for 0.019 mg/L on June 25, 2018. Ammonia concentrations for the 2012 North dam seepage sample are typical of seepage samples collected from other Doris as-built infrastructure using Quarry 2 rock (ranging from 0.0098 to 0.66 mg/L with an average of 0.1 mg/L, n=43). This suggests that the observed decrease of ammonia concentrations in North Dam seepage since construction of the dam is likely due to the flushing of blast residues.

Nitrite data are summarized as follows (Figure 3-5):

- TL-5: nitrite concentrations in 2019 ranged from 0.30 to 0.80 mg/L as N and have been slightly increasing since 2017, following the biological-mediated trends at TL-1 (which is the source of reclaim water for the process plant). Concentrations at TL-5 were consistently higher than TL-1.
- TL-1: nitrite concentrations in 2019 ranged from 0.0012 to 0.24 mg/L as N. Since 2017, nitrite concentrations have been exhibiting an increasing trend with data suggesting the following seasonal trend: decrease during period of spring ice melt, followed by a steady increase between June and August, and relatively stable concentrations during Fall and Winter.
- North Dam toe seepage: nitrite concentrations in 2019 were all below or near the limit of detection (0.001 mg/L as N) except for 0.02 mg/L measured on July 29, 2019 which was a method detection limit. Concentrations at TL-1 were at least 1.2 times higher. Nitrite concentrations were roughly equivalent or slightly lower than values observed in 2017 (0.0012 to 0.021 mg/L as N).

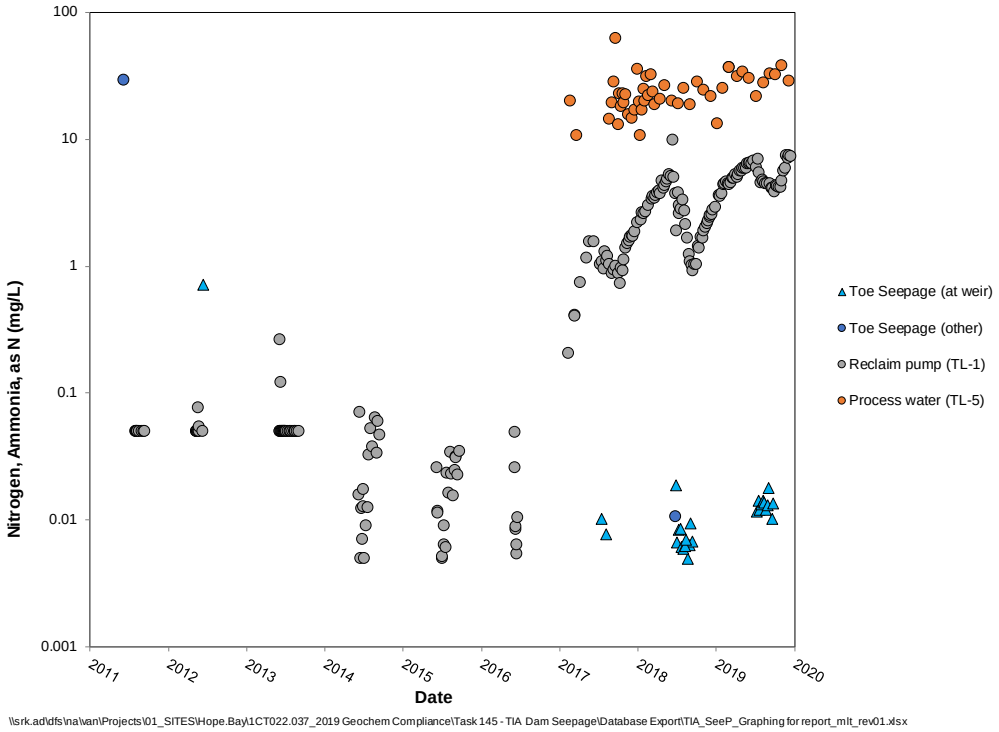


Figure 3-4: Ammonia Monitoring Data

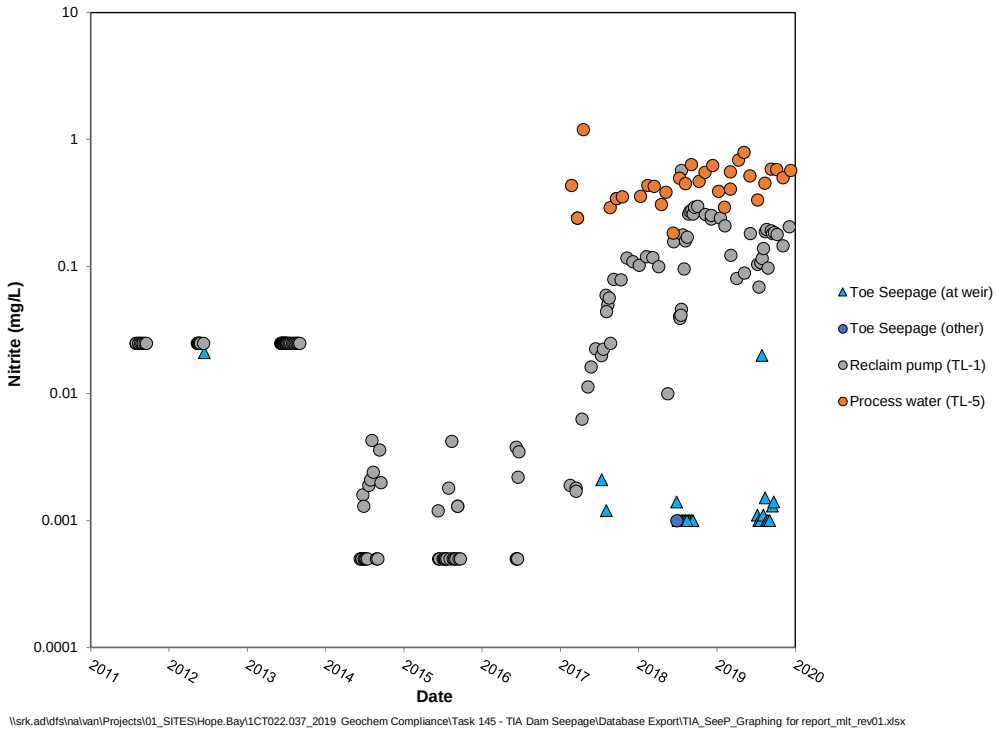


Figure 3-5: Nitrite Monitoring Data

3.1.4 Chloride and Sulphate

Calcium chloride drilling brines are used in the underground mine. As a result, the ore contains calcium chloride salts, which are processed in the mill and subsequently discharged into the TIA. In addition, saline mine water containing calcium chloride is pumped to the TIA (with the exception of June, as noted in Section 3.1.1). Drilling brines are not used during quarry development therefore construction rock does not contain calcium chloride drilling brines. Chloride data are summarized as follows (Figure 3-6):

- TL-5: chloride concentrations in 2019 ranged from 1,200 to 2,878 mg/L.
- TL-1: chloride concentrations in 2019 ranged from 861 to 1,460 mg/L. Since 2018, chloride concentrations have been exhibiting an increasing trend with a seasonal decrease during the open water season.
- North dam toe seepage: chloride concentrations in 2019 ranged from 14 to 33 mg/L, with levels at TL-1 at least 25 times higher than toe seepage samples. Chloride concentrations in 2019 were equivalent to 2013, 2017, and, 2018 North dam seepage samples (ranging from 15 to 30 mg/L) but lower than the 2011 seepage sample 11-TLR5. 11-TLR5 was collected from the apron of the dam and had an anomalously higher chloride concentration (685 mg/L) compared to the other seepage samples.

The source of sulphate to the TIA is the processing of ore containing sulphide minerals and milling reagents. Sulphate data are summarized as follows (Figure 3-7):

- TL-5: sulphate concentrations in 2019 ranged from 1,250 to 2,870 mg/L and were roughly equivalent with levels in 2017 and 2018. Concentrations at TL-5 were consistently higher than TL-1 by at least twofold.
- TL-1: sulphate concentrations in 2019 ranged from 402 to 655 mg/L. Since 2017, sulphate data indicate an increasing trend, however concentrations decreased in July 2019 after which an increasing trend was observed.
- North Dam toe seepage: sulfate concentrations in 2019 ranged from 14 to 27 mg/L, with levels at TL-1 at least 15 times higher than toe seepage samples. Sulphate concentrations in 2019 were equivalent or higher than 2012, 2017, and 2018 North dam seepage samples (ranging from 9 to 365 mg/L) but lower than the 2011 seepage sample 11-TLR5. 11-TLR5 was collected from the apron of the dam and had an anomalously higher sulphate concentration (193 mg/L) compared to the other seepage samples.

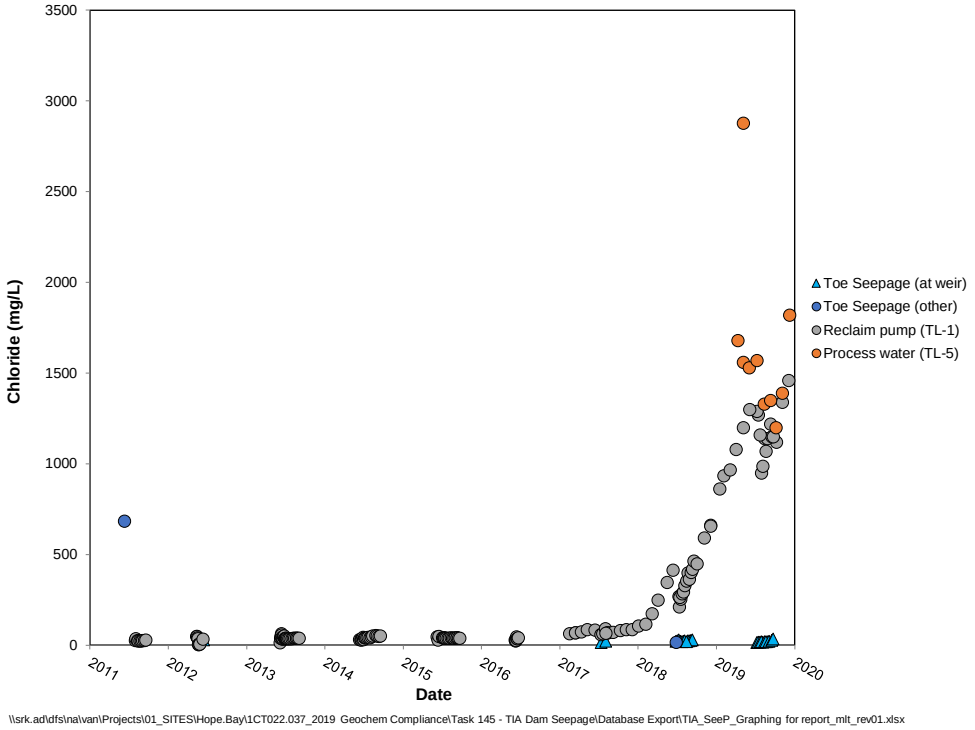


Figure 3-6: Chloride Monitoring Data

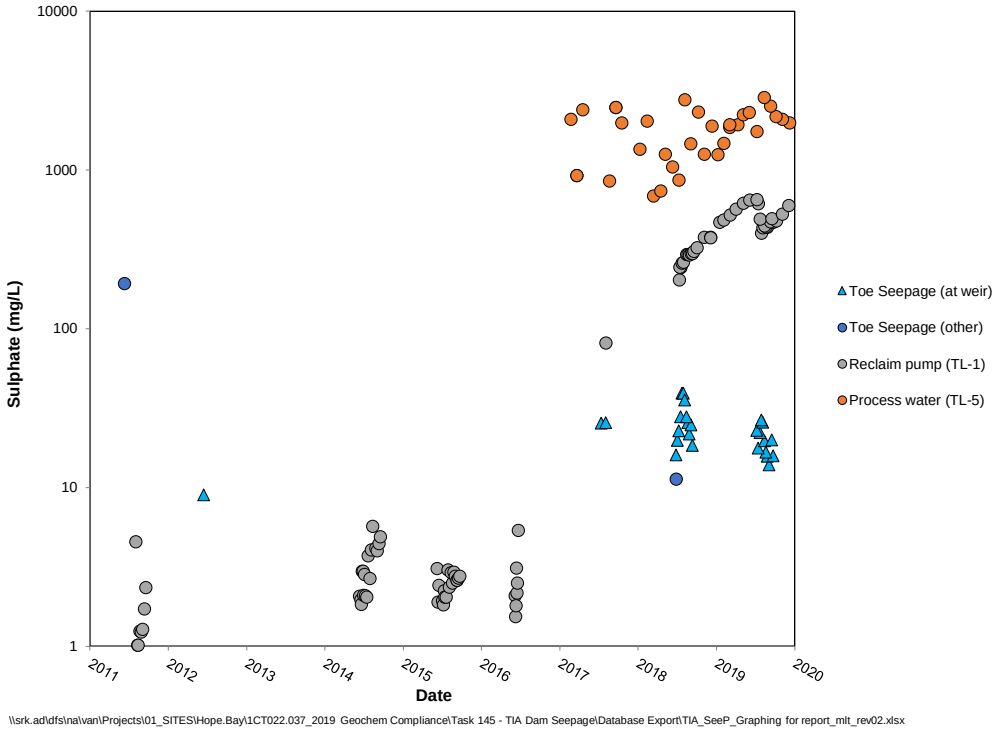


Figure 3-7: Sulphate Monitoring Data

3.2 Major Ions

Table 3-4 summarizes the major ion chemistry of the three TIA pond samples collected upstream of the South Dam; and TL-1 and North dam seepage samples prior to tailings deposition (2011-16) and since tailings deposition (2017-19) and Figure 3-8 presents the results in a Piper diagram Of note, is that most TL-1 samples could not be plotted because the major ion data set was incomplete.

Figure 3-8 indicates that almost all samples can be categorized into the five following geochemical groups: i) TL-1 samples collected prior to tailings deposition (2011-16); ii) TL-1 in 2017 (note one sample plotted in Figure 3-8); iii) TL-1 in 2018 and 2019; iv) North dam seepage samples from all years (2011-18); and v) TIA pond water at the south dam (2019). Of note is that the major ion chemistry of the North dam seepage samples is geochemically distinct from TL-1, both prior to and after tailings deposition. Each group is discussed as follows:

- TL-1
  - 2011-16: Prior to tailings deposition the major cations were characterized by sodium and calcium (medians of 14 and 7.5 mg/L, respectively) and the major anions by bicarbonate and chloride (medians of 35 mg/L as $CaCO_3$ and 26 mg/L, respectively).
  - 2017: Tailings deposition commenced in January 2017. The data from the one sample collected in August indicated that the major cation chemistry continued to be dominated by sodium and calcium but at higher concentrations (61 and 28 mg/L, respectively) and major anion chemistry shifted from bicarbonate-chloride to sulphate-bicarbonate (81 mg/L as $CaCO_3$ and 75 mg/L, respectively).
  - 2018 and 2019: the major cation chemistry continued to be dominated by sodium and calcium but at increasingly higher concentrations each year (medians increasing from 290 to 690 and 62 to 130 mg/L, respectively) and that the major anion chemistry shifted from sulphate-bicarbonate to chloride-sulphate (medians increasing from 440 to 1100 and 300 to 480 mg/L, respectively).
- TIA Pond Water at South Dam:
  - 2019: Samples from Spigot-1 and Spigot 2 (located at the tailings beach) were geochemically distinct from Spigot-3. At the time of sampling, tailings slurry had not yet been discharged from Spigot-3. The major cation chemistry for all three samples was dominated by sodium (range from 360 to 1,100 mg/L) while concentrations of calcium, magnesium and potassium were near equivalent (range from 44 to 97, 43 to 78, and, 33 to 63 mg/L, respectively). For samples Spigot-1 and Spigot-2, the major anion chemistry was dominated by chloride and sulphate (range from 850 to 1,300 mg/L and 1,300 to 1,500 mg/L, respectively) whereas the dominant anions at Spigot-2 bicarbonate and chloride (580 mg/L and 410 mg/L, respectively). Notably, sulphate concentrations at Spigot-3 were low (3.5 mg/L). Lower anion concentrations may be linked to a flushing of this area with spring runoff.

- North Dam Seepage: all seepage samples are grouped together in Figure 3-8 except the seepage sample collected in 2011 (sample ID 11-TLR5). Major ion concentrations are higher for 11-TLR-15 compared to all other North dam seepage samples, including sample 12-TLR-14. The higher ion concentrations may be attributable to the hypersaline pocket of groundwater was intersected during the construction season prior to sample collection. The major ion chemistry of 12-TLR-14 and the 2017-19 seepage samples is summarized as follows:
  - 12-TLR-14 was collected at the same location as the v-notch weir with the major cation chemistry characterized by calcium and sodium (38 and 27 mg/L, respectively) and major anion chemistry characterized by bicarbonate and chloride (150 mg/L as $CaCO_3$ and 30 mg/L, respectively).
  - 2017-19: Compared to 12-TLR-14, the major ion chemistry was equivalent for cations (median calcium and sodium concentrations of 37 and 24 mg/L, respectively) but variable compared to selected anions. Consistent with 12-TLR-14, major anion chemistry was dominated by bicarbonate with equivalent concentrations (median of 130 mg/L as $CaCO_3$), however based on median concentrations, chloride and sulphate were both significant anions (20 and 22 mg/L, respectively). Chloride and sulphate concentrations for the 2017-19 seepage samples are variable and the range of concentrations (14 to 33 mg/L and 11 to 40 mg/L, respectively) are equivalent to 12-TLR-14.

Table 3-4: Summary of Major Ion Chemistry, North Dam Seepage, TL-1 and TIA Pond at South Dam

Station	Date Range	Statistic[1]	Cations[2]				Anions[2]		
			Ca	Mg	K	Na	Total Alkalinity[3]	Cl	SO_4
North Dam Seepage	2011-13	11-TLR5	73	62	34	460	230	690	190
		12-TLR-14	38	9.9	3.8	27	150	30	9
	2017-19	Median	39	9.0	2.0	21	130	20	22
		Count	28	28	28	28	28	28	28
TL-1	2011-16	Median	7.5	5	1.6	14	35	26	1.5
		Count	10	10	10	10	10	10	10
	2017	August	28	8.3	4.4	61	75	67	81
	2018	Median	62	28	17	290	100	370	300
		Count	8	8	8	8	8	8	8
	2019	Median	130	72	31	690	120	1100	480
		Count	21	21	21	21	21	21	21
TIA Pond at South Dam	2019	SRK19-SD-SPIGOT1	97	78	63	1300	290	1300	1500
		SRK19-SD-SPIGOT2	60	73	58	1100	290	850	1300
		SRK19-SD-SPIGOT3	44	45	33	360	580	410	3.5

Source: \\srk.ad\dfs\na\van\Projects\01_SITES\Hope.Bay\1CT022.037_2019 Geochem Compliance\Task 145 - TIA Dam Seepage\Database Export\!TMAC_DMS_LinkedSpreadsheet_WQ_pivot_rtc.xlsx]

Notes

[1] Sample IDs presented for North Dam Seepage (2011-13) and TIA pond water at South Dam sample sets

[2] All units mg/L. Units for alkalinity are mg/L as $CaCO_3$.

[3] Alkalinity in Figure 3-8 plotted as bicarbonate. Referred to as bicarbonate in text in Section 3.5.

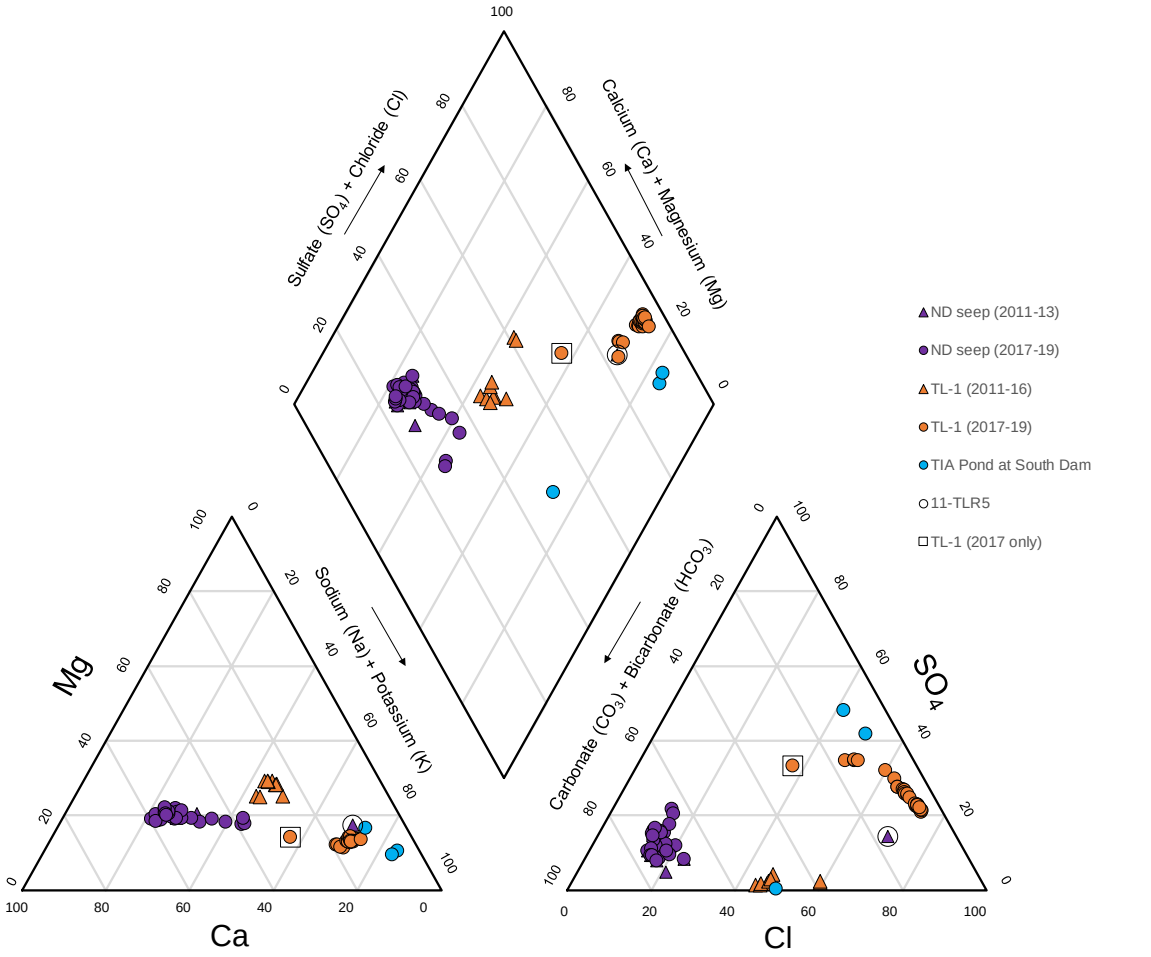


Figure 3-8: Piper Plot of TL-1, North Dam Seepage Samples, and South Dam Tailings Samples

4 Conclusion and Recommendations

In 2017, TMAC initiated a monitoring program of North Dam seepage by request from the EOR, including sample collection for water quality analysis. After construction of the South Dam, a similar seepage monitoring program of the South Dam was implemented; however, no seepage was observed in 2019. SRK reviewed the water quality database for North Dam seepage samples, and SNP stations TL-1 (TIA Reclaim Pond water collected at the reclaim pump), TL-5 (tailings supernatant discharge from mill) to investigate the potential source of the North Dam toe seep. Furthermore, three samples of TIA pond water upstream of the South Dam were collected to quantify pond water chemistry and freezing point depression of the TIA tailings as the chemical composition of porewater within the tailings beach will directly impact heat transfer and freeze-back of the tailings over time (SRK 2020a). Delayed freezeback of the tailings beach could limit heat loss from the South Dam foundation immediately below the upstream toe.

The major ion chemistry of TIA pond water for the South Dam tailings beach was dominated by sodium, sulphate and chloride. Based on the 2019 slurry tailings water chemistry, the estimated tailings freezing point depression is currently expected to have a negligible impact on tailings beach freezeback and thermal performance of the South Dam (SRK 2020a).

A review of the geochemical data related to the North Dam seepage assessment is summarized as follows:

- EC, ammonia, nitrite, chloride and sulphate were identified as geochemical tracers of TIA Reclaim Pond water, with concentrations in TIA Reclaim Pond water uniformly higher than North Dam toe seepage samples.
- Major ion concentrations and chemistry as assessed using a Piper diagram indicated that North Dam toe seepages are geochemically distinct from TIA Reclaim Pond water, prior to and after tailings deposition in the TIA.
- For other parameters, there were no appreciable differences in concentration between the toe seepage samples and TIA Reclaim Pond water.
- No data suggest the presence of TIA Reclaim Pond water in the North Dam toe seepage.

SRK also recommends a QA/QC program of field blanks and duplicates as a method of validating the geochemical data set. These recommended changes are to be included in an updated version of the North Dam seepage water quality monitoring program (SRK 2018a) and implemented in 2020.

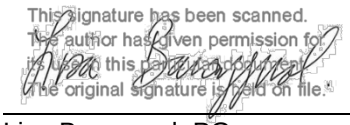
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The opinions expressed in this report have been based on the information available to SRK at the time of preparation. SRK has exercised all due care in reviewing information supplied by others for use on this project. Whilst SRK has compared key supplied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

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Attachment 1: Water Quality Data, 2019 North and South Dam Samples

Location	Sample ID (field or lab)	Date	Height at V-notch (cm)	pH Field Measurement	Conductivity Field Measurement	Oxidation - Reduction Potential, Field	Temperature Field Measurement	Flow	Field Cl	Conductivity (lab)	Hardness (as CaCO3)	pH	Total Suspended Solids	Total Dissolved Solids	Acidity (as CaCO3)	Alkalinity, Total (as CaCO3)	Ammonia, Total (as N)	Bromide (Br)	Chloride (Cl)	
			cm	pH	µS/cm		C	L/s	mg/L	µS/cm	mg/L	pH	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	
Process Water (TL-5)	L2217608-1	1/6/2019	-	-	-	-	-	-	-	-	619	8.3	24.4	-	-	-	13.1	-	-	
	L2228565-1	2/3/2019	-	8.1	7120	427	8.1	-	-	-	580	8.2	21.1	-	-	-	24.9	-	-	
	L2239803-1	3/3/2019	-	8.2	7760	-20	12.4	-	-	-	738	8.1	31.1	-	-	-	36.6	-	-	
	L2256607-1	4/10/2019	-	8.4	8190	2602	13.6	-	-	8140	779	8.2	23	-	-	290	31	-	1680	
	L2268345-1	5/5/2019	-	8.3	9240	42	14.3	-	2878	9310	701	8.0	30.6	-	-	299	33.8	-	1560	
	L2285440-1	6/2/2019	-	8.2	9320	88	12.9	-	3044	9180	720	8.2	22.5	-	-	354	30.1	-	1530	
	L2307093-1	7/7/2019	-	8.3	7750	87	13.9	-	2380	8130	716	8.4	20.7	-	-	279	21.7	-	1570	
	L2327981-1	8/11/2019	-	6.1	8260	231	17.2	-	2652	8700	662	6.2	45.8	-	-	66.4	27.8	-	1330	
	L2344220-1	9/8/2019	-	8.3	8250	203	14.3	-	-	9120	580	8.2	30	-	-	261	32.5	-	1350	
	L2361827-1	10/5/2019	-	8.2	7380	58	12.2	-	-	8270	637	8.3	21.2	-	-	291	32.2	-	1200	
	L2377610-1	11/3/2019	-	8.3	10070	167	9.9	-	-	8390	672	8.4	12.8	-	-	292	38	-	1390	
	L2394082-1	12/8/2019	-	8.2	9860	80	7	-	-	8480	788	8.3	26.4	-	-	290	28.3	-	1820	
Reclaim Pump (TL-1)	TL1 WEEKLY	1/2/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	TL1 WEEKLY	1/7/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	TL1-MONTHLY	1/15/2019	-	7.3	3030	187	1.8	-	-	3600	473	7.8	18	2170	-	118	3.57	-	861	
	TL1 WEEKLY	1/21/2019	-	7.9	3110	39	2	-	-			7.9	18.7	-	-	-	3.51	-	-	
	TL1 WEEKLY	1/28/2019	-	7.2	3520	233	0.4	-	-			7.7	16.6	-	-	-	3.7	-	-	
	TL1-MONTHLY	2/4/2019	-	7.4	4940	444	5.2	-	-	3810	555	7.8	13.9	2380	-	121	4.34	-	934	
	TL1-WEEKLY	2/11/2019	-	7.9	3530	109	2.1	-	-		556	8.0	16.8	-	-	-	4.42	-	-	
	TL1-WEEKLY	2/18/2019	-	7.5	3870	240	4.1	-	-			7.9	13.1	-	-	-	4.6	-	-	
	TL1-WEEKLY	2/25/2019	-	7.7	3790	242	4.1	-	-		590	8.0	13.2	-	-	-	4.44	-	#NA	
	TL1-MONTHLY	3/4/2019	-	7.4	3990	161	5.8	-	-	4110	584	7.8	14.7	2560	-	128	4.35	-	967	
	TL1-WEEKLY	3/11/2019	-	7.4	4350	161	1.8	-	-			8.7	9.6	-	-	-	4.49	-	-	
	TL1-WEEKLY	3/18/2019	-	7.2	4260	133	4.1	-	-		662	7.8	13.4	-	-	-	4.9	-	-	
	TL1-WEEKLY	3/25/2019	-	7.6	4630	119	4.4	-	-		659	7.7	9	-	-	-	4.92	-	#NA	
	TL1-MONTHLY	4/1/2019	-	7.6	4850	95	4.8	-	-	4520	622	7.7	5.5	2690	-	147	5.21	-	1080	
	TL1-WEEKLY	4/8/2019	-	7.6	4700	226	8.1	-	-		610	7.8	6.9	-	-	-	4.95	-	-	
	TL1-WEEKLY	4/15/2019	-	7.8	4830	109	3.3	-	-		646	7.9	5.4	-	-	-	5.26	-	-	
	TL1-WEEKLY	4/22/2019	-	7.5	4880	131	4.2	-	-		633	7.8	3.5	-	-	-	5.57	-	-	
	TL1-WEEKLY	4/29/2019	-	7.6	5140	67	4.1	-	-		707	8.1	5	-	-	-	5.6	-	-	
	TL1-MONTHLY	5/6/2019	-	7.5	5180	89	4.4	-	-	5140	684	8.3	6.7	3050	-	161	5.91	-	1200	
	TL1-WEEKLY	5/13/2019	-	7.6	5540	71	3.9	-	-		726	8.2	5	-	-	-	5.9	-	-	
	TL1-WEEKLY	5/20/2019	-	7.5	5340	-9	8.6	-	-		655	8.2	6	-	-	-	5.86	-	-	
	TL1-WEEKLY	5/27/2019	-	7.7	-	147	737	-	-		760	8.2	5	-	-	-	6.42	-	#NA	
	TL1-MONTHLY	6/3/2019	-	7.6	5590	14	4.6	-	-	5480	741	8.1	6.8	3340	-	167	6.35	-	1300	
	TL1-WEEKLY	6/10/2019	-	7.5	5790	44	3.6	-	-		711	8.1	4.4	-	-	-	6.53	-	-	
	TL1-WEEKLY	6/17/2019	-	7.7	5380	26	3.9	-	-		794	8.1	3.3	-	-	-	6.38	-	-	
	TL1-WEEKLY	6/24/2019	-	7.6	5570	35	2.3	-	-		745	8.2	5.2	-	-	-	6.68	-	-	
	TL1-MONTHLY	7/1/2019	-	7.6	5150	61	3.6	-	1550	5370	709	8.1	4.9	3450	-	169	6.11	-	-	
	TL1-WEEKLY	7/8/2019	-	7.6	5270	23	5.6	-	-	5260	706	8.2	6.3	-	-	160	5.92	-	1290	
	TL1-WEEKLY	7/15/2019	-	7.6	5190	66	5.2	-	-	5230	700	-	-	-	-	-	-	-	1270	
	TL1-WEEKLY	7/22/2019	-	7.8	4570	55	8.6	-	-	4610	670	8.2	1.3	-	-	116	5.4	-	1160	
	TL1-WEEKLY	7/29/2019	-	7.8	4050	58	11.9	-	-	4120	569	8.2	6.3	-	-	105	5.92	-	949	
	TL1-WEEKLY	8/5/2019	-	8.2	3990	124	12.6	-	-	4020	531	8.2	11.4	-	-	107	4.72	-	986	
	TL1-MONTHLY	8/12/2019	-	8.5	4200	82	12.8	-	1361	4320	583	8.2	16	2610	-	109	4.59	-	1140	
	TL1-MONTHLY	8/19/2019	-	8.4	3760	63	15.4	-	1218	4350	592	8.3	15.5	-	-	108	4.47	-	1070	
	TL1-WEEKLY	8/26/2019	-	8.5	4350	86	12.3	-	1370	4720	-	-	-	-	-	-	-	-	1140	
	TL1-WEEKLY	9/2/2019	-	8.6	4660	95	9.9	-	1495	4820	-	-	-	-	-	-	-	-	-	
	TL1-MONTHLY	9/9/2019	-	8.7	4430	92	8.4	-	-		649	8.4	23.1	2890	-	114	4.46	-	-	
	TL1-WEEKLY	9/16/2019	-	8.6	4110	82	6.3	-	1328	4490	612	8.4	18.7	-	-	112	4.1	-	1150	
	TL1-WEEKLY	9/23/2019	-	8.1	4210	64	5.7	-	1328	4570	576	8.4	17.9	-	-	113	4.11	-	1150	
	TL1-WEEKLY	9/29/2019	-	8.0	4210	26	5.1	-	-	4280	606	8.4	22.5	-	-	-	3.8	-	-	
	TL1-MONTHLY	10/7/2019	-	8.4	4240	112	3.7	-	-		628	8.2	19.2	2740	-	113	4.33	-	1120	
	TL1-WEEKLY	10/14/2019	-	8.1	4410	59	4.1	-	-	4420	650	8.3	20.2	-	-	-	4.24	-	-	
	TL1-WEEKLY	10/21/2019	-	8.7	39.3	101	6.1	-	-		673	8.3	16.9	-	-	-	4.18	-	-	
	TL1-WEEKLY	10/28/2019	-	8.0	4250	22	6.2	-	-		676	8.1	14.2	-	-	-	4.16	-	-	
	TL1-MONTHLY	11/4/2019	-	7.9	6310	187	0.9	-	-		674	8.2	15.6	3200	-	122	4.66	-	1340	
	TL1-WEEKLY	11/11/2019	-	7.8	6120	166	2.9	-	-	5140	667	8.1	16.7	-	-	-	5.63	-	-	

Location	Sample ID (field or lab)	Date	Height at V-notch (cm)	pH Field Measurement	Conductivity Field Measurement	Oxidation - Reduction Potential, Field	Temperature Field Measurement	Flow	Field Cl	Conductivity (lab)	Hardness (as CaCO3)	pH	Total Suspended Solids	Total Dissolved Solids	Acidity (as CaCO3)	Alkalinity, Total (as CaCO3)	Ammonia, Total (as N)	Bromide (Br)	Chloride (Cl)	
			cm	pH	µS/cm		C	L/s	mg/L	µS/cm	mg/L	pH	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	
	TL1-WEEKLY	11/18/2019	-	7.8	6480	74	7.1	-	-		657	8.1	20.3	-	-	-	5.91	-	-	
	TL1-WEEKLY	11/25/2019	-	7.8	7080	207	5	-	-		850	8.1	17.9	-	-	-	7.39	-	-	
	TL1-MONTHLY	12/2/2019	-	7.9	7200	198	3.7	-	-		769	7.9	19.8	3650	-	-	7.04	-	1460	
	TL1-WEEKLY	12/9/2019	-	7.8	7190	155	2.6	-	-	5850	773	8.2	13.8	-	-	-	7.45	-	-	
	TL1-WEEKLY	12/16/2019	-	7.9	5910	156	4.3	-	-	-	845	8.1	9.9	-	-	-	7.32	-	-	
	TL1-WEEKLY	12/23/2019	-	7.5	6320	29	3.3	-	-	-	-	-	10.4	-	-	-	-	-	-	
	TL1-WEEKLY	12/30/2019	-	8.0	8000	143	2.3	-	-	-	-	-	10	-	-	-	-	-	-	
At V-notch Weir	NDSEEP	7/1/2019	4.0	7.7	285	92	4.5	0.06	-	278	114	8.2	3	-	-	112	0.0095	-	14.7	
	NDSEEP	7/8/2019	4.5	7.7	322	194	6.4	0.06	55	288	116	8.2	3	-	-	113	0.0116	-	14.1	
	NDSEEP	7/15/2019	5.0	8.1	302	57	3.1	0.07	-	-	-	-	-	-	-	-	-	-	16.7	
	NDSEEP	7/22/2019	5.5	8.7	349	41	5.5	0.08	-	333	139	8.3	4.7	-	-	126	0.012	-	17.3	
	NDSEEP	7/29/2019	-	7.6	376	45	8.5		-	343	139	8.1	3	-	-	127	0.0133	-	19	
	NDSEEP	8/5/2019	-	7.9	379	52	7.6		-	348	132	8.3	3	-	-	134	0.0143	-	17.3	
	NDSEEP	8/12/2019	6.0	7.8	354	82	6.4	0.08	13	343	135	8.3	3	-	-	147	0.0138	-	19.3	
	NDSEEP	8/19/2019	7.5	7.9	338	65	6.4	0.1	16	360	144	8.3	4.3	-	-	141	0.012	-	20.1	
	NDSEEP	8/26/2019	8.0	7.9	332	80	6.6	0.11	16	-	-	-	-	-	-	-	-	-	19.9	
	NDSEEP	9/2/2019	7.5	7.7	395	60	4.6	0.1	111	-	-	-	-	-	-	-	-	-	22.7	
	NDSEEP	9/9/2019	4.5	7.7	399	71	4.9	0.06	1496	-	-	-	-	-	-	-	-	-	-	
	NDSEEP	9/16/2019	6.0	7.7	354	56	2.2	0.08	-	374	145	8.0	-3	-	-	142	-	-	26.2	
	NDSEEP	9/23/2019	4.5	8.0	347	0.91	0.4	0.06	-	377	143	8.4	-3	-	-	134	-	-	33.2	
TIA at upstream face of North Dam	ND Upstream	7/1/2019	-	7.7	1397	100	4.9	-	387	-	-	-	-	-	-	-	-	-	-	
	ND Upstream	7/8/2019	-	7.6	2710	110	8.9	-	775	-	-	-	-	-	-	-	-	-	-	
	ND Upstream	7/15/2019	-	7.9	3740	90	8.1	-	-	-	-	-	-	-	-	-	-	-	-	
	ND Upstream	7/22/2019	-	8.0	3710	51	10.1	-	-	-	-	-	-	-	-	-	-	-	-	
	ND Upstream	7/29/2019	-	8.3	3710	54	11.4	-	-	-	-	-	-	-	-	-	-	-	-	
	ND Upstream	8/5/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	ND Upstream	8/12/2019	-	8.7	3710	100	12.8	-	1249	-	-	-	-	-	-	-	-	-	-	
	ND Upstream	8/19/2019	-	8.8	3710	63	11.6	-	1297	-	-	-	-	-	-	-	-	-	-	
	ND Upstream	8/26/2019	-	8.6	3870	82	12.7	-	1300	-	-	-	-	-	-	-	-	-	-	
	ND Upstream	9/2/2019	-	8.6	4150	66	5.9	-	1328	-	-	-	-	-	-	-	-	-	-	
	ND Upstream	9/9/2019	-	8.9	3990	84	7.6	-	1469	-	-	-	-	-	-	-	-	-	-	
	ND Upstream	9/16/2019	-	8.7	4080	89	5.8	-	1328	-	-	-	-	-	-	-	-	-	-	
	ND Upstream	9/23/2019	-	8.3	4080	23	2.7	-	1273	-	-	-	-	-	-	-	-	-	-	
TIA at upstream face of South Dam	SRK19-SD-Spigot-1	8/4/2019	-	-	-	-	-	-	-	7120	563	8.0	966	-	-	291	17.0	-	1290	
	SRK19-SD-Spigot-2	8/4/2019	-	-	-	-	-	-	-	5990	450	8.3	505	-	-	290	20.7	-	854	
	SRK19-SD-Spigot-3	8/4/2019	-	-	-	-	-	-	-	2240	296	8.3	3570	-	-	578	3.28	-	407	

Location	Sample ID (field or lab)	Date	Fluoride (F)	Nitrate (as N)	Nitrite (as N)	Total Nitrogen	Cyanide, Total	Cyanide, Free	Cyanide, WAD	Cyanate	Thiocyanate	Phosphorus (P)-Total	Sulphate (SO4)	Aluminum (Al)-Dissolved	Antimony (Sb)-Dissolved	Arsenic (As)-Dissolved	Barium (Ba)-Dissolved	Beryllium (Be)-Dissolved	Bismuth (Bi)-Dissolved	Boron (B)-Dissolved	Cadmium (Cd)-Dissolved	Calcium (Ca)-Dissolved
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Process Water (TL-5)	L2217608-1	1/6/2019	-	8.42	0.393	-	5.69	1.75	1.9	11.7	10.5	0.25	1250	-	-	-	-	-	-	-	-	-
	L2228565-1	2/3/2019	-	6.66	0.294	-	16	5.38	6.62	45.3	14.4	0.5	1480	-	-	-	-	-	-	-	-	-
	L2239803-1	3/3/2019	-	17.2	0.559	-	3.47	1.08	1.31	72.9	27.2	0.25	1860	-	-	-	-	-	-	-	-	-
	L2256607-1	4/10/2019	-	25.1	0.693	-	4.75	0.546	0.656	52.8	17.9	0.25	1930	0.0631	0.00147	0.00164	0.0288	0.0001	0.00025	0.69	0.000025	161
	L2268345-1	5/5/2019	-	19.7	0.795	-	4.17	0.31	0.33	42.3	19.1	0.51	2230	0.0301	0.002	0.00153	0.0306	0.0001	0.00025	0.636	0.000025	142
	L2285440-1	6/2/2019	-	9.18	0.52	-	3.99	0.121	0.229	57	17.3	0.5	2310	0.0536	0.00235	0.0021	0.0395	0.0001	0.00025	0.806	0.000026	126
	L2307093-1	7/7/2019	-	11	0.336	-	5.64	0.738	1.4	28.2	13	0.5	1750	0.0375	0.00224	0.00178	0.0318	0.0001	0.00025	0.728	0.000058	141
	L2327981-1	8/11/2019	-	8.65	0.455	-	0.005	0.005	0.005	51.1	0.62	2.5	2870	0.05	0.005	0.005	0.0824	0.001	0.0025	0.99	0.00193	140
	L2344220-1	9/8/2019	-	12.5	0.587	-	3.77	0.013	0.027	55	20.3	0.5	2540	0.042	0.0029	0.0023	0.039	0.0002	0.0005	0.75	0.00005	106
	L2361827-1	10/5/2019	-	10.7	0.584	-	2.68	0.076	0.131	77.1	10.5	0.51	2180	0.029	0.0019	0.0014	0.0256	0.0002	0.0005	0.56	0.00005	118
	L2377610-1	11/3/2019	-	11.2	0.501	-	5.36	0.33	0.41	53.5	21	0.25	2100	0.0645	0.0042	0.00249	0.0242	0.0001	0.00025	0.592	0.000025	113
	L2394082-1	12/8/2019	-	11.2	0.572	-	2.16	0.11	-0.1	63.4	22.5	0.51	1980	0.0432	0.00328	0.00629	0.0287	0.0001	0.00025	0.753	0.000035	128
Reclaim Pump (TL-1)	TL1 WEEKLY	1/2/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TL1 WEEKLY	1/7/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TL1-MONTHLY	1/15/2019	-	2.61	0.242	-	0.116	0.005	0.005	2.58	0.98	0.0746	471	0.0089	0.0005	0.0009	0.02	0.0002	0.2	0.28	0.00001	104
	TL1 WEEKLY	1/21/2019	-	-	-	-	0.123	-	0.005	1.29	1	0.25	-	0.71	0.5	0.88	0.119	0.5	0.25	0.282	0.25	19
	TL1 WEEKLY	1/28/2019	-	-	-	-	0.133	-	0.005	3.3	2.5	0.1	-	0.95	0.5	0.82	0.115	0.5	0.25	0.315	0.25	119
	TL1-MONTHLY	2/4/2019	-	2.63	0.21	8.32	0.131	0.5	0.005	3.42	0.89	0.71	484	0.67	0.5	0.87	0.2	0.2	0.2	0.31	0.1	12
	TL1-WEEKLY	2/11/2019	-	-	-	-	0.154	-	0.0075	3.63	0.71	0.25	-	0.85	0.29	0.97	0.122	0.4	0.1	0.317	0.11	121
	TL1-WEEKLY	2/18/2019	-	-	-	-	0.131	-	0.0268	2.82	0.5	0.25	-	0.7	0.29	0.96	0.124	0.2	0.1	0.316	0.15	127
	TL1-WEEKLY	2/25/2019	-	-	-	-	0.182	-	0.0071	2.49	0.86	-	-	0.57	0.33	0.12	0.145	0.4	0.1	0.318	0.12	123
	TL1-MONTHLY	3/4/2019	-	2.55	0.123	7.9	0.158	0.57	0.005	1.47	0.75	0.611	522	0.69	0.5	0.16	0.2	0.5	0.2	0.34	0.25	126
	TL1-WEEKLY	3/11/2019	-	-	-	-	0.155	-	0.0072	1.89	0.72	0.25	-	0.76	0.29	0.96	0.158	0.2	0.1	0.277	0.1	117
	TL1-WEEKLY	3/18/2019	-	-	-	-	0.198	-	0.0102	2.73	0.97	-	-	0.81	0.5	0.113	0.146	0.1	0.25	0.319	0.25	145
	TL1-WEEKLY	3/25/2019	-	-	-	-	0.184	-	0.0124	2.4	0.97	-	-	0.67	0.5	0.15	0.2	0.2	-	0.38	0.1	145
	TL1-MONTHLY	4/1/2019	-	2.58	0.81	8.8	0.193	0.145	0.0179	3.33	0.69	0.631	569	0.54	0.5	0.17	0.2	0.4	0.2	0.34	0.1	136
	TL1-WEEKLY	4/8/2019	-	-	-	-	0.215	-	0.0209	1.62	0.83	-	-	0.5	0.5	0.114	0.159	0.1	0.25	0.331	0.25	129
	TL1-WEEKLY	4/15/2019	-	-	-	-	0.261	-	0.0411	4.17	0.38	-	-	0.359	0.5	0.14	0.158	0.1	0.25	0.346	0.25	139
	TL1-WEEKLY	4/22/2019	-	-	-	-	0.253	-	0.033	2.28	0.97	-	-	0.73	0.5	0.17	0.158	0.1	0.25	0.339	0.25	131
	TL1-WEEKLY	4/29/2019	-	-	-	-	0.3	-	0.0412	1.44	1.12	-	-	0.71	0.5	0.12	0.174	0.1	0.25	0.44	0.25	154
	TL1-MONTHLY	5/6/2019	-	2.54	0.89	9.75	0.285	0.42	0.0418	2.94	1.08	0.774	618	0.65	0.5	0.115	0.2	0.1	0.2	0.36	0.25	136
	TL1-WEEKLY	5/13/2019	-	-	-	-	0.285	-	0.0383	1.32	1.18	-	-	0.59	0.5	0.19	0.186	0.1	0.25	0.416	0.25	156
	TL1-WEEKLY	5/20/2019	-	-	-	-	0.293	-	0.0358	1.68	1.18	-	-	0.59	0.5	0.13	0.184	0.1	0.25	0.374	0.25	138
	TL1-WEEKLY	5/27/2019	-	-	-	-	0.282	-	0.0358	2.43	1.21	-	-	0.52	0.37	0.112	0.188	0.4	0.1	0.439	0.1	157
	TL1-MONTHLY	6/3/2019	-	2.65	0.182	1.9	0.321	0.43	0.05	0.75	1.26	0.628	65	0.55	0.5	0.14	0.2	0.1	0.2	0.42	0.25	152
	TL1-WEEKLY	6/10/2019	-	-	-	-	0.282	-	0.042	2	1.42	-	-	0.5	0.5	0.113	0.194	0.1	0.25	0.46	0.25	146
	TL1-WEEKLY	6/17/2019	-	-	-	-	0.283	-	0.0284	1.44	1.4	-	-	0.41	0.38	0.116	0.211	0.2	0.5	0.424	0.88	16
	TL1-WEEKLY	6/24/2019	-	-	-	-	0.32	-	0.036	0.27	1.29	-	-	0.92	0.5	0.113	0.194	0.1	0.25	0.418	0.25	159
	TL1-MONTHLY	7/1/2019	-	2.28	0.99	12.9	0.326	0.266	0.0271	1.83	1.32	0.592	652	0.58	0.5	0.16	0.2	0.1	0.2	0.41	0.25	148
	TL1-WEEKLY	7/8/2019	-	2.73	0.14	1.2	0.287	0.271	0.026	2.1	1.28	0.3	655	0.5	0.5	0.111	0.2	0.1	0.2	0.35	0.13	149
	TL1-WEEKLY	7/15/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TL1-WEEKLY	7/22/2019	-	2.84	0.18	9.32	0.138	0.23	0.0188	1.8	1.08	0.3	491	0.67	0.5	0.9	0.2	0.1	0.2	0.34	0.167	141
	TL1-WEEKLY	7/29/2019	-	2.73	0.14	1.2	0.287	0.271	0.026	2.1	1.28	0.3	655	0.5	0.5	0.111	0.2	0.1	0.2	0.35	0.13	149
	TL1-WEEKLY	8/5/2019	-	2.71	0.139	8.9	0.193	0.5	0.005	0.2	0.64	0.3	433	0.95	0.5	0.67	0.2	0.2	0.2	0.32	0.12	113
	TL1-MONTHLY	8/12/2019	-	3.46	0.188	9.1	0.46	0.156	0.0136	0.2	0.64	0.352	446	0.97	0.5	0.8	0.2	0.4	0.2	0.31	0.1	12
	TL1-MONTHLY	8/19/2019	-	3.1	0.196	8.7	0.334	0.132	0.0103	2.82	0.68	0.3	441	0.93	0.5	0.84	0.2	0.2	0.2	0.34	0.1	121
	TL1-WEEKLY	8/26/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TL1-WEEKLY	9/2/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TL1-MONTHLY	9/9/2019	-	3.24	0.192	8.87	0.0482	0.0163	0.0162	2.49	0.73	0.0565	474	0.0108	0.0005	0.00078	0.02	0.0005	0.2	0.38	0.000025	130
	TL1-WEEKLY	9/16/2019	-	2.79	0.183	7.73	0.0321	0.0118	0.011	2.16	0.5	0.3	495	0.011	0.0005	0.00076	0.02	0.0005	0.2	0.34	0.000025	126
	TL1-WEEKLY	9/23/2019	-	2.99	0.185	8	0.044	0.0149	0.0129	4.8	0.7	0.3	471	0.0102	0.0005	0.00079	0.02	0.0002	0.2	0.32	0.00001	122
	TL1-WEEKLY	9/29/2019	-	-	-	-	0.0413	-	0.0093	3.57	0.5	-	-	0.0112	0.0005	0.00094	0.0179	0.0001	0.00025	0.332	0.000025	120
	TL1-MONTHLY	10/7/2019	-	2.88	0.179	8.87	0.0657	0.0145	0.0128	1.68	0.81	0.0567	479	0.0123	0.0005	0.00082	0.02	0.0001	0.2	0.37	0.000025	135
	TL1-WEEKLY	10/14/2019	-	-	-	-	0.0531	-	0.0143	0.48	0.75	-	-	0.0106	0.0005	0.00098	0.0199	0.0001	0.00025	0.366	0.000025	136
	TL1-WEEKLY	10/21/2019	-	-	-	-	0.0482	-	0.008	1.2	0.79	-	-	0.0116	0.00035	0.00092	0.0184	0.00004	0.0001	0.367	0.00001	134
	TL1-WEEKLY	10/28/2019	-	-	-	-	0.0445	-	0.0075	4.2	0.69	-	-	0.0117	0.00032	0.00089	0.0184	0.00004	0.0001	0.368	0.00001	129
	TL1-MONTHLY	11/4/2019	-	3.45	0.146	9.04	0.0542	0.005	0.005	5.52	0.89	0.0346	530	0.0122	0.0005	0.00103	0.02	0.0001	0.2	0.41	0.000025	145
	TL1-WEEKLY	11/11/2019	-	-	-	-	0.151	-	0.005	7.59	1.06	-	-	0.0115	0.00051	0.0014	0.0202	0.0001	0.00025	0.396	0.000025	136

Location	Sample ID (field or lab)	Date	Fluoride (F)	Nitrate (as N)	Nitrite (as N)	Total Nitrogen	Cyanide, Total	Cyanide, Free	Cyanide, WAD	Cyanate	Thiocyanate	Phosphorus (P)-Total	Sulphate (SO4)	Aluminum (Al)-Dissolved	Antimony (Sb)-Dissolved	Arsenic (As)-Dissolved	Barium (Ba)-Dissolved	Beryllium (Be)-Dissolved	Bismuth (Bi)-Dissolved	Boron (B)-Dissolved	Cadmium (Cd)-Dissolved	Calcium (Ca)-Dissolved
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	TL1-WEEKLY	11/18/2019	-	-	-	-	0.119	-	0.005	4.35	0.97	-	-	0.0135	0.0005	0.00106	0.017	0.0001	0.00025	0.388	0.000025	130
	TL1-WEEKLY	11/25/2019	-	-	-	-	0.209	-	0.005	6.03	1.31	-	-	0.0202	0.00056	0.00117	0.0204	0.00004	0.0001	0.419	0.000013	152
	TL1-MONTHLY	12/2/2019	-	3.91	0.206	12.6	0.312	0.005	0.005	0.42	1.32	0.0765	600	0.0138	0.00059	0.00128	0.021	0.0001	0.2	0.48	0.000025	148
	TL1-WEEKLY	12/9/2019	-	-	-	-	0.338	-	0.005	17.2	2.28	-	-	0.0163	0.00057	0.00113	0.0203	0.0001	0.00025	0.458	0.000107	147
	TL1-WEEKLY	12/16/2019	-	-	-	-	0.327	-	0.0058	7.98	1.63	-	-	0.0107	0.00062	0.00115	0.022	0.0005	0.2	0.53	0.000025	163
	TL1-WEEKLY	12/23/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TL1-WEEKLY	12/30/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
At V-notch Weir	NDSEEP	7/1/2019	-	0.103	0.001	0.487	0.005	0.005	-	1	0.5	0.3	20.5	0.0143	0.0005	0.00056	0.02	0.0001	0.2	0.1	0.000005	34.3
	NDSEEP	7/8/2019	-	0.15	0.0011	0.525	0.005	0.005	-	2	-	0.3	22.9	0.013	0.0005	0.00064	0.02	0.0001	0.2	0.1	0.000005	34.9
	NDSEEP	7/15/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	NDSEEP	7/22/2019	-	0.225	0.001	0.707	0.005	0.005	-	1	-	0.3	22.1	0.0166	0.0005	0.00056	0.02	0.0001	0.2	0.1	0.000005	42.2
	NDSEEP	7/29/2019	-	0.43	0.02	0.86	0.005	0.005	-	1	-	0.3	26.6	0.0378	0.0005	0.00056	0.02	0.0001	0.2	0.1	0.000005	40
	NDSEEP	8/5/2019	-	0.3	0.0011	0.77	0.005	0.005	-	2	-	0.3	25.8	0.0272	0.0005	0.00062	0.02	0.0001	0.2	0.1	0.000005	38.7
	NDSEEP	8/12/2019	-	0.189	0.0015	0.853	0.005	0.005	-	0.2	-	0.3	19.7	0.0532	0.0005	0.00059	0.02	0.0001	0.2	0.1	0.000005	39.4
	NDSEEP	8/19/2019	-	0.191	0.001	0.839	0.005	0.005	-	0.2	-	0.3	16.7	0.0244	0.0005	0.00069	0.02	0.0001	0.2	0.1	0.000005	42
	NDSEEP	8/26/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	NDSEEP	9/2/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	NDSEEP	9/9/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	NDSEEP	9/16/2019	-	0.143	0.0013	0.666	-	-0.005	-	-	-	-	20	0.0256	0.0005	0.0005	0.02	0.0001	0.2	0.1	0.000005	42.5
	NDSEEP	9/23/2019	-	0.112	0.0014	0.656	-	-0.005	-	-	-	-	15.8	0.0361	0.0005	0.00051	0.02	0.0001	0.2	0.1	0.000005	42.2
TIA at upstream face of North Dam	ND Upstream	7/1/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ND Upstream	7/8/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ND Upstream	7/15/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ND Upstream	7/22/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ND Upstream	7/29/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ND Upstream	8/5/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ND Upstream	8/12/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ND Upstream	8/19/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ND Upstream	8/26/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ND Upstream	9/2/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ND Upstream	9/9/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ND Upstream	9/16/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ND Upstream	9/23/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TIA at upstream face of South Dam	SRK19-SD-Spigot-1	8/4/2019	-	0.05	0.05	19.6	-	0.1	0.05	8.14	0.784	-	1450	0.008	0.0012	0.001	0.0211	0.0001	0.0001	0.92	0.00001	97
	SRK19-SD-Spigot-2	8/4/2019	-	23	0.82	40.5	-	0.1	0.05	12.7	0.784	-	1330	0.01	0.0007	0.0024	0.0139	0.0001	0.0001	1.61	0.00001	60.1
	SRK19-SD-Spigot-3	8/4/2019	-	0.005	0.005	5.6	-	0.1	0.63	4.42	1.23	-	3.5	0.015	0.0004	0.0048	0.0214	0.0001	0.0001	0.15	0.00001	43.8

Location	Sample ID (field or lab)	Date	Cesium (Cs)-Dissolved	Chromium (Cr)-Dissolved	Cobalt (Co)-Dissolved	Copper (Cu)-Dissolved	Iron (Fe)-Dissolved	Lead (Pb)-Dissolved	Lithium (Li)-Dissolved	Magnesium (Mg)-Dissolved	Manganese (Mn)-Dissolved	Mercury (Hg)-Dissolved	Molybdenum (Mo)-Dissolved	Nickel (Ni)-Dissolved	Phosphorus (P)-Dissolved	Potassium (K)-Dissolved	Rubidium (Rb)-Dissolved	Selenium (Se)-Dissolved	Silicon (Si)-Dissolved	Silver (Ag)-Dissolved	Sodium (Na)-Dissolved
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Process Water (TL-5)	L2217608-1	1/6/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	L2228565-1	2/3/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	L2239803-1	3/3/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	L2256607-1	4/10/2019	-	0.0005	0.0249	0.828	1.31	0.00025	0.0405	91.8	0.179	0.000005	0.0135	0.136	0.25	96.1	-	0.0013	1.55	0.00005	1550
	L2268345-1	5/5/2019	-	0.0005	0.0091	0.195	1.11	0.00025	0.0496	84.3	0.185	0.0000058	0.0152	0.0767	0.44	86.1	-	0.00142	1.61	0.00005	1550
	L2285440-1	6/2/2019	-	0.0005	0.0199	0.02	1.2	0.00025	0.0557	98.3	0.144	0.000005	0.0347	0.0561	0.55	103	-	0.00247	1.83	0.00005	1990
	L2307093-1	7/7/2019	-	0.0005	0.0248	1.3	1.54	0.00025	0.0458	88.5	0.196	0.0000051	0.045	0.119	0.54	78.6	-	0.00296	1.7	0.000176	1460
	L2327981-1	8/11/2019	-	0.005	0.007	150	0.5	0.0025	0.076	75.7	1.27	0.0006	0.0265	3.51	2.5	65.5	-	0.0035	3.9	0.0005	1710
	L2344220-1	9/8/2019	-	0.001	0.0104	0.062	1.41	0.0005	0.041	76.7	0.13	0.0000141	0.0836	0.0069	0.5	77.3	-	0.00266	1.81	0.0001	1950
	L2361827-1	10/5/2019	-	0.001	0.0089	0.0579	0.99	0.0005	0.034	82.9	0.179	0.0000135	0.106	0.0428	0.5	66.7	-	0.00875	1.6	0.0001	1790
	L2377610-1	11/3/2019	-	0.0005	0.00893	0.446	1.28	0.00025	0.0335	94.3	0.134	0.000005	0.0612	0.0396	0.25	61.5	-	0.00588	1.27	0.00005	1820
	L2394082-1	12/8/2019	-	0.0005	0.0164	0.0069	0.772	0.00025	0.0563	114	0.0997	0.000025	0.0416	0.12	0.61	82	-	0.00208	1.49	0.00005	1790
Reclaim Pump (TL-1)	TL1 WEEKLY	1/2/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TL1 WEEKLY	1/7/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TL1-MONTHLY	1/15/2019	-	0.001	0.00277	0.0283	0.133	0.0005	0.0211	52.2	0.363	0.000005	0.0028	0.0079	0.3	27.9	-	0.00031	1.95	0.00002	541
	TL1 WEEKLY	1/21/2019	0.5	0.5	0.272	0.186	0.135	0.25	0.23	54.5	0.361	-	0.248	0.8	0.25	28.3	0.119	0.32	2.1	0.5	54
	TL1 WEEKLY	1/28/2019	0.5	0.5	0.28	0.193	0.116	0.25	0.225	6.8	0.398	-	0.264	0.86	0.25	31.6	0.126	0.3	2.8	0.5	6
	TL1-MONTHLY	2/4/2019	-	0.1	0.291	0.252	0.9	0.5	0.239	62.1	0.427	0.5	0.28	0.87	0.3	31.4	-	0.23	2.17	0.2	627
	TL1-WEEKLY	2/11/2019	-	0.2	0.294	0.315	0.136	0.1	0.225	61.4	0.442	0.5	0.27	0.83	0.1	32.9	-	0.26	2.25	0.2	666
	TL1-WEEKLY	2/18/2019	0.43	0.2	0.34	0.413	0.127	0.1	0.221	62	0.436	0.5	0.267	0.91	0.1	33	0.119	0.15	2.28	0.2	623
	TL1-WEEKLY	2/25/2019	-	0.2	0.341	0.341	0.131	0.1	0.234	68.6	0.52	0.5	0.297	0.93	0.1	34.4	-	0.25	2.38	0.2	686
	TL1-MONTHLY	3/4/2019	-	0.1	0.332	0.168	0.97	0.5	0.241	65.5	0.464	0.5	0.28	0.96	0.3	32.6	-	0.35	2.27	0.5	643
	TL1-WEEKLY	3/11/2019	0.42	0.2	0.315	0.127	0.15	0.1	0.24	6.5	0.482	0.5	0.279	0.9	0.1	32.1	0.129	0.3	2.58	0.2	613
	TL1-WEEKLY	3/18/2019	-	0.5	0.336	0.222	0.152	0.25	0.249	72.5	0.5	0.5	0.35	0.11	0.25	35.5	-	0.48	2.21	0.5	693
	TL1-WEEKLY	3/25/2019	-	0.1	0.334	0.185	0.141	0.5	0.269	72.2	0.499	0.5	0.29	0.11	-	36.1	-	0.33	-	0.2	698
	TL1-MONTHLY	4/1/2019	-	0.1	0.349	0.213	0.173	0.5	0.244	68.5	0.511	0.5	0.3	0.11	0.3	36.1	-	0.4	2.45	0.2	689
	TL1-WEEKLY	4/8/2019	-	0.5	0.375	0.288	0.246	0.25	0.247	7.2	0.511	0.5	0.315	0.17	0.25	35.3	-	0.41	2.19	0.5	71
	TL1-WEEKLY	4/15/2019	-	0.5	0.37	0.31	0.265	0.25	0.24	72.9	0.58	0.5	0.311	0.17	0.25	35.4	-	0.51	2.38	0.5	738
	TL1-WEEKLY	4/22/2019	-	0.5	0.373	0.27	0.229	0.25	0.246	74.2	0.533	0.5	0.35	0.111	0.25	35.4	-	0.33	2.48	0.5	752
	TL1-WEEKLY	4/29/2019	-	0.5	0.376	0.341	0.24	0.25	0.284	78.3	0.538	0.5	0.343	0.119	0.25	39.4	-	0.36	2.75	0.5	797
	TL1-MONTHLY	5/6/2019	-	0.1	0.45	0.29	0.279	0.5	0.263	83.7	0.588	0.5	0.3	0.125	0.3	39.5	-	0.47	2.64	0.5	817
	TL1-WEEKLY	5/13/2019	-	0.5	0.377	0.224	0.297	0.25	0.277	81.5	0.538	0.5	0.356	0.117	0.25	38.3	-	0.47	2.65	0.5	755
	TL1-WEEKLY	5/20/2019	-	0.5	0.379	0.189	0.142	0.25	0.271	75.7	0.554	0.5	0.358	0.119	0.25	39.1	-	0.36	2.71	0.5	835
	TL1-WEEKLY	5/27/2019	-	0.2	0.392	0.181	0.338	0.1	0.312	89	0.622	0.5	0.359	0.122	0.1	43.4	-	0.36	2.89	0.2	844
	TL1-MONTHLY	6/3/2019	-	0.1	0.42	0.234	0.141	0.5	0.297	87.7	0.578	0.5	0.36	0.118	0.3	42.2	-	0.61	2.85	0.5	839
	TL1-WEEKLY	6/10/2019	-	0.5	0.386	0.241	0.31	0.25	0.293	84.5	0.567	0.5	0.339	0.129	0.25	41.7	-	0.26	2.79	0.5	869
	TL1-WEEKLY	6/17/2019	-	0.1	0.41	0.246	0.339	0.5	0.38	95.6	0.624	0.5	0.366	0.13	0.6	48.5	-	0.323	2.98	0.1	929
	TL1-WEEKLY	6/24/2019	-	0.5	0.45	0.17	0.277	0.25	0.281	84.5	0.556	0.5	0.347	0.132	0.25	39.8	-	0.25	2.65	0.5	883
	TL1-MONTHLY	7/1/2019	-	0.1	0.387	0.135	0.259	0.5	0.27	82.3	0.549	0.5	0.36	0.124	0.3	38.4	-	0.44	2.71	0.5	81
	TL1-WEEKLY	7/8/2019	-	0.1	0.384	0.211	0.199	0.5	0.25	8.9	0.595	0.53	0.35	0.122	0.3	41.5	-	0.539	2.58	0.2	823
	TL1-WEEKLY	7/15/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TL1-WEEKLY	7/22/2019	-	0.1	0.317	0.444	0.131	0.5	0.228	77.6	0.446	0.5	0.31	0.91	0.3	36.7	-	0.376	2.15	0.2	759
	TL1-WEEKLY	7/29/2019	-	0.1	0.384	0.211	0.199	0.5	0.25	8.9	0.595	0.53	0.35	0.122	0.3	41.5	-	0.539	2.58	0.2	823
	TL1-WEEKLY	8/5/2019	-	0.1	0.279	0.466	0.18	0.5	0.25	6.4	0.381	0.5	0.3	0.74	0.3	3.1	-	0.18	2.1	0.2	63
	TL1-MONTHLY	8/12/2019	-	0.1	0.293	0.562	0.83	0.5	0.187	69	0.374	0.5	0.33	0.8	0.3	28.5	-	0.19	2.4	0.2	64
	TL1-MONTHLY	8/19/2019	-	0.1	0.285	0.527	0.56	0.5	0.216	7.7	0.392	0.91	0.36	0.76	0.3	28.7	-	0.26	1.96	0.2	66
	TL1-WEEKLY	8/26/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TL1-WEEKLY	9/2/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TL1-MONTHLY	9/9/2019	0	0.001	0.00306	0.056	0.084	0.0005	0.0227	79.2	0.402	0.000005	0.004	0.0077	0.3	33	-	0.00025	2.06	0.00005	775
	TL1-WEEKLY	9/16/2019	-	0.001	0.00292	0.0488	-	0.0005	0.0217	72.3	0.387	0.000005	0.0042	0.0076	0.3	30.3	-	0.00039	2.01	0.00005	680
	TL1-WEEKLY	9/23/2019	-	0.001	0.00282	0.0469	-	0.0005	0.0206	66.1	0.381	0.0000108	0.0044	0.007	0.3	30.3	-	0.00023	1.97	0.00002	675
	TL1-WEEKLY	9/29/2019	-	0.0005	0.00304	0.0499	-	0.00025	0.0199	74.2	0.397	0.000019	0.0049	0.0079	0.25	30.7	-	0.00025	2.05	0.00005	691
	TL1-MONTHLY	10/7/2019	0	0.001	0.00303	0.0524	0.069	0.0005	0.023	70.6	0.399	0.0000159	0.0049	0.008	0.3	30.9	-	0.00025	1.92	0.00005	715
	TL1-WEEKLY	10/14/2019	-	0.0005	0.00312	0.0518	-	0.00025	0.022	75.4	0.418	0.000005	0.00523	0.0079	0.25	32.2	-	0.0004	2.04	0.00005	727
	TL1-WEEKLY	10/21/2019	-	0.0002	0.00324	0.051	-	0.0001	0.0236	82.3	0.415	0.000005	0.00543	0.0079	0.1	35.2	-	0.00018	2.05	0.00002	788
	TL1-WEEKLY	10/28/2019	-	0.0002	0.00326	0.0506	-	0.0001	0.0236	85.7	0.441	0.0000164	0.00524	0.0083	0.1	35.2	-	0.00016	2.32	0.00002	854
	TL1-MONTHLY	11/4/2019	0	0.001	0.00315	0.0481	0.086	0.0005	0.0246	75.8	0.415	0.0000138	0.0066	0.0082	0.3	33.5	-	0.0005	2.25	0.00005	777
	TL1-WEEKLY	11/11/2019	-	0.0005	0.00353	0.0513	-	0.00025	0.0237	79.7	0.401	0.0000081	0.00846	0.0097	0.25	37.7	-	0.00054	2.17	0.00005	838

Location	Sample ID (field or lab)	Date	Cesium (Cs)-Dissolved	Chromium (Cr)-Dissolved	Cobalt (Co)-Dissolved	Copper (Cu)-Dissolved	Iron (Fe)-Dissolved	Lead (Pb)-Dissolved	Lithium (Li)-Dissolved	Magnesium (Mg)-Dissolved	Manganese (Mn)-Dissolved	Mercury (Hg)-Dissolved	Molybdenum (Mo)-Dissolved	Nickel (Ni)-Dissolved	Phosphorus (P)-Dissolved	Potassium (K)-Dissolved	Rubidium (Rb)-Dissolved	Selenium (Se)-Dissolved	Silicon (Si)-Dissolved	Silver (Ag)-Dissolved	Sodium (Na)-Dissolved
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	TL1-WEEKLY	11/18/2019	-	0.0005	0.00346	0.055	-	0.00025	0.0219	80.4	0.402	0.000005	0.0086	0.0092	0.25	37.3	-	0.00037	2.03	0.00005	806
	TL1-WEEKLY	11/25/2019	-	0.0002	0.00334	0.0622	-	0.0001	0.027	114	0.464	0.0000149	0.01	0.0091	0.1	52.3	-	0.00053	2.51	0.00002	1100
	TL1-MONTHLY	12/2/2019	-	0.001	0.00395	0.0511	0.159	0.0005	0.0275	97.3	0.442	0.0000082	0.0101	0.009	0.3	41.2	-	0.0005	2.5	0.00005	993
	TL1-WEEKLY	12/9/2019	-	0.0005	0.00397	0.0394	0.208	0.00025	0.0258	98.6	0.393	0.0000195	0.0108	0.0103	0.25	39.9	-	0.0004	2.13	0.00005	1010
	TL1-WEEKLY	12/16/2019	-	0.001	0.00389	0.0244	0.281	0.0005	0.0306	106	0.453	0.0000133	0.0104	0.0095	0.3	43.9	-	0.00037	2.33	0.00005	1050
	TL1-WEEKLY	12/23/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TL1-WEEKLY	12/30/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
At V-notch Weir	NDSEEP	7/1/2019	-	0.001	0.0003	0.0069	0.086	0.0005	0.0021	6.88	0.00596	0.000005	0.001	0.001	0.3	2	-	0.00012	2.87	0.00002	14.6
	NDSEEP	7/8/2019	-	0.001	0.0003	0.0066	0.06	0.0005	0.0024	6.95	0.0036	-	0.001	0.001	0.3	2	-	0.000145	2.99	0.00002	15.5
	NDSEEP	7/15/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	NDSEEP	7/22/2019	-	0.001	0.0003	0.0073	0.104	0.0005	0.0027	8.04	0.00396	-	0.001	0.001	0.3	2	-	0.00017	3.47	0.00002	17.6
	NDSEEP	7/29/2019	-	0.001	0.0003	0.0081	0.083	0.0005	0.0026	9.58	0.00385	-	0.001	0.001	0.3	2	-	0.000154	3.55	0.00002	22
	NDSEEP	8/5/2019	-	0.001	0.0003	0.0079	0.074	0.0005	0.003	8.46	0.00316	-	0.001	0.0011	0.3	2	-	0.000188	3.66	0.00002	21.3
	NDSEEP	8/12/2019	-	0.001	0.0003	0.0084	0.121	0.0005	0.0032	8.95	0.00421	-	0.001	0.0015	0.3	2	-	0.000202	4.4	0.00002	19.3
	NDSEEP	8/19/2019	-	0.001	0.0003	0.0085	0.101	0.0005	0.0035	9.48	0.00407	-	0.001	0.0015	0.3	2	-	0.000181	4.44	0.00002	19.4
	NDSEEP	8/26/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	NDSEEP	9/2/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	NDSEEP	9/9/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	NDSEEP	9/16/2019	-	0.001	0.0003	0.007	0.098	0.0005	0.0032	9.5	0.00578	0.000005	0.001	0.0013	0.3	2	-	0.00015	4.58	0.00002	20
	NDSEEP	9/23/2019	-	0.001	0.0003	0.0075	0.148	0.0005	0.003	9.17	0.00667	0.0000114	0.001	0.0013	0.3	2	-	0.0001	4.82	0.00002	20.1
TIA at upstream face of North Dam	ND Upstream	7/1/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ND Upstream	7/8/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ND Upstream	7/15/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ND Upstream	7/22/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ND Upstream	7/29/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ND Upstream	8/5/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ND Upstream	8/12/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ND Upstream	8/19/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ND Upstream	8/26/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ND Upstream	9/2/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ND Upstream	9/9/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ND Upstream	9/16/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ND Upstream	9/23/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TIA at upstream face of South Dam	SRK19-SD-Spigot-1	8/4/2019	-	0.0005	0.0052	0.0097	0.06	0.0005	0.0649	78	0.255	0.0005	0.0469	0.0013	0.05	62.9	-	0.0011	3.92	0.00008	1280
	SRK19-SD-Spigot-2	8/4/2019	-	0.0005	0.0042	0.0393	0.02	0.0005	0.0123	72.8	0.13	0.0005	0.0197	0.0044	0.05	57.5	-	0.004	1.45	0.00008	1080
	SRK19-SD-Spigot-3	8/4/2019	-	0.0016	0.001	0.0006	0.32	0.0005	0.0336	45.2	0.0323	0.0005	0.0012	0.0019	0.23	33	-	0.0005	10.1	0.00008	358

Location	Sample ID (field or lab)	Date	Strontium (Sr)-Dissolved	Sulfur (S)-Dissolved	Tellurium (Te)-Dissolved	Thallium (Tl)-Dissolved	Thorium (Th)-Dissolved	Tin (Sn)-Dissolved	Titanium (Ti)-Dissolved	Tungsten (W)-Dissolved	Uranium (U)-Dissolved	Vanadium (V)-Dissolved	Zinc (Zn)-Dissolved	Zirconium (Zr)-Dissolved
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Process Water (TL-5)	L2217608-1	1/6/2019	-	-	-	-	-	-	-	-	-	-	-	-
	L2228565-1	2/3/2019	-	-	-	-	-	-	-	-	-	-	-	-
	L2239803-1	3/3/2019	-	-	-	-	-	-	-	-	-	-	-	-
	L2256607-1	4/10/2019	1.2	755	-	0.00005	-	0.0005	0.0015	-	0.000748	0.0025	0.005	0.0003
	L2268345-1	5/5/2019	1.1	842	-	0.00005	-	0.0005	0.0015	-	0.000554	0.0025	0.005	0.0003
	L2285440-1	6/2/2019	1.2	945	-	0.00005	-	0.0005	0.0015	-	0.000869	0.0025	0.005	0.001
	L2307093-1	7/7/2019	1.1	627	-	0.00005	-	0.0005	0.0015	-	0.000477	0.0025	0.005	0.001
	L2327981-1	8/11/2019	1.1	970	-	0.0005	-	0.005	0.015	-	0.0005	0.025	0.263	0.01
	L2344220-1	9/8/2019	1.1	983	-	0.0001	-	0.001	0.003	-	0.00065	0.005	0.01	0.002
	L2361827-1	10/5/2019	0.9	857	-	0.0001	-	0.001	0.003	-	0.00028	0.005	0.01	0.002
	L2377610-1	11/3/2019	1.0	820	-	0.00005	-	0.0005	0.0015	-	0.000224	0.0025	0.005	0.001
	L2394082-1	12/8/2019	1.1	707	-	0.00005	-	0.0005	0.0015	-	0.000632	0.0025	0.005	0.001
Reclaim Pump (TL-1)	TL1 WEEKLY	1/2/2019	-	-	-	-	-	-	-	-	-	-	-	-
	TL1 WEEKLY	1/7/2019	-	-	-	-	-	-	-	-	-	-	-	-
	TL1-MONTHLY	1/15/2019	-	-	-	0.0002	-	0.0005	0.01	-	0.0002	0.001	0.005	-
	TL1 WEEKLY	1/21/2019	0.78	173	0.1	0.5	0.5	0.5	0.15	0.5	0.192	0.25	0.5	0.3
	TL1 WEEKLY	1/28/2019	0.78	178	0.1	0.5	0.5	0.5	0.15	0.5	0.195	0.25	0.5	0.3
	TL1-MONTHLY	2/4/2019	0.87	-	-	0.2	-	0.5	0.1	-	0.2	0.1	0.5	-
	TL1-WEEKLY	2/11/2019	0.83	26	-	0.2	-	0.2	0.6	-	0.179	0.1	0.2	0.3
	TL1-WEEKLY	2/18/2019	0.86	193	0.4	0.2	0.2	0.2	0.6	0.36	0.28	0.1	0.2	0.12
	TL1-WEEKLY	2/25/2019	0.95	23	-	0.2	-	0.2	0.6	-	0.29	0.1	0.2	0.3
	TL1-MONTHLY	3/4/2019	0.83	-	-	0.2	-	0.5	0.1	-	0.21	0.25	0.5	-
	TL1-WEEKLY	3/11/2019	0.88	25	0.4	0.2	0.2	0.2	0.6	0.3	0.238	0.1	0.2	0.12
	TL1-WEEKLY	3/18/2019	1	21	-	0.5	-	0.5	0.15	-	0.23	0.25	0.5	0.3
	TL1-WEEKLY	3/25/2019	-	-	-	0.2	-	0.5	0.1	-	0.21	0.1	0.5	-
	TL1-MONTHLY	4/1/2019	1.8	199	-	0.2	-	0.5	0.1	-	0.21	0.1	0.5	0.3
	TL1-WEEKLY	4/8/2019	1.1	23	-	0.5	-	0.5	0.15	-	0.234	0.25	0.5	0.3
	TL1-WEEKLY	4/15/2019	1.8	215	-	0.5	-	0.5	0.15	-	0.232	0.25	0.5	0.3
	TL1-WEEKLY	4/22/2019	1.8	219	-	0.5	-	0.5	0.15	-	0.21	0.25	0.5	0.3
	TL1-WEEKLY	4/29/2019	1.15	227	-	0.5	-	0.5	0.15	-	0.234	0.25	0.5	0.3
	TL1-MONTHLY	5/6/2019	0.952	235	-	0.2	-	0.5	0.1	-	0.23	0.25	0.5	0.3
	TL1-WEEKLY	5/13/2019	1.16	214	-	0.5	-	0.5	0.15	-	0.242	0.25	0.5	0.3
	TL1-WEEKLY	5/20/2019	1.17	241	-	0.5	-	0.5	0.15	-	0.247	0.25	0.5	0.3
	TL1-WEEKLY	5/27/2019	1.2	267	-	0.2	-	0.2	0.6	-	0.237	0.1	0.2	0.3
	TL1-MONTHLY	6/3/2019	1.19	252	-	0.2	-	0.5	0.1	-	0.26	0.25	0.5	0.1
	TL1-WEEKLY	6/10/2019	1.16	243	-	0.5	-	0.5	0.15	-	0.263	0.25	0.5	0.1
	TL1-WEEKLY	6/17/2019	1.2	262	-	0.1	-	0.1	0.3	-	0.253	0.5	0.1	0.3
	TL1-WEEKLY	6/24/2019	1.27	225	-	0.5	-	0.5	0.15	-	0.255	0.25	0.5	0.1
	TL1-MONTHLY	7/1/2019	1.17	229	-	0.2	-	0.5	0.1	-	0.26	0.25	0.5	0.1
	TL1-WEEKLY	7/8/2019	1.18	-	-	0.2	-	0.5	0.1	-	0.24	0.5	0.5	-
	TL1-WEEKLY	7/15/2019	-	-	-	-	-	-	-	-	-	-	-	-
	TL1-WEEKLY	7/22/2019	1.4	-	-	0.2	-	0.5	0.1	-	0.2	0.5	0.5	-
	TL1-WEEKLY	7/29/2019	1.18	-	-	0.2	-	0.5	0.1	-	0.24	0.5	0.5	-
	TL1-WEEKLY	8/5/2019	0.916	-	-	0.2	-	0.5	0.1	-	0.2	0.1	0.5	-
	TL1-MONTHLY	8/12/2019	0.989	16	-	0.2	-	0.5	0.1	-	0.2	0.1	0.5	0.4
	TL1-MONTHLY	8/19/2019	0.987	-	-	0.2	-	0.5	0.1	-	0.2	0.1	0.5	-
	TL1-WEEKLY	8/26/2019	-	-	-	-	-	-	-	-	-	-	-	-
	TL1-WEEKLY	9/2/2019	-	-	-	-	-	-	-	-	-	-	-	-
	TL1-MONTHLY	9/9/2019	1.12	0	-	0.0002	-	0.0005	0.01	-	0.0002	0.0025	0.005	-
	TL1-WEEKLY	9/16/2019	1.03	0	-	0.0002	-	0.0005	0.01	-	0.0002	0.0025	0.005	-
	TL1-WEEKLY	9/23/2019	1.08	0	-	0.0002	-	0.0005	0.01	-	0.0002	0.001	0.005	-
	TL1-WEEKLY	9/29/2019	0.958	190	-	0.00005	-	0.0005	0.0015	-	0.000181	0.0025	0.005	0.001
	TL1-MONTHLY	10/7/2019	1.04	165	-	0.0002	-	0.0005	0.01	-	0.0002	0.0025	0.005	0.001
	TL1-WEEKLY	10/14/2019	1.14	182	-	0.00005	-	0.0005	0.0015	-	0.000179	0.0025	0.005	0.001
	TL1-WEEKLY	10/21/2019	1.08	194	-	0.00002	-	0.0002	0.0006	-	0.0002	0.001	0.002	0.0004
	TL1-WEEKLY	10/28/2019	1.09	213	-	0.00002	-	0.0002	0.0006	-	0.0002	0.001	0.002	0.0004
	TL1-MONTHLY	11/4/2019	1.26	201	-	0.0002	-	0.0005	0.01	-	0.00022	0.0025	0.005	0.001
	TL1-WEEKLY	11/11/2019	1	216	-	0.00005	-	0.0005	0.0015	-	0.000237	0.0025	0.005	0.001

Location	Sample ID (field or lab)	Date	Strontium (Sr)-Dissolved	Sulfur (S)-Dissolved	Tellurium (Te)-Dissolved	Thallium (Tl)-Dissolved	Thorium (Th)-Dissolved	Tin (Sn)-Dissolved	Titanium (Ti)-Dissolved	Tungsten (W)-Dissolved	Uranium (U)-Dissolved	Vanadium (V)-Dissolved	Zinc (Zn)-Dissolved	Zirconium (Zr)-Dissolved
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	TL1-WEEKLY	11/18/2019	1.14	215	-	0.00005	-	0.0005	0.0015	-	0.00022	0.0025	0.005	0.001
	TL1-WEEKLY	11/25/2019	1.25	267	-	0.00002	-	0.0002	0.0006	-	0.000208	0.001	0.0028	0.0004
	TL1-MONTHLY	12/2/2019	1.27	249	-	0.00002	-	0.0005	0.01	-	0.00022	0.0025	0.005	0.001
	TL1-WEEKLY	12/9/2019	1.25	244	-	0.00005	-	0.0005	0.0015	-	0.00023	0.0025	0.0153	0.001
	TL1-WEEKLY	12/16/2019	1.45	0	-	0.00002	-	0.0005	0.01	-	0.00022	0.0025	0.0164	-
	TL1-WEEKLY	12/23/2019	-	-	-	-	-	-	-	-	-	-	-	-
	TL1-WEEKLY	12/30/2019	-	-	-	-	-	-	-	-	-	-	-	-
At V-notch Weir	NDSEEP	7/1/2019	0.0432	-	-	0.0002	-	0.0005	0.01	-	0.0002	0.0005	0.005	-
	NDSEEP	7/8/2019	0.0435	-	-	0.0002	-	0.0005	0.01	-	0.0002	0.0005	0.005	-
	NDSEEP	7/15/2019	-	-	-	-	-	-	-	-	-	-	-	-
	NDSEEP	7/22/2019	0.0472	-	-	0.0002	-	0.0005	0.01	-	0.0002	0.0005	0.005	-
	NDSEEP	7/29/2019	0.0589	-	-	0.0002	-	0.0005	0.01	-	0.0002	0.0005	0.005	-
	NDSEEP	8/5/2019	0.0564	-	-	0.0002	-	0.0005	0.01	-	0.0002	0.0005	0.005	-
	NDSEEP	8/12/2019	0.0523	-	-	0.0002	-	0.0005	0.01	-	0.0002	0.0005	0.005	-
	NDSEEP	8/19/2019	0.0545	-	-	0.0002	-	0.0005	0.01	-	0.0002	0.0005	0.005	-
	NDSEEP	8/26/2019	-	-	-	-	-	-	-	-	-	-	-	-
	NDSEEP	9/2/2019	-	-	-	-	-	-	-	-	-	-	-	-
	NDSEEP	9/9/2019	-	-	-	-	-	-	-	-	-	-	-	-
	NDSEEP	9/16/2019	0.0522	-	-	0.0002	-	0.0005	0.01	-	0.0002	0.0005	0.005	-
	NDSEEP	9/23/2019	0.0535	-	-	0.0002	-	0.0005	0.01	-	0.0002	0.0005	0.005	-
TIA at upstream face of North Dam	ND Upstream	7/1/2019	-	-	-	-	-	-	-	-	-	-	-	-
	ND Upstream	7/8/2019	-	-	-	-	-	-	-	-	-	-	-	-
	ND Upstream	7/15/2019	-	-	-	-	-	-	-	-	-	-	-	-
	ND Upstream	7/22/2019	-	-	-	-	-	-	-	-	-	-	-	-
	ND Upstream	7/29/2019	-	-	-	-	-	-	-	-	-	-	-	-
	ND Upstream	8/5/2019	-	-	-	-	-	-	-	-	-	-	-	-
	ND Upstream	8/12/2019	-	-	-	-	-	-	-	-	-	-	-	-
	ND Upstream	8/19/2019	-	-	-	-	-	-	-	-	-	-	-	-
	ND Upstream	8/26/2019	-	-	-	-	-	-	-	-	-	-	-	-
	ND Upstream	9/2/2019	-	-	-	-	-	-	-	-	-	-	-	-
	ND Upstream	9/9/2019	-	-	-	-	-	-	-	-	-	-	-	-
	ND Upstream	9/16/2019	-	-	-	-	-	-	-	-	-	-	-	-
	ND Upstream	9/23/2019	-	-	-	-	-	-	-	-	-	-	-	-
TIA at upstream face of South Dam	SRK19-SD-Spigot-1	8/4/2019	0.855	503	0.0002	0.00005	0.0001	0.0005	0.0011	0.0005	0.00005	0.001	0.001	0.0001
	SRK19-SD-Spigot-2	8/4/2019	0.53	479	0.0002	0.00005	0.0001	0.0005	0.0007	0.0022	0.0006	0.001	0.001	0.0001
	SRK19-SD-Spigot-3	8/4/2019	0.237	3.6	0.0002	0.00005	0.0001	0.0005	0.0027	0.0027	0.00008	0.001	0.001	0.0002

Appendix L – South Dam Ground Temperature Cable Review

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Memo

To:	Project file	**Client:**	TMAC Resources Inc.
From:	Christopher Stevens, PhD	**Project No:**	1CT022.038
Reviewed By:	John Kurylo, PEng	**Date:**	June 19, 2020
Subject:	Hope Bay South Dam: Thermal Performance Review		

1 Introduction

The tailings management system (TMS) for the Hope Bay Project includes sub-aerial tailings deposition into the Doris tailings impoundment area (TIA). The South Dam is one of three dams that will be constructed to form the ultimate Tail Lake TIA. The TIA currently consists of the water retaining, frozen core North Dam commissioned in 2012 and the frozen foundation South Dam to retain tailings solids (Figure 1).

Phase 1 construction of the South Dam was undertaken over the winter of 2018 (SRK 2019a; 2019b). The structure was designed and constructed as a frozen foundation dam with an upstream geosynthetic clay liner (GCL) keyed into the permafrost foundation to achieve containment (Figure 1). To further limit water seepage and heat transfer to the foundation, the TIA is operated to allow for continuous tailings beach along the upstream face of the dam. It is imperative that both the key trench and underlying permafrost foundation be maintained in a frozen state to achieve the required stability and containment over the 25-year design life.

This memo reviews measured ground temperature and thermal performance of the South Dam from completion of construction to December 31, 2019.

2 Design and Construction

2.1 Dam Components

The main components of the South Dam include the excavated key trench, GCL, and dam shell (Figure 1). The key trench was excavated using drill and blast techniques to tie into permafrost. The GCL was design with a chevron shape along the upstream slope of the key trench and above ground portion of the dam fill. The GCL is placed above and below bedding and transition material and surrounding by the of run-of-quarry (ROQ) forming the dam shell.

Phase 1 of the South Dam, approved under the existing Water License, has a crest elevation of 38.0 m. Phase 2 of the dam will include a downstream raise of the dam with tie-in of the existing GCL. Phase 2 design includes a downstream dam raise to the ultimate crest elevation of 46 m.

The entire key trench was designed for Phase 1 as it would be difficult to tie into the liner below ground during Phase 2. A minimum fill was designed to allow for thermal protection of the foundation during Phase 1 tailings deposition.

Additional details on design of the South Dam is provided by SRK (2019a). Phase 1 As-built reporting including as-built drawings and quality assurance (QA) records and quality control (QC) documentation are provided by SRK (2019b).

2.2 Foundation

The South Dam is located on the south end of the former Tail Lake on the watershed boundary that separates the TIA from Ogama Lake. The dam alignment extends across a local valley, with slightly higher surface elevation on either side of the valley (Figure 1). Geotechnical programs were completed under four separate investigations to inform design of the dam. The investigations included recovery of frozen soil core and cuttings, the logging and sampling of the soil and rock, laboratory testing of soil index properties, percolation testing of the foundation, and installation of ground temperature cables in select boreholes.

The cross-valley dam alignment is characterized by a thin veneer of hummocky organic soil underlain by saline marine silty clay and clayey and silt which transitions to sand and gravel till over bedrock. Overburden thickness generally decreases toward the east and west abutments and increase in thickness toward two central gullies that are separated by a bedrock outcrop (Figure 1). The average permafrost temperature within the dam footprint prior to construction was -8°C.

Frozen soil cores were used to visually estimated excess ground ice. The excess ground ice was up to approximately 90%, with some discrete bodies of nearly pure massive ground near 100%. Additional observations of ground ice were based on cuttings, gravimetric moisture content results, and visual inspection of the excavated key-trench during construction. Ice-wedges have been inferred from airphoto interpretations and were visually confirmed during key trench excavation.

Soil porewater samples recovered using brine drilling in the summer of 2003 and winter of 2006 were found to average 36 ppt (n=12) which is equivalent to a freezing point depression of approximately -2°C. The soil porewater freezing point depression used in the design was based on these measurements. More recently in the winter of 2018, sonic drill samples indicated an average porewater salinity of 3.1 ppt (n=55) resulting in an estimated freezing point depression of -0.2°C (maximum value of 8.5 ppt, estimated freezing point depression of -0.5°C). Air-hammer drillholes completed with a rock quarry drill rig prior to dam construction also indicated an average porewater salinity of 4.5 ppt (n=55) resulting in an estimated freezing point depression of -0.2°C (maximum value of 11.7 ppt, freezing point depression of -0.6°C). The higher salinity values from 2003 and 2006 are likely caused by brine contamination of the sample during drilling.

2.3 Construction

Construction of the Phase 1 dam was undertaken between January 2018 and mid-July 2018. Mean daily air temperatures over the construction period ranged from a minimum of -42°C on February 17, 2018 to a maximum of +13°C on July 11, 2018. Civil earthwork included key trench excavation, sub-grade preparation, GCL installation in the lower portion of the key trench, below ground backfill of the key trench, placement of above ground downstream and upstream dam fill. Ground temperature cables were installed at selection monitoring locations (Figures 1 and 2).

Key trench drill and blast excavation was followed by material removal and surface preparation, and below ground backfill of the key trench between April and June. Downstream dam fill was placed between early May and early June, followed by GCL installation and above ground placement of dam fill between early June and mid-July. A previously constructed temporary deposition berm was raised in May 2018 to limit TIA was from impacting the active construction area (Figure 1).

3 Thermal Design and Modeling

The thermal design of the South Dam has allowed for sufficient rockfill cover to limit warming and thaw of the permafrost foundation. The effectiveness of the thermal cover decreases as the width and height of the structure decreases toward the eastern and western abutments, and seasonal heat loss and gain are more pronounced within the embankment and key trench. The thermal regime of the dam is controlled largely by atmosphere-to-surface heat exchange, thermal and physical conditions along the upstream face of the dam, and heat transfer through the fill material.

The design does not consider the affects of heat advected by surface water infiltration (snowmelt or precipitation) or water seepage from the facility. The latter is mitigated by the fine-grained, low permeability tailings beach developed immediately upstream and GCL installed within the upstream face and keyed into the permafrost foundation.

Thermal modeling was carried to support thermal design of the dam using a commercially available finite element program SVHeat from SoilVision (SRK 2019c). The thermal design for the dam was carried out using two-dimensional cross sections representative of the dam geometry with consideration for thermal conduction. Two critical sections were modeled; the typical maximum and minimum fill sections of the dam.

The modeling was completed to determine if the design is suitable to maintain the liner within a frozen key-in trench and to estimate extent of thaw beneath the foundation. The foundation was considered to be frozen during design if the ground temperature remained colder than -2°C which accounted for the average site-wide porewater freezing point depression within natural overburden soil.

Thermal modeling completed as apart of engineering design concluded:

- For the maximum dam section, the maximum temperature at the monitoring point with a bedrock foundation and thin overburden foundation was -4.0°C and -4.8°C, respectively (Figure 3).
- For the minimum dam section, the maximum modeled temperature at the key trench monitoring point with a thin overburden and thick overburden foundation was -3.0°C and -3.3°C, respectively (Figure 4).
- Seasonal variations in foundation temperature generally decreases as the size of the dam and fill thickness increased, due to an increased distance for conductive heat transfer of energy.
- Tailings were expected to freezeback over time under due to sub-aerial exposure and atmospheric heat transfer, which consequently provides additional containment and promotes lateral heat transfer with the dam.

4 Tailings Deposition

The South Dam was designed as a tailings solid retaining structure and thermal performance is contingent on maintaining an exposed tailings beach along the upstream face (minimum width of 100 m). To achieve these conditions, tailings deposition has been monitored to ensure ponding of supernatant water does not occur along the face of the dam.

The TIA is currently designed for storage of 16.2 Mm^3 of tailings with 20% allowance for ice entrainment (SRK 2016). The total Phase 1 tailings storage capacity is 2.32 Mm^3. Phase 2 tailings deposition will include a downstream raise of the South Dam and construction of a new West Dam to provide additional capacity. Six spigot points are planned for Phase 1; three spigots located from the South Dam and two spigots from the east side of the TIA.

Phase 1 tailings deposition at the TIA began in January 2017 at two spigot locations on the east side of the TIA. In August 2017 the deposition was switched a temporary deposition berm to develop a tailings beach and minimize the risk of the TIA pond encroaching on the South Dam footprint prior to construction. Over the winter of 2018, the tailings deposition was moved to east side of the TIA until late June of 2019. Deposition commenced from the upstream face of the South Dam from June of 2019 to October 2019. Tailings deposition again switched to the east side of the TIA in October of 2019 to allow for winter heat loss from the South Dam tailings beach and to limit ice entrapment in this area.

5 Ground Temperature Monitoring System

The South Dam is routinely inspected by TMAC during operation and includes an annual inspection completed by the Engineer of Record. In addition, monitoring points have been installed as part of the design to evaluate deformation and thermal regime of the dam and foundation. This monitoring has been developed to allow for evaluation of dam performance over the life of the structure and implementation of mitigation measures, if required. Ground temperature cables (GTCs) were install in the foundation of the dam and within the fill to monitor temperature of the permafrost foundation and along the upstream slope of the key trench

(Figure 2). Ground temperature measurements for all instrumented sites are provided by SRK (2020).

5.1 Instrument Layout

Digital GTCs and data loggers manufactured by BeadedStream were installed at 6 representative monitoring sections along the dam alignment during construction. The instrumented sections include Stations 0+065, 0+155, 0+240, 0+365, 0+460, 0+510 (Figure 1). Temperature is recorded every four hours using the datalogger and transmitted every twelve hours via iridium satellite to allow for near real-time monitoring.

The general arrangement of the GTCs includes vertical cables (VTS) installed beneath the upstream, downstream and key trench and horizontal cables installed along the upstream slope of the key trench and the above ground portion of the GCL (Figure 2). One GTC (SD-HST-B1-KT) was installed on top of the lower/upper GCL overlap near the upstream crest of the key trench.

Two additional ground temperature cables (SD-VTS-US1 and SD-VTS-US2) were installed to monitor conditions within an area susceptible to melting of massive ground ice. These locations are near the lowest elevation of the dam alignment where ice wedges form a polygonal network and surface water was expected to pond prior to tailings beach development. The two cables also provide long-term temperatures beneath the tailing beach.

Active tailings deposition from the South Dam has extended across monitoring Section 3+65. At the end of 2019, the additional monitoring section were outside of the tailings beach.

5.2 Instrument Function

A total of twenty-seven GTCs were installed during Phase 1 construction (SRK 2019b). A total of twenty GTCs were functioning at the start of March 2020 (Table 1). Of the seven inactive GTCs, three were damaged throughout or immediately following Phase 1 construction. Attempts were made to repair these cables. Three cables cease to transmit data in 2019 (SD-VTS-155-US, SD-HTS-240-KT, SD-VTS-240-KT) and two cables cease to transmit data beyond January 29, 2020 (SD-HTS-155-KT, SD-VTS-365-KT). The cause(s) of some of the inactive cables has not been determined and warrants further onsite investigation.

Table 1: Ground Temperature Cable Status

Station ID	GTC ID	Datalogger	# of Sensors (Functional / As-built)	Status	Comment
0+65	SD-VTS-065-KT	SD-DL01B	11 / 11	Active	-
0+65	SD-HTS-065-US	SD-DL01A	5 / 5	Active	-
1+55	SD-VTS-155-KT	SD-DL01B	11 / 11	Active	-
1+55	SD-HTS-155-US	SD-DL01A	5 / 5	Active	-
1+55	SD-VTS-155-US	SD-DL01A	1 / 11	Inactive	Sensor 1 functional, ended on 11/8/2019
1+55	SD-VTS-155-DS	SD-DL01A	11 / 11	Active	-
1+55	SD-HTS-155-KT	-	0 / 11	Inactive	Damaged during construction
2+40	SD-HTS-240-KT	SD-DL02A	0 / 11	Inactive	Measurements ended on 1/29/2020
2+40	SD-VTS-240-KT	SD-DL02A	0 / 11	Inactive	Measurements ended on 1/29/2020
2+40	SD-HTS-240-US	SD-DL02B	7 / 7	Active	-
2+40	SD-VTS-240-US	SD-DL02A	0 / 11	Inactive	Measurements ended on 10/22/2019
2+40	SD-VTS-240-DS	SD-DL02A	0 / 11	Inactive	Measurements ended on 10/10/2019
3+65	SD-VTS-365-KT	-	0 / 11	Inactive	Damaged following construction
3+65	SD-HTS-365-KT	SD-DL03A	11 / 11	Active	-
3+65	SD-HTS-365-US	SD-DL03B	11 / 11	Active	-
3+65	SD-VTS-365-US	SD-DL03A	11 / 11	Active	-
3+65	SD-VTS-365-DS	SD-DL03B	11 / 11	Active	-
3+65	SD-VTS-US1	SD-DL03A	2 / 13	Active	Sensors 1 and 2 active
3+65	SD-VTS-US2	SD-DL03A	1 / 15	Active	Sensor 1 active
4+60	SD-VTS-460-KT	SD-DL04A	11 / 11	Active	-
4+60	SD-HTS-460-KT	SD-DL04B	11 / 11	Active	-
4+60	SD-VTS-460-US	SD-DL04A	11 / 11	Active	-
4+60	SD-VTS-460-DS	SD-DL04A	11 / 11	Active	-
4+60	SD-HTS-460-US	SD-DL04B	0 / 5	Inactive	Damaged following construction
5+10	SD-VTS-510-KT	SD-DL04B	11 / 11	Active	-
5+10	SD-HTS-510-US	SD-DL04B	5 / 5	Active	-
NA	SD-HTS-B1-KT	SD-DL04A	20 / 20	Active	-

Notes:

1. Number of functional GTC sensors on 3/1/2020

6 Thermal Response

6.1 Construction Period

Ground temperature was measured throughout the construction period to monitoring thermal conditions during material placement and to identify possible instrument damage during construction. The data record over this period was limited to the time of cable installation and availability of field staff to make the daily measurements.

Over the construction period, the dam fill material temperature generally followed the air temperature. Fill placed below grade in the key trench over the winter was able to maintain the relatively colder initial material temperature, compared to above ground fill placed at the start of the spring freshet. The general difference in material temperature was expected and emphasis was placed on completed prior to air temperature rising above 0°C.

In early June of 2018, an unexpected warming of ground temperature was observed from the horizontal GTC installed along the upstream slope of the key trench and from the top sensors on vertical GTC installed below the base of the key trench (Figure 5). The warming events consisted of rapid increase temperature of approximately 12°C in less than 24 hrs along the upstream key trench slope (Figure 5).

The observe warming was not consistent with the increase in air temperature and displayed traits of non-conductive heat transfer through the dam fill. The increase in ground temperature propagated from deeper on the key trench slope to shallower depth sensors which indicates a deeper heat source. The lack of attenuation of the warming event with time and depth also suggests non-conductive heat transfer which results in more immediate changes in sensible heat when compared to thermal conduction. Heat from the warming event was conducted beneath the key trench foundation but was determined to have minor thermal influence on the long-term ground thermal regime.

The rapid increase in ground temperature (warming event) was inferred to be caused by the advection of heat from seepage of surface water along the upstream slope of the key trench fill (ROQ material). The thermal response was immediately verified in the field and an interceptor ditch was installed to limit surface water contact with the fill.

6.2 Base of Tailings

Ground temperature near the base of tailings beach is monitored immediately upstream of the toe at SD-VTS-US-2. Since late January of 2019, the ground temperature 0.5 m below the base of tailings beach has seasonally varied from -0.4°C to -7.2°C. Ground cooling was measured over both the winter of 2019 and 2020. The measurements suggest that heat sourced from the tailings is seasonally lost during winter periods of non-deposition, and extensive thaw of the upstream foundation has not occurred beneath the tailings at the monitoring location. The seasonal variability in ground temperature is expected to decrease as additional tailings are deposited and the effective depth of the sensor increases.

Over the same period, ground temperature measured at a similar depth beneath the upstream toe at SD-VTS-US-1 has slightly cooled from -0.1°C to -0.6°C. Ground cooling is expected to continue at a slow rate as this location is beneath the upstream fill of the dam.

6.3 Upstream and Downstream Toe

Figures 6 through 11 show the minimum, maximum, and average foundation ground temperature for 2019. Table 2 shows the average ground temperature and seasonal active thaw depth beneath the upstream and downstream toe. The average ground temperature is provided for the uppermost sensor located 0.5 m below grade.

The reported thaw depth is based on the 0°C and the -2°C isotherm which considers the average design freezing point depression for saline overburden soil. Active layer thaw beneath the upstream toe ranged from 0 to 0.9 m based on the 0°C isotherm and 0.5 to 2.5 m with consideration of the -2°C freezing point depression. As previously noted, the porewater salinity collected immediately prior to construction indicate salinity values were significantly less than those collected with brine drilling. The brine drill samples are considered to be contaminated by drill fluid and not representative of the in-situ conditions.

The upstream and downstream toe average ground temperature was measured to be -5.5°C to -7.6°C, with exception of warmer temperatures (-0.7°C) measured at SD-VTS-365-US (Table 2; Figures 6 through 11). The relatively warm ground temperatures measured at SD-VTS-365-US are due to active tailings deposition across the site. Permafrost warming with depth is the most pronounced at the upstream toe, as observed by the decrease in ground temperature with depth (Figure 9). The thermal regime is characteristic of degrading permafrost. At Section 3+65, tailings deposition over the upstream toe has increased in the effective depth of the sensors which limits seasonal variations from atmospheric heat transfer to the ground.

Table 2: Average Ground Temperature and Thaw Depth for Upstream and Downstream Toe

Station	GTC ID	Location	Thaw Depth, 0°C Isotherm (m)	Thaw Depth, -2°C Isotherm[1] (m)	Average Ground Temperature[2], 2019 (°C)
0+155	SD-VTS-155-US	Upstream Toe	-	-	-6.7
	SD-VTS-155-DS	Downstream Toe	0.0	0.5	-5.7
0+240	SD-VTS-240-US	Upstream Toe	0.9	1.4	-
	SD-VTS-240-DS	Downstream Toe	0.6	1.0	-5.5
0+365	SD-VTS-365-US	Upstream Toe	0.0	2.5	-0.7
	SD-VTS-365-DS	Downstream Toe	0.1	1.0	-7.6
0+460	SD-VTS-460-US	Upstream Toe	0.9	1.8	-
	SD-VTS-460-DS	Downstream Toe	0.9	1.8	-6.4

Notes:

1. Thaw depth based on the -2°C isothermal represents the design freezing point depression for soil porewater
2. Average ground temperature based on uppermost sensors

6.4 Key Trench

The maximum ground temperature measured at the base of the key trench for 2018 and 2019 is shown in Table 3. The maximum annual key trench temperature for the thickest fill sections ranged from -6.0°C to -7.3°C at Station 0+240 and 0+365, and -5.4°C at Station 0+155. At the thinnest fill sections (Stations 0+065, 0+460, and 0+510), the maximum temperature ranged from -3.2°C to -4.7°C in 2018 and -4.7°C to -4.8°C in 2019. Thaw, as defined by the design freezing point depression of -2°C, was not observed in the ground temperature measured beneath the key trench.

The relatively warmer key trench temperature measured at Stations 0+065, 0+460, and 0+510 results from reduced fill over the key trench compared to thicker fill sections (2+40 and 3+65). The foundation at these stations also consists of bedrock or are characterized by thin overburden soil which results in greater seasonal heat gain to the foundation. The relatively colder key trench temperatures were measured at the sections with greater fill thickness founded on ice-rich soil with a higher heat capacity and latent heat requirement.

Seasonal variations in ground temperature due to heat gain and loss from the ground were also measured beneath the key trench (Figures 6 through 11). The greatest variation in temperature were at sections with the minimum fill thickness and decrease as fill thickness increase, as expected. The seasonal change in foundation temperature are in general agreement with the previous thermal modeling results.

Table 3: Maximum Key Trench Ground Temperature

Station	GTC ID	Ground Temperature (°C)[1]	
		2018	2019
0+065	SD-VTS-065-KT	-4.7	-4.7
0+155	SD-VTS-155-KT	-	-5.4
0+240	SD-VTS-240-KT	-6.6	-7.3
0+365	SD-VTS-365-KT	-6.9[2]	-6.0[3]
0+460	SD-VTS-460-KT	-3.9	-4.8
0+510	SD-VTS-510-KT	-3.2	-4.8

Notes:

1. Maximum temperature at base of key trench
2. Ground temperature for 0+365 based mid-April to mid-July data
3. Measurement from Sensor 7 of SD-HTS-365-KT supplemented due to missing data for from SD-VTS-365-KT

Horizonal GTCs installed along the upstream slope of the key trench at SD-HTS-365-KT and SD-HTS-460-KT are shown in Figure 12. The warmest ground temperatures were recorded by the uppermost sensors installed at the crest of the key trench which represents the shallowest depth for HTS-KT sensors (Figure 2). At SD-HTS-365-KT, the minimum and maximum temperature for the upper most sensor was -1.3°C and -16.6°C, respectively. The range in temperature at SD-HTS-240-KT is -2.4°C to -8.2°C. The equivalent GTC installed at SD-HTS-460-KT ranged in temperature from -1.0°C and -10.9°C.

The upstream slope key trench temperature observed confirm seasonal heat gain and loss. The upstream key trench ground temperature decreases with increased sensors depth and decreased offset from the dam centerline (Figure 12). Thaw would not be expected along the upstream slope of the key trench based on the measured temperature and assuming a freezing point depression near 0°C.

7 Energy Balance

An energy balance approach was used to evaluate the annual gain and loss of energy from the dam foundation. Fourier's law of heat conduction was used to calculate daily heat flux using the average daily ground temperature measured in the key trench and soil and bedrock thermal properties from SRK (2019c). A daily negative flux indicates heat loss and a positive flux indicates gain to the foundation. All fluxes were added to estimate the net annual gain or loss of heat to the foundation.

This approach assumes that the top of the soil foundation is homogenous and governed by heat conduction, advection of heat from water seepage is not present, and latent heat of fusion during the freezing and thaw periods is equivalent at the end of the year. The estimates neglect temperature-dependent changes in the thermal properties and unfrozen water content of the frozen soil. The analysis was completed for sites with suitable ground temperature data.

Table 4 shows the annual heat flux beneath the key trench and downstream toe. The results are shown graphically in Figure 13. The net annual heat flux is positive for all sites, indicating more thermal energy was gained vs. lost from the permafrost foundation. Greater seasonal variability in heat gain and loss from the foundation is observed beneath the downstream toe when compared to beneath the key trench, as expected.

The net annual heat flux with the foundation was estimated to range from +21 to +63 MJ m^{-2} and +7.5 to +29.3 MJ m^{-2} beneath the downstream toe and key trench, respectively (Table 4). Minimal heat transfer with the foundation beneath the key trench at SD-VTS-240-KT is the result of greater dam fill which reduces annual heat transfer between the atmosphere and foundation. The net positive heat flux over one-year will result warming of the permafrost foundation and eventual thaw. Over time the annual energy transfer to the foundation is expected to change as Phase 2 dam construction takes place and with completion of tailings beaching at the South Dam.

Table 4: Total Annual Heat Flux with Foundation

GTC ID	Heat Loss (MJ m^{-2})	Heat Gain (MJ m^{-2})	Net Heat Flux (MJ m^{-2})
SD-VTS-155-KT	-2.0	43.1	41.1
SD-VTS-240-KT	-1.5	9.0	7.5
SD-VTS-460-KT	-2.3	31.7	29.3
SD-VTS-510-KT	-2.7	19.7	17.1
SD-VTS-155-DS	-15.5	78.0	62.6
SD-VTS-365-DS	-30.2	58.5	28.3
SD-VTS-460-DS	-87.7	109.0	21.4

8 Findings and Recommendations

The South Dam was designed and constructed as a frozen foundation dam to retain tailings solids. The safe operation of the dam requires careful consideration of thermal performance of the structure. Review of the South Dam ground temperature data collected in 2019 has led to the following findings and recommendations.

- The dam is generally performing as thermally designed. Figure 14 shows a summary of the maximum and average temperature for key locations of the dam.
- Design freezing point depression of -2°C based on porewater samples recovered from brine drilling may not be representative of in-situ conditions due to contamination of the core by drilling fluids. The finding is supported by more recent soil samples collected over representative depths with sonic and air-hammer drilling. The average porewater freezing point depression for 110 recent samples was -0.2°C (minimum value of -0.6°C).
- Maximum annual key trench ground temperature decreased in the year following construction. The slightly warmer key trench temperature immediately following construction (2018) was expected due to the extended construction season and observed advection of heat from surface meltwater. The maximum annual key trench temperature for the monitoring sections for 2019 is within the expected range of temperature.
- Ground thermal regime beneath the key trench shows minimal seasonal heat gain or loss beneath the dam sections with thicker fill, such as Section 2+40. A similar thermal regime is expected beneath the key trench at Section 3+65. Relatively slow rates of permafrost warming in the key trench foundation are expected for dam sections with thicker fill until active tailings deposition cease, and sufficient time has past for tailings freezeback to occur.
- Greater seasonal variation in key trench temperature have been measured beneath dam sections with minimum fill cover (Sections 0+65. 1+55, 4+60, 5+10). The measured seasonal variation in key trench temperature are generally comparable to the modeled values for 2019.
- Active layer thaw beneath the upstream and downstream toe based on the 0°C isotherm and -2°C isotherm range from 0 to 0.9 m and 0.5 to 2.5 m, respectively. Thaw beneath the dam toe can be expected over the life of the structure and should be monitored to ensure conditions remain within the design limits.
- Thermal evidence of water seepage at the base of the GCL tie-in and within the permafrost foundation was not observed in 2019.
- Four GTCs cease to transmit measurements from Section 2+40. All four cables are recorded by the same data logger. Further investigation of the cause(s) leading to the inactive status of the GTCs is warranted.
- GTCs provide thermal monitoring of the dam to ensure conditions remain within the intended design for safe operation and tailings containment. Replacement GTC are recommended to maintain the monitoring system; SD-VTS-155-US; SD-VTS-240-US; SD-VTS-240-DS. Prior to GTC replacement, the surface cable lead and connection with the data loggers should be

checked for damage and repair, where possible. The upstream toe at section 2+40 is currently outside of tailings beach which would allow for replacement of SD-VTS-240-US prior to burial by tailings.

- As part of additional thermal evaluation of the dam, it is recommended that the existing thermal models be updated to reflect construction as-built conditions, tailings deposition, and the new understanding of the soil freezing point depression. The later is expected to alter the unfrozen water content curve and thermal properties of the soil and therefore heat transfer in the foundation over time.
- In support of ongoing surveillance of the dam, ground temperature data loggers and cables should be routinely inspected following the dam operation, maintenance, and surveillance (OMS) manual.

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

9 References

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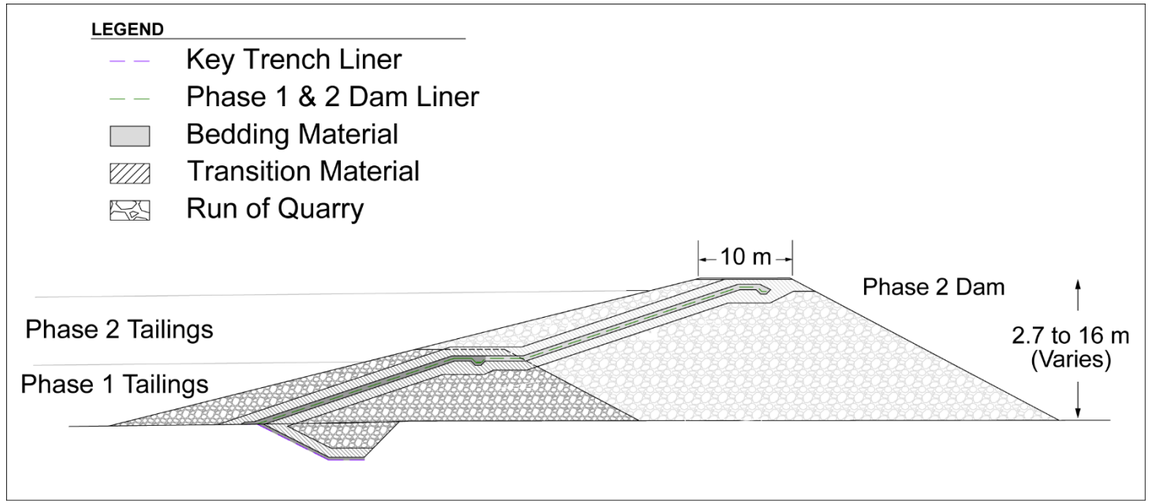
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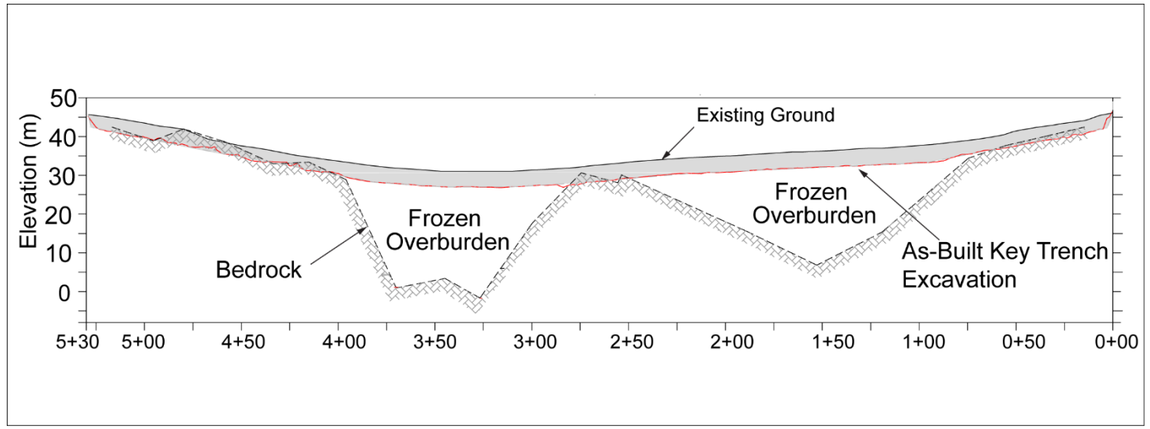
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Figures

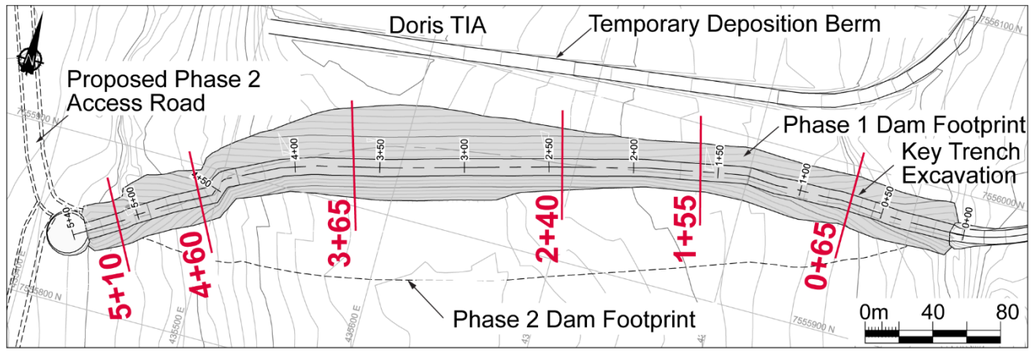
South Dam Phase 1 and Phase 2 (Simplified Cross Section)



As-built Phase 1 – Key Trench



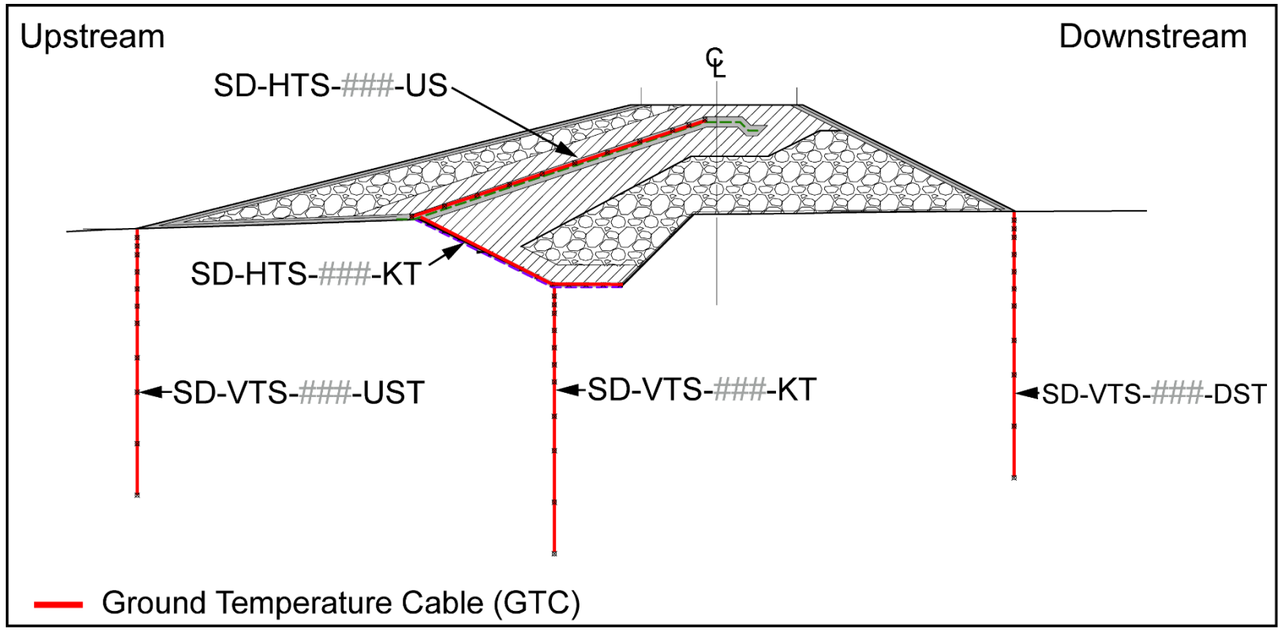
As-built Phase 1 – Plan View



Notes:
1. Red lines and section numbers represent ground temperature cables (GTC) monitoring sections

srk consulting	MAC RESOURCES	2019 Annual Geotechnical Inspection Tailings Impoundment Area
		South Dam **Cross Section and Plan View**
Job No: 1CT022.038 Filename: South Dam Thermal Review2019	HOPE BAY PROJECT	Date: March 2020 | Approved: CWS | Figure: **1**

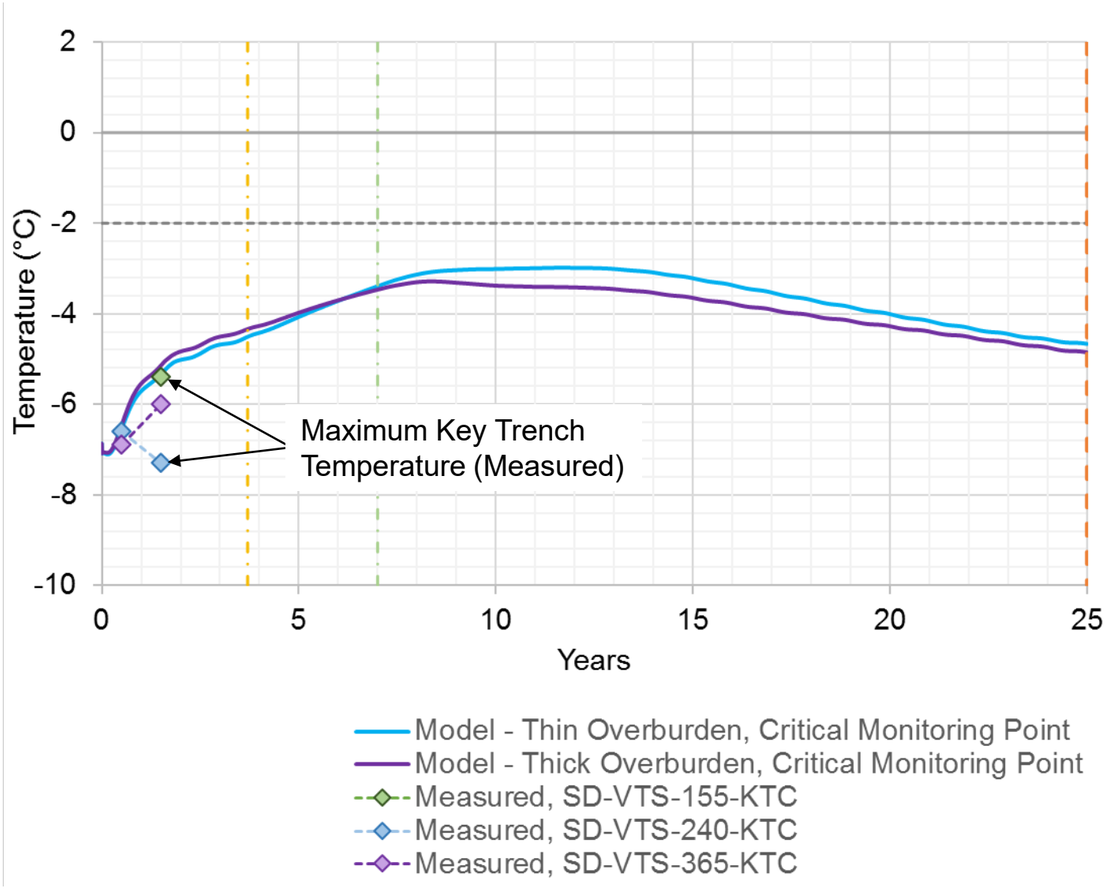
Ground Temperature Cable (GTC) Configuration

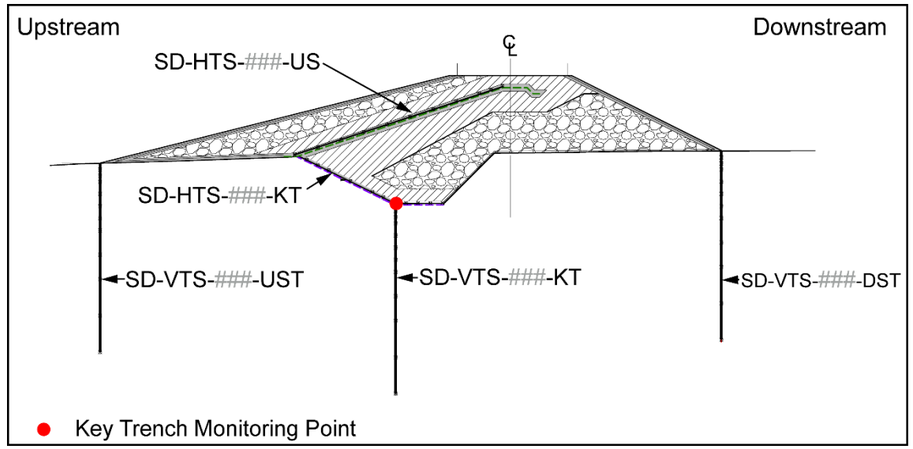


Notes:
1. As-built drawings for each GTC monitoring section provided by SRK (2019c)

srk consulting	MAC RESOURCES	2019 Annual Geotechnical Inspection Tailings Impoundment Area
		Typical Configuration of Ground Temperature Cables
Job No: 1CT022.038 Filename: South Dam Thermal Review2019	HOPE BAY PROJECT	Date: March 2020 | Approved: CWS | Figure: **2**

Maximum Section of Dam – Key Trench Monitoring Point

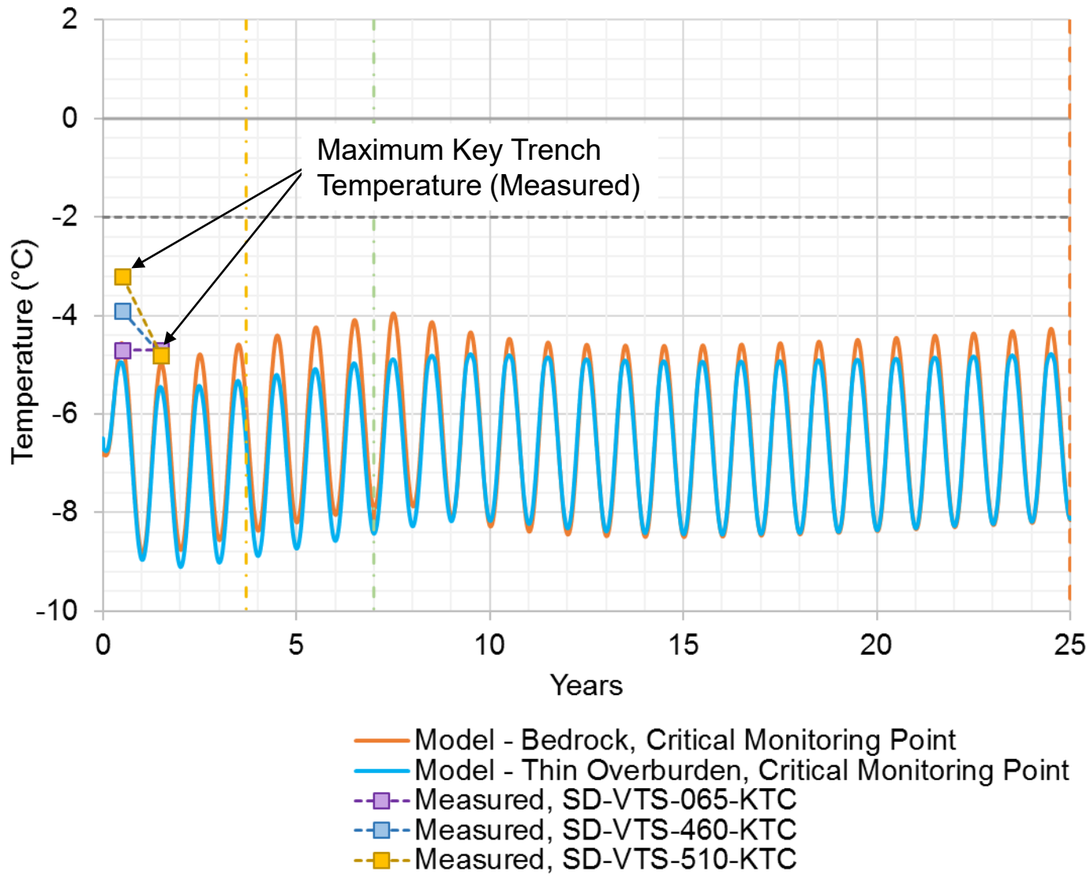


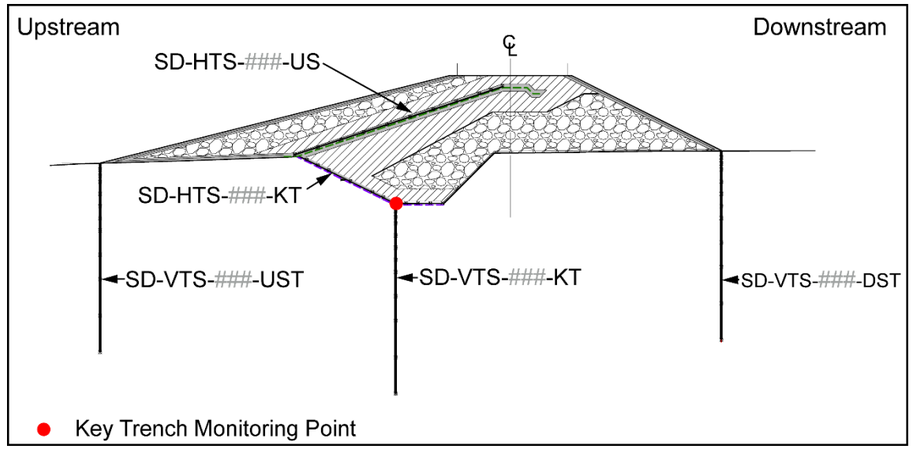


Notes:
1. Maximum modeled ground temperature for critical key trench monitoring point from SRK (2019c)
2. Maximum temperature measured at the base of key trench shown for SD-VTS-155-KT, -240-KT, -365-KT

srk consulting	TMAC RESOURCES	2019 Annual Geotechnical Inspection Tailings Impoundment Area
		Maximum Section of Dam – Key Trench Monitoring Point
Job No: 1CT022.038 Filename: South Dam Thermal Review2019	HOPE BAY PROJECT	Date: March 2020 / Approved: CWS / Figure: 3

Minimum Section of Dam – Key Trench Monitoring Point

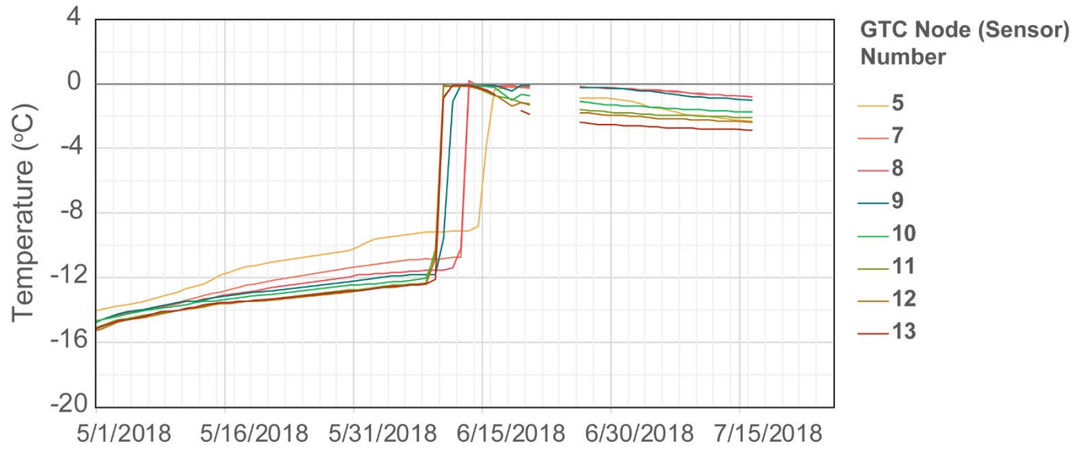


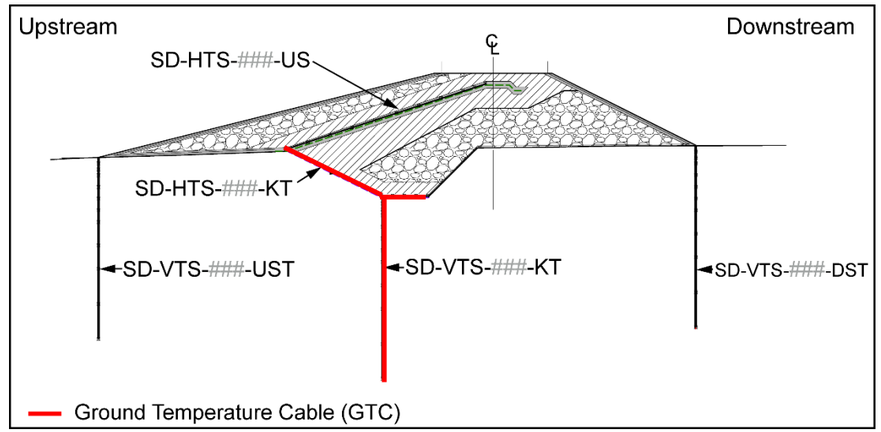


Notes:
1. Maximum modeled ground temperature for critical key trench monitoring point from SRK (2019c)
2. Maximum temperature measured at the base of key trench shown for SD-VTS-155-KT, -240-KT, -365-KT

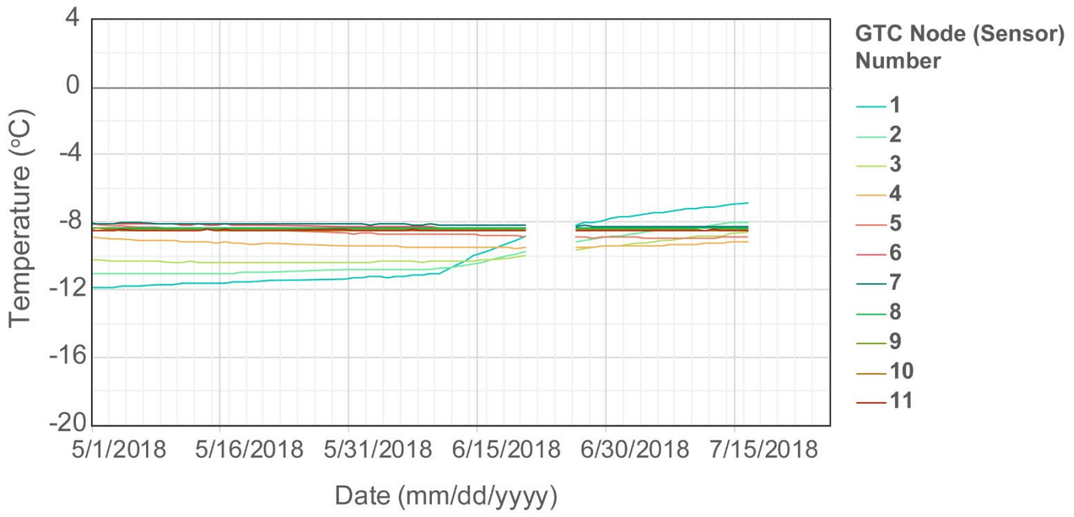
srk consulting	TMAC RESOURCES	2019 Annual Geotechnical Inspection Tailings Impoundment Area
		Minimum Section of Dam – Key Trench Monitoring Point
Job No: 1CT022.038 Filename: South Dam Thermal Review2019	HOPE BAY PROJECT	Date: March 2020 · Approved: CWS · Figure: 4

Construction Period – Ground Temperature at SD-HTS-365-KT





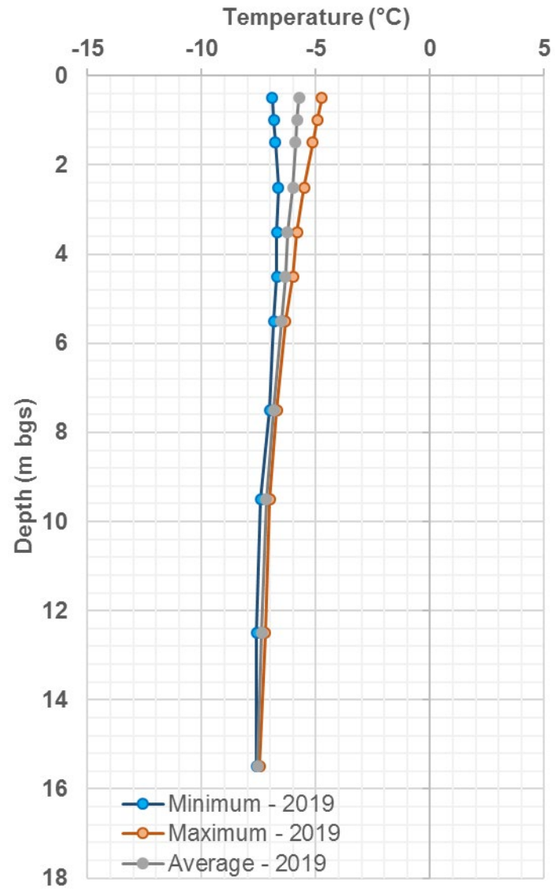
Construction Period – Ground Temperature at SD-VTS-365-KT



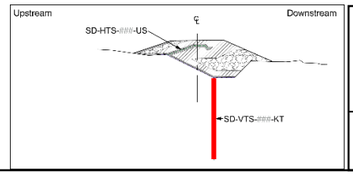
Notes:
1. Ground temperature measured over construction period at SD-HTS-365-KT and SD-VTS-365-KT
2. Rapid warming of ground temperature observed other monitoring sections over a similar period of time

srk consulting	MAC RESOURCES	2019 Annual Geotechnical Inspection Tailings Impoundment Area
		Construction Period – Rapid Ground Temperature Warming
Job No: 1CT022.038 Filename: South Dam Thermal Review2019	HOPE BAY PROJECT	Date: March 2020 | Approved: CWS | Figure: **5**

SD-VTS-065-KT



Notes:
1. Ground temperature cables not installed beneath upstream and downstream toe at Section 0+65



srk consulting

Job No: 1CT022.038
Filename: South Dam Thermal Review2019

MAC RESOURCES

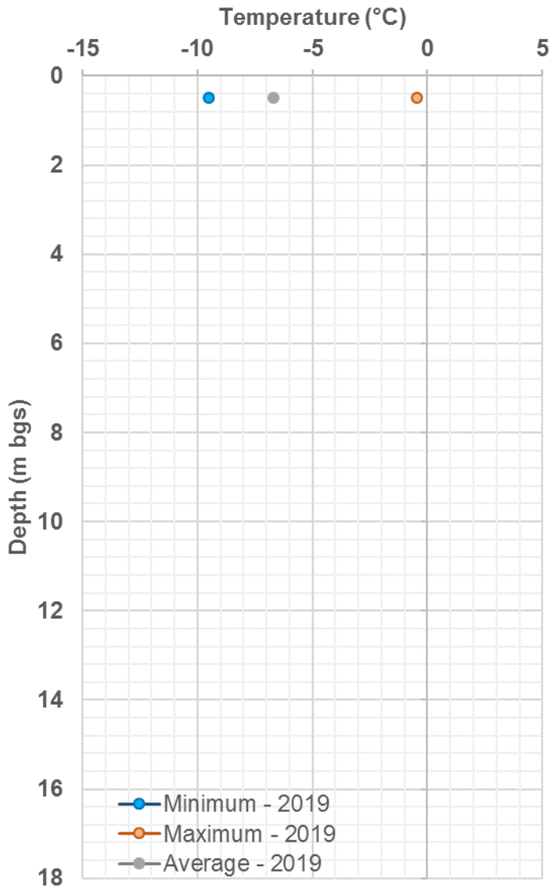
HOPE BAY PROJECT

2019 Annual Geotechnical Inspection
Tailings Impoundment Area

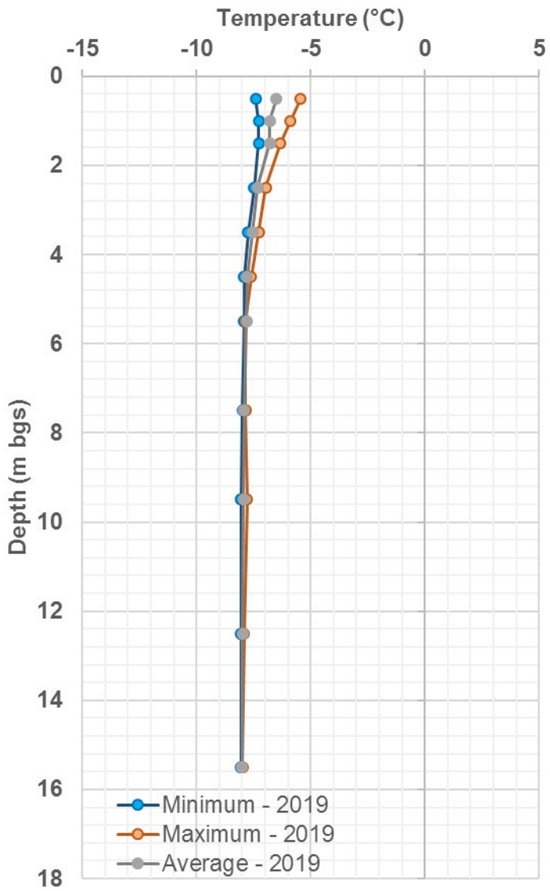
Foundation Ground Temperature – Section 0+65

Date:	Approved:	Figure:
March 2020	CWS	6

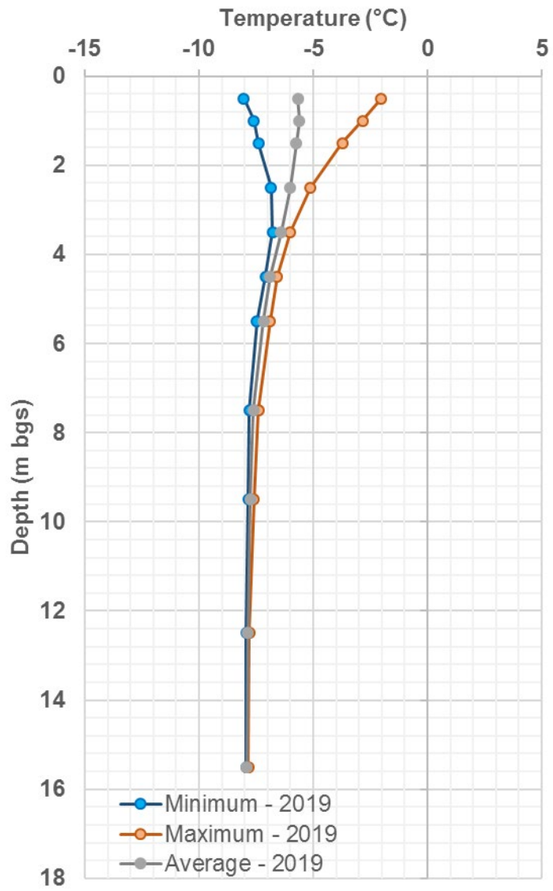
SD-VTS-155-US



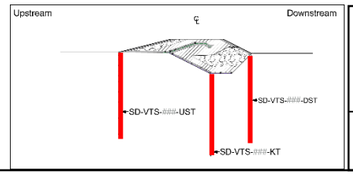
SD-VTS-155-KT



SD-VTS-155-DS



Notes:
1. Ground temperature sensors failure below uppermost node at SD-VTS-155-US



srk consulting

Job No: 1CT022.038
Filename: South Dam Thermal Review2019

MAC RESOURCES

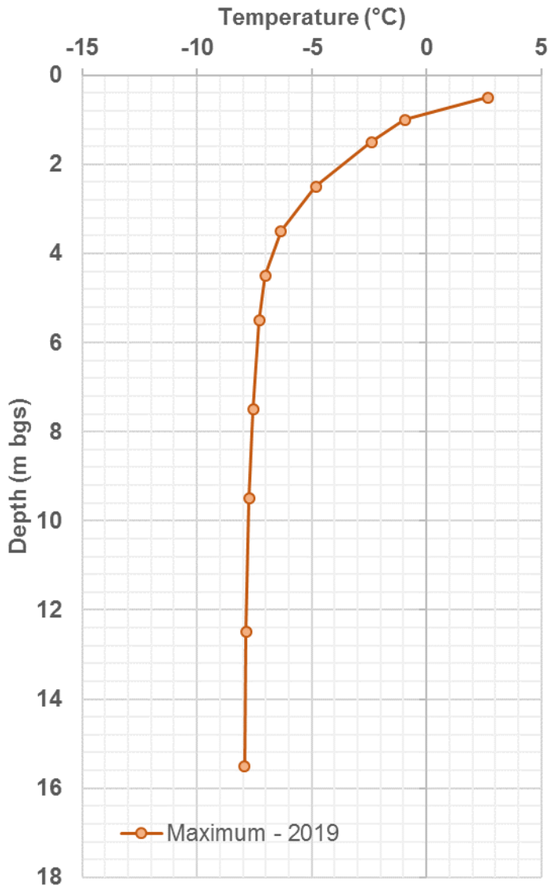
HOPE BAY PROJECT

2019 Annual Geotechnical Inspection
Tailings Impoundment Area

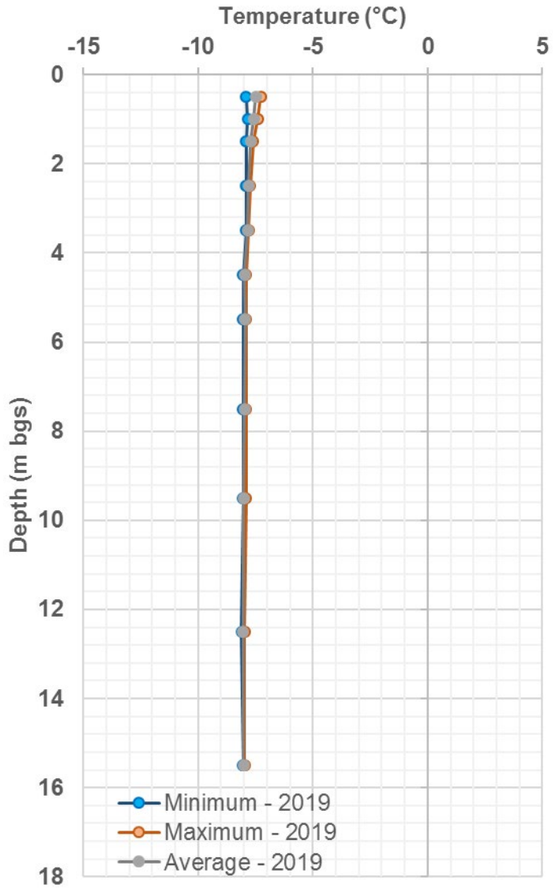
Foundation Ground Temperature – Section 1+55

Date:	Approved:	Figure:
March 2020	CWS	7

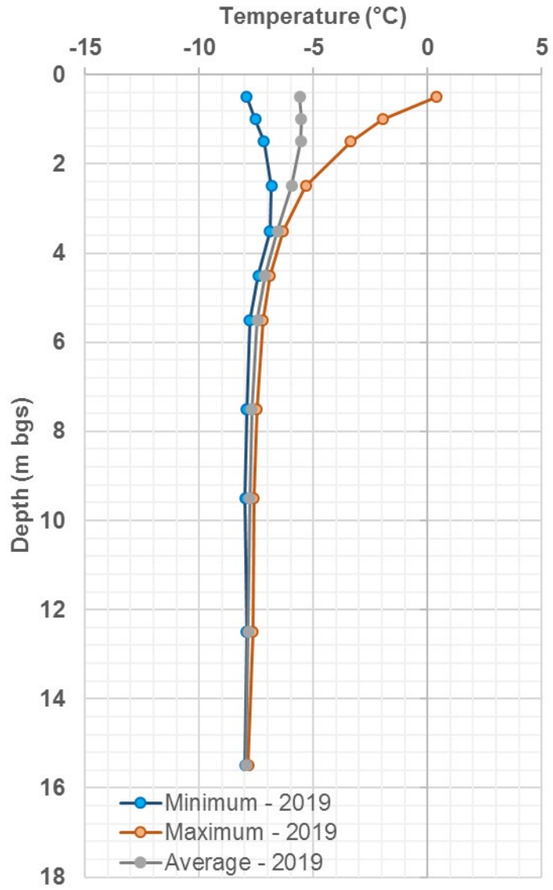
SD-VTS-240-US



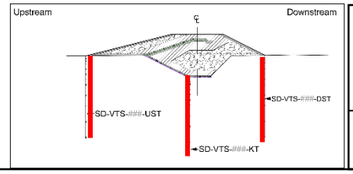
SD-VTS-240-KT



SD-VTS-240-DS



Notes:
1. Insufficient data for calculation of minimum ground temperature at SD-VTS-240-US



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Job No: 1CT022.038
Filename: South Dam Thermal Review2019

MAC RESOURCES

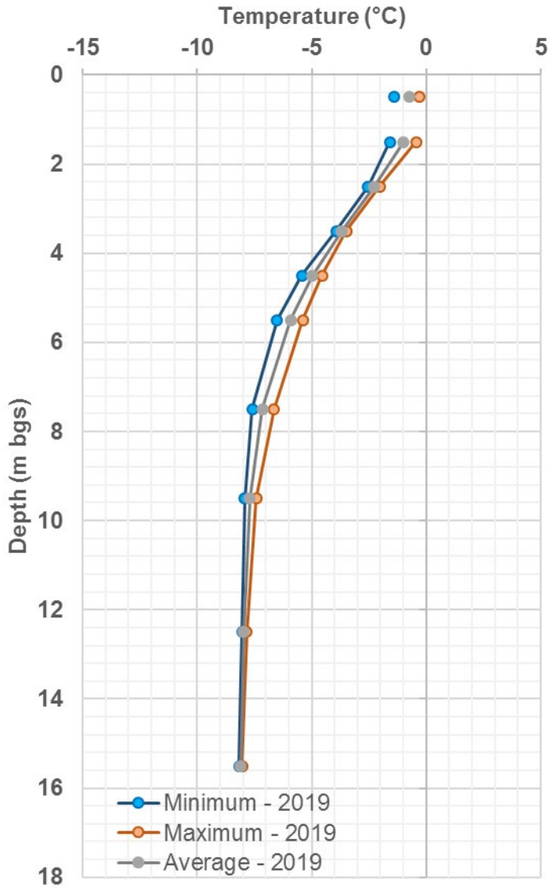
HOPE BAY PROJECT

2019 Annual Geotechnical Inspection
Tailings Impoundment Area

Foundation Ground Temperature – Section 2+40

Date:	Approved:	Figure:
March 2020	CWS	8

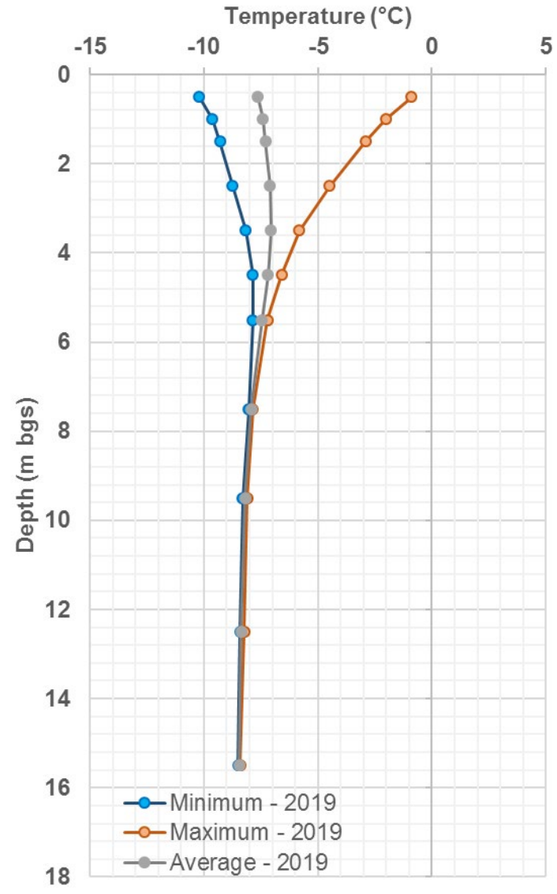
SD-VTS-365-US



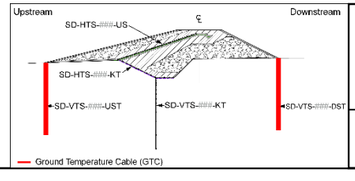
SD-VTS-365-KT

Ground Temperature Data Not Received for 2019

SD-VTS-365-DS



Notes:
1. Ground temperature data not received from GTC SD-VTS-365



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Job No: 1CT022.038
Filename: South Dam Thermal Review2019

TMAC RESOURCES

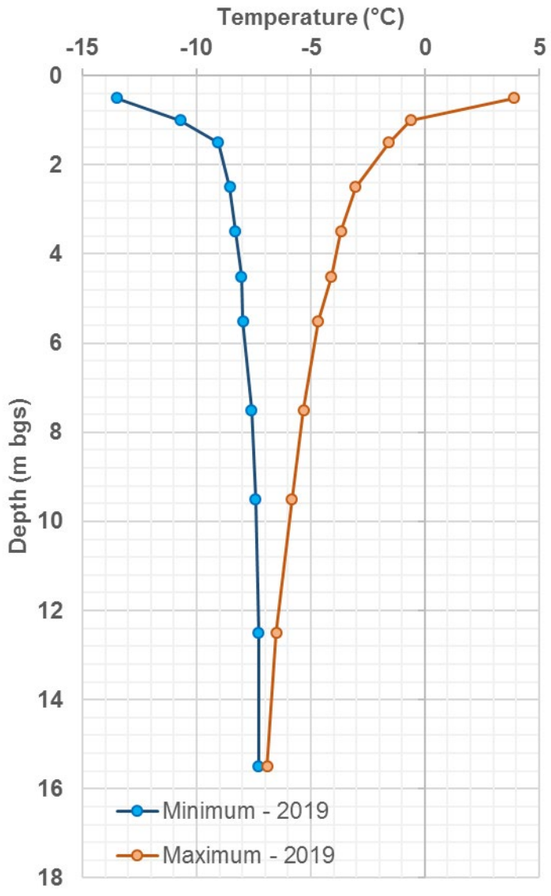
HOPE BAY PROJECT

2019 Annual Geotechnical Inspection
Tailings Impoundment Area

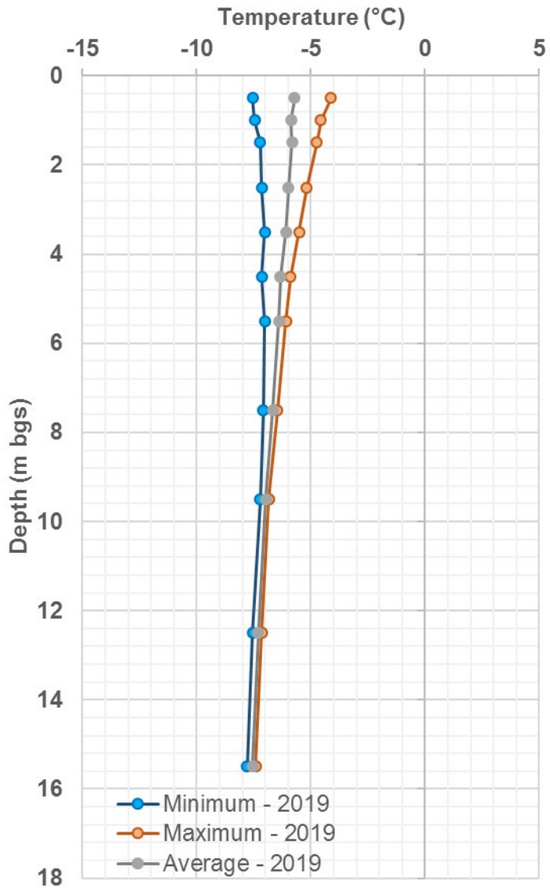
Foundation Ground Temperature – Section 3+65

Date:	Approved:	Figure:
March 2020	CWS	9

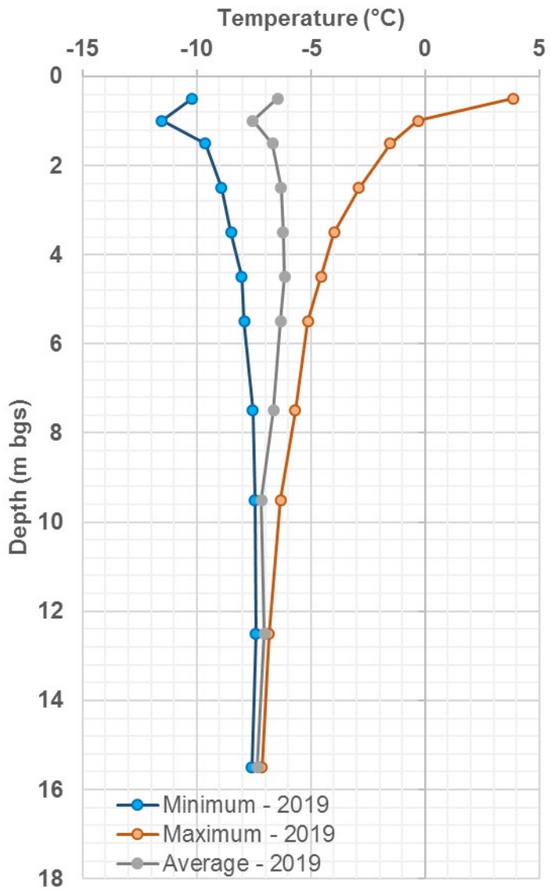
SD-VTS-460-US



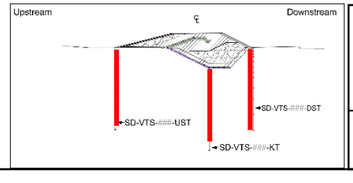
SD-VTS-460-KT



SD-VTS-460-DS



Notes:
1. Insufficient data for calculation of average ground temperature at SD-VTS-460-US



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Job No: 1CT022.038
Filename: South Dam Thermal Review2019

TMAC RESOURCES

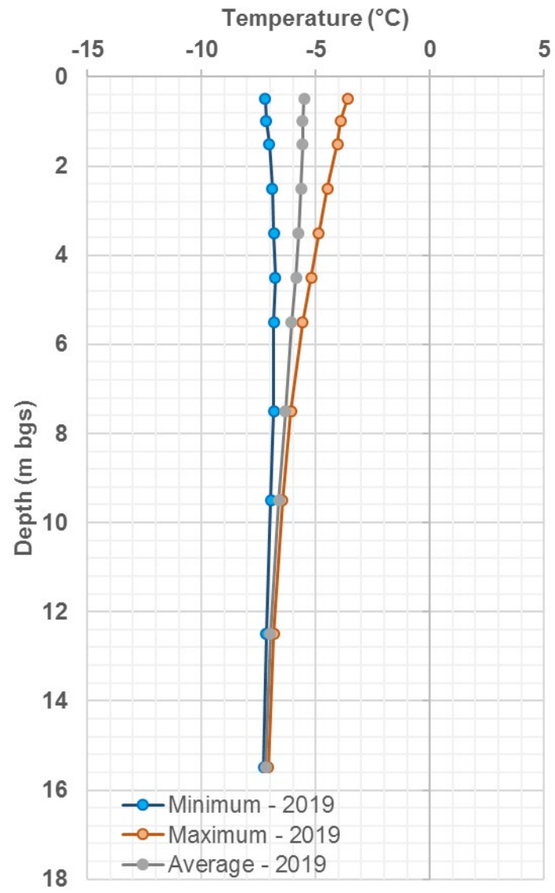
HOPE BAY PROJECT

2019 Annual Geotechnical Inspection
Tailings Impoundment Area

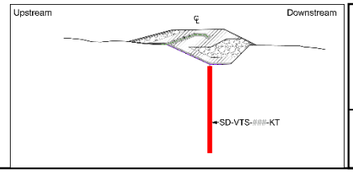
Foundation Ground Temperature – Section 4+60

Date: March 2020 | Approved: CWS | Figure: **10**

SD-VTS-510-KT



Notes:
1. Ground temperature cables not installed beneath upstream and downstream toe at Section 5+10



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Job No: 1CT022.038
Filename: South Dam Thermal Review2019

TMAC RESOURCES

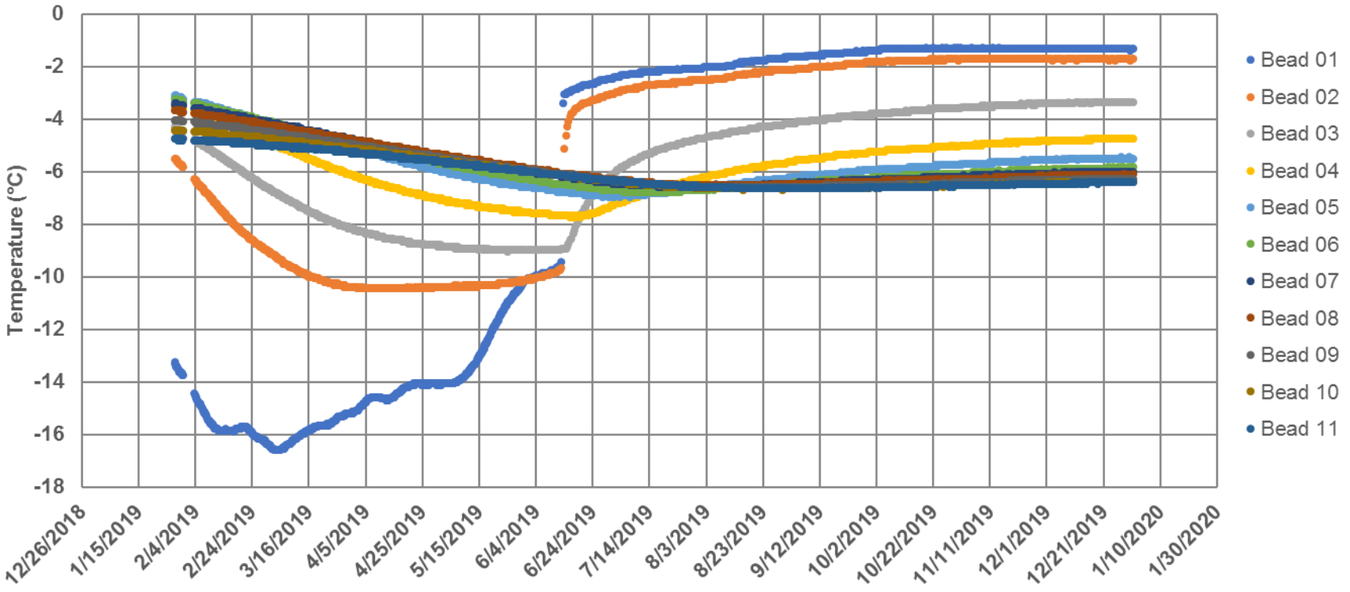
HOPE BAY PROJECT

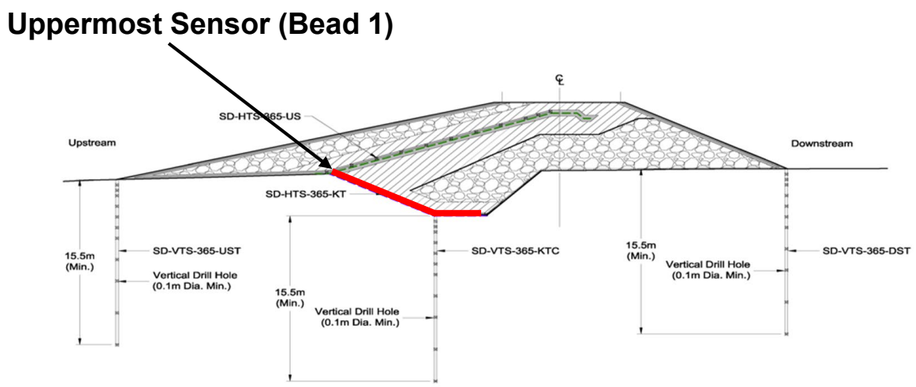
2019 Annual Geotechnical Inspection
Tailings Impoundment Area

Foundation Ground Temperature – Section 5+10

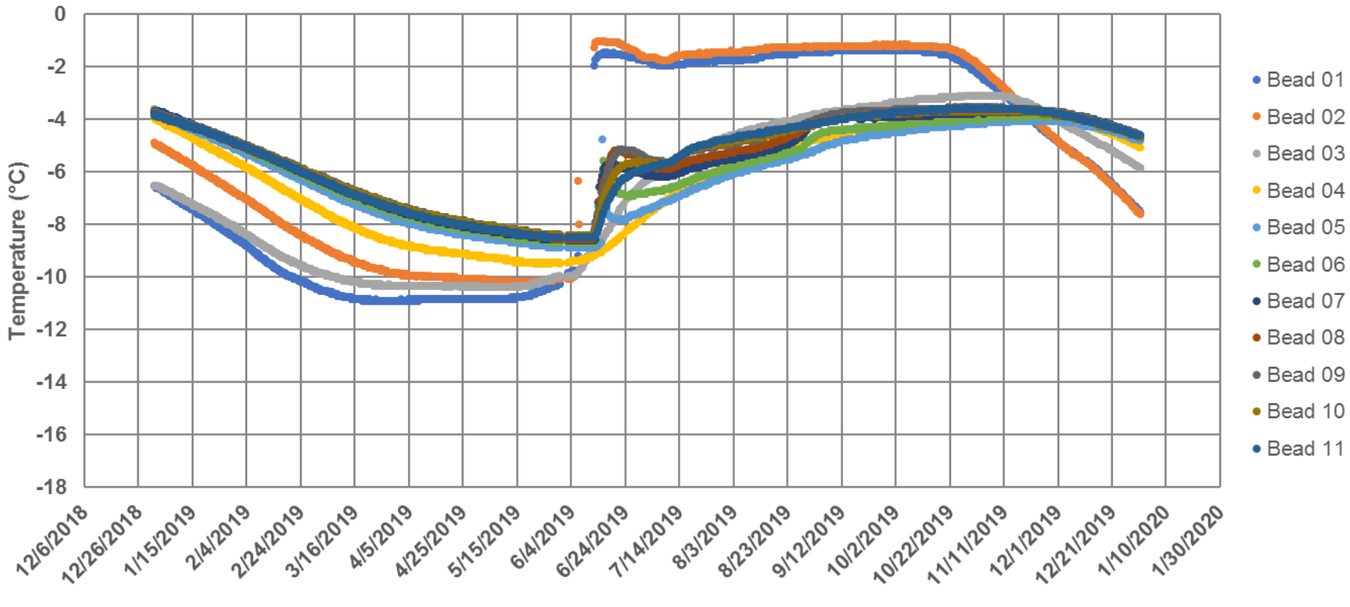
Date:	Approved:	Figure:
March 2020	CWS	**11**

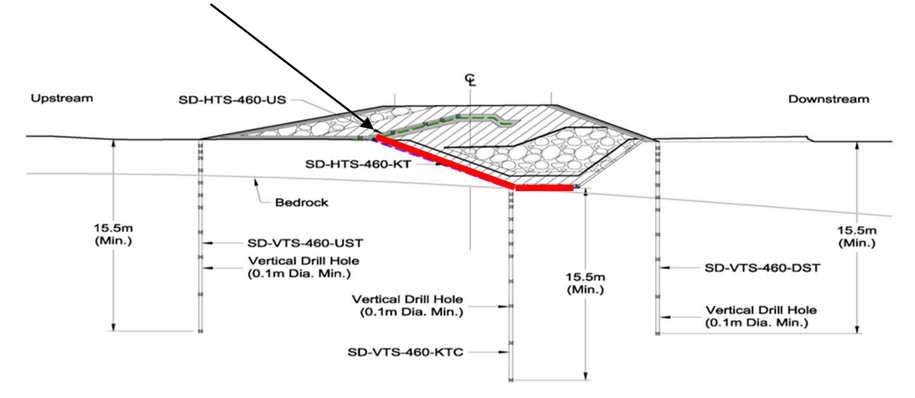
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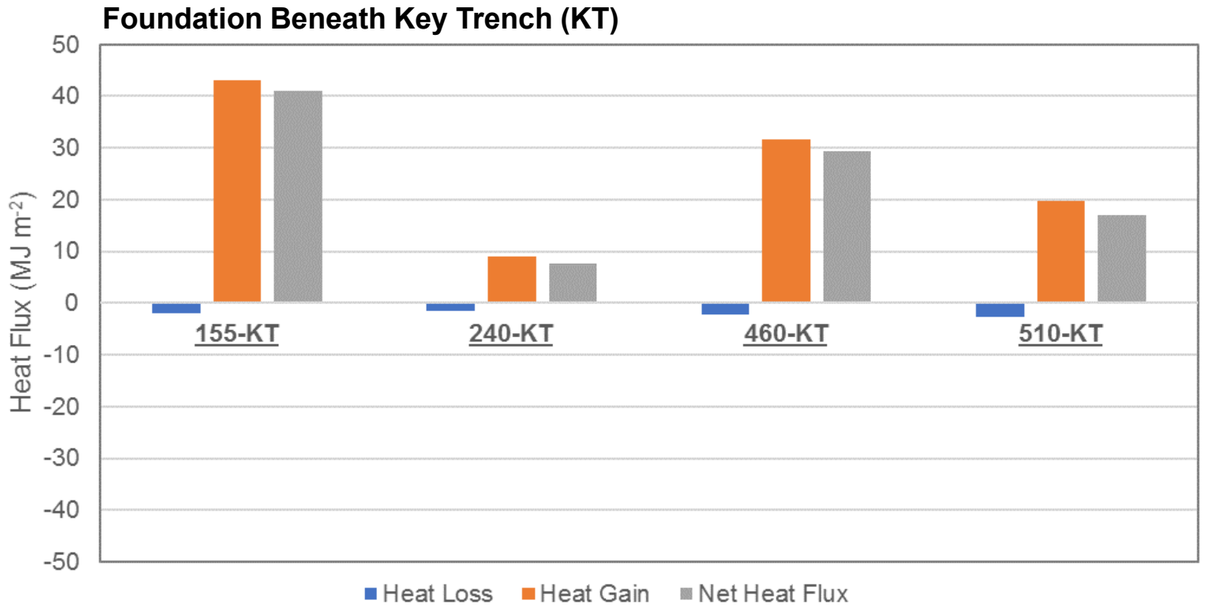
SD-HTS-460-KT

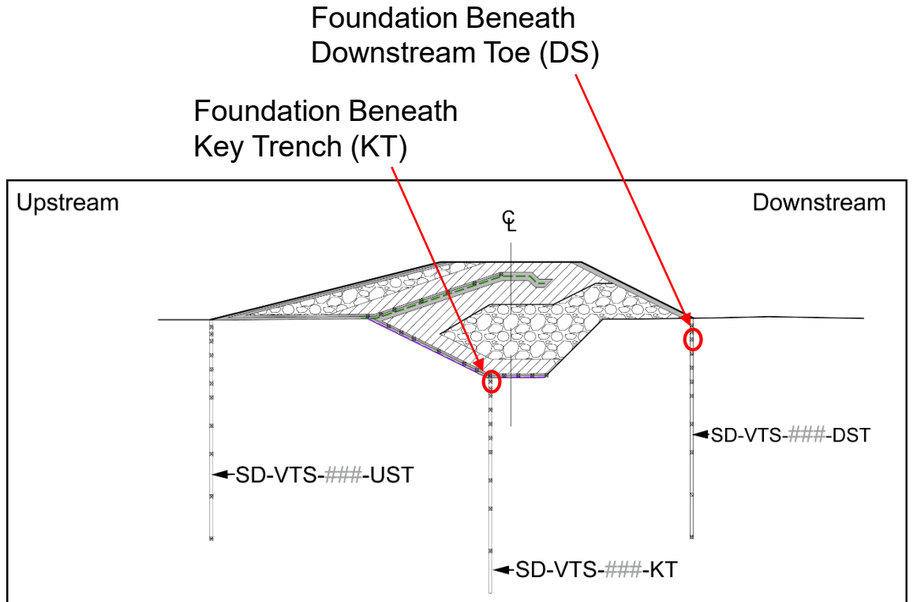


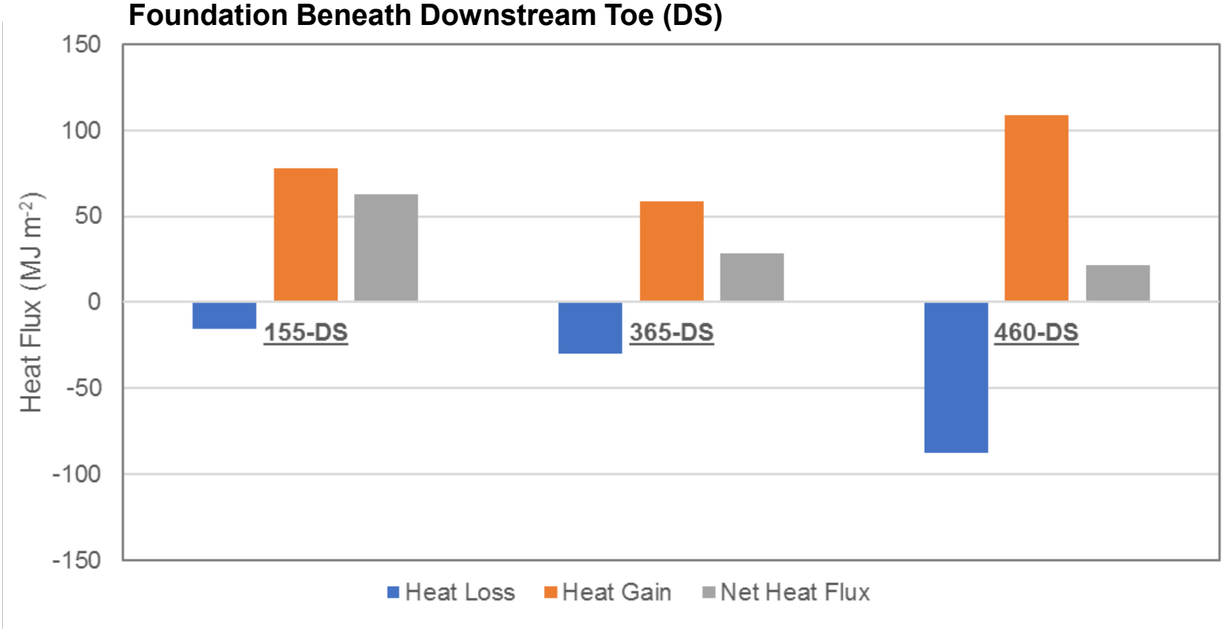


Notes:
1. Uppermost sensor (Bead 1) located at the shallowest key trench depth furthest upstream from the dam centerline

srk consulting	TMAC RESOURCES	2019 Annual Geotechnical Inspection Tailings Impoundment Area
		Key Trench Upstream Slope – Sections 3+65 & 4+60
Job No: 1CT022.038 Filename: South Dam Thermal Review2019	HOPE BAY PROJECT	Date: March 2020 | Approved: CWS | Figure: **12**



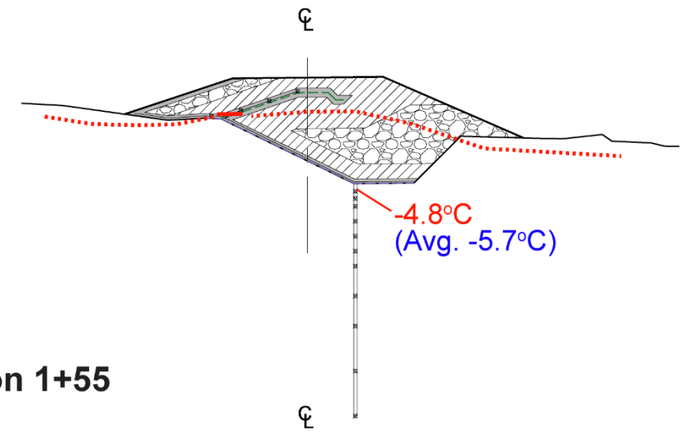




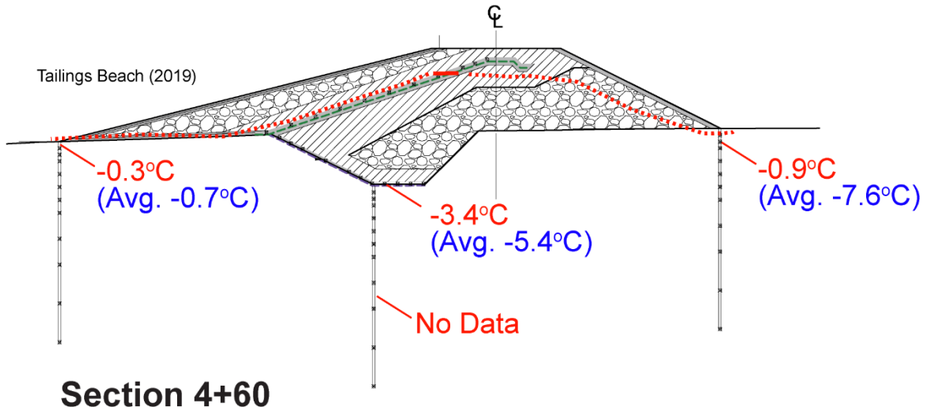
Notes:
1. Heat gain, loss, and net annual heat flux for 2019 at monitoring sites with sufficient data for analysis

srk consulting	TMAC RESOURCES	2019 Annual Geotechnical Inspection Tailings Impoundment Area
		Annual Energy Balance – Dam Foundation
Job No: 1CT022.038 Filename: South Dam Thermal Review2019	HOPE BAY PROJECT	Date: March 2020 · Approved: CWS · Figure: **13**

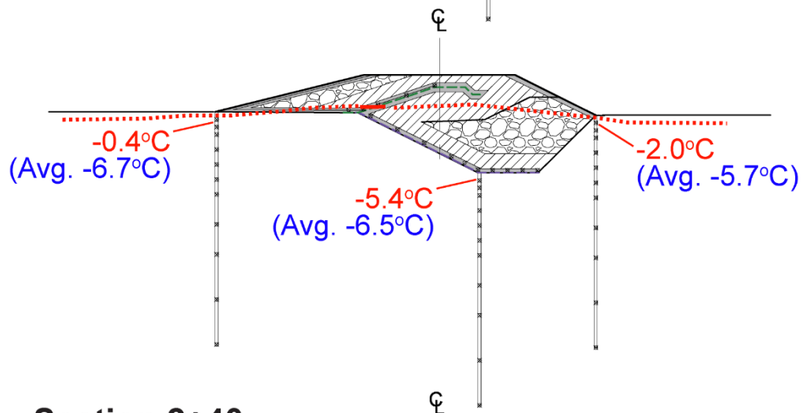
Section 0+65



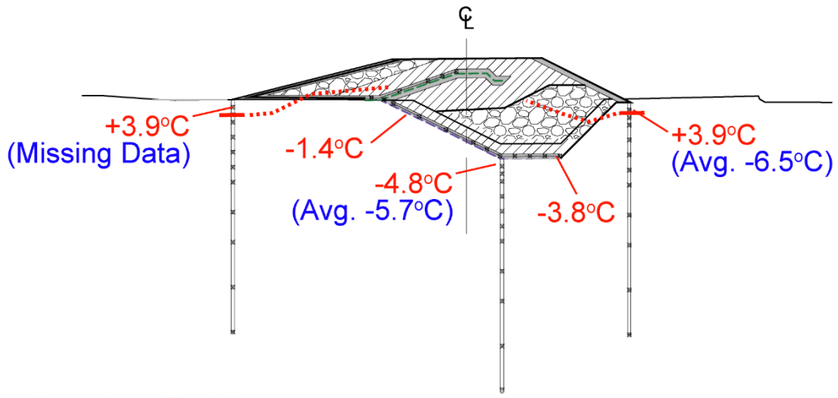
Section 3+65



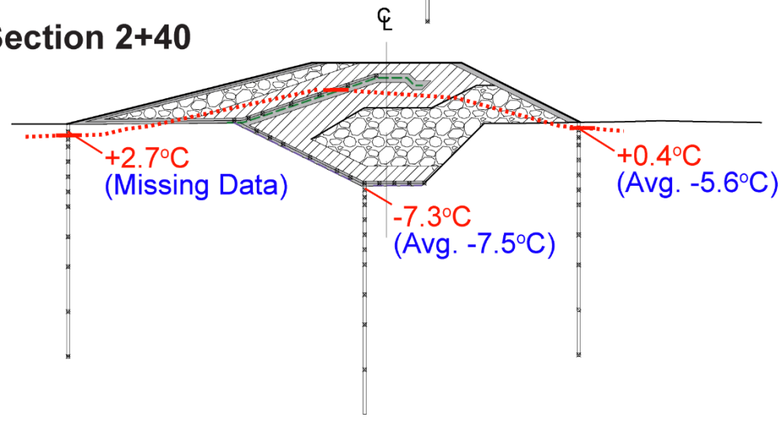
Section 1+55



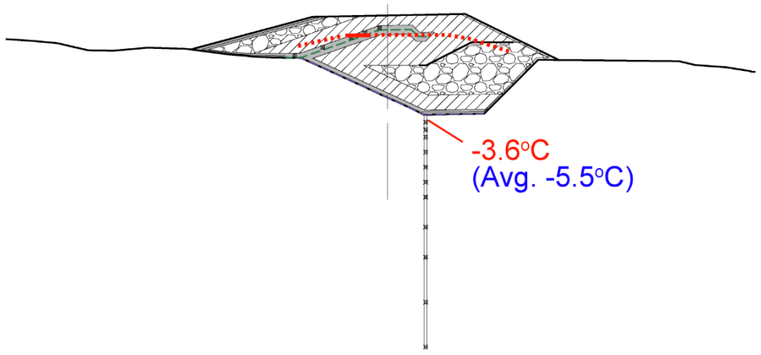
Section 4+60



Section 2+40



Section 5+10



Notes:
1. Temperature shown in blue represent average (Avg.) values for 2019
2. Temperature shown in red represent maximum values for 2019
3. Solid red line represent approximate position of thaw based on 0°C isotherm
4. Red dashed line represent interpreted position of thaw for the 0°C isotherm

srk consulting

Job No: 1CT022.038
Filename: South Dam Thermal Review2019

MAC RESOURCES

HOPE BAY PROJECT

2019 Annual Geotechnical Inspection
Tailings Impoundment Area

Monitoring Sections – 2019 Summary

Date:	Approved:	Figure:
March 2020	CWS	**14**

Appendix M – Tailings Porewater Freezing Point Depressions Checks

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Memo

To:	Project File	**Client:**	TMAC Resources
From:	Christopher Stevens, PhD	**Project No:**	1CT022.038
Reviewed By:	John Kurylo, PEng	**Date:**	June 19, 2020
Subject:	Tailings Porewater Freezing Point Depression		

1 Introduction

The South Dam is designed as a frozen foundation tailings solid retention dam. Thermal performance of the dam is partly reliant on maintaining a tailings beach against the upstream face. In the winter, active tailings deposition is shifted to the east side of the tailings impoundment area (TIA). The change in location of active tailings deposition allows for the thermal loading along the upstream face of the dam to be reduced as winter heat loss from the tailings beach surface takes place. It is expected that the exposed tailings will freezeback and contribute to ground cooling beneath the upstream toe of the dam.

The chemical composition of porewater within the tailings beach will directly impact heat transfer and freezeback of the tailings over time. The composition of dissolved solids in the fluid is known to influence the fluid freezing point and the fraction of unfrozen water in the tailings at below freezing temperatures. These conditions have a direct impact on the tailing thermal conductivity, heat capacity, and latent heat of fusion which control heat transfer.

2 Tailings Samples

Bulk tailings beach samples were collected from three locations along the upstream face of the South Dam in 2019. The supernatant water from the bulk samples was analyzed to evaluate the water chemistry and freezing point depression of the TIA tailings. Table 1 summarizes the approximate locations of the tailings sampling points at the location of the South Dam spigot (Spigot 1 through 3).

Table 1: Location of Tailings Sampling

Sample ID	Easting[1]	Northing[1]	Elevation
SRK19-SD-SPIGOT1	435534	7555937	205
SRK19-SD-SPIGOT2	435632	7555967	203
SRK19-SD-SPIGOT3	435819	7556003	204

Notes:

1. Coordinates of sample locations are approximate.

Bulk surface tailings samples were collected by Derrick Midwinter (SRK) using a shovel and a clean 20 L plastic buckets. The buckets were sealed with lids and stored onsite until shipment to Global ARD Testing Service Inc. in Burnaby, British Columbia. Rain had occurred at the site several days prior to tailings sampling (personal comm. D. Midwinter).

Consolidation of the tailings during transport resulted in supernatant water forming in each sample bucket. Laboratory testing was completed on the supernatant water and included pH, EC, alkalinity, dissolved trace metals and anions SO4, Cl, ammonia, NO3 and NO2. SRK (2020) provides additional details on sample collection, laboratory testing, data QA/QC, and geochemical analysis.

3 Freezing Point Depression

The freezing point depression was calculated from the chemical composition of the tailings supernatant water results. Major ions and anions considered included calcium, magnesium, manganese, sodium, and potassium. The freezing point depression was calculated as:

$$\delta T = iK_f m$$

where:

δT is the change in temperature (°C)
i is the van't Hoff factor
K_f is the molar freezing point depression constant (°C kg mol^{-1})
m is the molarity of the solutes

The calculated freezing point depression for the supernatant water was 0.10°C, 0.21°C, and 0.25°C for sample SRK19-SD-SPIGOT1, SRK19-SD-SPIGOT2, and SRK19-SD-SPIGOT3, respectively. Based on the available information, the estimated tailings freezing point depression would be expected to have a negligible impact on freezeback of the tailings beach when compared to freshwater. The fine-grained tailings are expected to have a high unfrozen water content which has a larger influence on the thermal properties and heat transfer through the tailings over time. Additional collection of tailings samples to evaluate the freezing point depression may be warranted following suspected changes in the chemistry of the groundwater or mill water received by the TIA.

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

4 References

SRK Consulting (Canada) Inc. (SRK). 2020. 2019 North and South Dam Seepage Water Quality Investigation, Hope Bay Project. Submitted to TMAC Resources Inc.

Appendix N – Tailings Deposition Update

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Memo

To:	Project File	**Client:**	Sabina Gold & Silver Corp.
From:	Murray McGregor	**Project No:**	1CT022.038
Reviewed By:	John Kurylo, MSc, PEng	**Date:**	March, 2020
Subject:	TSF Tailings Deposition Plan – March 2020 Update		

1 Introduction

The Hope Bay Project is a gold mining (and milling) project which is being undertaken by TMAC Resources Inc. The project is located 705 km northeast of Yellowknife and 153 km southwest of Cambridge Bay in Nunavut Territory, east of Bathurst Inlet. The project encompasses three areas of mineralization with additional exploration targets. The three mineral resources are Doris, Madrid, and Boston.

The Project consists of two phases. Phase 1 includes mining and infrastructure at Doris, while Phase 2 includes mining and infrastructure at Madrid and Boston located approximately 10 and 60 km due south from Doris, respectively. As of December 2018, the Doris Type A Water Licence was amended to include Madrid (2AM-DOH1335), and Boston was granted its own Type A Water Licence (2AM-BOS1835). The tailings are deposited sub-aerially into the Doris Tailings Impoundment Area (TIA) approximately 5 km from the Doris Mill area. The Doris TIA was previously a natural lake (Tail Lake) but has been delisted in accordance with Schedule II of the Metal Mining Effluent Regulations (MMER).

Tailings containment is currently provided by two structures; a water retaining frozen core dam (North Dam) and a frozen foundation tailings containment dam (South Dam). The North Dam construction was completed in 2012 (SRK, 2012) and the South Dam starter dam was completed in July 2018 (SRK, 2019). A deposition plan was previously prepared to identify options for increased tailings storage capacity within the Doris TIA (SRK, 2017).

In order to accommodate the additional tailings from Phase 2 works, additional containment is required. As part of the Annual Geotechnical Inspection (AGI), and to assist with the TMAC Prefeasibility Study update that was in progress the deposition plans were revisited. In general tailings deposition plans for the TIA will be reviewed annually as part of the AGI. As part of the Phase 2 plans, the South Dam will be raised, and a new dam will need to be constructed at the south-western edge of the TIA (West Dam). The West Dam will be constructed and operated similarly to the South Dam (i.e. tailings containment dam with frozen foundation).

This memo presents the results of deposition modelling in support of the Annual Geotechnical Inspection (AGI). This assessment considers the currently projected Life of Mine (LoM) tailings and discounts for tailings placed by the end of 2019.

2 Operation Philosophy

2.1 Deposition Strategy

The overall deposition strategy begins with discharging tailings from several points starting from the South Dam and progressively moving the tailings beach toward the north. The intent is to maintain a free-draining surface that drains to the reclaim pond at closure.

The use of single spigot points at a given time was done to simplify as much as practical the operation strategy. Single point deposition has been specified for the winter months in order to minimize the risk of ice entrainment. During the summer periods, three spigot points are specified; however, these can be operated one at a time splitting deposition between each point evenly.

A beach has been formed at the South Dam in 2019. Tailings deposition will continue to progressively move water away from South Dam while maintaining a free draining surface to the north. After construction of the West Dam, summer deposition will move to the West Dam in order to form a beach to move the pond away from the dam. Moving water away from the South Dam and West Dam will facilitate freeze-back of the foundation and eliminate seepage potential under the dams. Deposition will then continue progressively along the east side of the TIA for the remaining life of mine tailings.

The North Dam will continue to act as a water retaining dam for the life of the TIA. The water demands will need to be checked as tailings deposition continues and the size of the reclaim pond reduces.

Best Management Practices will be adopted to schedule seasonal changes in discharge locations to minimize ice buildup and possibly permanent entrapment of ice within the tailings mass. The deposition planning presented in this memo does not present complete details of such seasonal operations; seasonal operations will be developed and presented in an Operations, Maintenance and Surveillance (OMS) Manual. This OMS Manual will be prepared by TMAC in accordance with the requirements under the mine's Water Licence.

2.2 Reclaim

The water reclaim is currently situated at the north end of the tailings pond adjacent the North Dam. It consists of an on-land pump connected to a barge with a floating pipe. Water sourced from the reclaim will be pumped to the mill area for reuse in the mill circuit or discharge following treatment.

The full supply level of 33.5 masl should not be exceeded under normal operating circumstances. The barge has been anchored in a locally deep area (>2m depth) at the north end of the TIA to facilitate pumping during winter periods when relatively deep ice can develop. The position of the

barge may need to be re-evaluated as tailings deposition begins to encroach in the area; however, preliminary deposition modelling suggests this is many years away.

3 Objectives, Operational Criteria and Assumptions

The tailings deposition plan has been completed to determine the following:

- Allow for the development of an accurate tailings surface which would facilitate the development of a representative stage-capacity curve for the TSF through its life;
- Determining optimum tailings discharge locations and durations that coincide with the deposition philosophy;
- Optimization of deposition locations to facilitate use of reclaim water and limit ice entrainment
- Identify the timing requirements for construction the West Dam and South Dam raise
- Determine the sensitivity of beach angle

Tailings deposition planning was completed using the program Muk3D 2018. The deposition modeling assumptions are summarized in Table 1, and are based on actual site survey data, laboratory testing, and experience with tailings that have similar characteristics. The as-built surfaces from 2019 were incorporated into the base surface for the analysis to account for existing tailings placement.

Table 1: Summary of Tailings Deposition Modeling Assumptions

Component	Value
Total Tailings Storage Requirement [1]	20.0 Mt (15.4 Mm^3)
Tailings currently Deposited [1]	1.2 Mt
Remaining Tailings Storage Requirement [1]	18.8 Mt (14.5 Mm^3)
Deposited Tailings Dry Density	1.3 t/m^3 (based on testing)
Tailings Beach Slope (Subaerial Portion)	0.5% to 1.0% [2]
Tailings Beach Slope (Sub-aqueous Portion)	1.0%
TSF Full Supply Level (normal operations)	33.5 m
Discharge Method	Single/multi point discharge

Notes: [1]Tailings storage requirements based on information provided beginning of 2020
[2]Short term tailings modelled at 0.5% subaerial slope (similar to 2019 survey); life of mine tailings modelled at both 0.5% and 1.0% subaerial slopes to capture the likely range of possible outcomes

Tailings throughput has been modelled at 2000 t/day initially, then ramped up to a maximum allowance of 4000 t/day (to look at potential variability in the mining plan and milling rates). The scheduled of production rates looked at as part of this annual check is summarized in Table 2 below.

Table 2: Summary of Tailings Production Rates (TMAC 2020)

Year (inclusive)	Tonnes/Day
2020 to 2023	2000
2024	3500
2025 to 2034	4000

4 Deposition Modelling Results

Deposition modelling was undertaken for three scenarios:

- Short term-deposition with subaerial slope of 0.5% and subaqueous slope of 1.0% (pond level near current elevation of 33.0masl)
- Life of Mine deposition with subaerial slope of 0.5% and subaqueous slope of 1.0% (pond level at full supply level of 33.5masl)
- Life of Mine deposition with subaerial and subaqueous slope both modelled at 1.0% (pond level at full supply level of 33.5masl)

Variable deposition and beach slope angles were looked at was due to the fact that as-built surveys are showing slightly variable beach slopes; slope angles are ultimately dependent on solids content and if other water stream such as underground inflows are being deposited with or beside the tailings streams. Looking at the variable beach slopes gives a bit of a sensitivity analysis on the overall tailings storage volumes and reclaim pond size.

The plan view of the modelling results for the three scenarios are presented in Figures 1, 2 and 3. Discharge points are consistent in each scenario and have been labelled in each (D01 to D13); however, not all deposition points appear in each scenario. A further breakdown of deposition models is shown in Attachment 1.

The near-term deposition was completed based on the current discharge point operating until spring 2020 (D01). Tailings are then discharged from the South Dam to continue raising the beach (D02). As the following winter approaches, tailings are discharged from a single point away from the South Dam beach (D03). For subsequent years, deposition is split into two phases representing 7 months summer and 5 months winter deposition. The deposition location and elevations for the two Life of Mine (LoM) scenarios are presented in Table 3. In all scenarios, winter deposition is completed from discharge points internal to the TIA and away from the dams.

The 1.0% subaerial beach slope represents the more conservative scenario in terms of rate of rise and required discharge locations. Based on the 1.0% deposition model outputs reported in Table 3, the South Dam raise will be required in 2022. Tailings begin to encroach on the West Dam foundation area in 2025; therefore, the West Dam construction should begin in winter 2023.

In both scenarios modelled, the final volume of the pond under normal operating circumstances is relatively small (less than 400,000m^3).

Table 3: Summary of Deposition Modelling

Year	Modelling Stage	Subaerial slope = 0.5%				Subaerial slope = 1.0%			
		Discharge Location	Elevation [masl]	Tonnage [tonnes]	Pond Volume [m3]	Discharge Location	Elevation [masl]	Tonnage [tonnes]	Pond Volume [m3]
2020	1	D01	35.1	360,000	6,589,000	D01	36.2	360,000	6,617,000
2020	2	D02	36.1	183,000	6,542,000	D02	37.8	183,000	6,603,000
2020	3	D02 (D99)	36.1	57,000	6,498,000	D02 (D99)	37.8	57,000	6,559,000
2020	4	D03	34.8	30,000	6,485,000	D03	35.1	30,000	6,544,000
2020	5	D03 (D99)	34.8	90,000	6,416,000	D03 (D99)	35.1	90,000	6,475,000
2021	6	D02 (D99)	36.1	430,000	6,086,000	D02 (D99)	37.8	430,000	6,144,000
2021	7	D03	35.8	300,000	5,964,000	D03	37.1	300,000	6,042,000
2022	8	D02	37.7	430,000	5,873,000	D02	40.2	430,000	6,020,000
2022	9	D03	36.5	300,000	5,700,000	D03	38.5	300,000	5,928,000
2023	10	D02	38.5	430,000	5,576,000	D02	41.8	430,000	5,910,000
2023	11	D03	37.3	300,000	5,409,000	D03	39.4	300,000	5,764,000
2024	12	D02	39.3	430,000	5,295,000	D02	42.9	430,000	5,728,000
2024	13	D03	37.9	300,000	5,127,000	D03	40.3	300,000	5,588,000
2025	14	D02	40.2	752,500	4,893,000	D02	44.3	752,500	5,479,000
2025	15	D03	39.0	525,000	4,611,000	D03	41.9	525,000	5,257,000
2026	16	D02	41.2	860,000	4,369,000	D02	45.8	860,000	5,171,000
2026	17	D03	39.9	600,000	4,043,000	D03	43.3	600,000	4,921,000
2027	18	D02	42.1	860,000	3,801,000	D03	44.5	860,000	4,630,000
2027	19	D03	40.7	600,000	3,471,000	D03	47.0	600,000	4,551,000
2028	20	D02	42.9	860,000	3,228,000	D05	43.2	860,000	4,258,000
2028	21	D03	41.4	600,000	2,907,000	D04	43.9	600,000	4,030,000
2029	22	D02	43.6	860,000	2,670,000	D05	44.5	860,000	3,776,000
2029	23	D03	42.2	600,000	2,365,000	D04	45.1	600,000	3,574,000
2030	24	D02	44.3	860,000	2,148,000	D05	45.6	860,000	3,347,000
2030	25	D03	42.8	600,000	1,868,000	D06	44.2	600,000	3,087,000
2031	26	D02	45.0	860,000	1,685,000	D06	45.0	860,000	2,726,000
2031	27	D03	43.5	600,000	1,444,000	D07	43.6	600,000	2,439,000
2032	28	D02	45.6	860,000	1,299,000	D08	43.1	860,000	2,046,000
2032	29	D03	44.2	600,000	1,069,000	D09	42.4	600,000	1,783,000
2033	30	D05	43.3	860,000	810,000	D10	41.5	860,000	1,437,000
2033	31	D04	43.7	600,000	680,000	D11	41.3	600,000	1,193,000
2034	32	D05	44.1	860,000	494,000	D12	41.8	860,000	871,000
2034	33	D04	44.4	600,000	418,000	D12	42.4	600,000	721,000
2035	34	D05	44.7	860,000	286,000	D13	42.4	860,000	490,000
2035	35	D04	45.1	600,000	246,000	D13	43.0	600,000	392,000

Note: Discharge D99 in parenthesis indicates tailings spilling into deep portion of tailings pond without significant rise at discharge location.

5 Discussion

Two deposition scenarios have been modelled for the currently projected LoM tailings:

I. Subaerial slopes of 0.5% and subaqueous slopes of 1.0%
II. Subaerial and subaqueous of 1.0%

One additional short-term deposition scenario was also modelled, as outlined in Section 4, but is not discussed in detail in this section. The focus of these discussions is on the LoM tailings deposition.

The 2019 tailings beach was measured (based on as-built surveys) at roughly 0.5% to 0.7% subaerial slope; therefore, the subaerial slopes modelled can represent the range of expected outcomes for future deposition.

The modelling exercise undertaken indicates that the existing TIA can accommodate the LoM tailings with limited modification (including the maximum production rates assumed, although these may not be realized on site). A raise of the South Dam is required by 2022 and West Dam construction needs to begin in winter 2023 based on the more conservative of the two scenarios (1.0% subaerial slopes). It should be noted that there is some flexibility in tailings deposition. For example, a northern discharge location could be used for in the short term if the tailings beach rises to the crest of the South Dam faster than anticipated.

The modelling was completed for an overall density of 1.3t/m^3. The capacity of the TIA could be significantly impacted by tailings density; therefore, as-placed density needs to be checked throughout to ensure this assumption remains valid. Localized density tests will likely not capture potential entrained ice; therefore, density should be checked by comparing ground surveys and bathymetry to the mill throughput.

In early stages of deposition, the winter discharge points are relatively close to the pond and the modelling suggests that most of the winter deposition results in subaqueous tailings which limits the potential for ice entrainment. In later years, the distance from winter discharge points to the pond increases and potential for ice entrainment will increase. Monitoring ice entrainment and as placed density in the next few years will help establish the associated risks. If the risk is significant, alternate deposition strategies could be developed that move winter deposition points closer to the pond.

The overall capacity of the TIA in the currently planned form is not particularly sensitive to the tailings slope angle; however, additional discharge locations are required in order to maintain the free draining surface to the north if the beach angle is steeper. Note that the deposition strategy for 1.0% subaerial slopes has roughly twice the discharge locations than for the 0.5% subaerial slope scenario.

Water management may be an issue toward the end of mine life since the reclaim pond becomes significantly smaller (less than 400,000m^3). The water balance should continue to be constantly checked (and reviewed in detail annually) in order to confirm that process water demands can be met from the reduced pond volume. It is also likely that significant quantities of water will need to

be treated and discharged annually in order to progressively reduce the volume in the pond and remain below the normal operating water level of 33.5masl.

The deposition plan should be reviewed as part of the next AGI to ensure the assumptions remain valid and there is capacity for the projected life of mine tailings.

6 References

SRK Consulting (Canada) Inc. (SRK, 2012). North Dam As-Built Report, Hope Bay Project. Report prepared for Hope Bay Mining Ltd. Project Number 1CH008.058. October 2012.

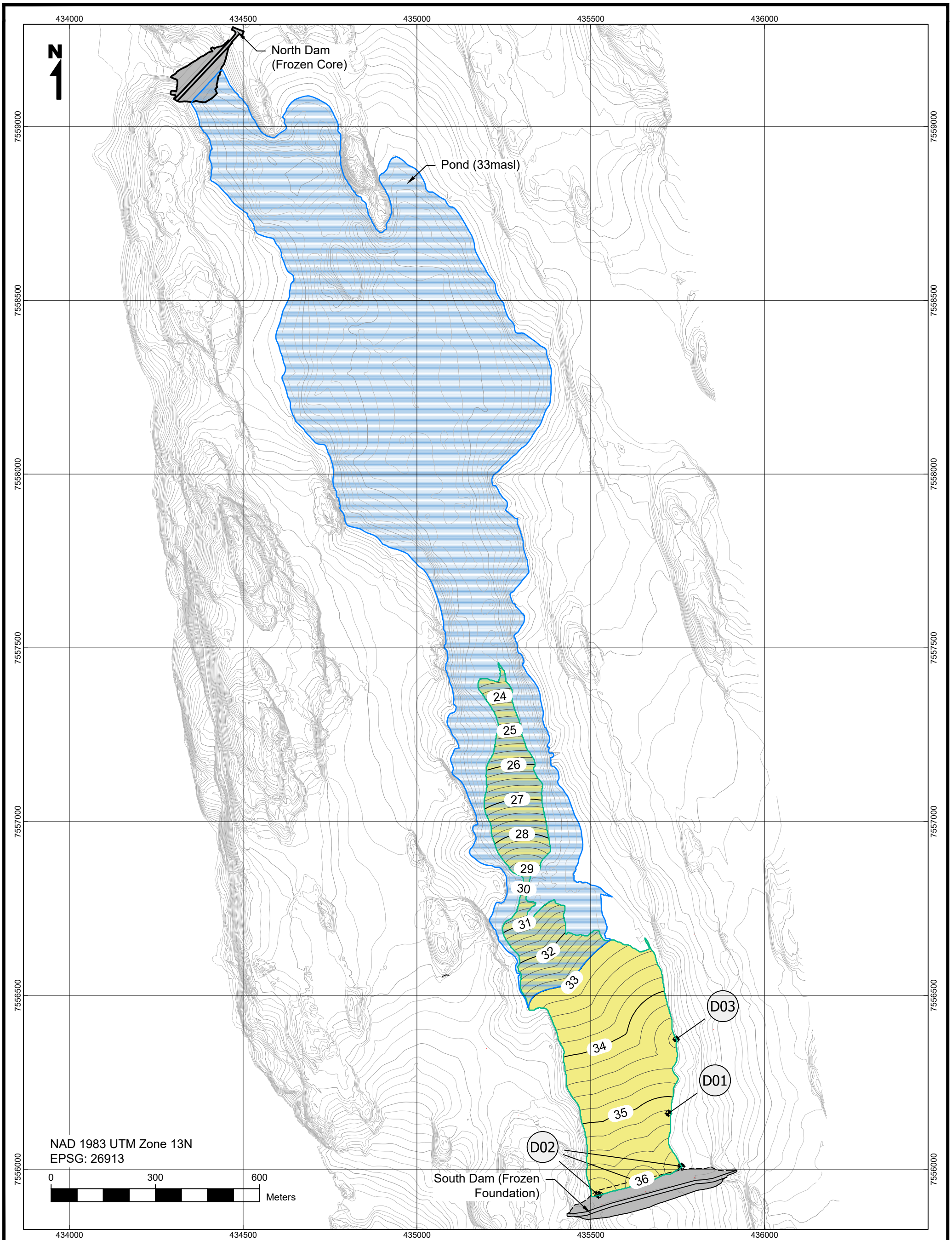
SRK Consulting (Canada) Inc. (SRK, 2017). Phase 2 Doris Tailings Impoundment Area Tailings Deposition Plan, Hope Bay Project. Report prepared for TMAC Resources Inc. Project Number 1CT002.013. November 2017.

SRK Consulting (Canada) Inc. (SRK, 2019). Phase 1 South Dam As-Built Report, Hope Bay Project. Report prepared for TMAC Resources Inc. Project Number 1CT022.031. March 2019.

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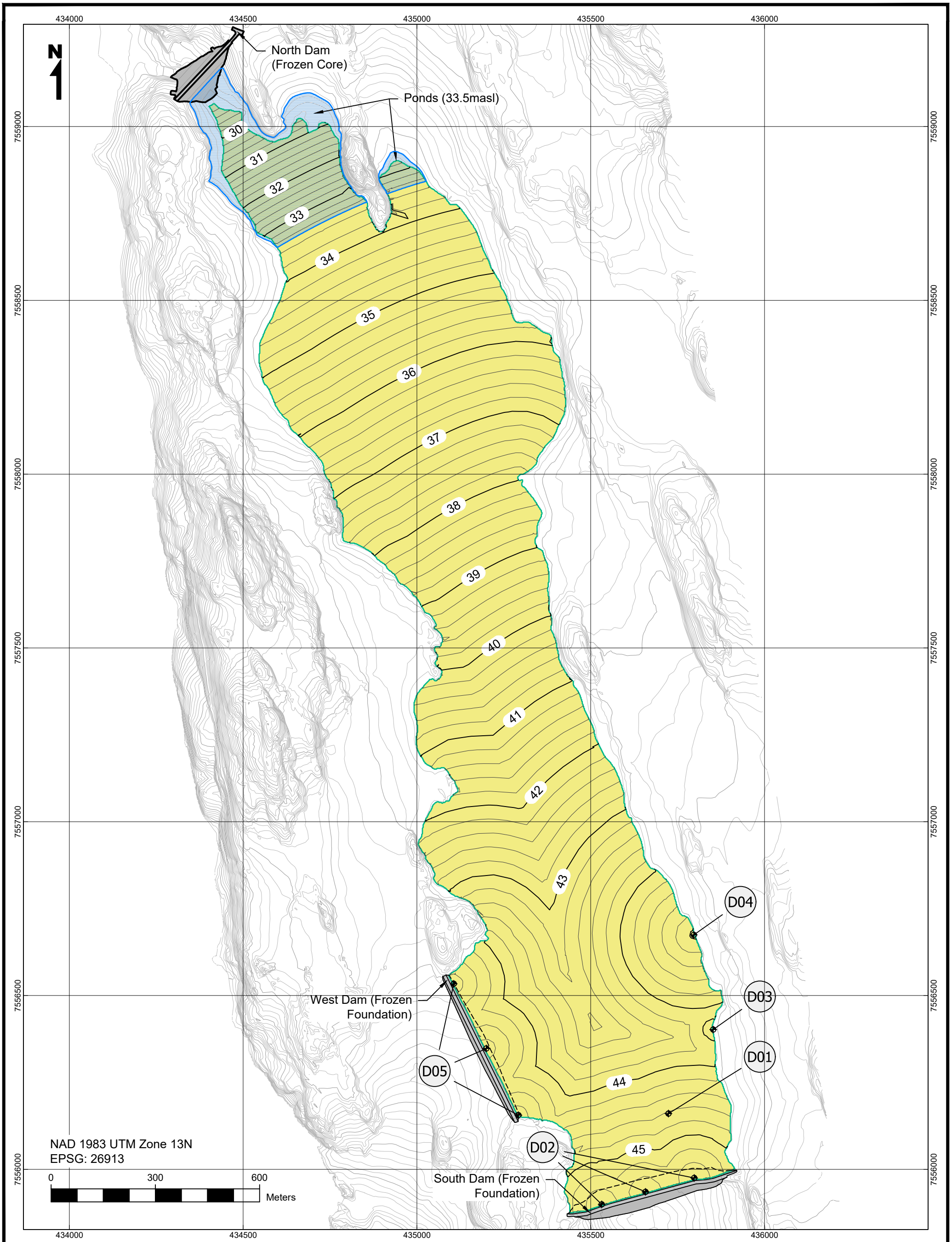
The opinions expressed in this report have been based on the information available to SRK at the time of preparation. SRK has exercised all due care in reviewing information supplied by others for use on this project. Whilst SRK has compared key supplied data with expected values, the accuracy of the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

Figures



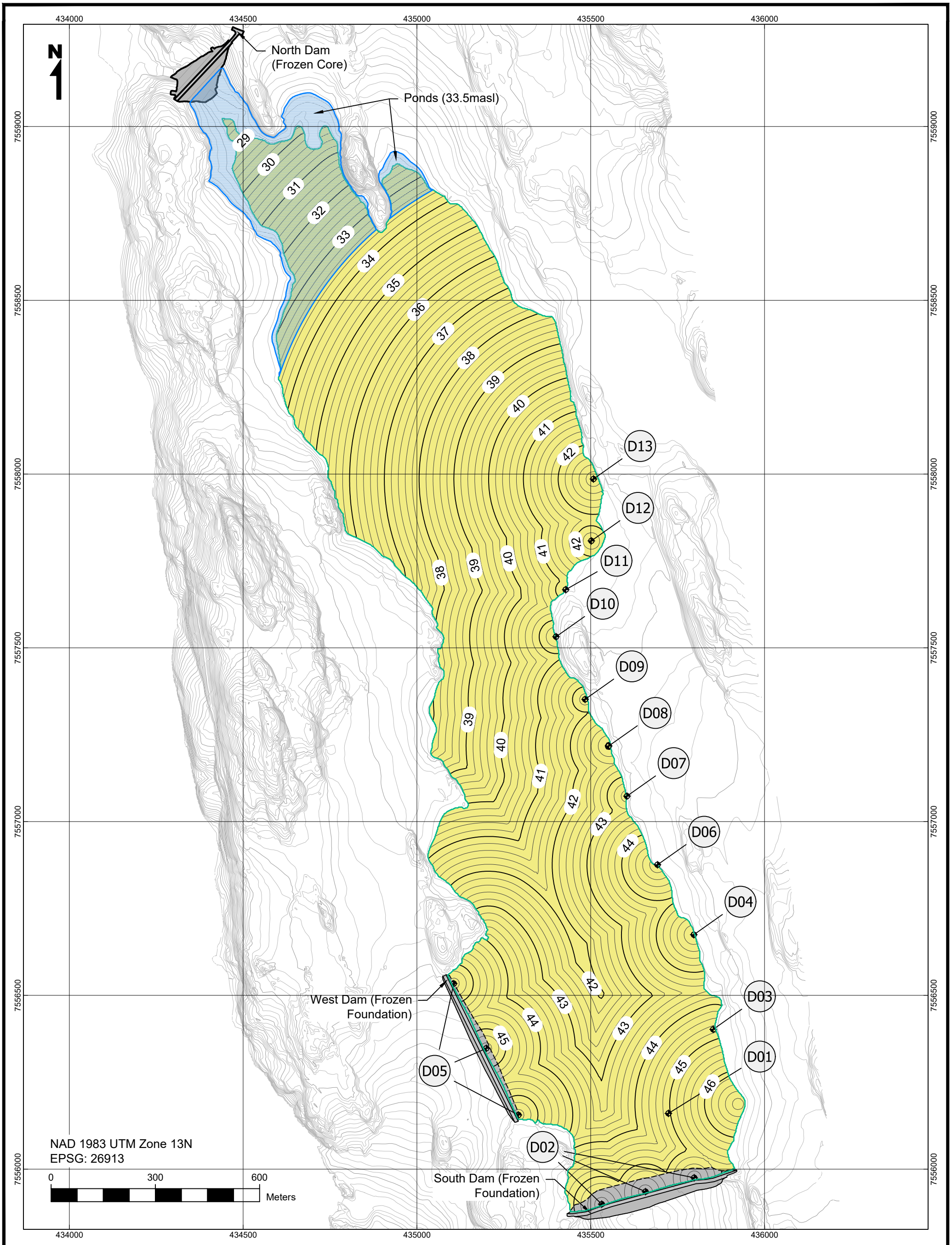
MARCH 2020	30880	HOPE BAY ENGINEERING SUPPORT	1:10000
srk consulting		Projected Tailings Deposition 2020	Figure 1

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MARCH 2020	30880	HOPE BAY ENGINEERING SUPPORT	1:10000
srk consulting		Life of Mine Deposition Plan (0.5% Subaerial slope)	Figure 2

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MARCH 2020	30880	HOPE BAY ENGINEERING SUPPORT	1:10000
srk consulting		Life of Mine Deposition Plan (1.0% Subaerial slope)	Figure 3

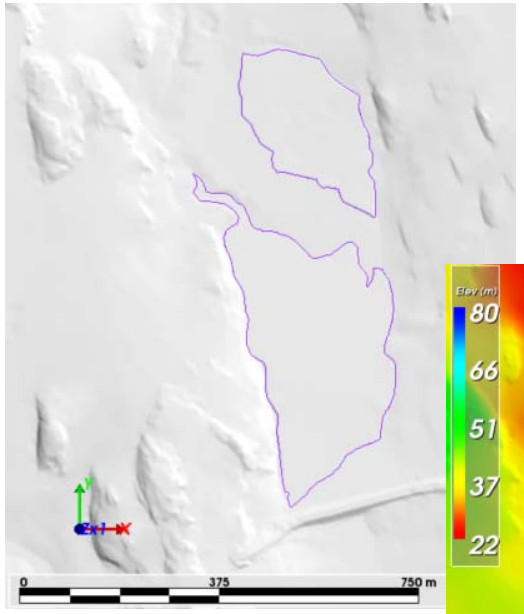
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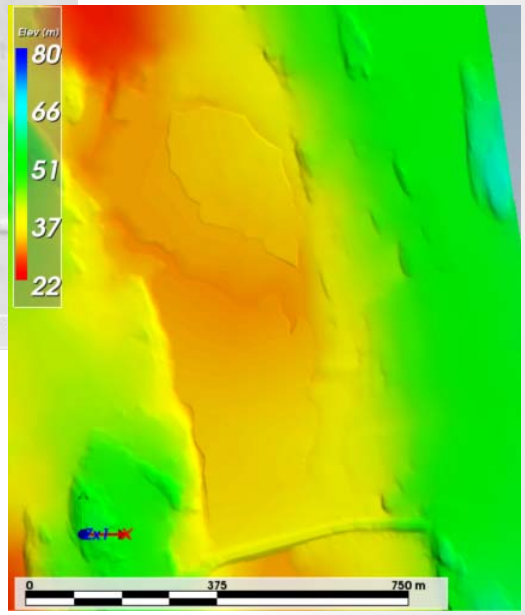
Attachment 1

Hope Bay Deposition Plan - Notes

Surfaces:

- Surfaces seem to load in alright (blue outlines)
- Minor differences in surface elevation approximately 0.5-0.7m at tie-in points
- Small gap between survey and cliff face on west side of southern tails surface
- Surface area:
  - East tails 50,000m^2
  - South tails 107,000m^2
- Assume maximum error of 0.5m, then volume error would be about 78,500m^3
- However, I think this is certainly an overestimate of error and these surfaces are fit for the task
- These will be smoothed out very rapidly during deposition modelling (i.e. less than a year and these will be smoothed into the underlying surface)



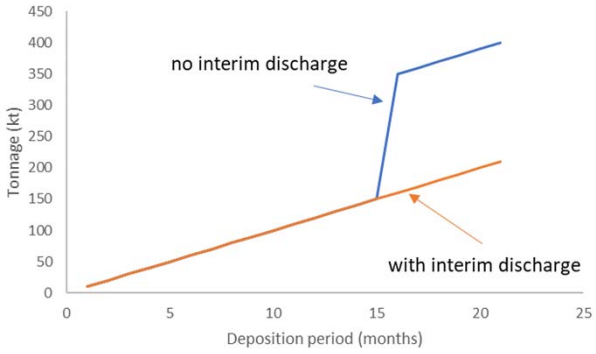


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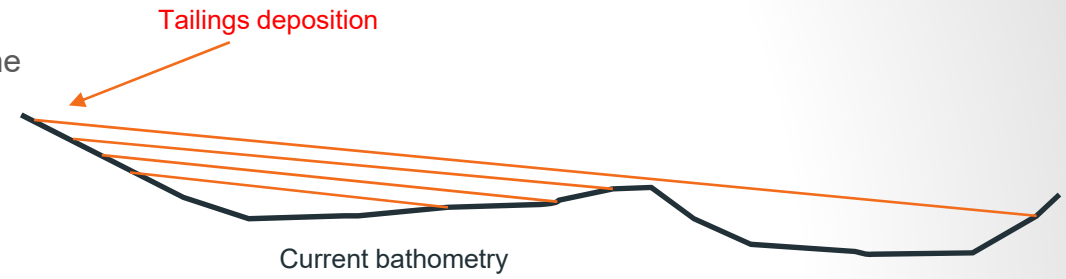
Hope Bay Deposition Plan - Notes

Surfaces:

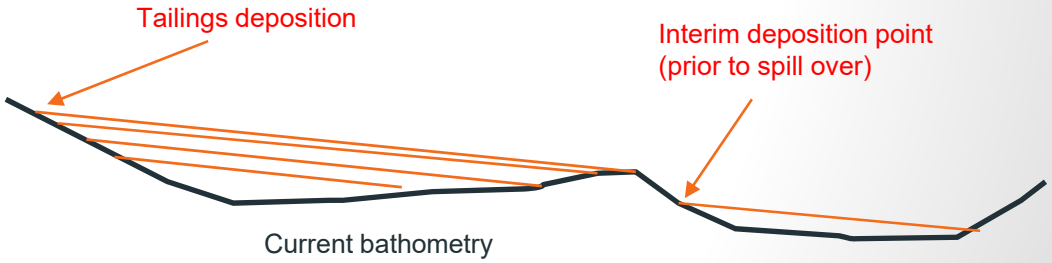
- Geometry of topography will lead to some modelling issues based on deposition grading
- Basically the modelling will crash because of the stepwise jumps in deposition volumes with minimal increment in height due to spill over
- See graphic illustration to right →
- This can be overcome by adding a new interim deposition point in the lower basin that can account for spill over into the central deep portion of Tail Lake



Scenario 1:



Scenario 2:

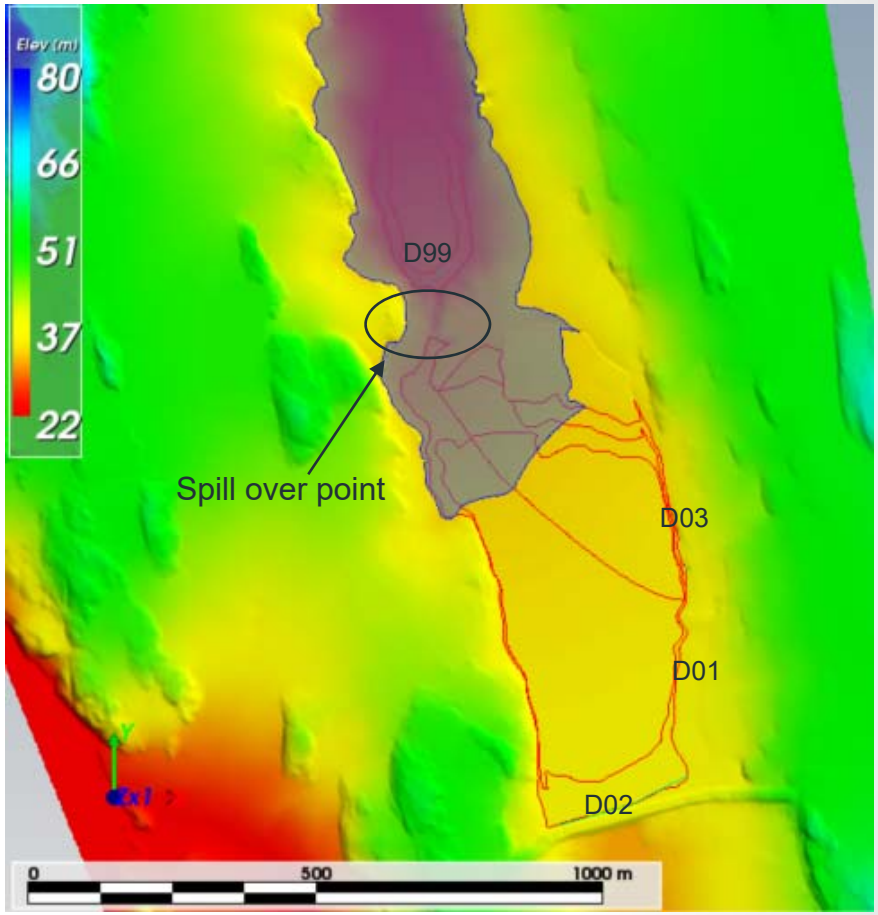


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Hope Bay Deposition Plan - Notes

Preliminary test model for deposition 2020:

- Beach angles:
  - Slope 0.5% sub-aerial
  - Slope 1.0% sub- aqueous
- 50,000 t/month (assumed based on cursary look at throughput to TIA)
- Assume 1.2t/m^3 (probably conservative, data suggests upwards of 1.3t/m^3)
- Deposition points
  - 300,000 tonnes - D01 (current until July)
  - 182,000 tonnes - D02 (from south dam until pre-Nov spill over)
  - 18,000 tonnes – D99 (spill over from D02 until end Oct)
  - 30,000 tonnes – D03 (east deposition Nov)
  - 70,000 tonnes – D99 (spill over from D03 until end Dec)



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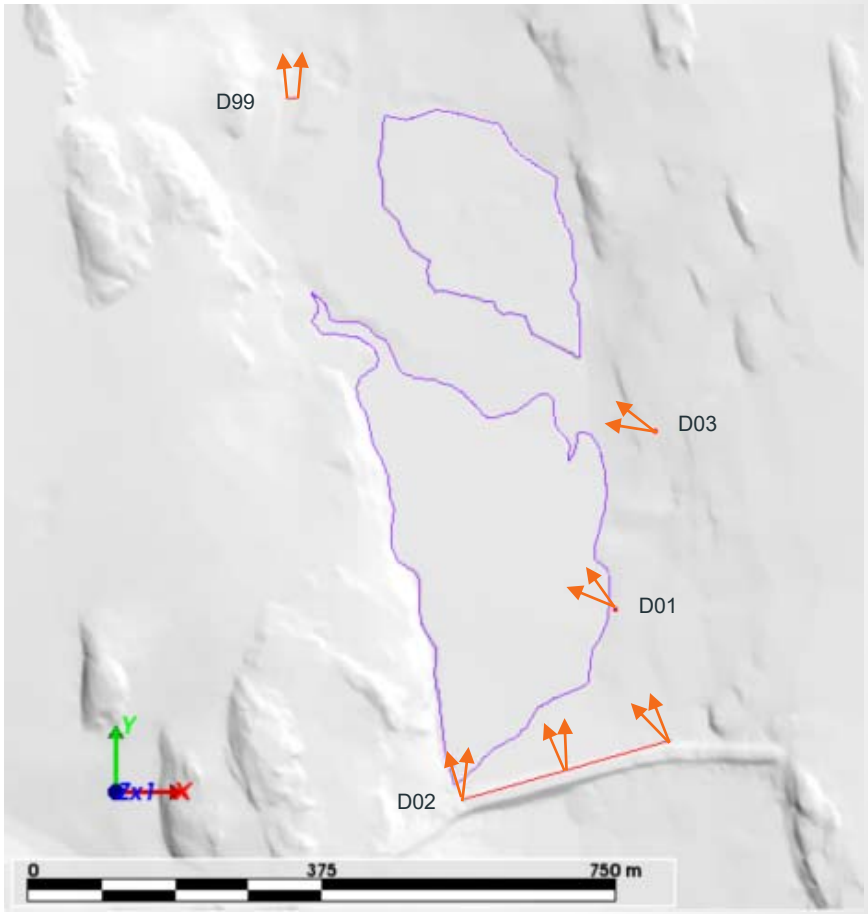
Hope Bay Deposition Plan - Notes

Preliminary model for deposition 2020:

- Beach angles:
  - Slope 0.5% sub-aerial
  - Slope 1.0% sub- aqueous
- 60,000 t/month (assumed based on 2000 t/day current milling capacity)
- Assume placed dry density 1.3 t/m^3

Deposition plan:

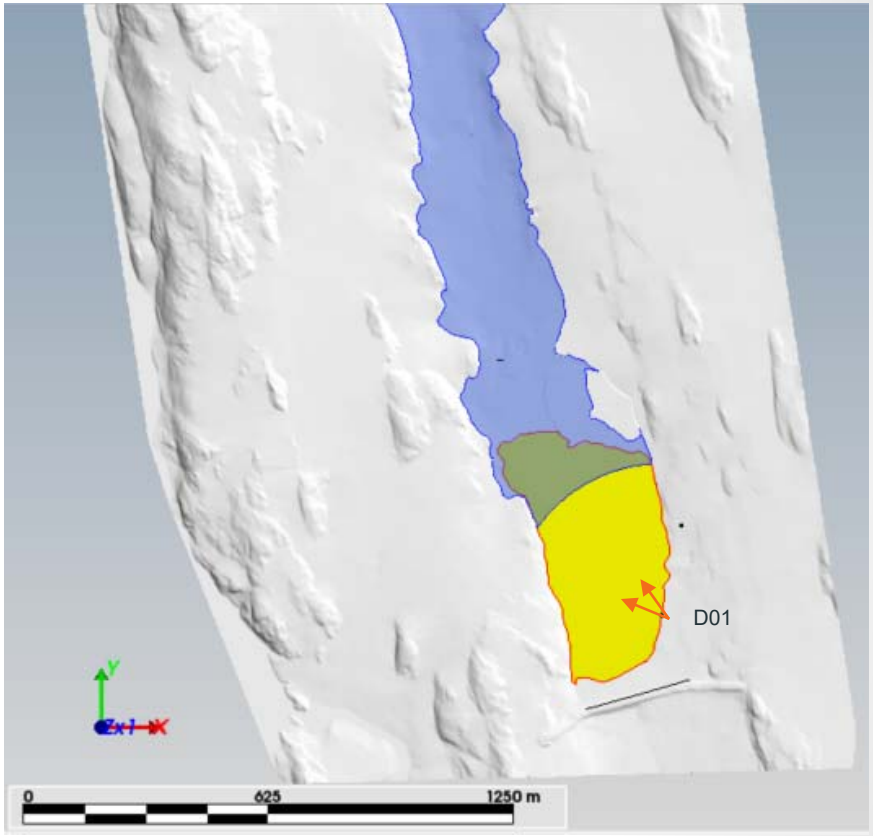
Year	Start	End	Duration	Primary Deposition Point	Total	From Primary Point	Overflow (D99)
	Month	Month	Months		(2000t/day)	Tonnes	tonnes
2020	01	06	6	D01	360000	360000	0
2020	07	10	4	D02	240000	202000	38000
2020	11	12	2	D03	120000	30000	90000



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Hope Bay Deposition Plan - Notes

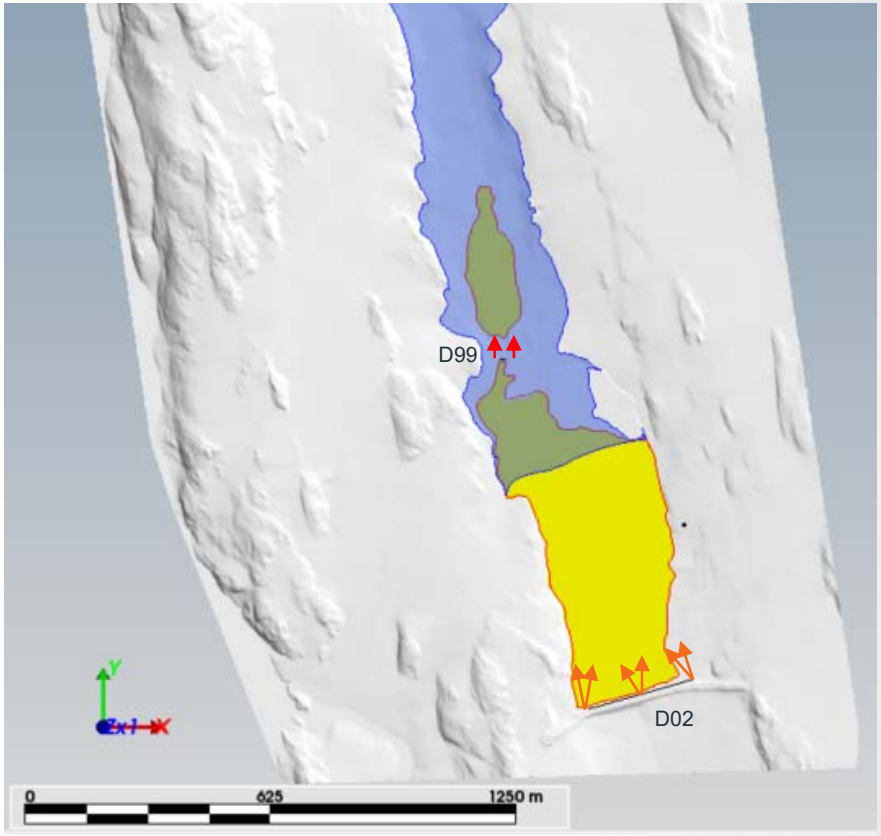
- Deposition from current discharge point (D01)
- 360,000 tonnes by end of June
- Volumes:
  - Sub-aerial tailings: 90,600m3
  - Sub-aqueous tailings: 186,100m3
  - Pond volume at 33mAD: 6,010,000m3



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Hope Bay Deposition Plan - Notes

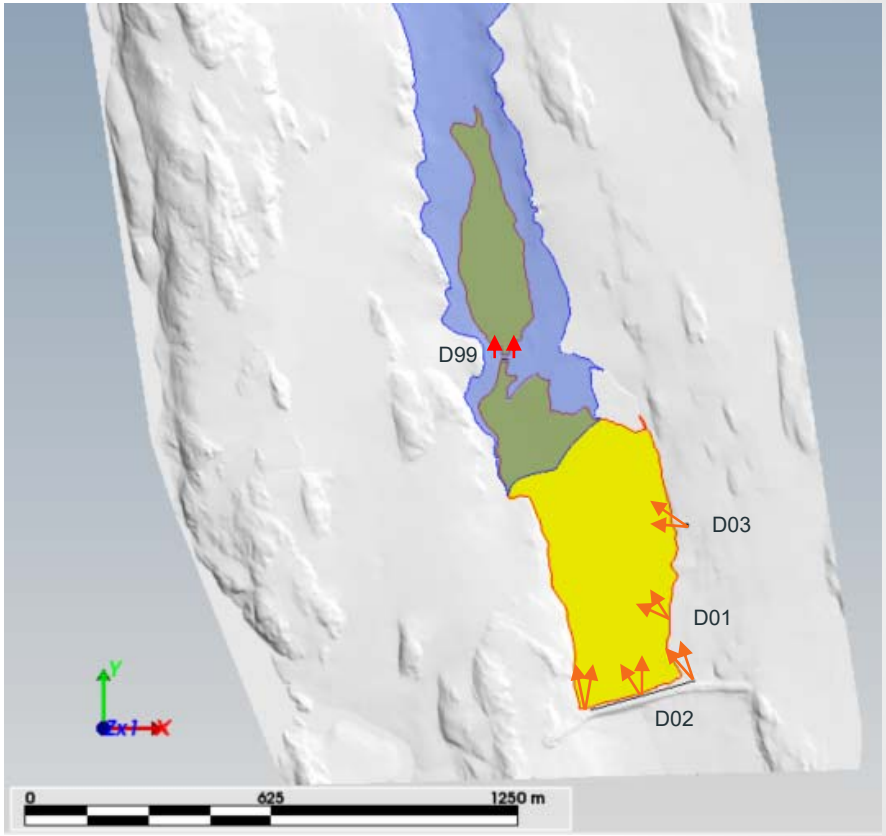
- Deposition from current discharge point (D01)
- 360,000 tonnes by end of June
- 240,000 tonnes from start of July to end of October
  - Discharge from South Dam beach (D02)
  - Overflow to deep lake occurs after 202,000 tonnes are deposited from D02
  - Remaining 38,000 modelled from spill point to deep lake (D99)
- Volumes:
  - Sub-aerial tailings: 203,900m3
  - Sub-aqueous tailings: 257,200m3
  - Pond volume at 33mAD: 5,939,000m3



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Hope Bay Deposition Plan - Notes

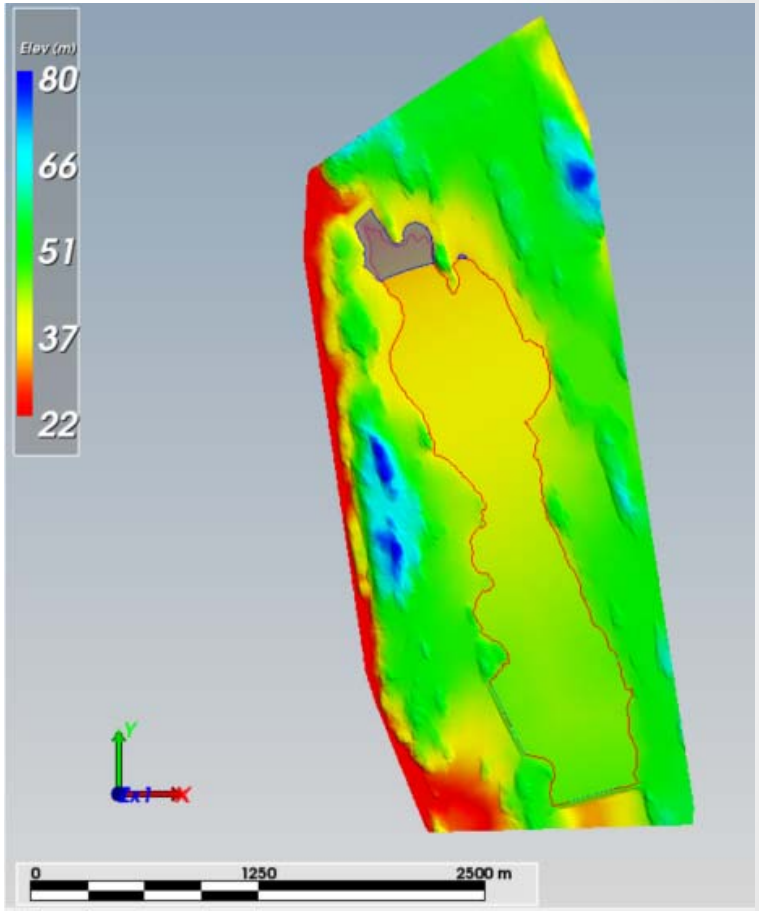
- Deposition from current discharge point (D01)
- 360,000 tonnes by end of June
- 240,000 tonnes from start of July to end of October
  - Discharge from South Dam beach (D02)
  - Overflow to deep lake occurs after 202,000 tonnes are deposited from D02
  - Remaining 38,000 modelled from spill point to deep lake (D99)
- 120,000 tonnes in November and December
  - Discharge from new winter discharge point (D03)
  - Overflow to deep lake occurs after 30,000 tonnes are deposited from D03
  - Remaining 90,000 modelled from spill point to deep lake (D99)
- Volumes:
  - Sub-aerial tailings: 219,600m3
  - Sub-aqueous tailings: 333,700m3
  - Pond volume at 33mAD: 5,862,000m3



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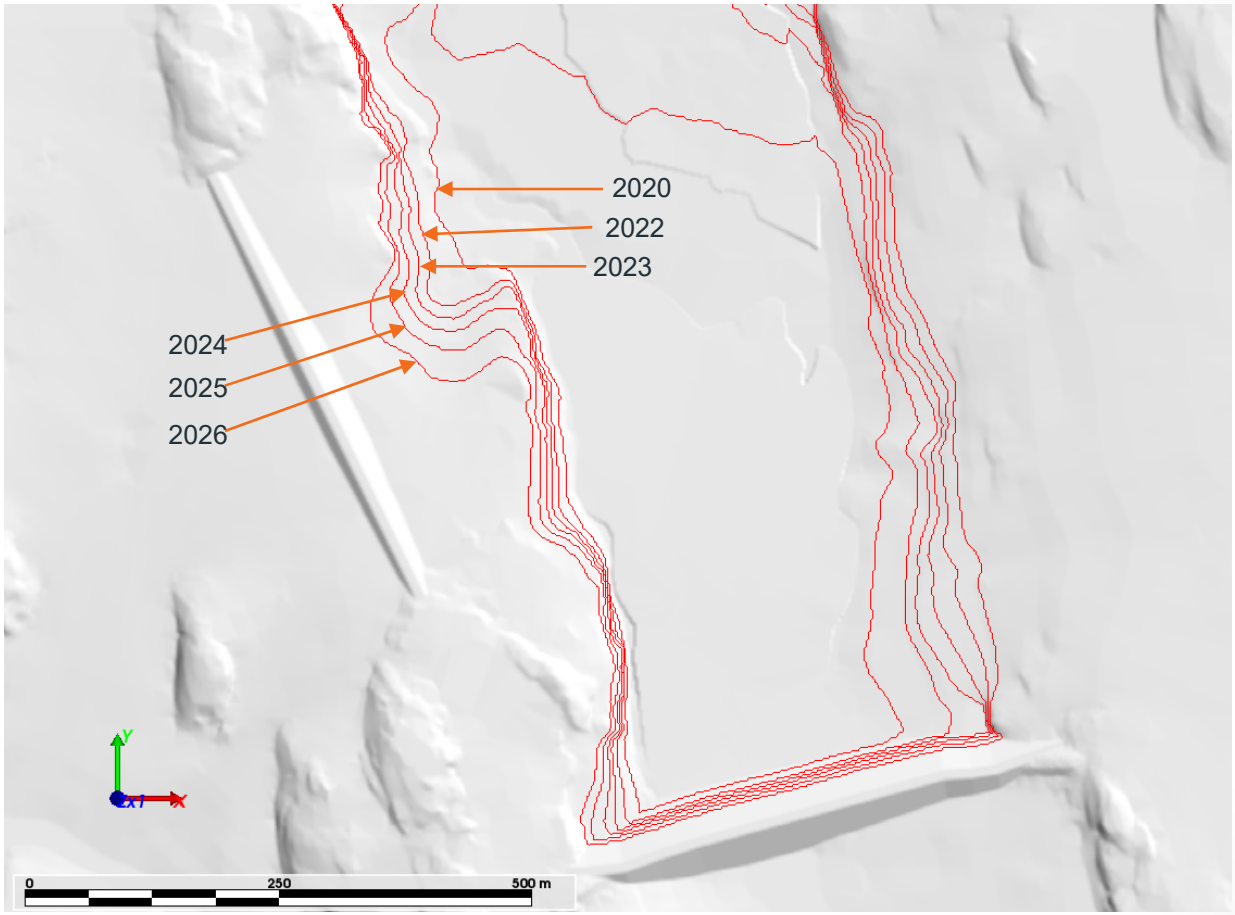
Hope Bay Deposition Plan – LOM tailings

- Deposition from discharge points near south of TSF
- Total tonnage 19.5Mt start of 2020 onwards
  - Note there is a discrepancy in tonnage reported in TMAC schedule
- Tailings outlines from staged deposition indicate flow remains to the north throughout deposition
- Total tailings and pond volumes at end of LOM:
  - Sub-aerial tailings: 8.5 Mm3
  - Sub-aqueous tailings: 6.5 Mm3
  - Pond volume at 33mAD: 245,000 m3



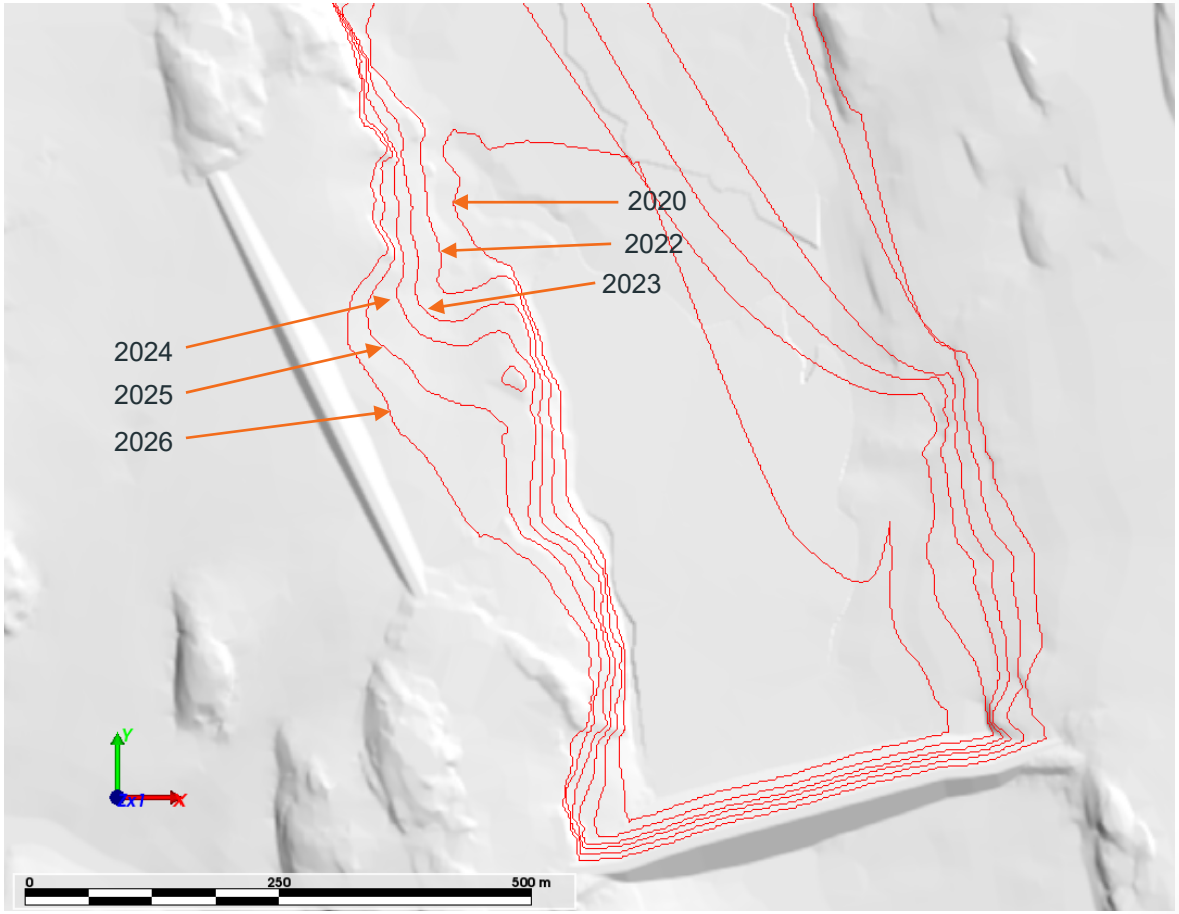
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Hope Bay Deposition Plan - LOM tailings



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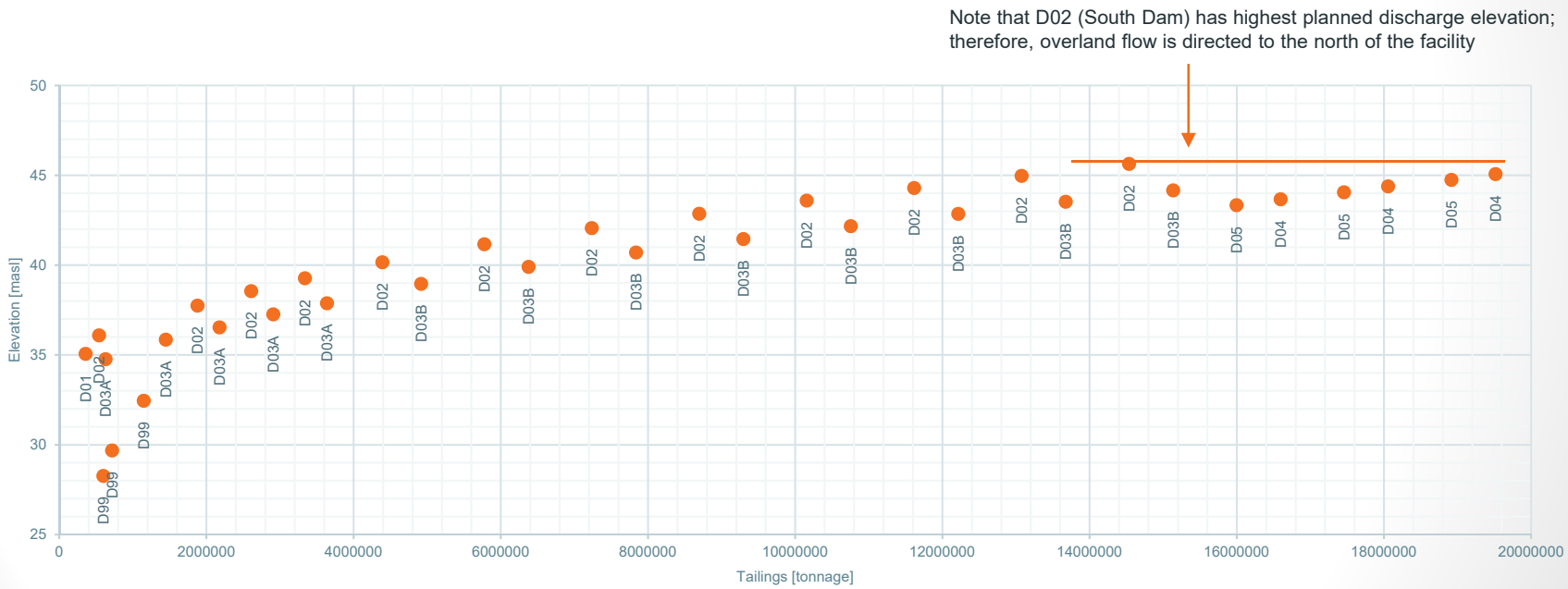
Hope Bay Deposition Plan – LOM 2 tailings



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Hope Bay Deposition Plan - LOM tailings

- Deposition plan throughout LOM tailings presented below
- Alternating deposition between summer and winter
- Summer deposition from D02 and D05 (South and West Dam respectively)



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Hope Bay Deposition Plan - LOM tailings

Short term deliverables:

- Prepare CAD drawing for end of LOM tailings surface
- Prepare memo summarizing method and findings

Next steps:

- Investigate discrepancy between TMAC tonnages
- What about ice entrainment?
  - this assessment is based on the 1.3 t/m3 achieved to date
  - As deposition continues, the distance to the pond becomes much longer
  - Need to reassess design assumptions at end of 2020 to see if ice entrainment starts to become a significant issue

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Appendix O – EOR Notification Letter

SRK Consulting (Canada) Inc.
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June 27, 2019
Project No: 1CT022.042

TMAC Resources Inc.
Suite 1010 – 95 Wellington Street West
Toronto, Ontario, M5J 2N7

Attention: **Oliver Curran, MSc. Vice President, Environmental Affairs**
Gil Lawson, P.Eng. Chief Operating Officer

Dear Oliver, Gil:

Re: Change of Engineer of Record - Doris Tailings Impoundment Area

This letter is to notify of the change of Engineer of Record for the Doris Tailings Impoundment Area. This role and responsibility was previously held by Dr. Maritz Rykaart, PEng.

From the 1st of June 2019, the Engineer of Record for the Doris Tailings Impoundment Area is John Kurylo, PEng.

John is a Northwest Territories and Nunavut Association of Professional Engineers and Geoscientists (NAPEG) registered professional engineer. John's contact details are provided below.

John Kurylo *MSc (DIC), PEng.*
Senior Consultant (Geotechnical)
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Email: jkurylo@srk.com

Sincerely,
SRK Consulting (Canada) Inc.

Cameron Hore, PEng.
Senior Consultant

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Denver 303.985.1333
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Vancouver 604.681.4196
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Group Offices:
Africa
Asia
Australia
Europe
North America
South America

Appendix P – OMS Updates and Training – Presentation





Doris TIA – Overview and OMS Discussions

John Kurylo, MSc (DIC), PEng

Site Discussions
November 22nd & 23rd, 2019
November 24th, 2019 *(shortened version)*

MAC RESOURCES

srk consulting

Outline

1. Background
2. OMS Structure Overview
3. ***Discussions:*** Review of water flow, and current pipe and pumps
4. Web Portal
5. ***Discussions:*** Revisit OMS in more detail and have additional operation discussions and feedback

BACKGROUND

Project Introduction



Image Source: https://jsis.washington.edu/archive/canada/file/archive/taskforce09/maps.shtml

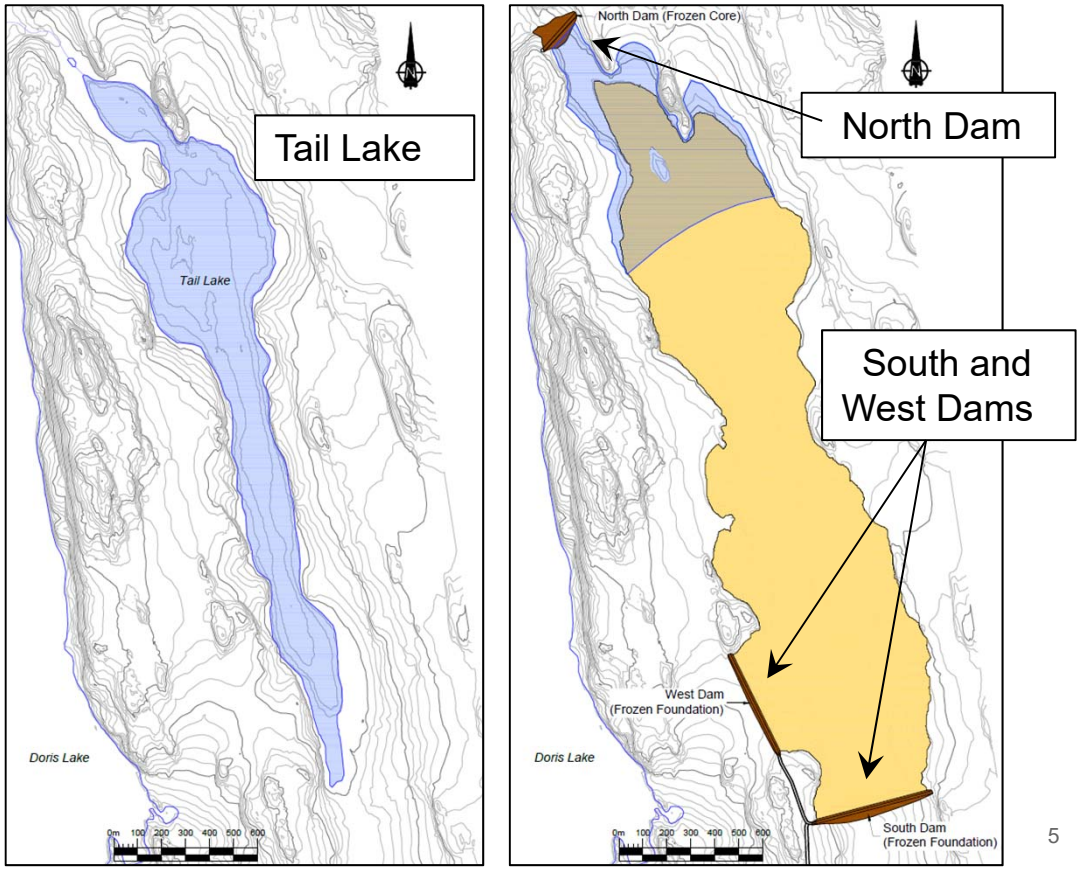
Geographic location of mine



Mine Site

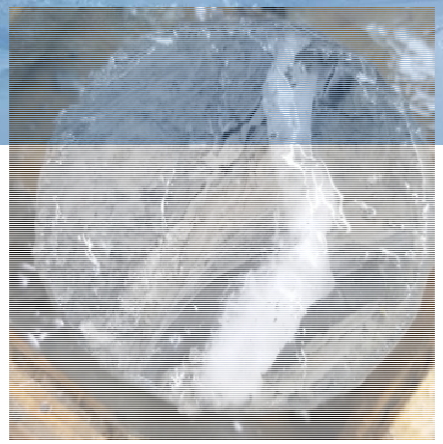
Tailings Impoundment Area (TIA)

- Former lake listed as Schedule II
- Sub-aerial deposition of tailings slurry
- Environmental containment
- High degree of safety



Design Considerations





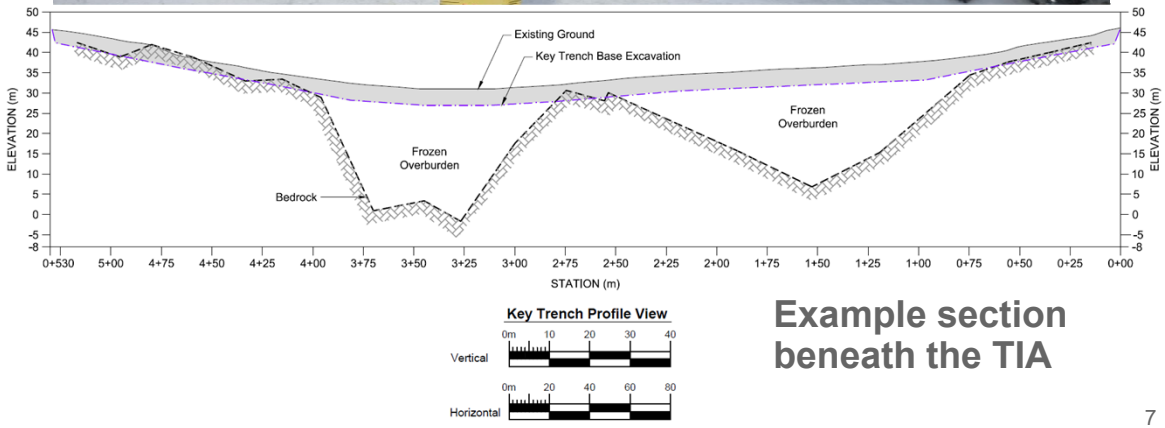
Ice-rich material present beneath the TIA

- Challenging foundation
  - Thick permafrost soils
  - Porewater salinity / depressed freezing point
  - Creep susceptible
  - Low strength soils when thawed
- Lack of borrow materials
  - Material with low permeability not available, or not suitable
- Climate and construction timing
- Project location

Foundation Conditions - SD

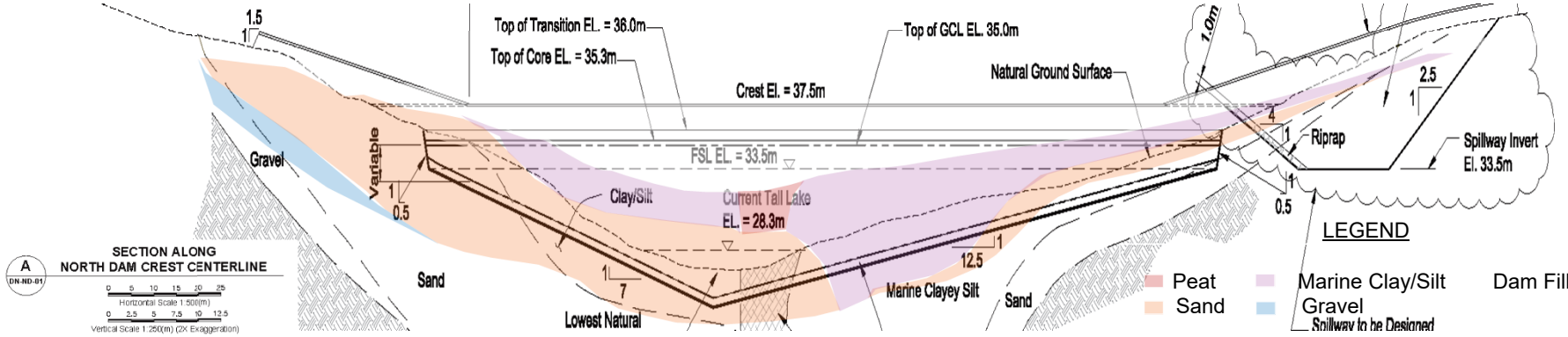
- Continuous cold (-8°C) permafrost
- Bedrock – basalt outcrops
- Thick deposits (>15m) of ice-rich sand and marine silts/clays
- Saline porewater





Example section beneath the TIA

Foundation Conditions - ND





Ice lenses on exposed high wall



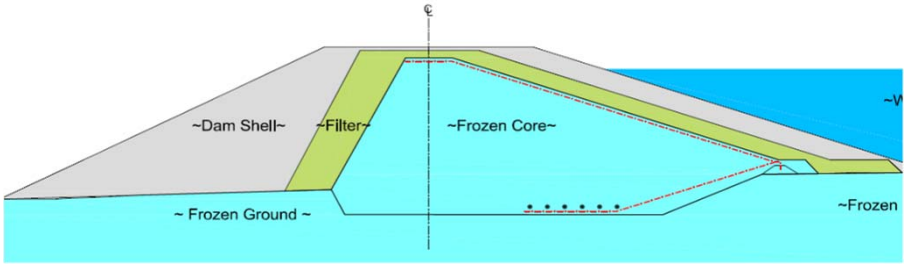
Organic rich soil (peat)



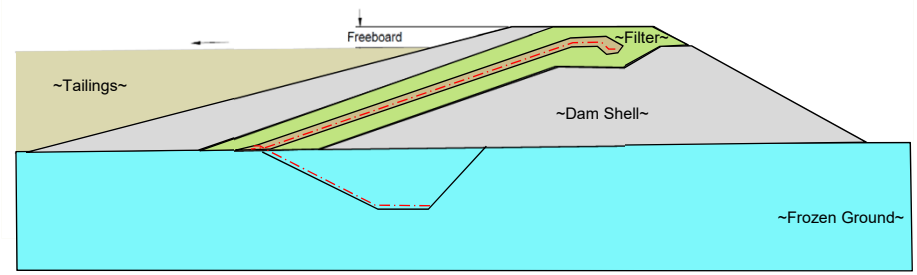
Hyper-saline overburden excavation ‘soft spot’

Definitions

- **Frozen Core Dam:** The water retaining structure is an impermeable frozen mass consisting of the dam core and foundation

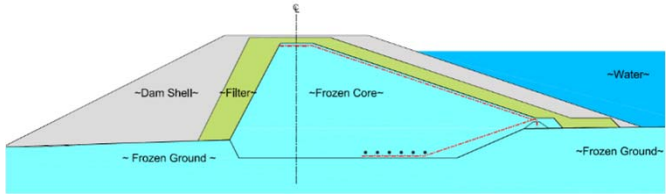


- **Frozen Foundation Dam:** A more classical (thawed) above ground structure that is bonded to a frozen (impermeable) foundation

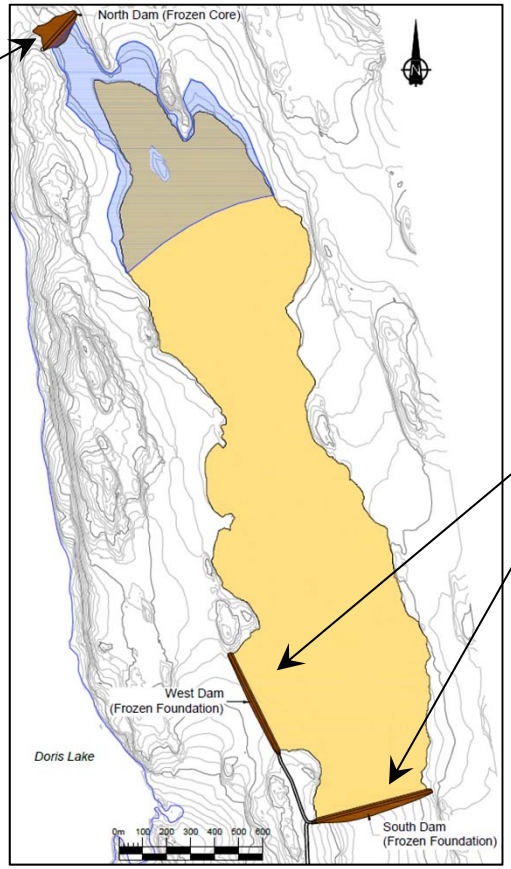


Tailings Impoundment Area (TIA)

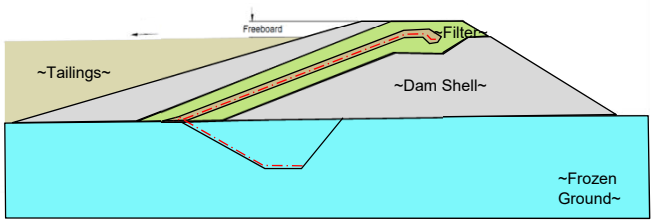
Frozen Core



North Dam



Frozen Foundation

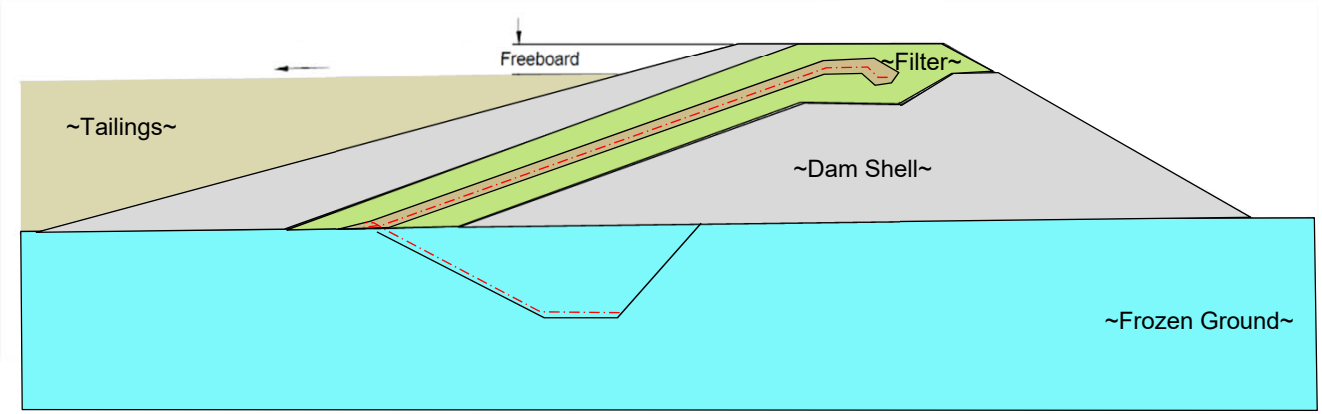


South and West Dams

Frozen Foundation Dam – South Dam

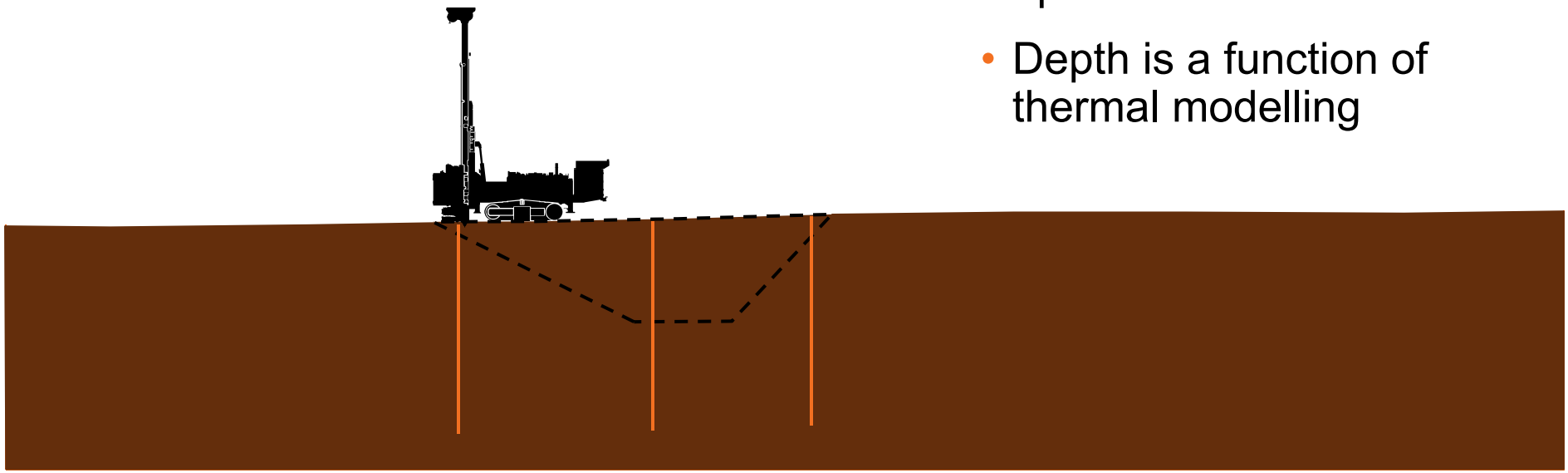
- Key that tailings (solids) deposited upstream

- Upstream geosynthetic clay liner (GCL) system keyed into the frozen foundation as a water retaining element for the unlikely case of foundation thawing / seepage



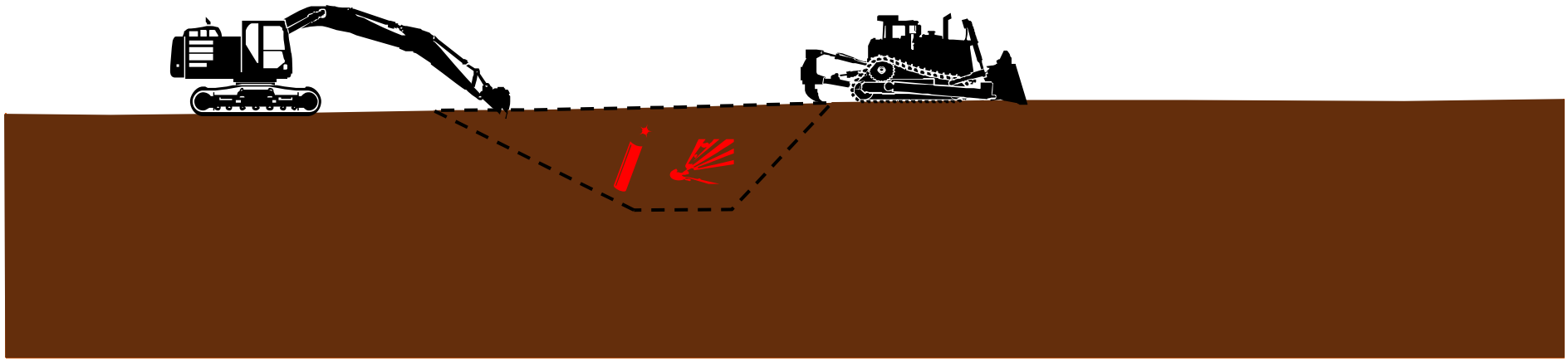
Frozen Foundation Dam

- Percolation testing
- Foundation confirmation
- Key trench depth optimization
- Depth is a function of thermal modelling



Frozen Foundation Dam

- Ripping in frozen overburden
- Drill/blast in bedrock
- 3 to 4 m depth





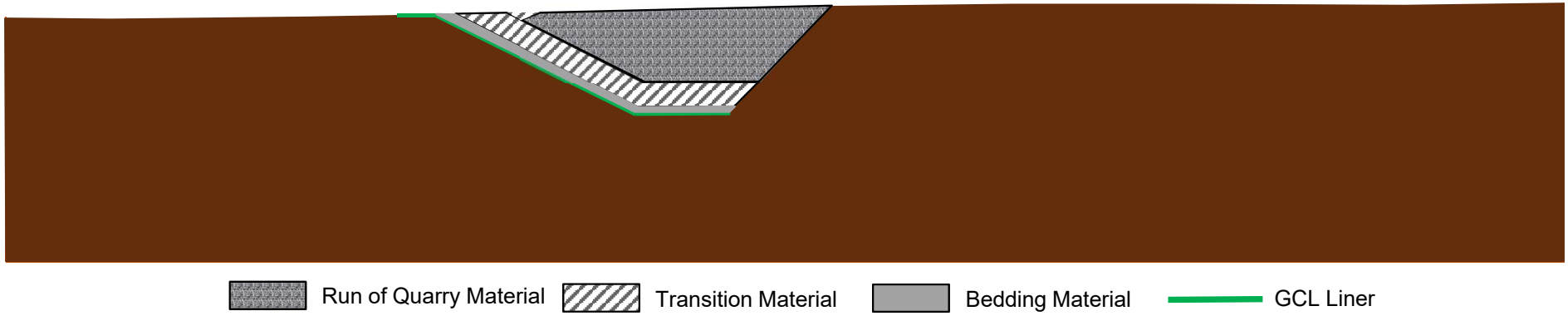
Foreground: Drilling of blast holes
Background: Key trench excavation



Near complete section of key trench

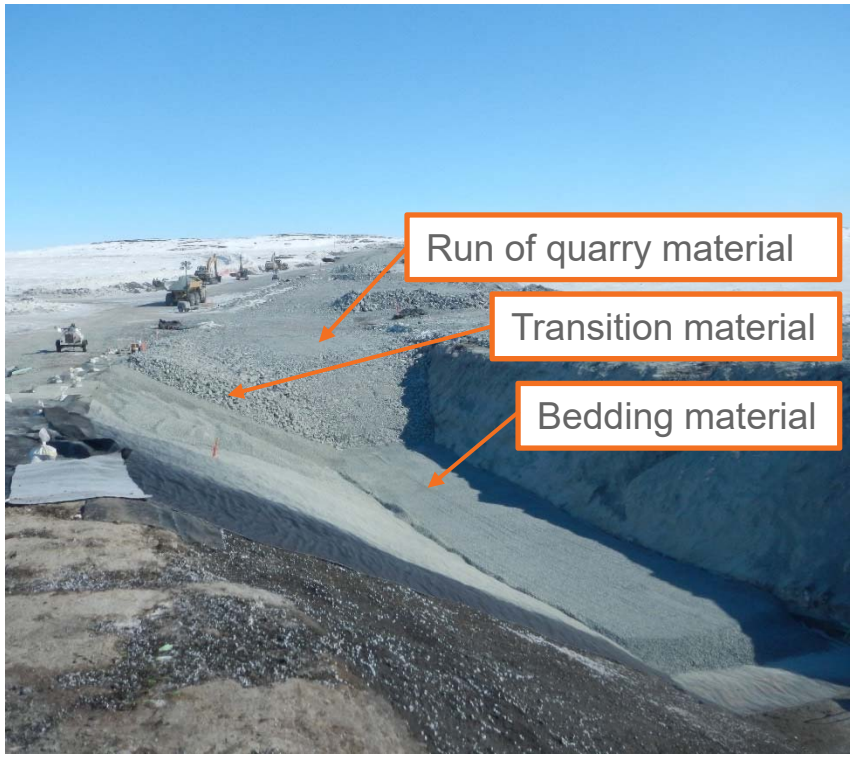
Frozen Foundation Dam

- Liner keyed into frozen foundation
- Winter construction





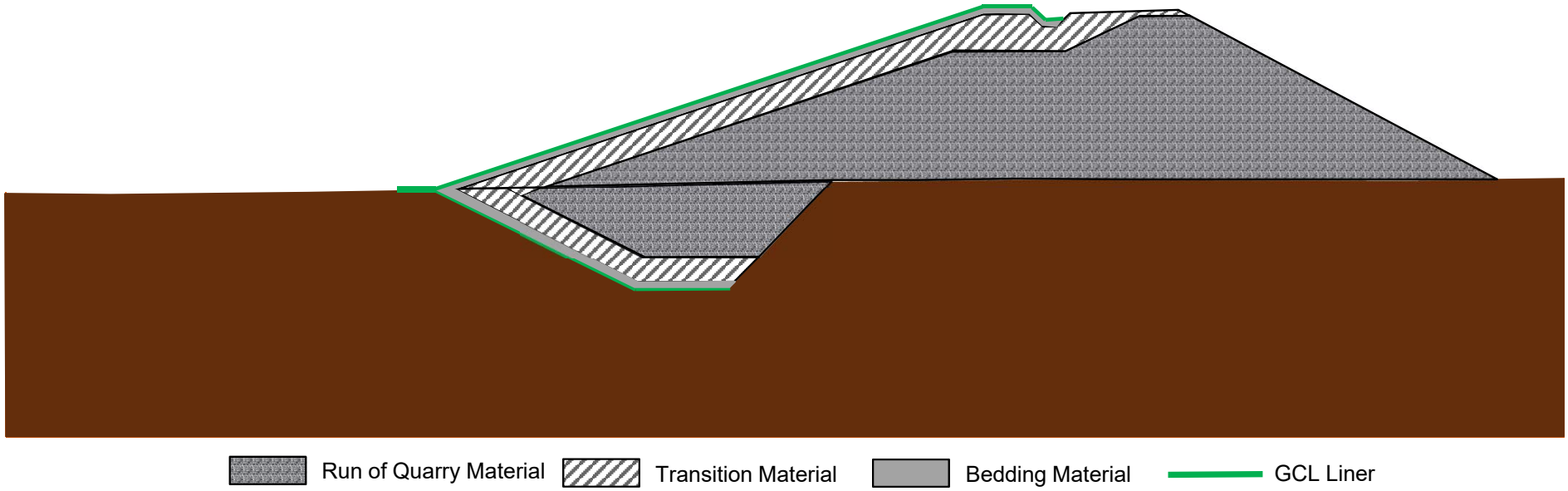
Deployment of liner on upstream slope of key trench



Backfilling of key trench above liner

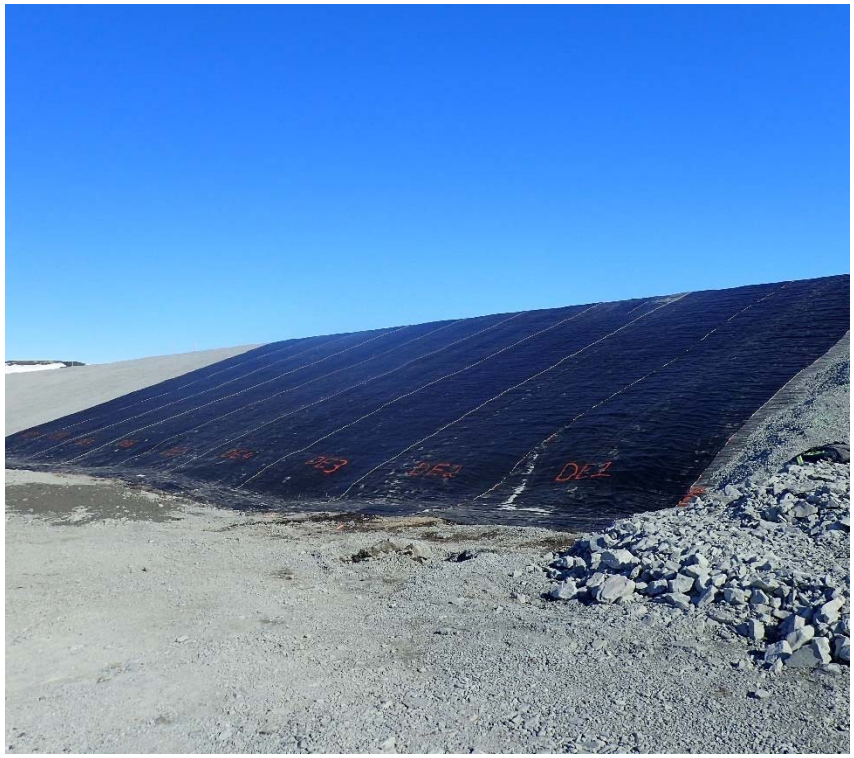
Frozen Foundation Dam

- Thermal protection
- Minimum cover section



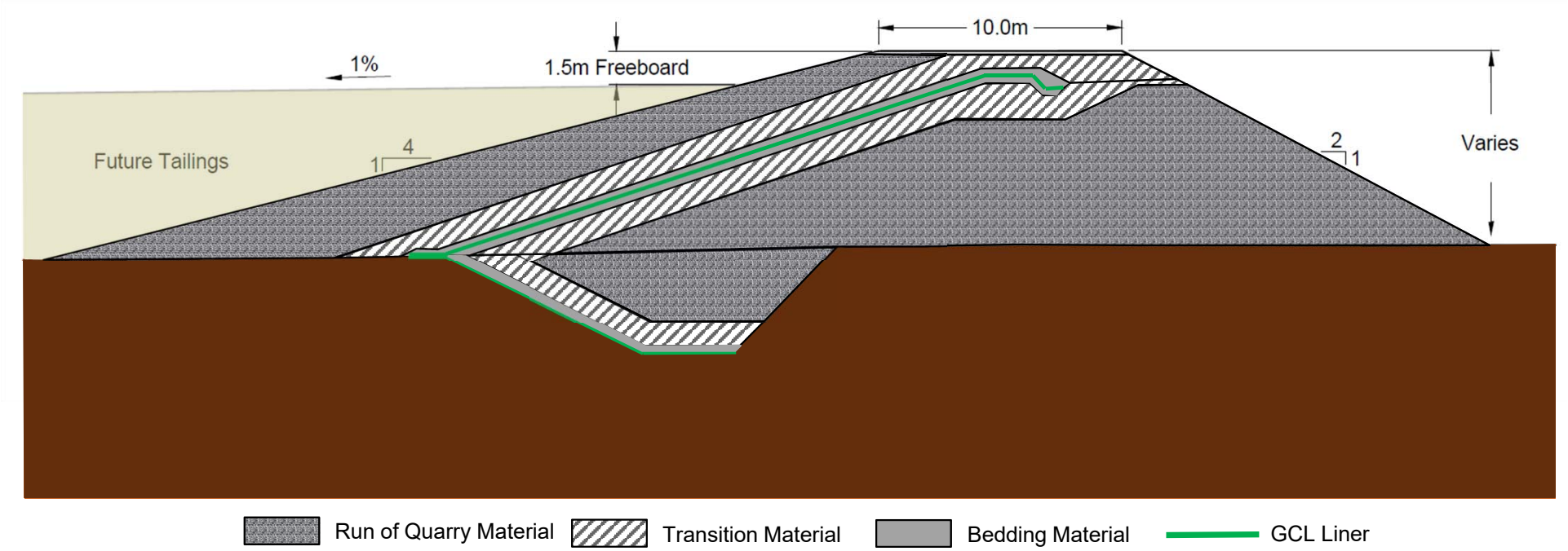


Deployment of liner on upstream slope of above ground fill



Deployed liner on upstream slope of above ground fill

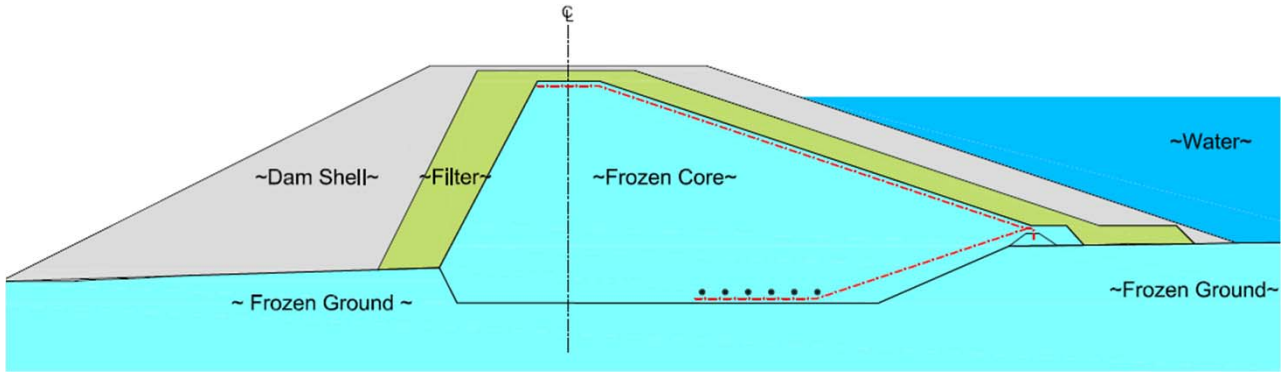
Frozen Foundation Dam



Frozen Core Dam – North Dam

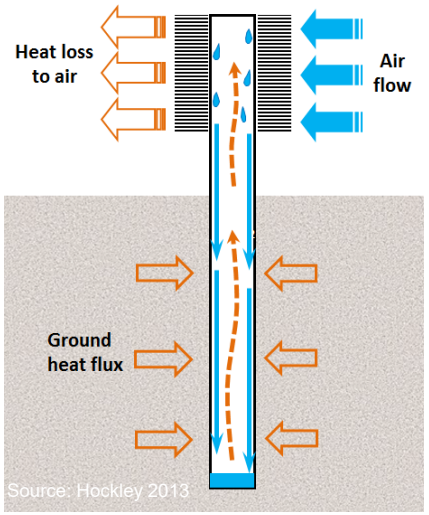
- Water retaining structure

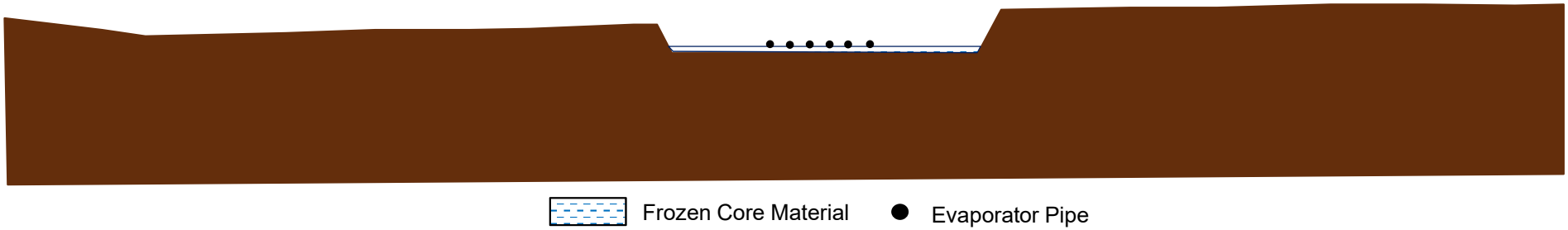
- Thermosyphon evaporator pipes provide passive cooling during the winter



Frozen Core Dam

- Passive refrigeration system
- Pressurized sealed pipes charged with a two-phase working gas (CO_2)
- Radiators help heat exchange







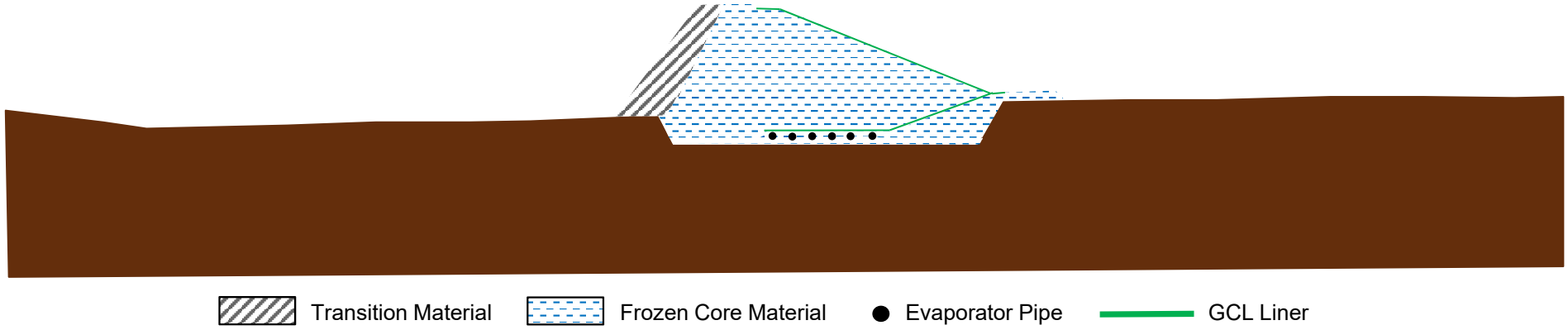
Thermosyphon evaporator pipes connected to radiator



Thermosyphon evaporator pipes installed along the key trench base

Frozen Core Dam

- Saturated crushed rock
- Placed in thin lifts
- Freeze back prior to next lift



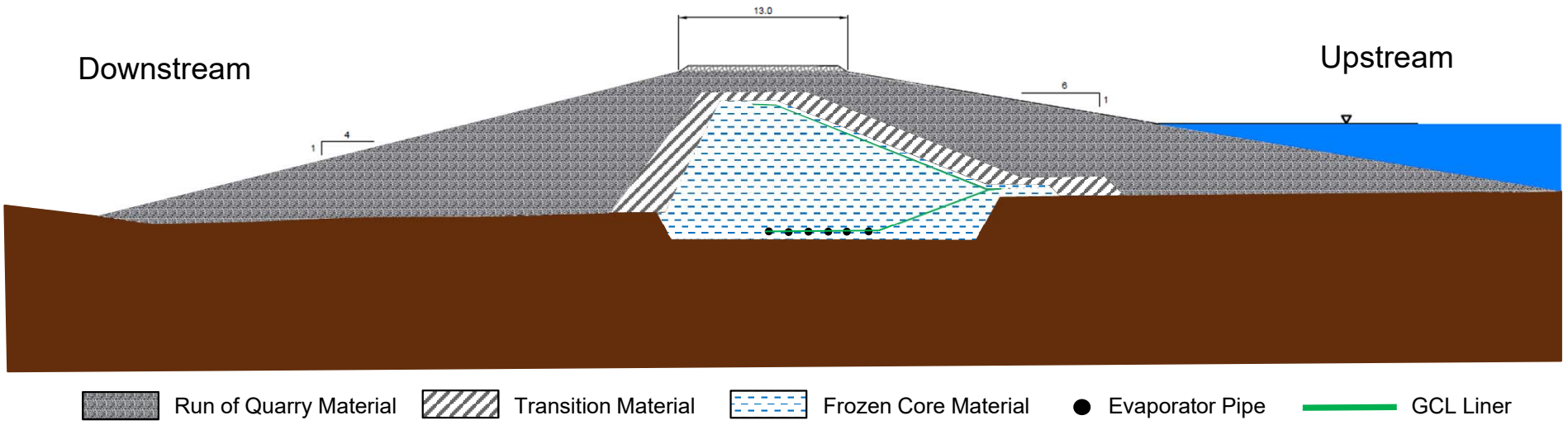


Frozen core construction



Liner installation in key trench

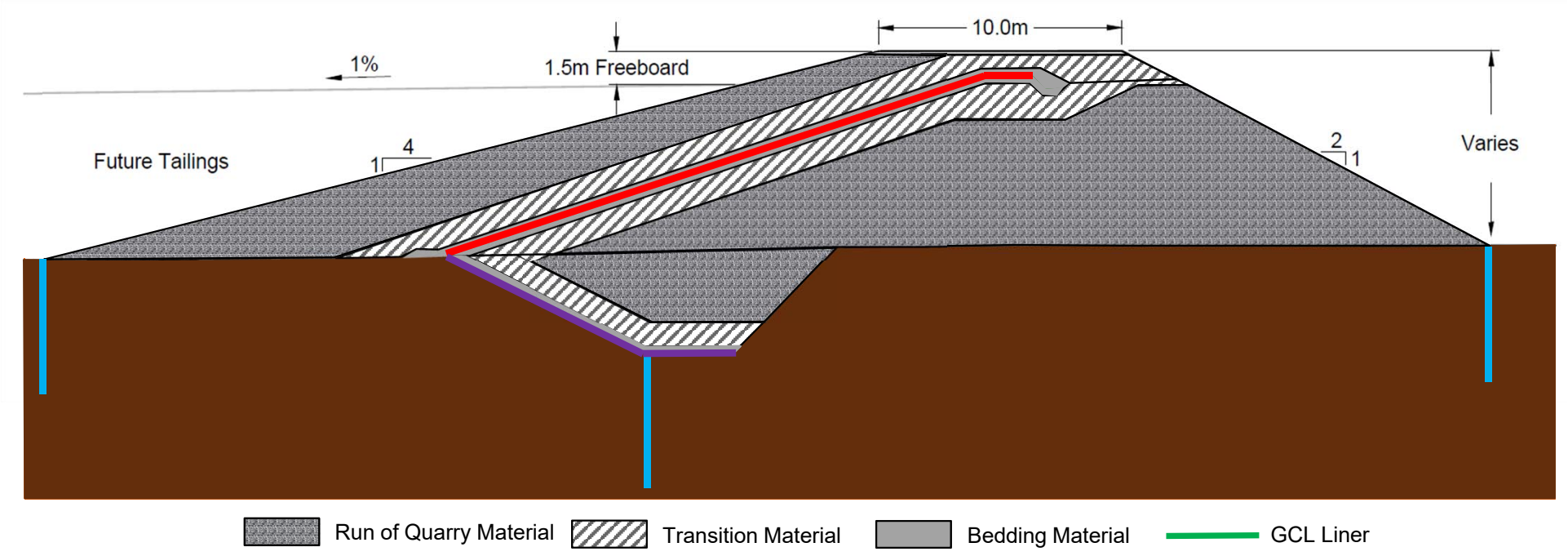
Frozen Core Dam



Instrumentation

Ground Temperature Cables

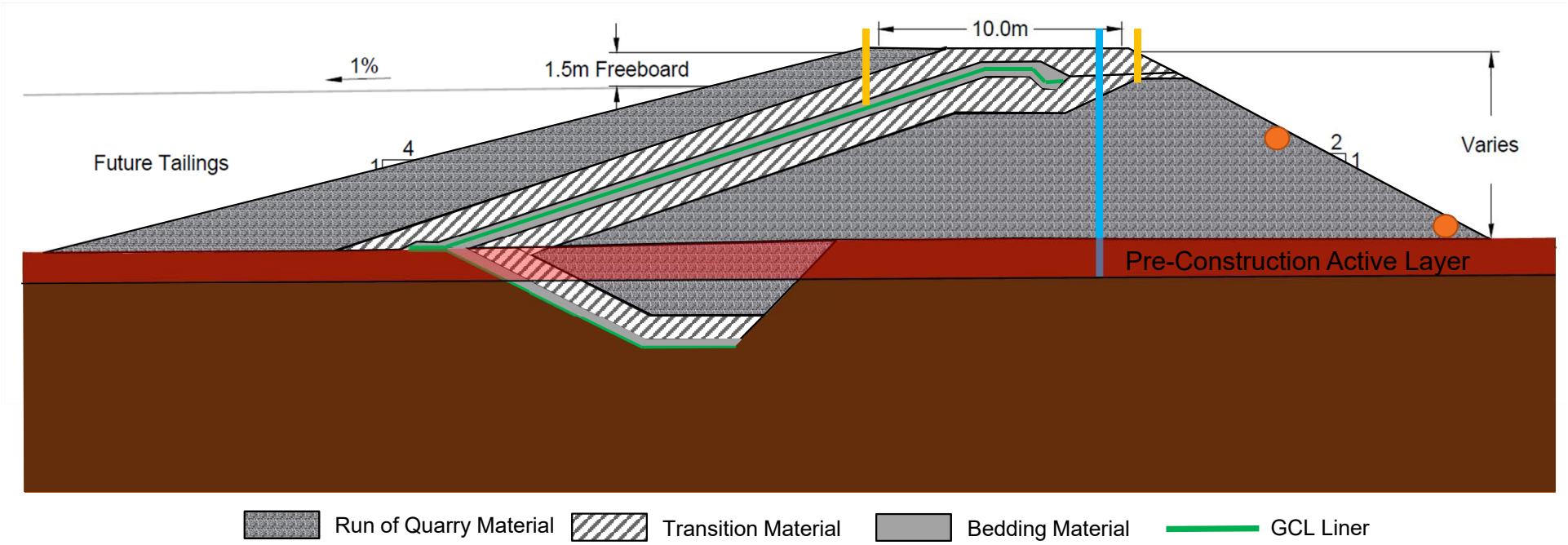
- Ground temperature cables monitor the thermal regime of the foundation and overall deformation performance



Instrumentation

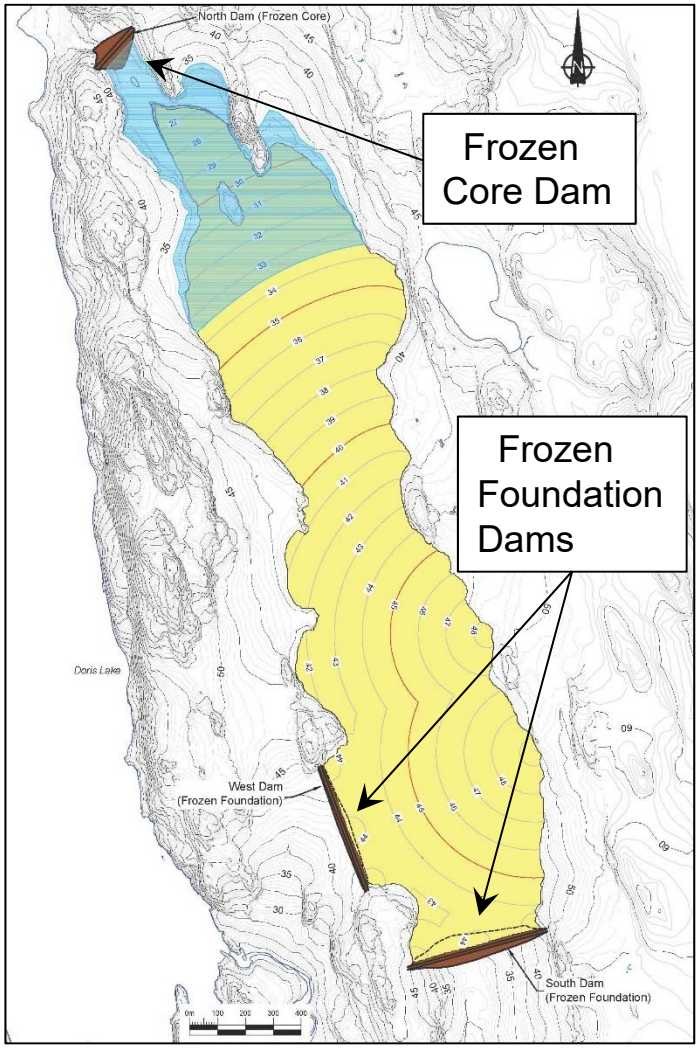
Settlement Monitoring

- Surficial, shallow, and deep settlement surveillance to monitor deformation



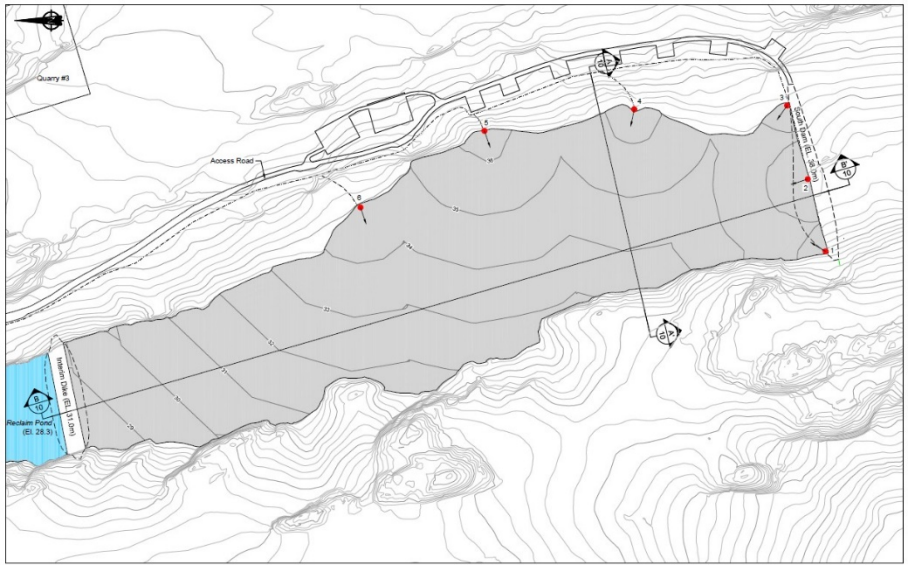
Tailings Deposition

- Development of substantive tailings beaches from the Frozen Foundation Dams (West and South Dams)
- No tailings deposition against the Frozen Core Dam (North Dam)
- Least amount of environmental risk
- Tailings freeze back



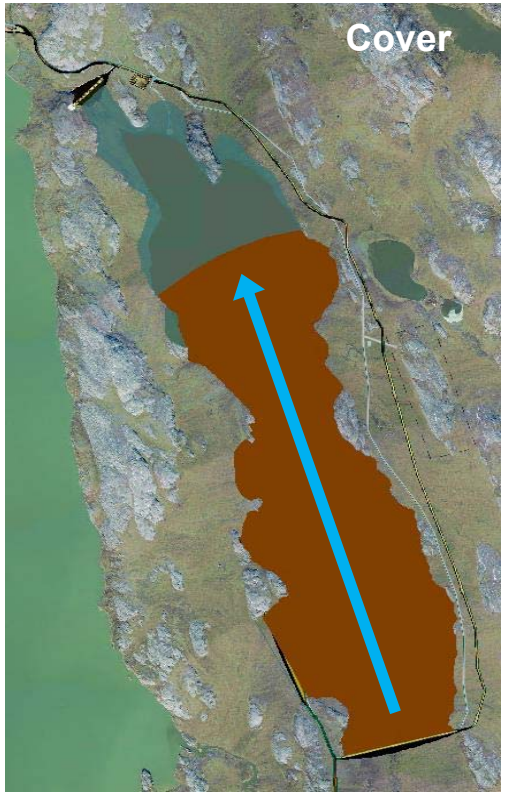
Tailings Deposition

- Develop minimum 100 m beach from South Dam asap!
- Single point discharge (3 spigot locations)
- Implement diversion protocol for low solids content tailings near Dam
- No saline water (or other non tailings water) to be discharged with tailings



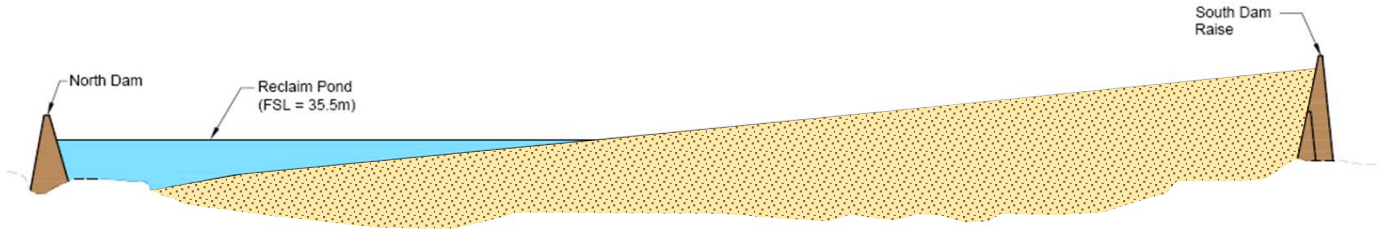
Closure of the TIA



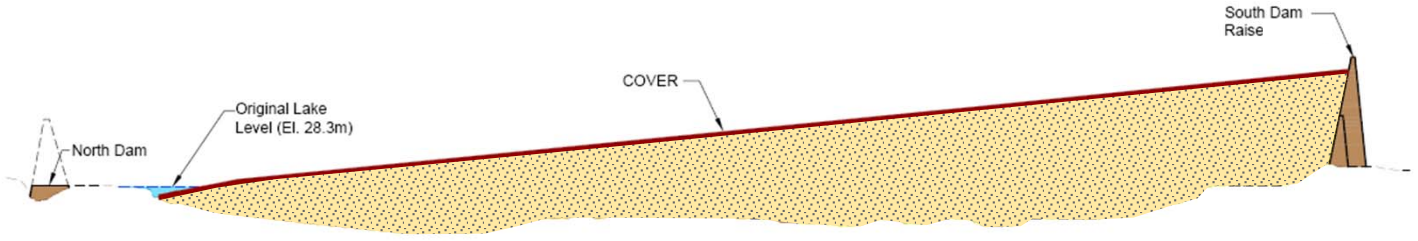




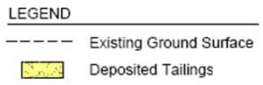
Closure of the TIA



End of Mine



Post Closure



General Comments

- Imperative to maintain the frozen state of the core and foundation of these containment structures to:
  - Retain primary element of impermeable functionality
  - Mitigate long term deformation

- Unique and innovative containment designs were required to overcome site-specific challenges

- Tailings management designs need to be adapted to account for local conditions to ensure the design is appropriate and will provide a high degree of safety in environmental containment

Photos (from 2018)





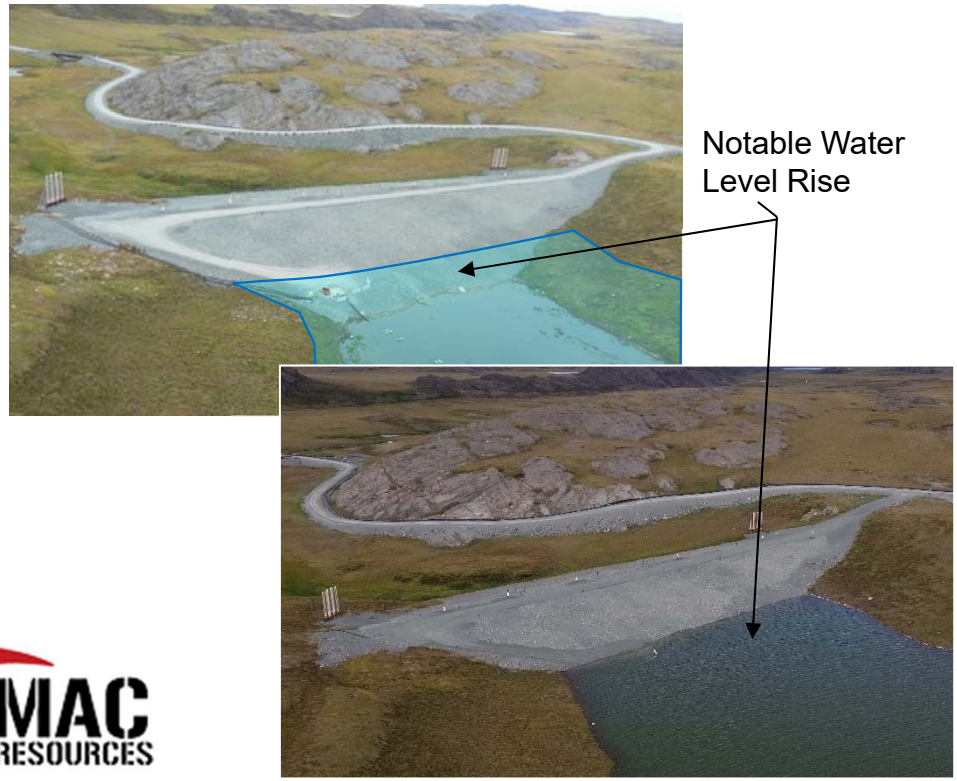
Photos (from 2019)





Photos (2018 vs 2019)

North Dam



South Dam



OMS Structure

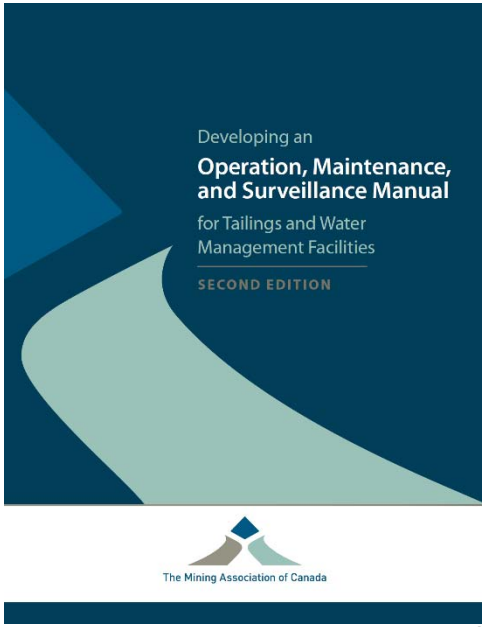
New Considerations / Guidelines

AT SITE:

- North Dam constructed in 2011and 2012 winters
- South Dam constructed in 2018
- 2019 active tailings deposition and Roberts Bay Marine Discharge now set up

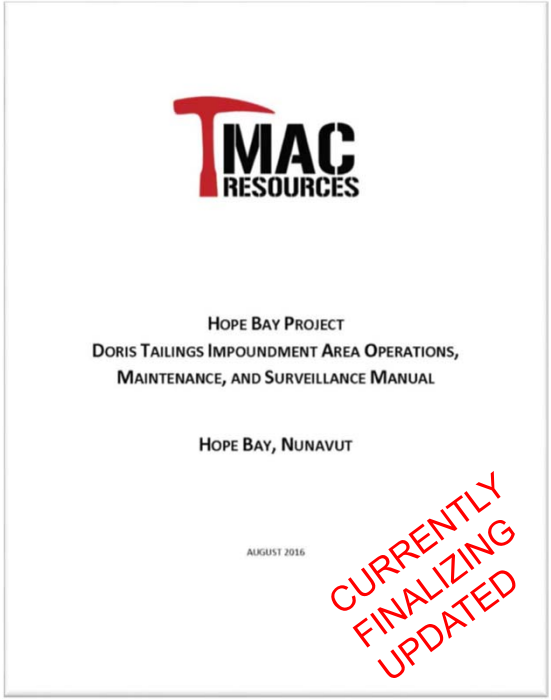
IN INDUSTRY:

- Recent dam failure and shift in prioritizing dam safety
- New guidelines



Doris TIA OMS

- Operations Maintenance and Surveillance (OMS) Manual
- Conforms to industry standard Mining Association of Canada (MAC) guidelines
- Includes
  - Governance
  - Reference documents
  - Roles and responsibilities
  - Facility overview
  - Operations
  - Maintenance
  - Surveillance
- ★ A substantive update/rewrite is required (2018 recommendation)



Framework – *MAC Guidelines*

Figure 1: Elements of the Tailings Management Framework

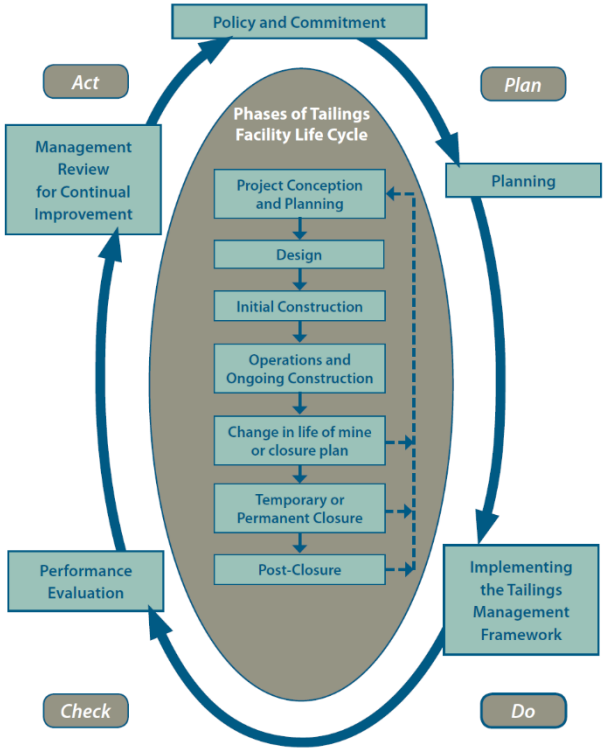
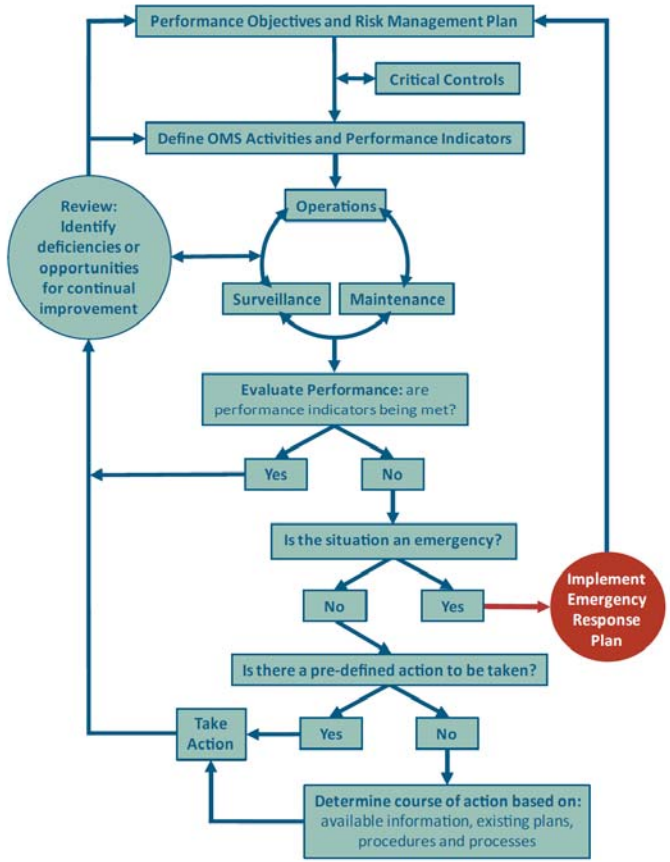


Figure 3: Decision-making framework for tailings management



OLD

6 Surveillance

6.1 Objective

Surveillance information is gathered through visual inspections, monitoring performance, safety audits, and data collection. Ongoing review of both qualitative and quantitative surveillance information informs appropriate preventative maintenance. The objectives of the surveillance program are to:

- Regularly monitor the operational performance of the TIA and its components,
- Consistently report observations, and
- Regularly review and interpret surveillance data.

Throughout the operational phase of the Project, the containment structures (North, South and West dams) will be subject to rigorous monitoring to evaluate their performance. This will include thermal, settlement and other general deformation monitoring. In addition, thermal monitoring of the tailings profile will be carried out to confirm tailings freeze-back assumptions. All of the above will be subject to annual inspections by a qualified professional engineer as part of routine annual inspections. The frequency of these inspections may be reduced as time progresses in accordance with the inspection engineer's recommendations.

6.2 Frequency and Responsibility

The Mill Manager is responsible for ensuring that the ongoing monitoring as documented in the dam surveillance SOP is carried out (SRK 2013). If determined necessary, the Mill Manager may consult with the EOR to complete a safety inspection outside of the routine annual DSI.

Annually, the EOR, or an authorized representative, undertakes a physical inspection of the TIA. This inspection is carried out in the summer and culminates in a detailed DSI report. The report includes findings and recommendations on the TIA performance taking into account inspection observations, interviews with operations staff responsible for the TIA, as well as a review and analysis of all monitoring data collected. This report is delivered in a timely manner so that, if required, maintenance and mitigation can be carried out to address areas of concern. Should important matters be observed, those will be communicated to TMAC at the time of the DSI.

In addition to the annual inspections, the DSR is arranged every seven years. The DSR is carried out by an independent third party and is a systematic assessment of all aspects of design, construction, maintenance, operation, processes, and systems affecting the safety of the TIA. This review encompasses all elements of the TIA, but focuses on the North Dam, South Dam and West Dam, and is based on the state-of-practice at the time of the inspection as opposed to when the facilities may have been designed. The first DSR needs to be completed in 2019.

NEW

6 Surveillance

Definition

Surveillance is the process of gathering information through visual inspections, monitoring performance, safety audits, and data collection.

Objectives

The objectives of the Doris TIA surveillance program are to

- regularly monitor the operational performance of the TIA and its components,
- consistently report observations,
- regularly review and interpret surveillance data, and
- inform preventative maintenance by generating qualitative and quantitative surveillance information.

Components

The surveillance elements for the Doris TIA includes

- visual site inspections,
- instrumentation monitoring (thermal, deformation, and water balance),
- tailings geochemistry monitoring,
- water quality monitoring,
- dam safety inspections, and
- dam safety reviews.

Data Management

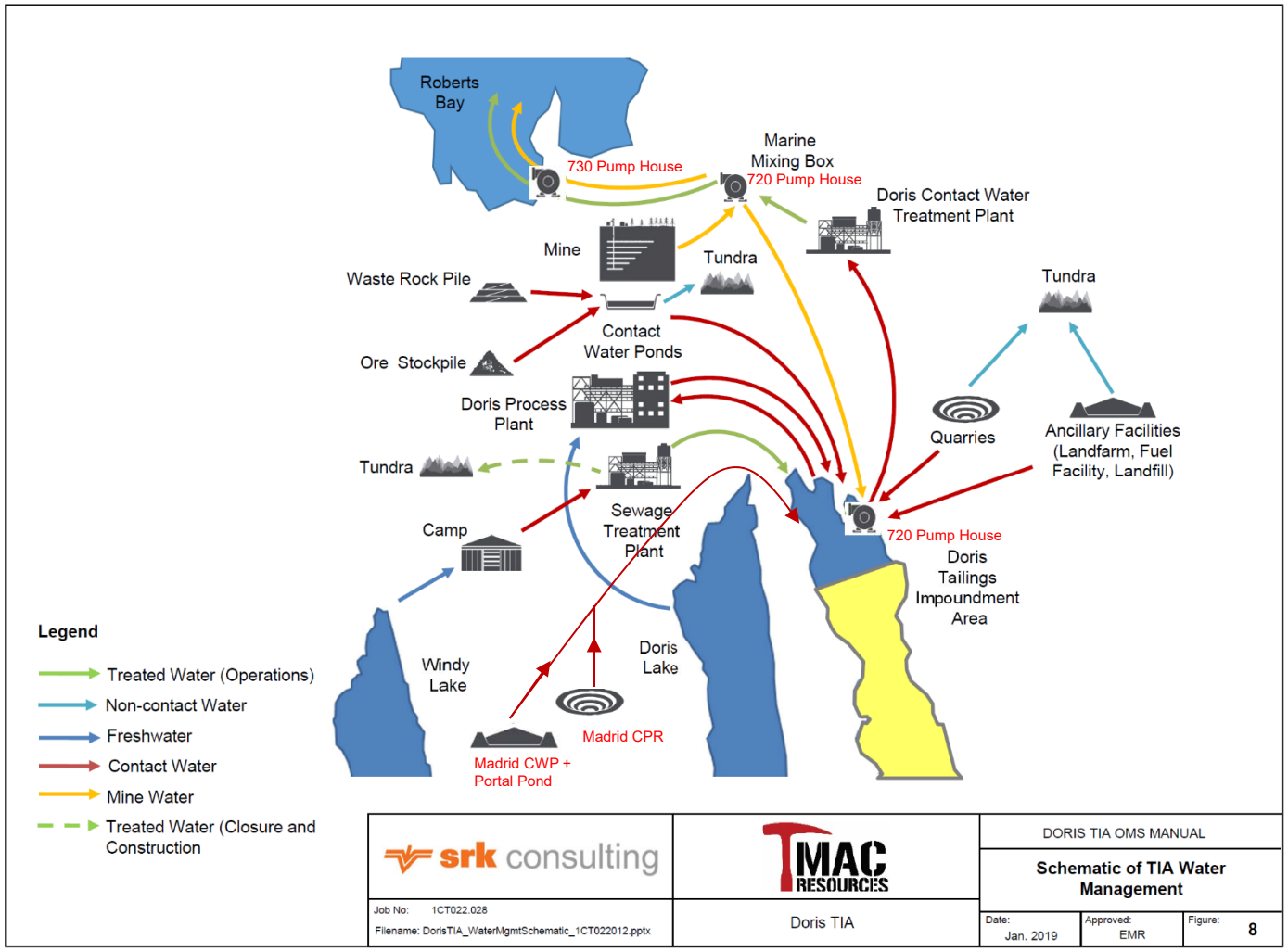
Staff should complete the following actions to manage monitoring data.

Step	Action
1	Back up all monitoring data electronically.
2	Scan manual notes and save together with raw and transposed data.
3	Immediately following collection, qualified staff should review data to • confirm integrity of the instrumentation and • ensure the TIA is performing to expectations and monitoring guidelines specified in the dam surveillance SOPs (SRK 2013, SRK 2019c).

The Mill (process) Manager is responsible for ensuring that the ongoing monitoring as documented in the dam surveillance SOP is carried out (SRK 2013, 2019c). If determined necessary, the Mill Manager may consult with the EOR to complete a safety inspection outside of the routine annual DSI.

Discussions:

Review of water flow, and current pipe and pumps connection to TIA water balance.



Updates to be made:

- Need to add in Madrid
- Need to put in more of the actual names used on site. (i.e. 720 pump house etc…)

WEB PORTAL
Background on Instrumentation

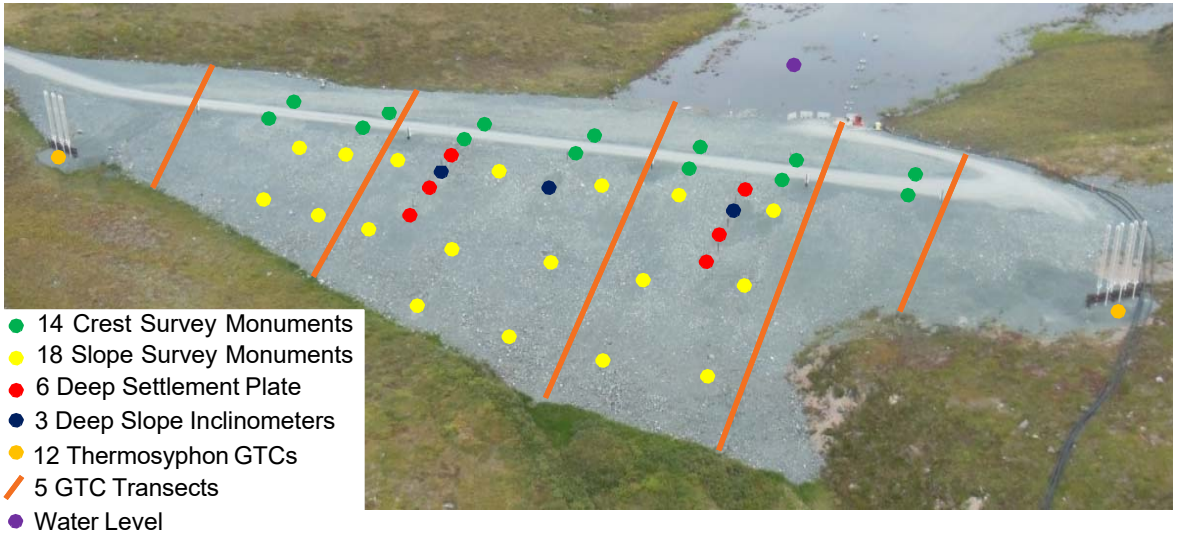
Monitoring Requirements

- Think about TMAC groups responsibility and how they interact with TIA.
- Mill team currently ‘champions’ of TIA OMS.
- Get notable support from Environment (specifically on instrumentation data collection).
- Also get support from
  - Projects
  - Mine
  - Site Services
- We are all somehow linked to the TIA on site. ☺

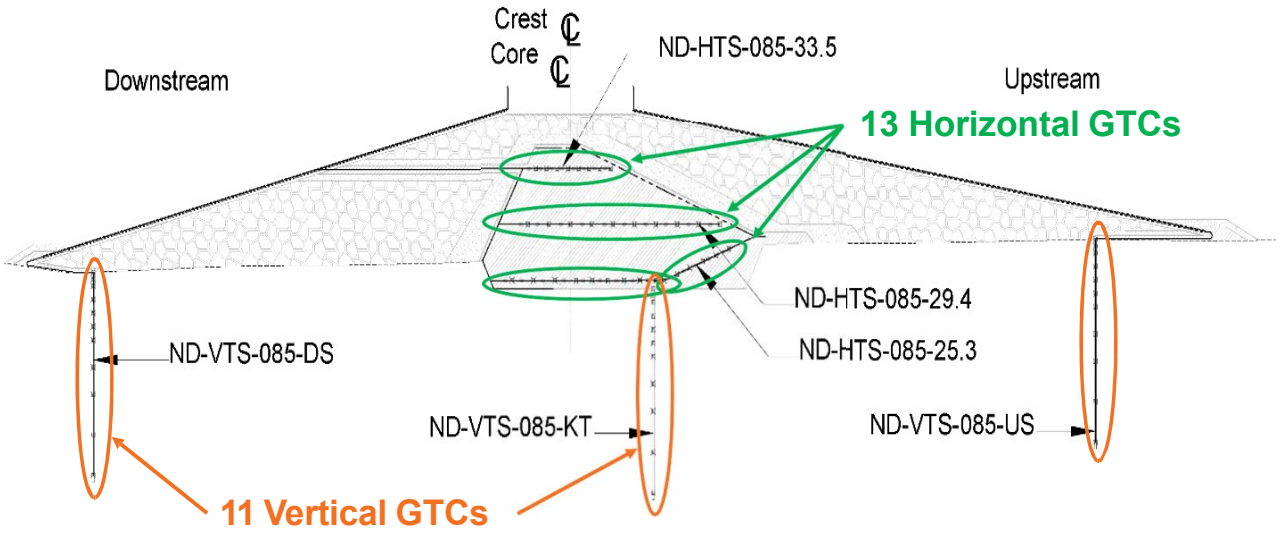
Element	Item	Method	Responsibility	Frequency
Thermal	Ground Temperature Cables	Dataloggers[3]	TMAC	Daily readings, monthly downloads
	Thermosyphons Status Thermistors	Dataloggers[3]	TMAC	Daily readings, monthly downloads
Deformation	Downstream Deep Settlement	Manual	TMAC	Monthly, May to November[1]
	Downstream Surface Settlement	Manual	TMAC	
	Crest Settlement	Manual	TMAC	
	Depression	Manual	TMAC	
	Inclinometers	Manual	TMAC	
Water Balance	Water Level	Datalogger Station[4][5]	TMAC	Daily readings (online portal)
	Water Level	Manual	TMAC	Minimum of once per year, when Reclaim pond is not frozen
	Seepage	Manual	TMAC	Weekly when seepage is observed
Visual	Walkover Survey	Manual	TMAC	Weekly (below FSL[2]) Daily (at or above FSL)
	Geotechnical Inspection	Manual	Engineer of Record	Annually
			Independent Engineer	7-year cycle
Maintenance				
North Dam Thermal Datalogger	Datalogger[3] Primary Batteries	Manually recharge	TMAC	Annually
	Datalogger[3] Backup Batteries	Manually replace	TMAC	5-year cycle
	Datalogger[3] Recalibration	Manual	TMAC	5-year cycle
	Desiccant Packs	Manually replace	TMAC	As required
Water Level Datalogger Station (TIA-2)	Datalogger Transmission Subscription[4]	Online	TMAC	Annually
	Physical Datalogger Station[4][5][6]	Manually recalibrate or replace	TMAC	As required

Mill taking over walkover surveys?

North Dam Instrumentation



North Dam Instrumentation (cont.)



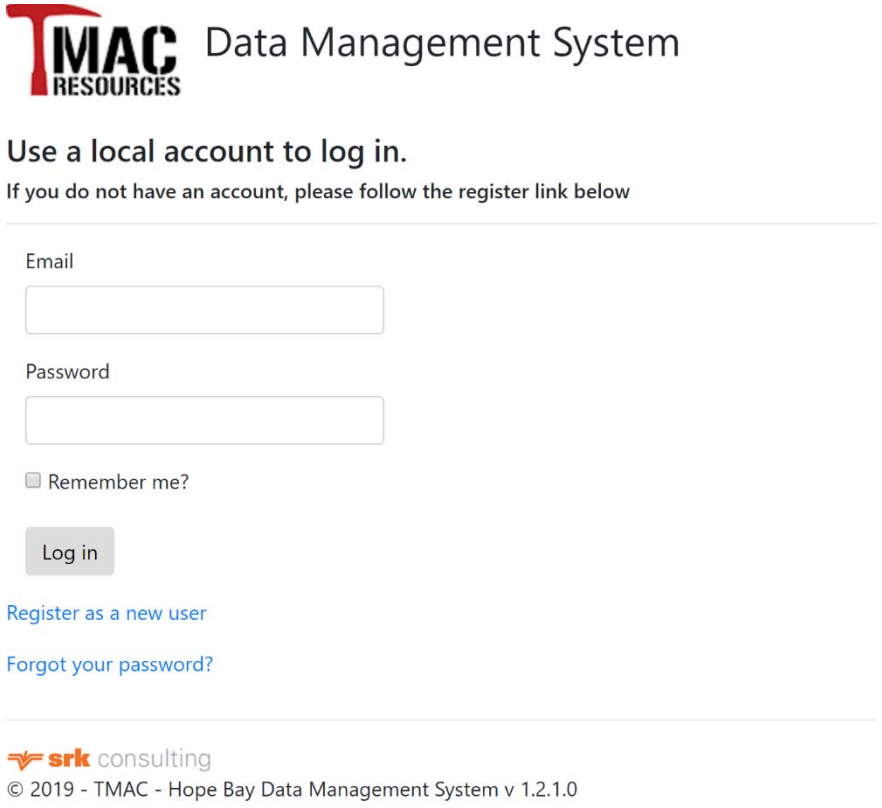
South Dam Instrumentation



WEB PORTAL
Overview

maps.srk.com

https://maps.srk.com/HopeBay/



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TMAC - Hope Bay

Environmental Data Management and GIS Map Viewer System



Data

The data menu provides access to a variety of environmental and time series data through an intuitive, simple to use, graphing tool to view the data over time by selecting the ***Data*** menu option.

Documents

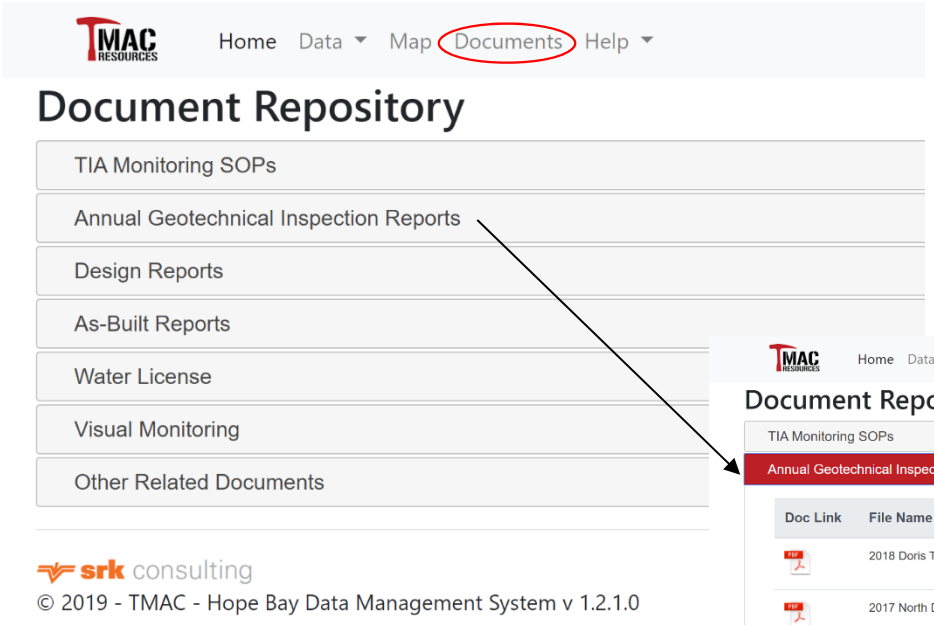
The Documents page provides quick access to a wide range pf project related documents including: SOPs, Geotech Inspection Reports, Design & As-Built reports and more.

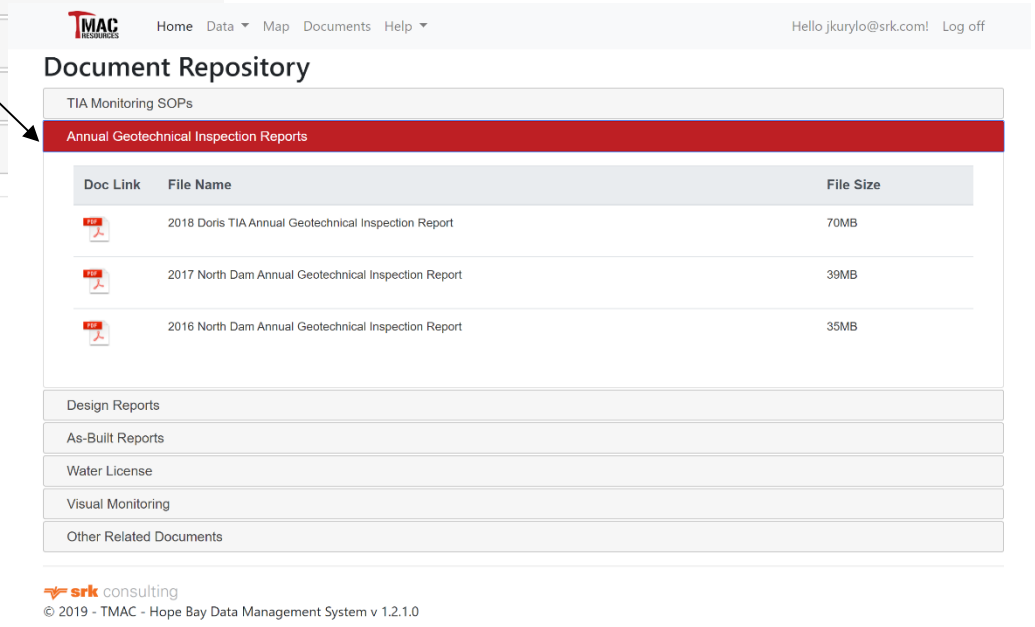
Map Viewer

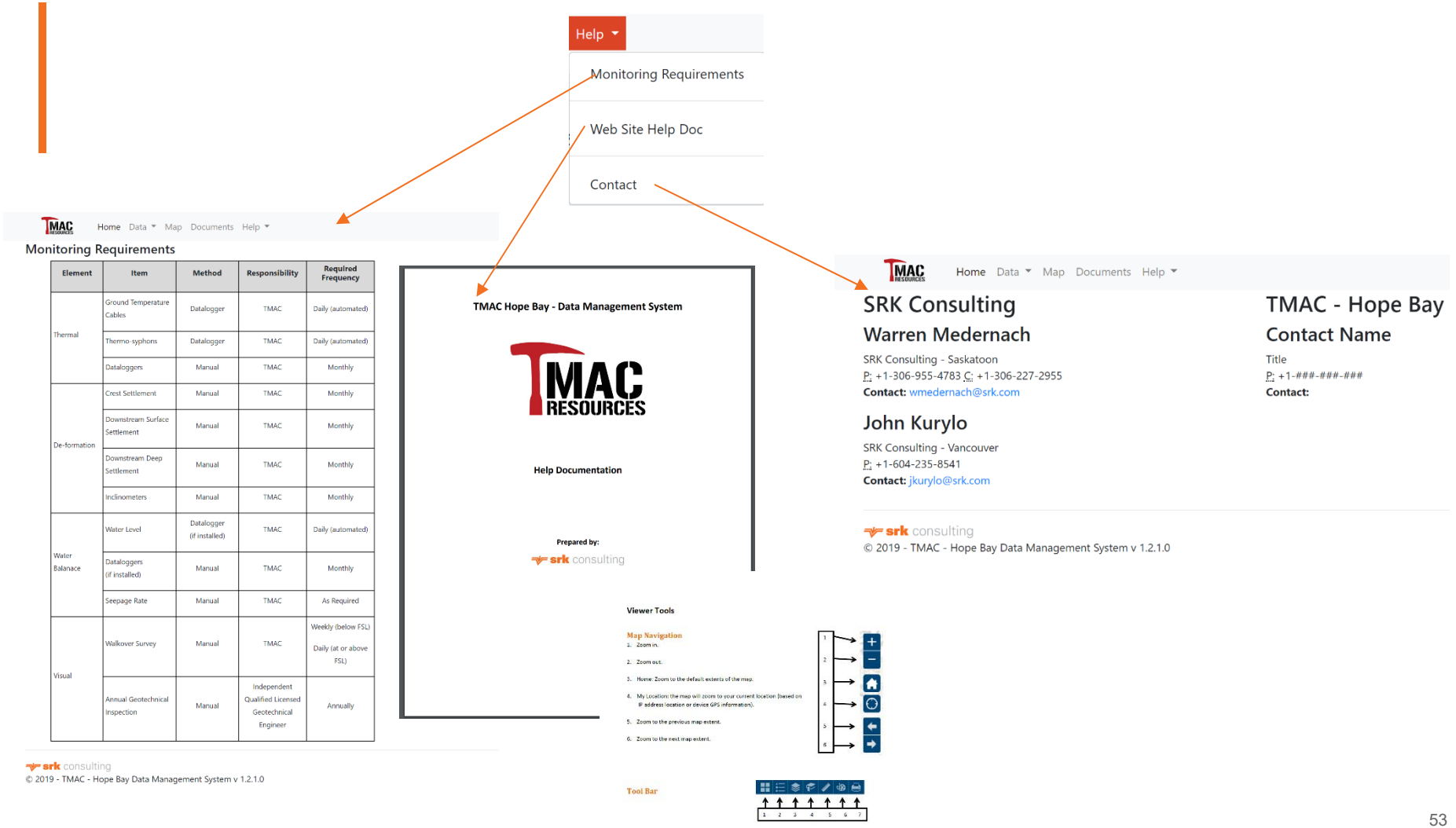
The map viewer provides a map centric view of the station data, with links to the charts and data as well as links to other relevant documents such as: photos, logs, external websites.

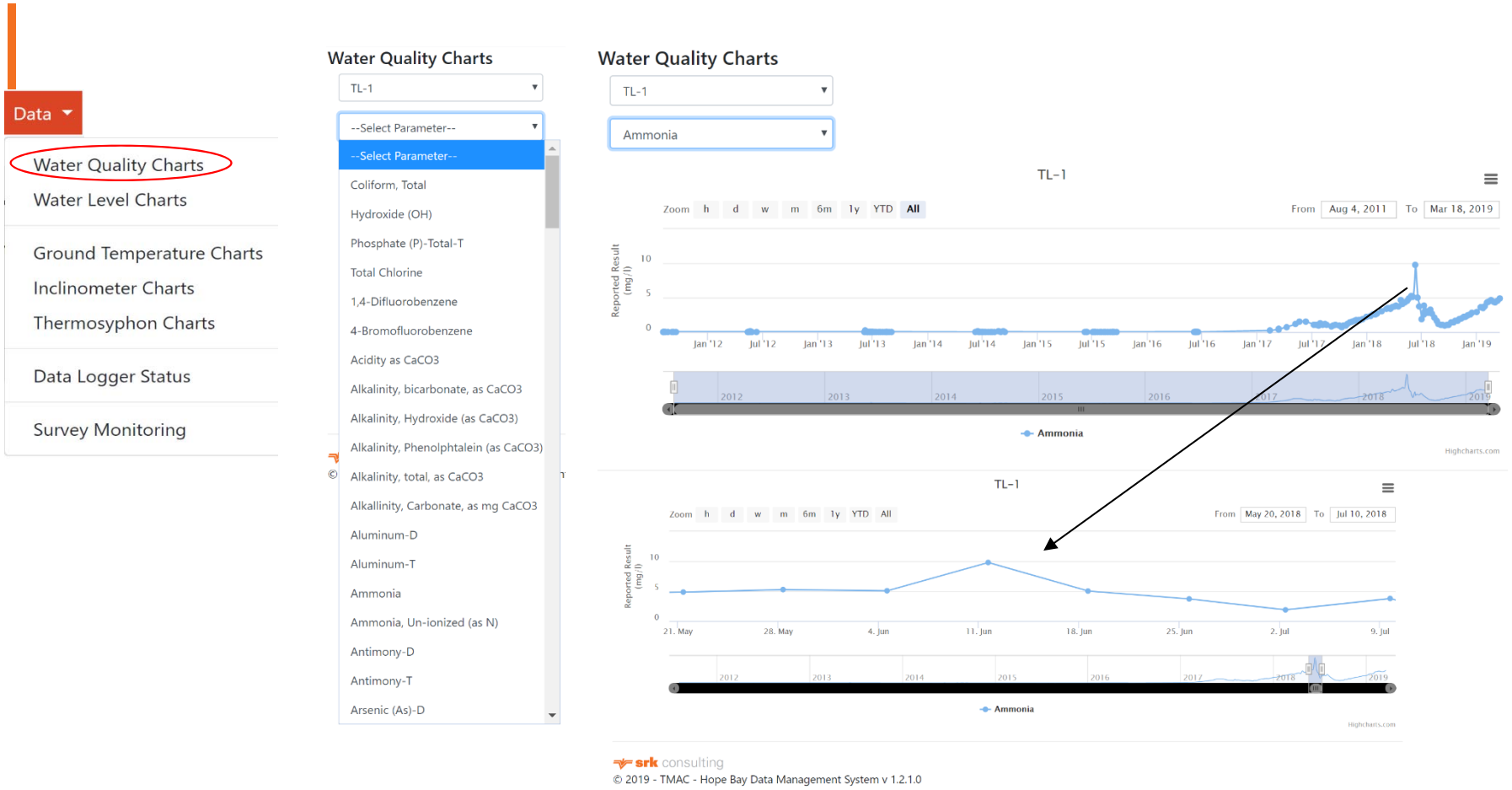
srk consulting

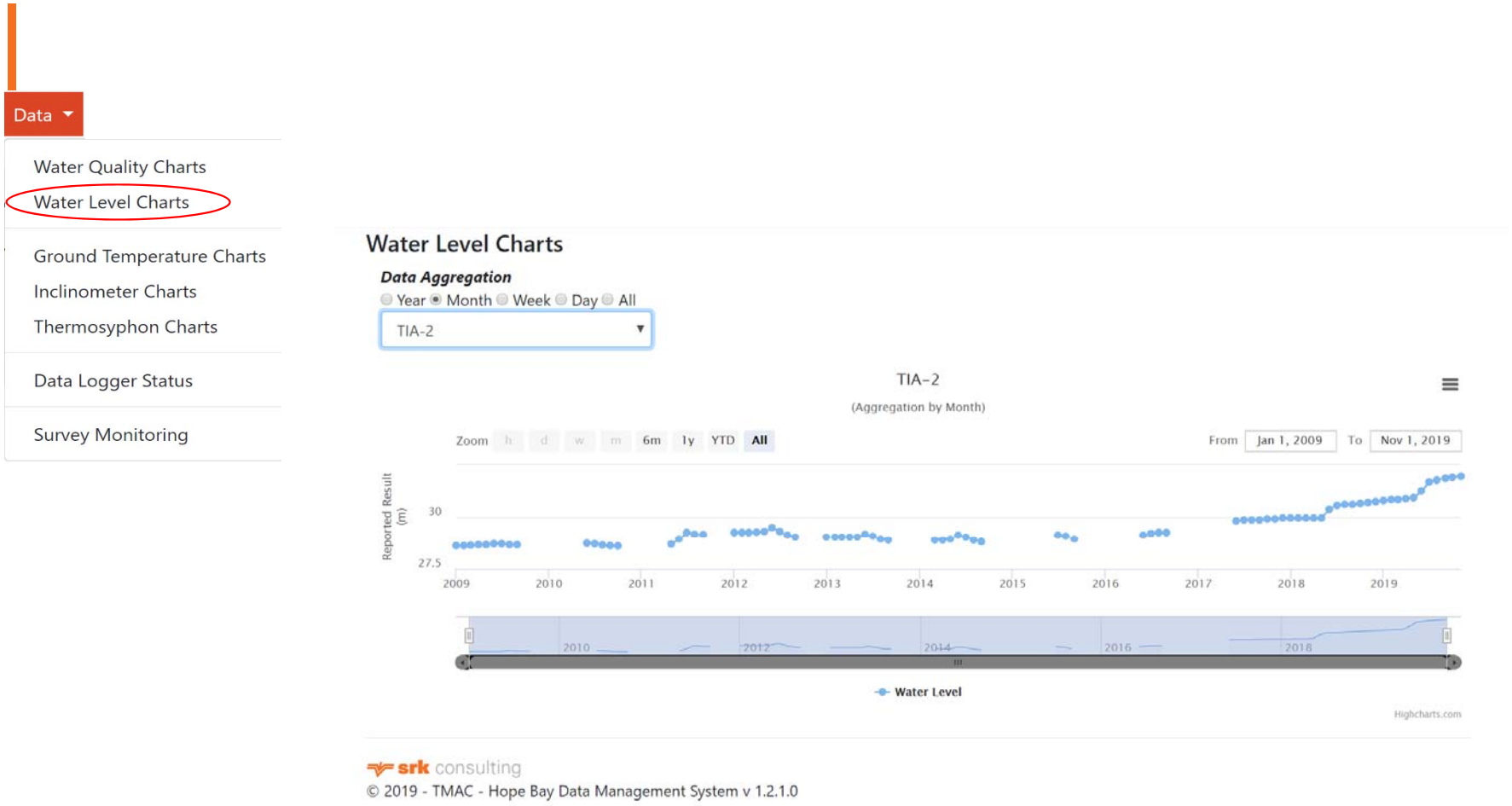
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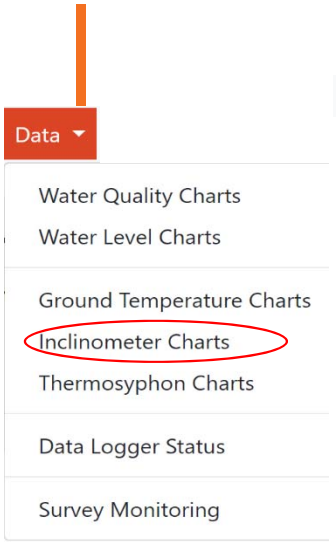

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Document Repository
TIA Monitoring SOPs
Annual Geotechnical Inspection Reports
Design Reports
As-Built Reports
Water License
Visual Monitoring
Other Related Documents
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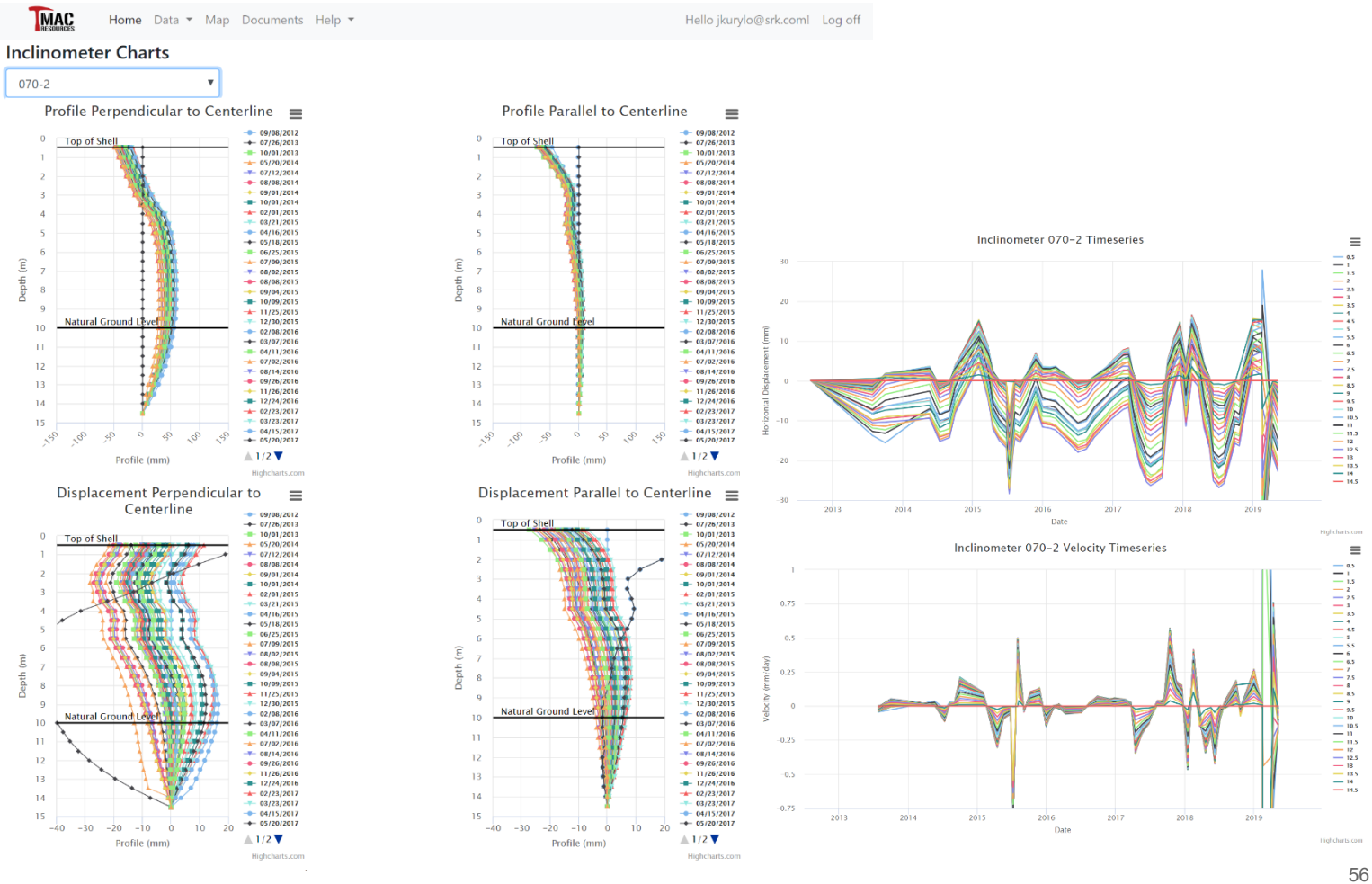

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Document Repository
TIA Monitoring SOPs
Annual Geotechnical Inspection Reports
Doc Link
File Name
File Size
2018 Doris TIA Annual Geotechnical Inspection Report
70MB
2017 North Dam Annual Geotechnical Inspection Report
39MB
2016 North Dam Annual Geotechnical Inspection Report
35MB
Design Reports
As-Built Reports
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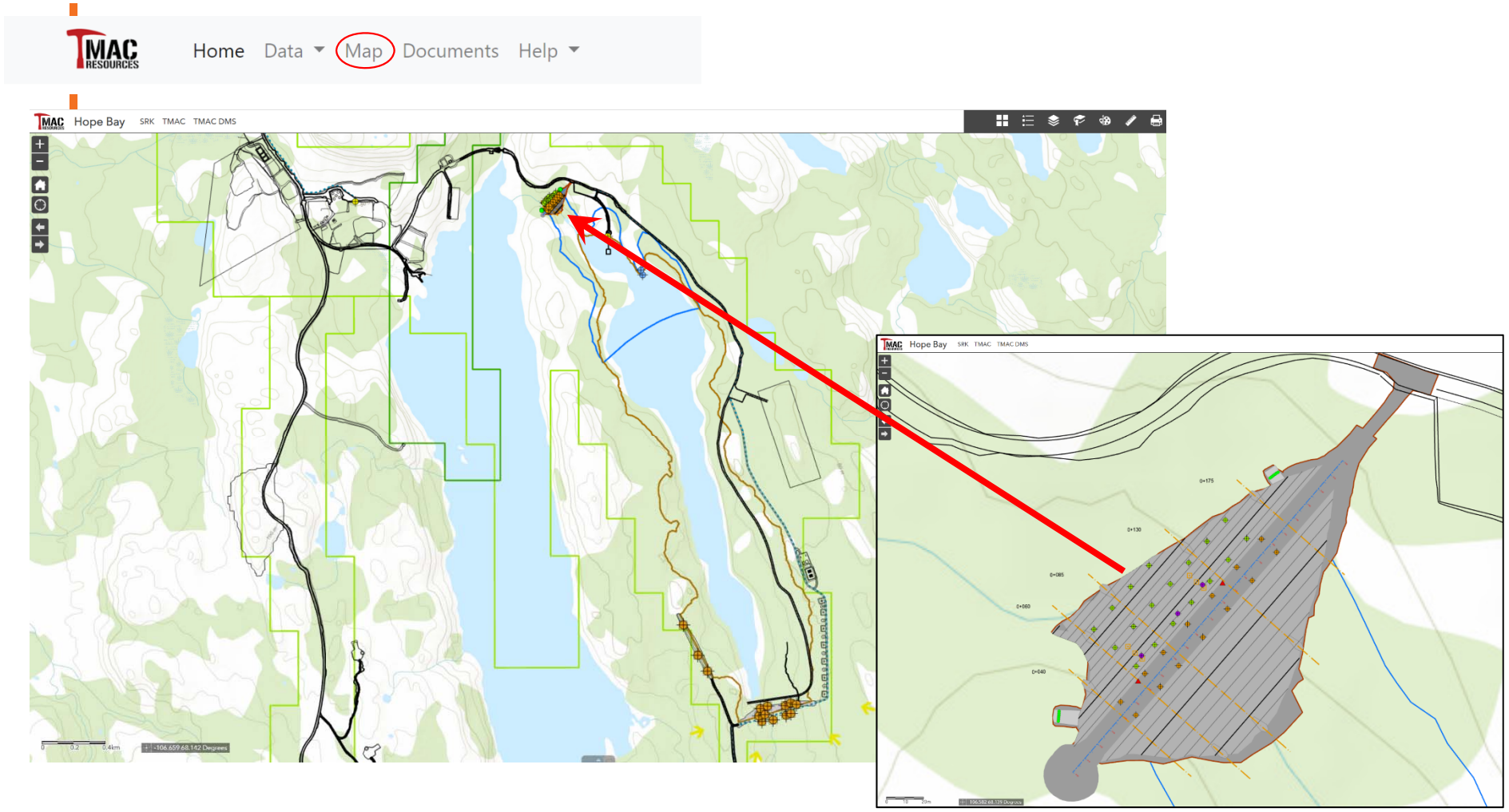

Help
Monitoring Requirements
Web Site Help Doc
Contact
Home Data Map Documents Help
Monitoring Requirements
Element | Item | Method | Responsibility | Required Frequency
Thermal | Ground Temperature Cables | Datalogger | TMAC | Daily (automated)
Thermo-syphons | Datalogger | TMAC | Daily (automated)
Dataloggers | Manual | TMAC | Monthly
De-formation | Crest Settlement | Manual | TMAC | Monthly
Downstream Surface Settlement | Manual | TMAC | Monthly
Downstream Deep Settlement | Manual | TMAC | Monthly
Inclinometers | Manual | TMAC | Monthly
Water Balanace | Water Level | Datalogger (if installed) | TMAC | Daily (automated)
Dataloggers (if installed) | Manual | TMAC | Monthly
Seepage Rate | Manual | TMAC | As Required
Visual | Walkover Survey | Manual | TMAC | Weekly (below FSL) Daily (at or above FSL)
Annual Geotechnical Inspection | Manual | Independent Qualified Licensed Geotechnical Engineer | Annually
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Viewer Tools
Map Navigation
1. Zoom in.
2. Zoom out.
3. Home: Zoom to the default extents of the map.
4. My Location: the map will zoom to your current location (based on IP address location or device GPS information).
5. Zoom to the previous map extent.
6. Zoom to the next map extent.
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John Kurylo
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TMAC - Hope Bay
Contact Name
Title
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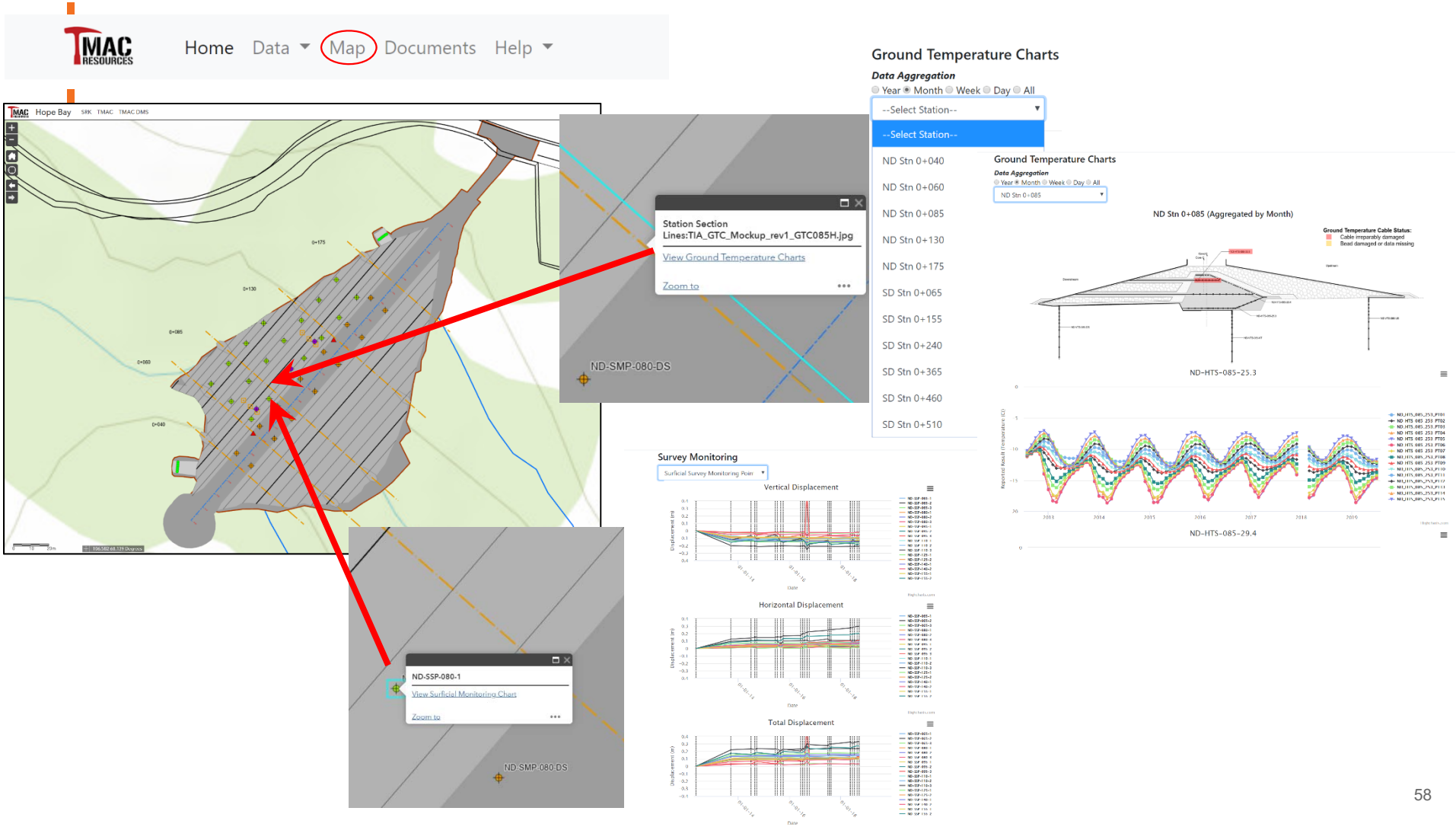

Data
Water Quality Charts
Water Level Charts
Ground Temperature Charts
Inclinometer Charts
Thermosyphon Charts
Data Logger Status
Survey Monitoring
Water Quality Charts
TL-1
--Select Parameter--
--Select Parameter--
Coliform, Total
Hydroxide (OH)
Phosphate (P)-Total-T
Total Chlorine
1,4-Difluorobenzene
4-Bromofluorobenzene
Acidity as CaCO3
Alkalinity, bicarbonate, as CaCO3
Alkalinity, Hydroxide (as CaCO3)
Alkalinity, Phenolphtalein (as CaCO3)
Alkalinity, total, as CaCO3
Alkallinity, Carbonate, as mg CaCO3
Aluminum-D
Aluminum-T
Ammonia
Ammonia, Un-ionized (as N)
Antimony-D
Antimony-T
Arsenic (As)-D
Water Quality Charts
TL-1
Ammonia
TL-1
Zoom h d w m 6m 1y YTD All
From Aug 4, 2011 To Mar 18, 2019
Reported Result (mg/l)
Ammonia
Highcharts.com
TL-1
Zoom h d w m 6m 1y YTD All
From May 20, 2018 To Jul 10, 2018
Reported Result (mg/l)
21. May
28. May
4. Jun
11. Jun
18. Jun
25. Jun
2. Jul
9. Jul
Ammonia
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Data
Water Quality Charts
Water Level Charts
Ground Temperature Charts
Inclinometer Charts
Thermosyphon Charts
Data Logger Status
Survey Monitoring
Water Level Charts
Data Aggregation
Year Month Week Day All
TIA-2
TIA-2
(Aggregation by Month)
Zoom h d w m 6m 1y YTD All
From Jan 1, 2009 To Nov 1, 2019
Reported Result (m)
30
27.5
2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019
Water Level
Highcharts.com
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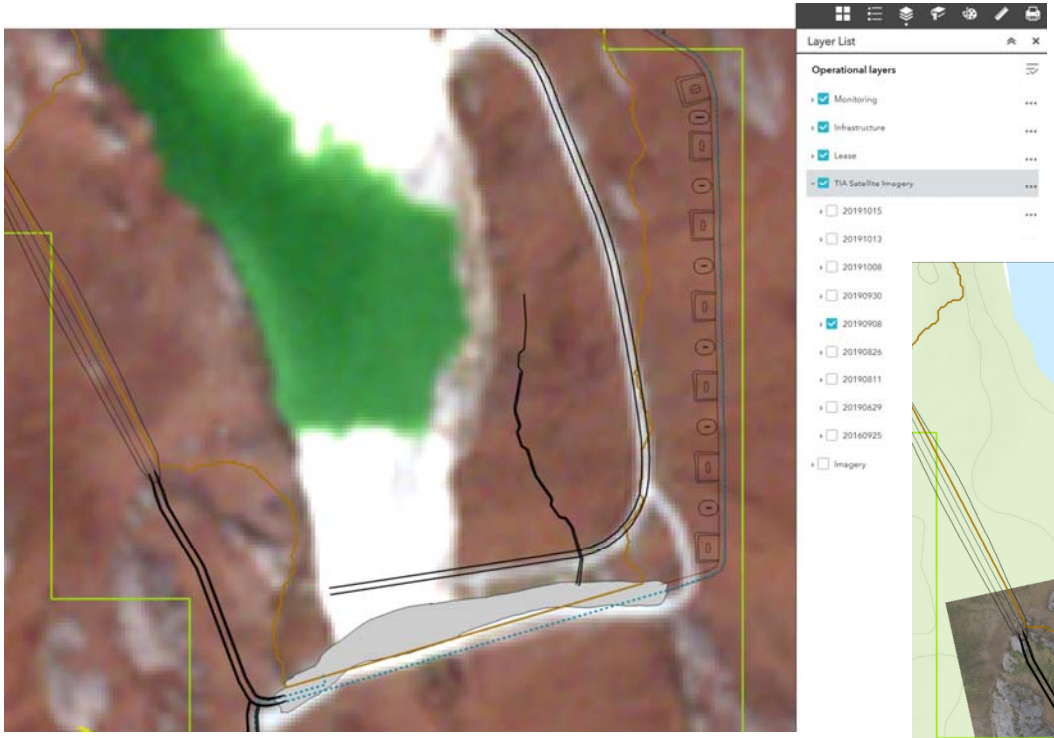

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Water Level Charts
Ground Temperature Charts
Inclinometer Charts
Thermosyphon Charts
Data Logger Status
Survey Monitoring


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Inclinometer Charts
070-2
Profile Perpendicular to Centerline
Top of Shell
Natural Ground Level
Depth (m)
Profile (mm)
Profile Parallel to Centerline
Displacement Perpendicular to Centerline
Displacement Parallel to Centerline
Inclinometer 070-2 Timeseries
Horizontal Displacement (mm)
Date
Inclinometer 070-2 Velocity Timeseries
Velocity (mm/day)
Highcharts.com

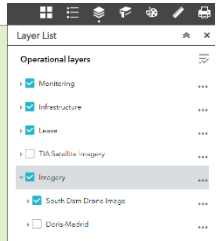

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Hope Bay
Station Section
Lines:TIA_GTC_Mockup_rev1_GTC085H.jpg
View Ground Temperature Charts
Zoom to
ND-SMP-080-DS
ND-SSP-080-1
View Surficial Monitoring Chart
Zoom to
ND-SMP-080-DS
Ground Temperature Charts
Data Aggregation
Year Month Week Day All
--Select Station--
--Select Station--
ND Stn 0+040
ND Stn 0+060
ND Stn 0+085
ND Stn 0+130
ND Stn 0+175
SD Stn 0+065
SD Stn 0+155
SD Stn 0+240
SD Stn 0+365
SD Stn 0+460
SD Stn 0+510
Survey Monitoring
Surficial Survey Monitoring Point
Vertical Displacement
Horizontal Displacement
Total Displacement
Ground Temperature Charts
Data Aggregation
ND Stn 0+085
ND Stn 0+085 (Aggregated by Month)
Ground Temperature Cable Status:
Cable irreparably damaged
Bead damaged or data missing
ND-HTS-085-25.3
ND-HTS-085-29.4

Home Data Map Documents Help







Discussions:

Revisit OMS in more detail, discuss some things to looks for in inspections, have additional operation discussions, get feedback

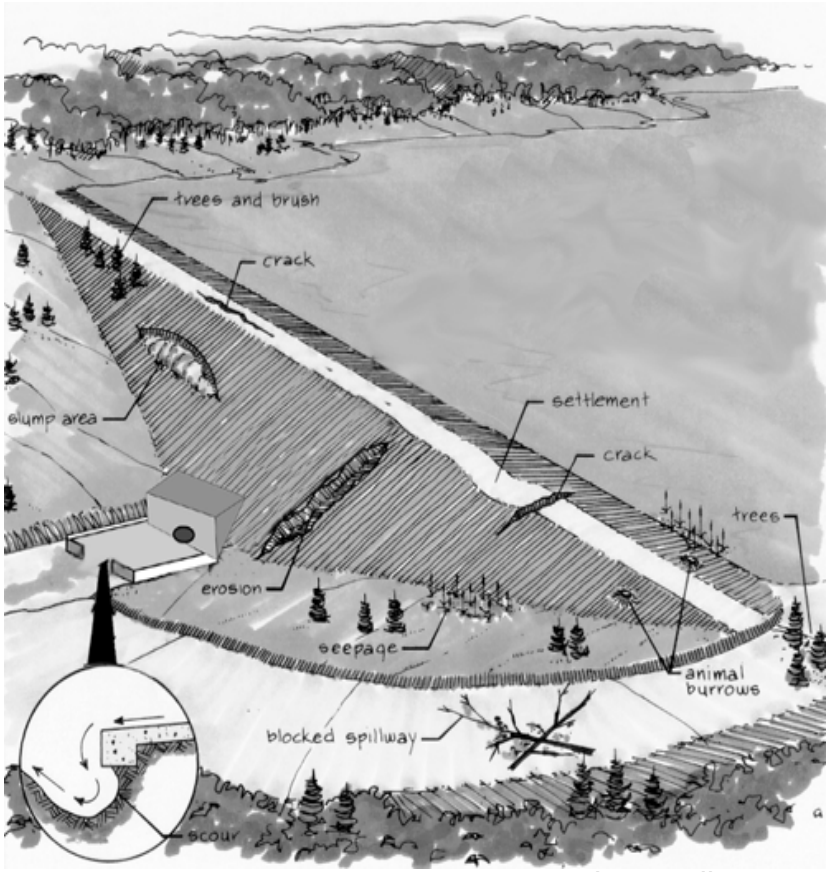
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Operations, Maintenance and Surveillance Manual: Hope Bay Project, Phase 2, Doris Tailings Impoundment Area
November 2019

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Attachment A: Site Management Structure **1**
Attachment B: Tailings Area Dust Control Strategy for Doris TIA **2**
Attachment C: Summary of Currently Available Dust Control Products **1**
Figures **2**

Dam Inspections



Ref: BC Dam Safety Program – Emergency Dam Assessment and Immediate Response Plan

Dam Inspections – examples

North Dam (past notes that were watched or corrected)

- Watch tension cracks on upstream slope near shoreline
- Backfill with crush around inclinometer housing of Station 0+130 m
- Replace bottom weatherproof housing for node D







Other TIA Inspections – examples

Pumps and Pipeline

- Damage to pipelines
- Settlement around equipment
- Function of pumps
- Housekeeping



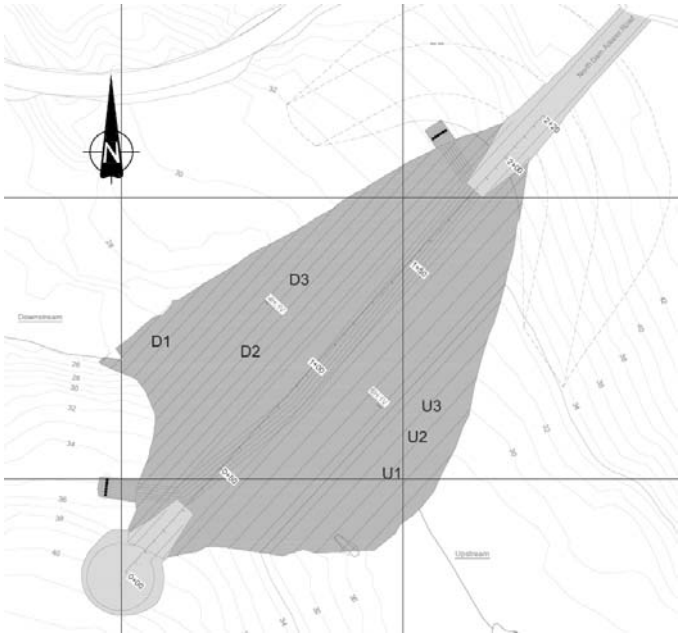






Reporting / Tracking Examples

Depression / settlement tracking



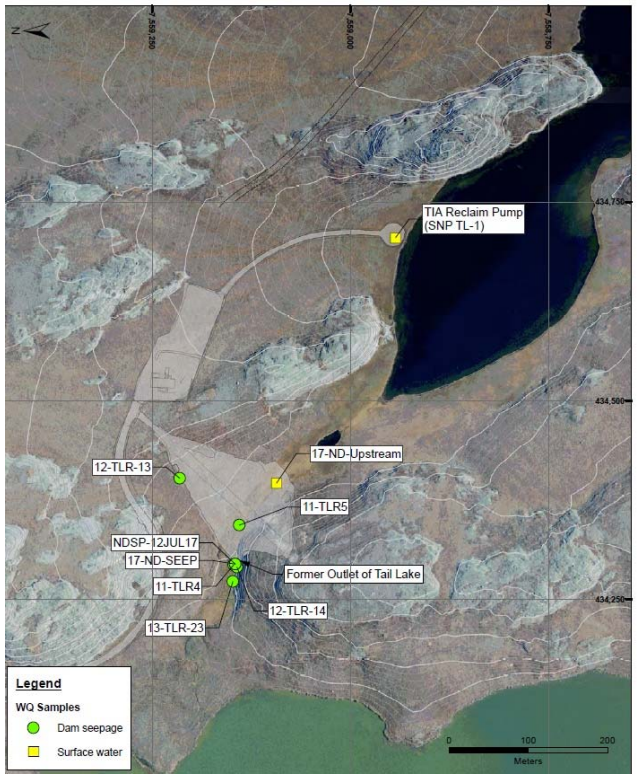
DEPRESSION TRACKING

ID	Location	Comments	Northing	Easting
U1	Upstream	First noted June 2014	7559104	434393
		Boundaries spray painted and ID given July 2014		
		No substantial changes from previous inspection		
U2	Upstream	First noted June 2014	7559117	434402
		Boundaries spray painted and ID given July 2014		
		No substantial changes from previous inspection		
U3	Upstream	First noted June 2014	7559128	434407
		Boundaries spray painted and ID given July 2014		
		July 4, 2015 - Expanding toward U2		
		No substantial changes from previous inspection		
D1	Downstream	Identified during 2014 annual geotechnical inspection, spray painted and given ID.	7559151	434311
		September 1, 2014 - expanded towards the south		
		September 20, 2014 - TMAC ESR noted the depression looks to have expanded, paint mark updated.		
		July 4, 2015 - Slight expansion toward the crest was noted in the daily report		
		No substantial changes from previous inspection		
D2	Downstream	First noted in 2013 Annual Geotechnical Inspection	7559147	434344
		September 14, 2014 - TMAC ESR noted that the depression may have expanded slightly		
		No substantial changes from previous inspection		
D3	Downstream	First noted in 2013 Annual Geotechnical Inspection	7559173	434360
		August 10, 2014 - larger area marked		
		No substantial changes from previous inspection		

Notes:
1. Depression locations are based on hand held GPS measurements, accuracy is at best +/- 4 m.
2. Other small depressions were removed from the tracking system in 2016. Only significant depression were carried forward from the 2016 Annual Inspection.

srk consulting	TMAC RESOURCES	2018 Annual Geotechnical Inspection
		Historic Depression Summary
Job No: 1CT002.028 File: pH_ND_AGI_DepressionTracking.pptx	DORIS TIA	Date: Dec. 2018 / Approved: PDL / Figure: **H.65**

Reporting / Tracking Examples



Seepage Tracking & Testing

TMAC RESOURCES

North Dam Weekly Walkover Survey Report

Date:	*10 Aug 2018*
Inspected By:	*Site personnel*
Conditions:	(ie. snow on ground, clear) clear

Visual Inspection:

This weekly walkover survey report is a means to track the condition on the North Dam, please provide details on changes that ha developed since the previous inspection and/or any observations of particular concern. All photos are appreciated. Please send t completed form (scans are fine) and any photos to hopebaymonitoring@tmk.com and pluedke@tmk.com

Upstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	(Yes)	No
Downstream Side of Dam		
Any visible concerns? (cracks, depressions, erosion, seepage, etc.)	Yes	(No)
Crest of Dam		
Any visible concerns? (cracks, depressions, erosion, etc.)	Yes	(No)
Thermosyphons North Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Thermosyphons South Side		
Any visible concerns? (cracks, punctures, peeling paint, birds nests, etc.)	Yes	(No)
Instrumentation (on crest and downstream side)		
Any visible concerns? (bent, rusted, cracked, etc.)	Yes	(No)
Thermistors and Dataloggers		
Any visible concerns? (frayed or cut cables, damaged boxes, etc.)	Yes	(No)
Suspended Sediment in TIA (When not frozen)		
Any suspended sediment in Tail Lake?	Yes	(No)
Water at the Toe of the Downstream Side of the Dam (If yes refer to Doris North – North Dam and Tail Lake Outflow Seepage Monitoring Work Plan 2018)	Yes	(No)

If you answered yes to any of the questions above please provide details and photos. Observations can be sketched on the figur provided on the next page. If seepage has been noted please estimate the flow.

Small crack at the time gravel close to the water. it might existlong time. We have not done the inspection for a whil not sure this exists before. it's very minor.

Rev. 20150519 North Dam Weekly Monito

TMAC Resources Page 2

Please provide any other observations you have made or items that did not fit in the space above

28 Aug 2017

bolt slightly bent backward

bolt on rail slightly leaning forward

small water pool

cracking in road material

Photos:

Please collect the following photos:	
Photo from north end looking south along the dam	☑
Photo from south and looking north along the dam	☑
Other photos, please describe	
cracks @ upstream part near road pictures of NDSSP-16-3 & ND-SP-15-2	

Rev. 20150519 North Dam Weekly Monitoring

Visual Inspections

Appendix Q – ERP and Dam Break Considerations - Presentation

Doris TIA –
Emergency Response Plan (ERP) Inputs & Discussions

John Kurylo, MSc, PEng

Site Discussions - November 24th, 2019

srk consulting

Emergency Management Guidance

- Mining Association of Canada (MAC) Guidelines - 2019

Emergency: A situation that poses an impending or immediate risk to health, life, property, and/or the environment and which requires urgent intervention to prevent or limit the expected adverse outcomes.

Overall Objective

- The emergency management procedures will have two key overarching objectives:
  - avoid injury or death of persons working on pipeline systems, and
  - prevent or minimize environmental damage.

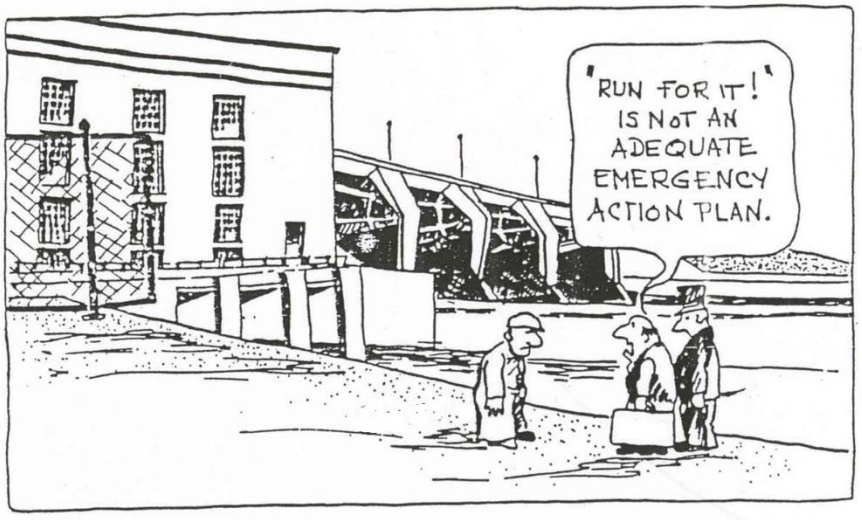


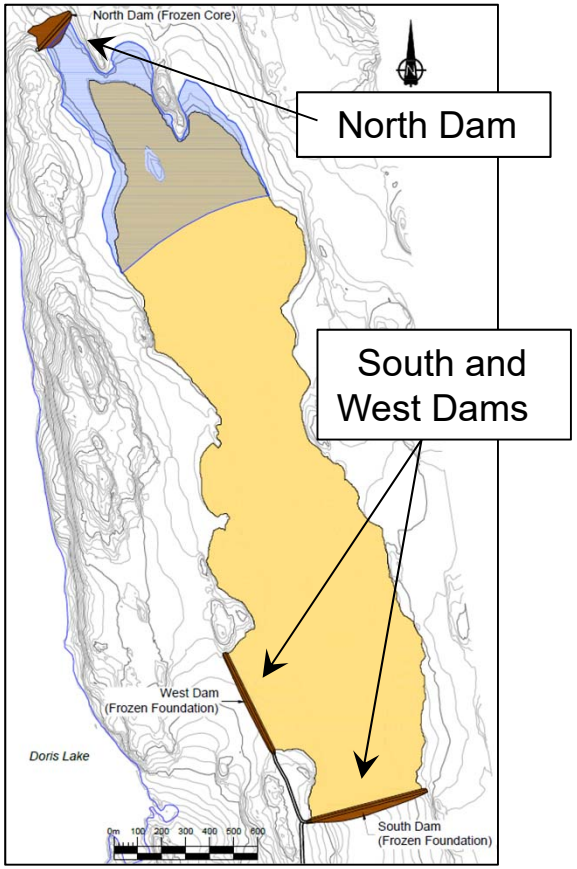
Image Ref:
dnr.wi.gov/topic/dams/documentsEAP.html

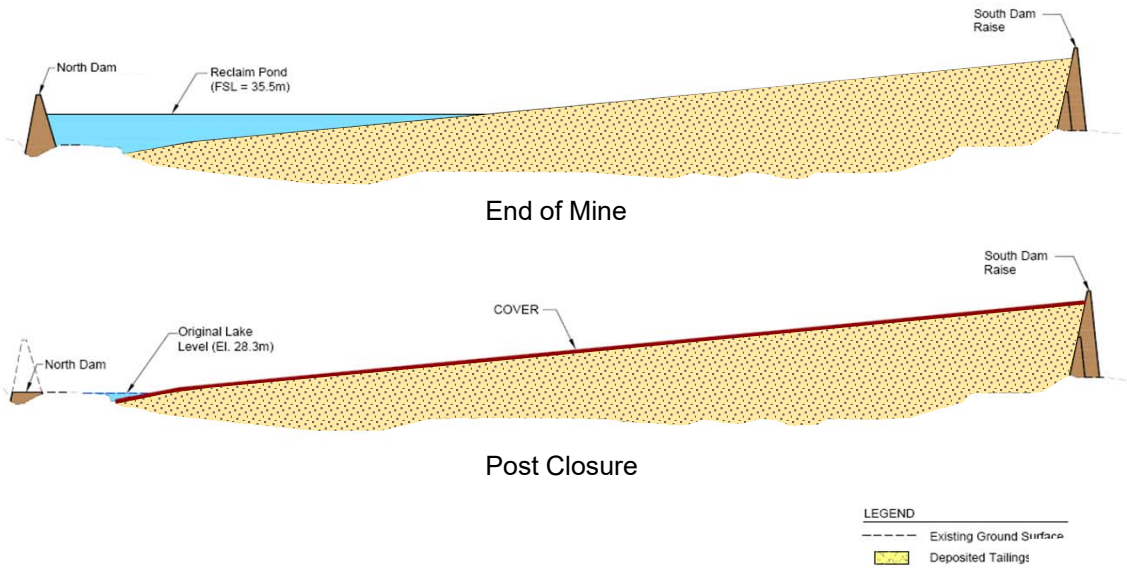
1 Overview of Doris TIA

Existing and Phase 2 Plans at Hope Bay

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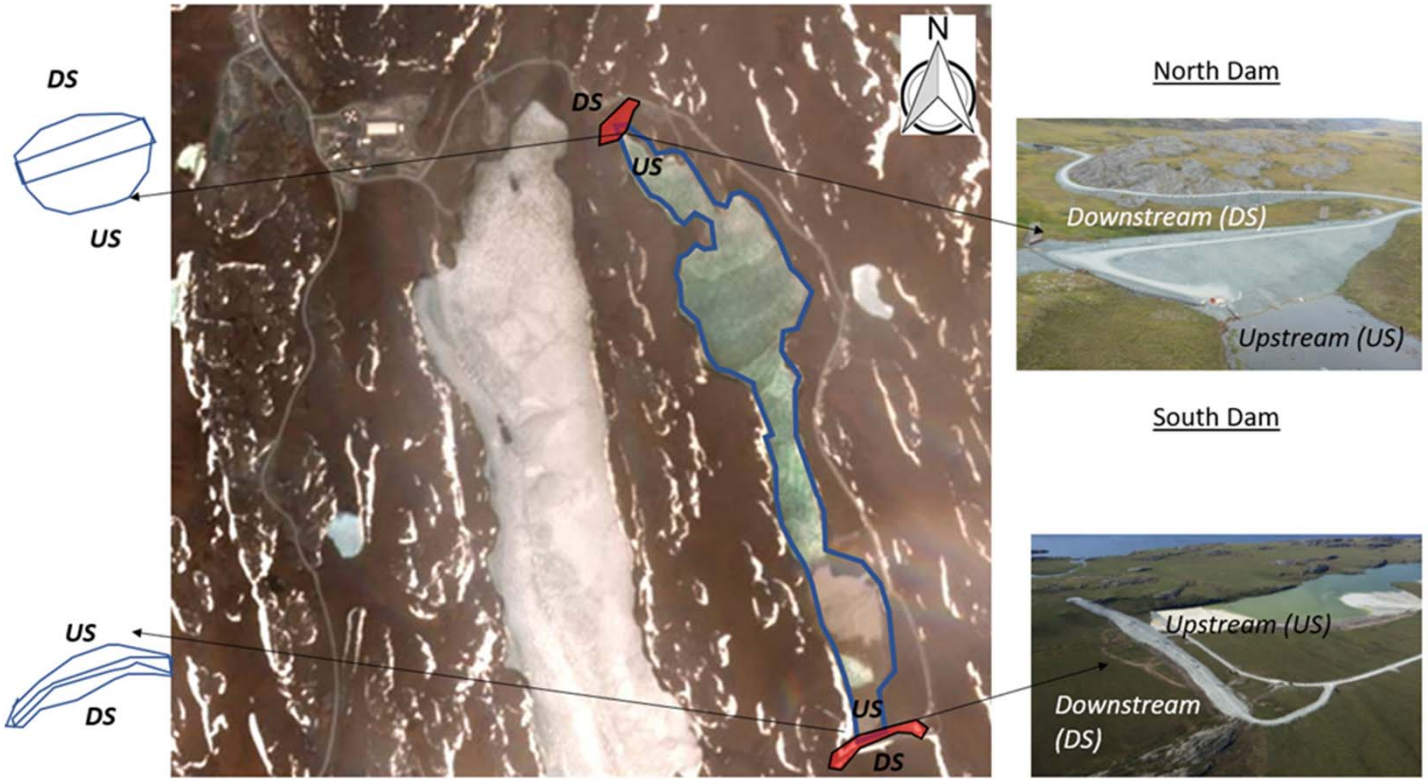
Tailings Impoundment Area (TIA)





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Tailings Impoundment Area (TIA) - current



- For 'UPSTREAM' think side that is holding back (retaining) water or tailings.
- For 'DOWNSTREAM' think the side with the less mining impacted environment

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2 Dam Hazard Ratings

Dams on site

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CDA - Dam Classification System

Does not take into account current state or probability. Just based on most significant possible outcome. The highest category of any category is what is adopted for the dam.

CDA consequence category	Potential loss of life	Environmental and cultural values	Infrastructure and economics
EXTREME	More than 100	Major loss… Restoration impossible…	Extreme losses…
VERY HIGH	100 or fewer	Significant loss… Restoration impractical…	Very high economic losses…
HIGH	10 or fewer	Significant loss… Restoration probable…	High economic losses…
SIGNIFICANT	Unspecified	No significant loss…	Loss to recreational facilities…
LOW	0	No long term loss…	Low economic loss…

Source: Canadian Dam Association Dam Safety Guidelines 2007 (2013 Edition) and Technical Bulletin: Application of Dam Safety Guidelines to Mining Dams (2014). The table is an extract of the CDA Dam consequence categories and criteria.

Secondary ref: https://www.bhp.com/-/media/documents/media/reports-and-presentations/2019

Hope Bay - Dam Classifications

The dams associated with the TIA area consist of

- **North Dam** - Frozen core rock fill dam with GCL
- **South Dam** – Frozen foundation dam with GCL. Constructed in two phases with downstream raises of GCL and rock fill.
- **West Dam** – Frozen foundation rock fill dam with geomembrane

The North, South, and West Dams were assigned a **HIGH** dam hazard classification in accordance with the CDA (2013) dam safety guidelines.

Dam Class	North Dam	South Dam	West Dam
Population at Risk	significant	significant	significant
Loss of Life	significant	significant	significant
Environmental and Cultural Values	high	high	high
Infrastructure and Economics	low	low	low
Overall Hazard Classification	high	high	high

srk consulting

3 Dam Break Analysis

Inputs and Outputs from Preliminary Checks

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What is a dam break study and why do we do it?

- Tailings dam failures can have catastrophic consequences
- Dam break assessments provide important information to develop safety protocols and to manage risk
- Currently a legislative requirement in most North American jurisdictions
- Results of the dam break assessment are used to determine the TSF classification and develop Emergency Action Plans

Breach of Teton Dam, June 5, 1976



Ref: en.wikipedia.org/wiki/Teton_Dam

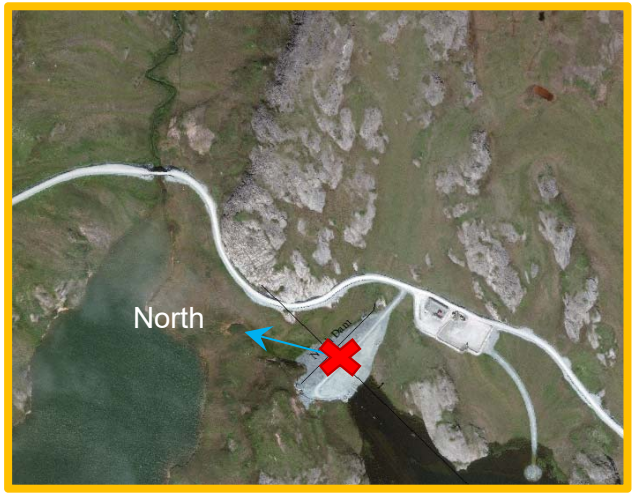
Analysis sequence

1. Identify and select critical breach location(s)
2. Estimate the volume of tailings and water that will be released
3. Determine breach parameters and assign hydrograph
4. Route the flood downstream (1 or 2D models)
5. Prepare inundation maps

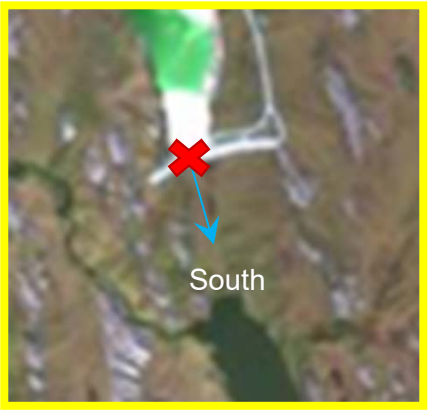
Analysis sequence
1. Selecting breach location

1. **Breach location(s)**
2. Release volumes
3. Breach hydrograph
4. Flood routing
5. Inundation maps

- Typically select one (or multiple), critical locations That have the highest potential for downstream impacts



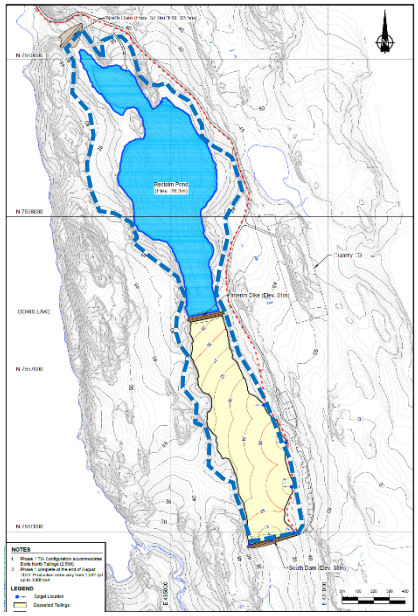




Analysis sequence
2. Estimating release volumes

1. Breach location(s)
2. **Release Volumes**
3. Breach hydrograph
4. Flood routing
5. Inundation maps

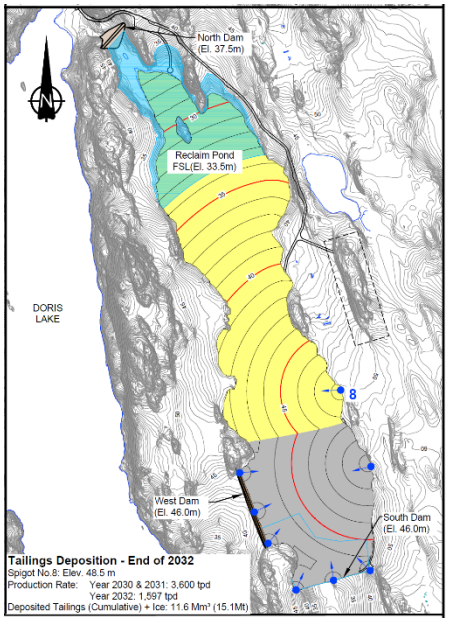
– How much is released is difficult to predict. Making what we believe to be conservative (higher volume) assumptions.



North Dam

Volume Released	12,938,000 m^3

Volume below elevation 37.5m



South Dam

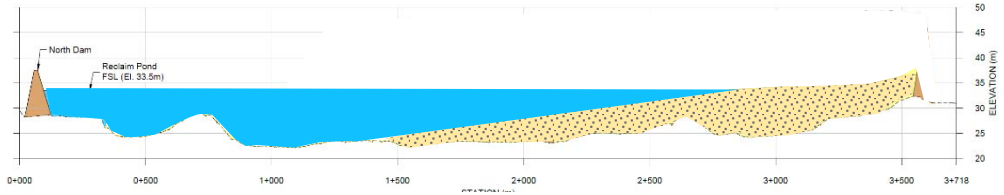
Volume Released	14,034,000 m^3

Volume between approx elev 30 to 46m

Analysis sequence
2. Estimating release volumes

1. Breach location(s)
2. **Release Volumes**
3. Breach hydrograph
4. Flood routing
5. Inundation maps

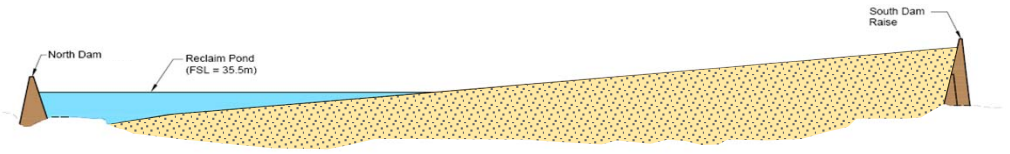
– How much is released is difficult to predict. Making what we believe to be conservative (higher volume) assumptions.



End of Phase 1
Just before Phase 2

North Dam

Volume Released	12,938,000 m^3



End of Mine
End Phase 2

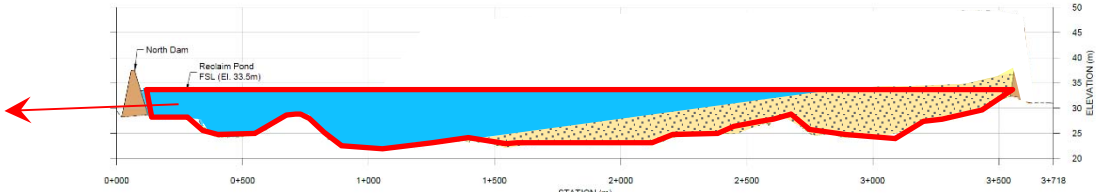
South Dam

Volume Released	14,034,000 m^3

Analysis sequence
2. Estimating release volumes

1. Breach location(s)
2. **Release Volumes**
3. Breach hydrograph
4. Flood routing
5. Inundation maps

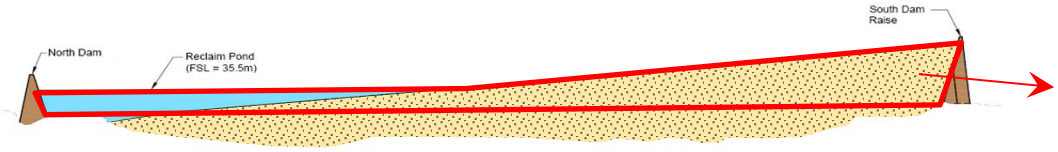
– How much is released is difficult to predict. Making what we believe to be conservative (higher volume) assumptions.



End of Phase 1
Just before Phase 2

North Dam

Volume Released	12,938,000 m^3



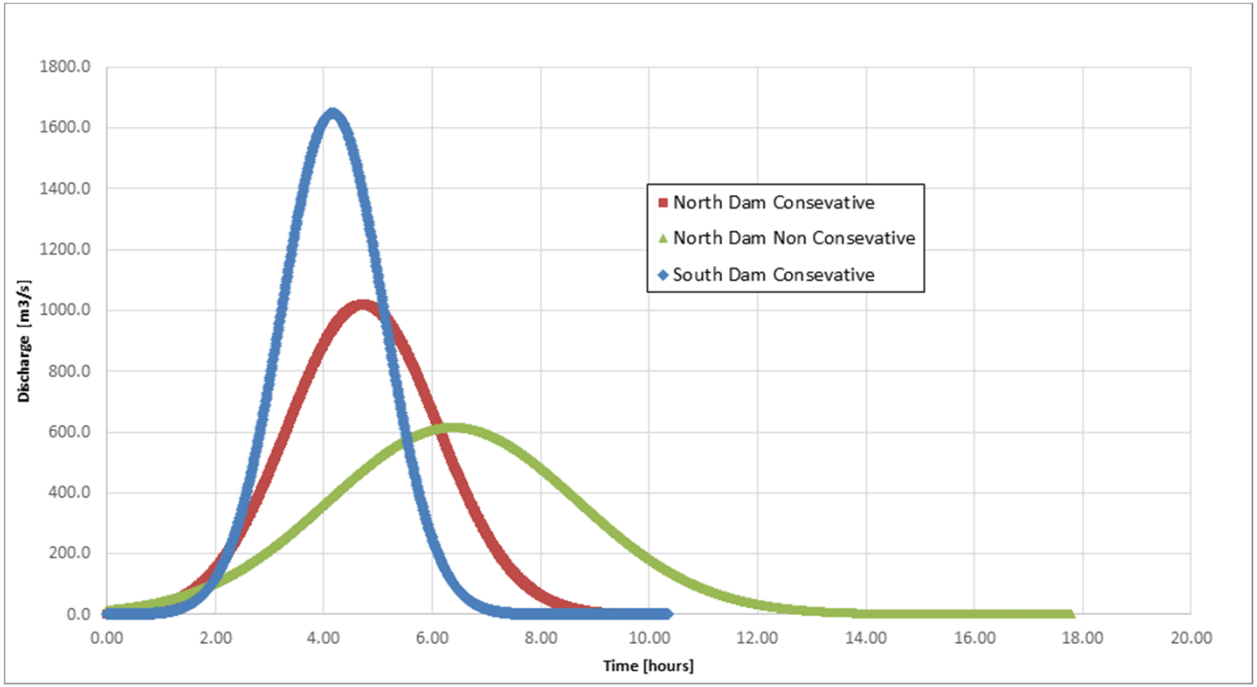
End of Mine
End Phase 2

South Dam

Volume Released	14,034,000 m^3

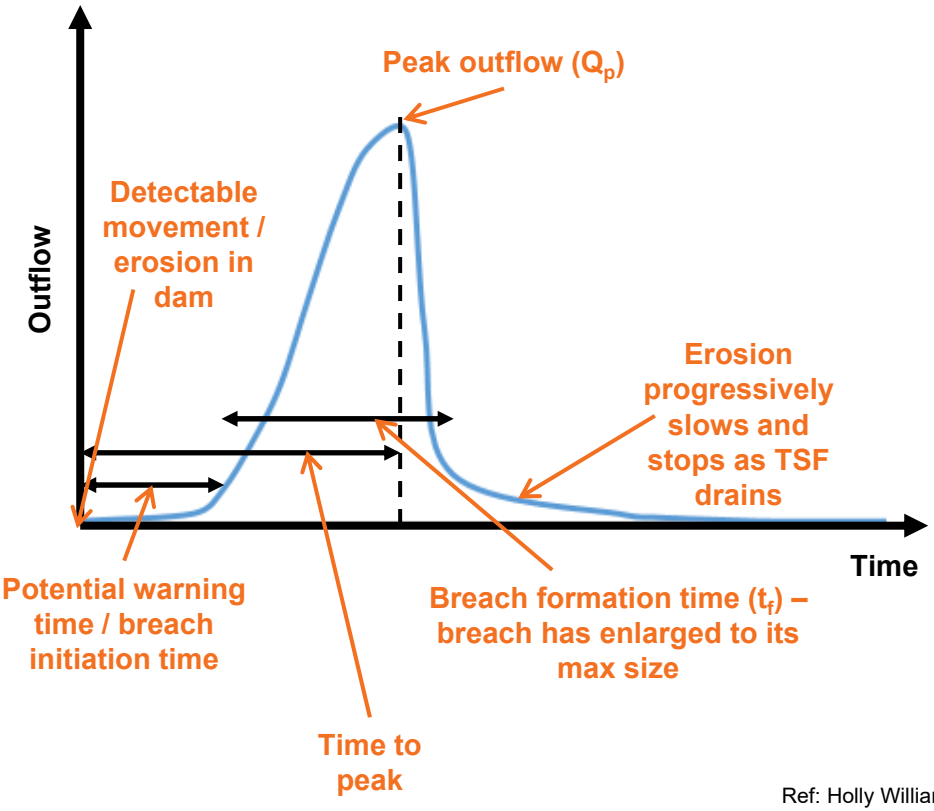
Analysis sequence
3. Determine breach parameters and assign hydrograph

1. Breach location(s)
2. Release volumes
3. **Breach Hydrograph**
4. Flood routing
5. Inundation maps



Analysis sequence
3. Determine breach parameters and assign hydrograph

1. Breach location(s)
2. Release volumes
3. **Breach Hydrograph**
4. Flood routing
5. Inundation maps

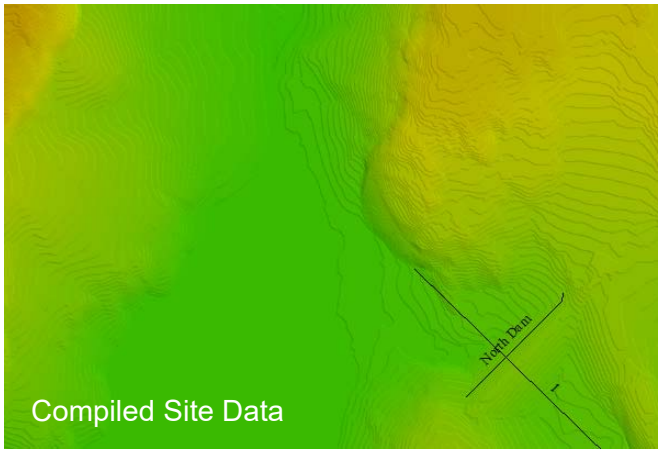


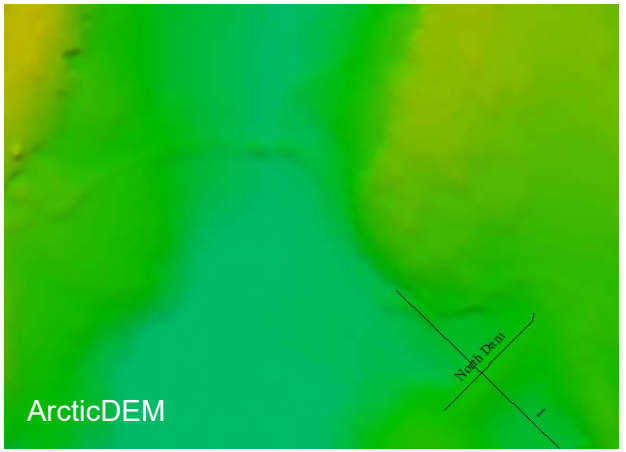
Ref: Holly Williams, SRK, 2017

Running a model
4. Flood routing - topography

1. Breach location(s)
2. Release volumes
3. Breach hydrograph
4. **Flood Routing**
5. Inundation maps

- The accuracy of the flood routing and subsequent inundation mapping is dictated by the topographic resolution
  - Crap input = crap output
- When do you stop a model?
  - Typical guidelines say flood routing should be continued to a point downstream where the dam break flood is considered to no longer pose a risk to life and there is limited potential for further damage.

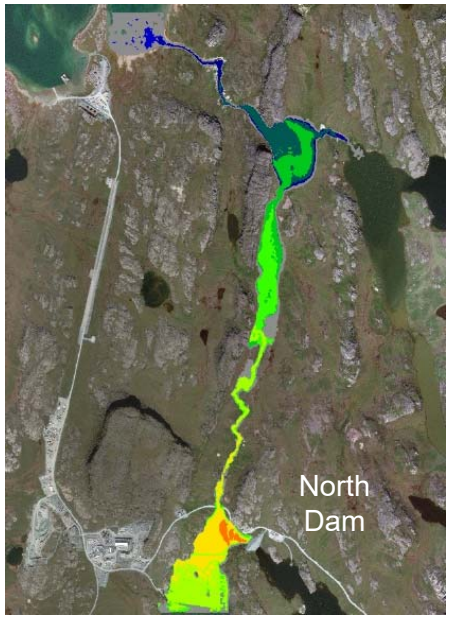


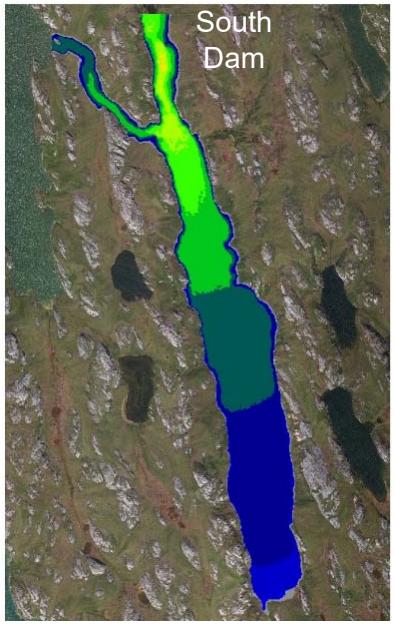


Running a model
5. Preparing inundation maps

1. Breach location(s)
2. Release volumes
3. Breach hydrograph
4. Flood routing
5. **Inundation maps**

- Include flood inundation extents, arrival times, depths, and velocities and areas / infrastructure at risk





Summary of Dam Break Set-up / Inputs

North Dam – large scale model (to ocean)

Breach Type	Overtopping
Volume Released	12,938,000 m^3
Rheology	Water *(conservative – longer quicker flow case)*
Breach Formation Time	7.5 hrs *(Xu & Zhang, 2009)*
Peak Outflow Rate	1020 m^3/s *(615 m^3/s estimated by Xu& Zhang, 2009, so reasonable fit)*
Flood Routing Model	FLO-2D
Grid Size	5x5m *(square model grid)*
Model Time	12 hrs (calculations set to stop after model time reach)
Time Step	0.1 hrs (6 minutes)
Manning	0.05 *(smooth terrain -*

South Dam – larger scale model (to Doris Lake)

Breach Type	Overtopping
Volume Released	14,034,000 m^3
Rheology	Water *(conservative – longer quicker flow case)* Tailings (shorter travel distance) case also run
Breach Formation Time	5.7 hrs *(Xu & Zhang, 2009)*
Peak Outflow Rate	1647 m^3/s *(1610 m3/s estimated by Xu& Zhang, 2009, so pretty close to perfect fit)*
Flood Routing Model	FLO-2D
Grid Size	5x5m *(square model grid)*
Model Time	7 hrs (calculations set to stop after model time reach)
Time Step	0.1 hrs (6 minutes)
Manning	0.05 *(smooth terrain - most of the flow with go through existing creeks, rock outcrops and tundra vegetation or frozen ground)*

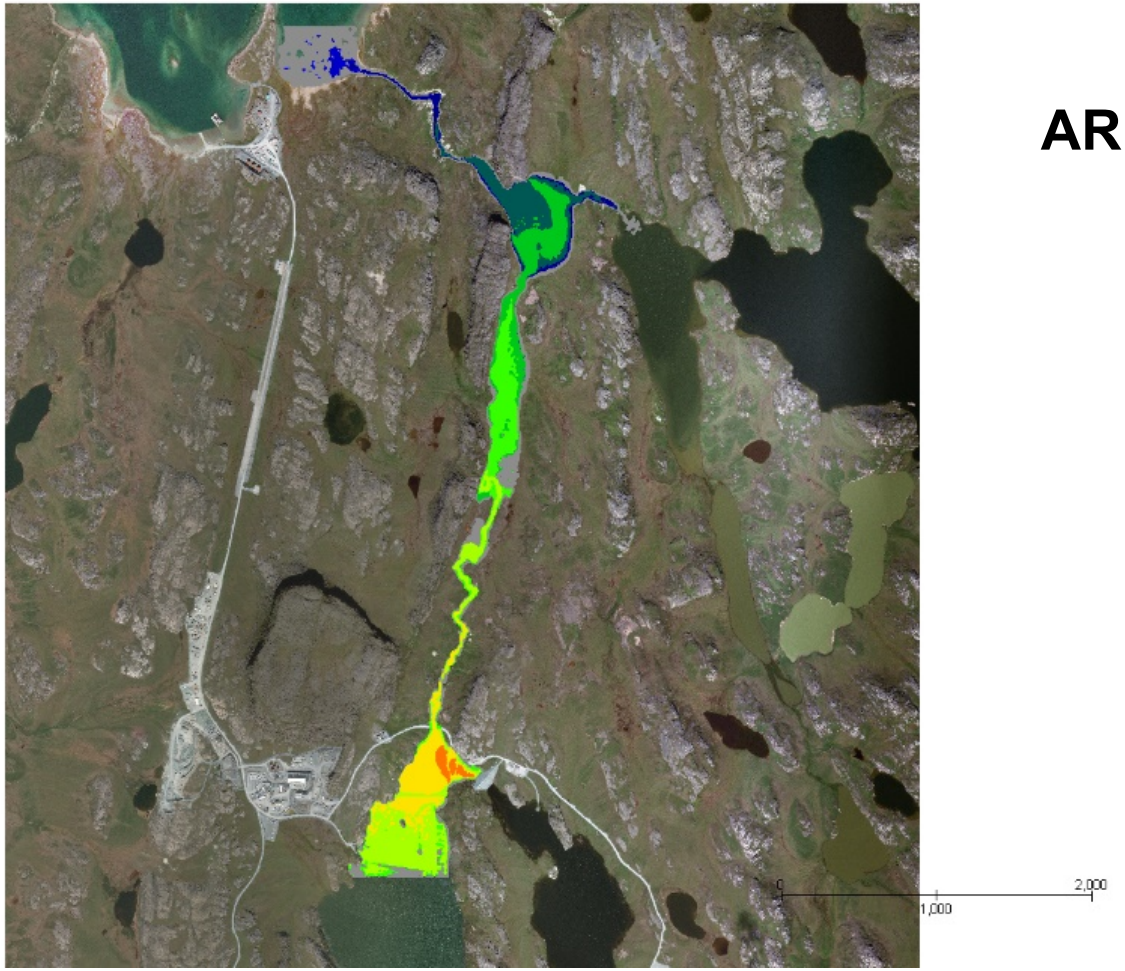
4 Inundation Maps

Impacts

srk consulting

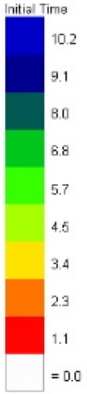
North Dam – General / Global Model (to ocean)

Grid Element Time to One Foot
(From simulation time 0.0 or initial breach discharge)



ARRIVAL TIME

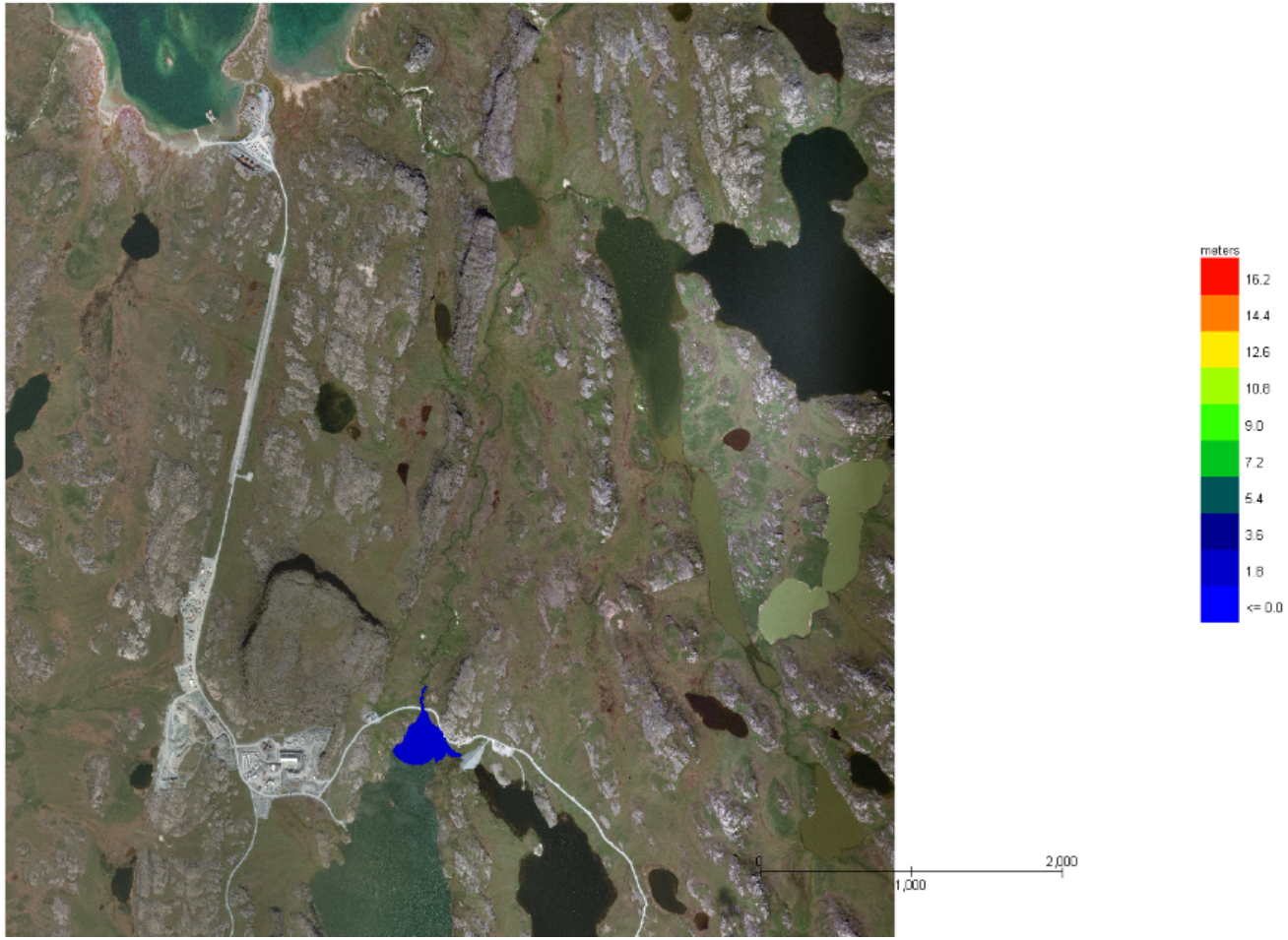
(~hrs)



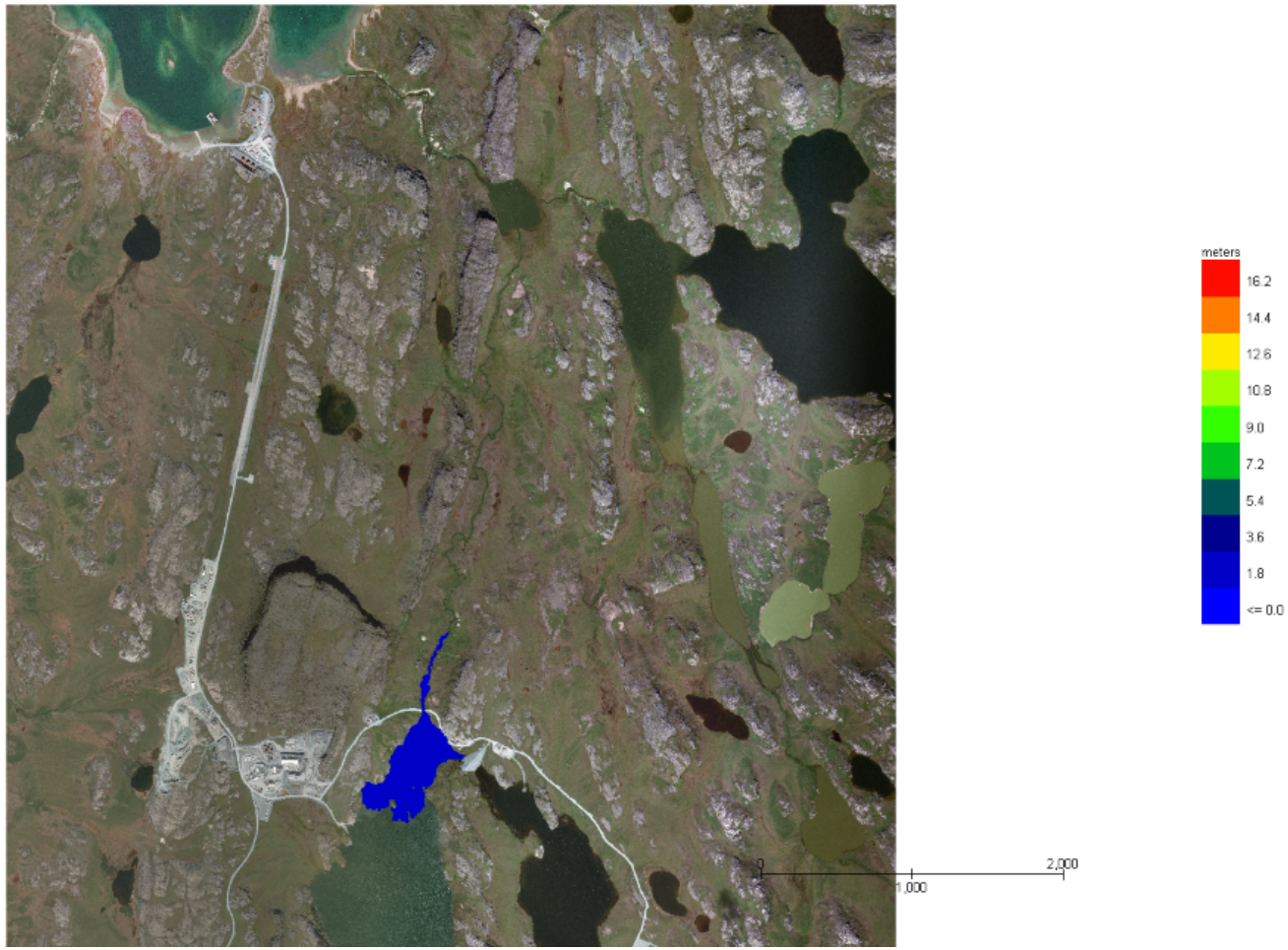
Grid Element Flow Depth (1800 sec.) [0.5:0:0]



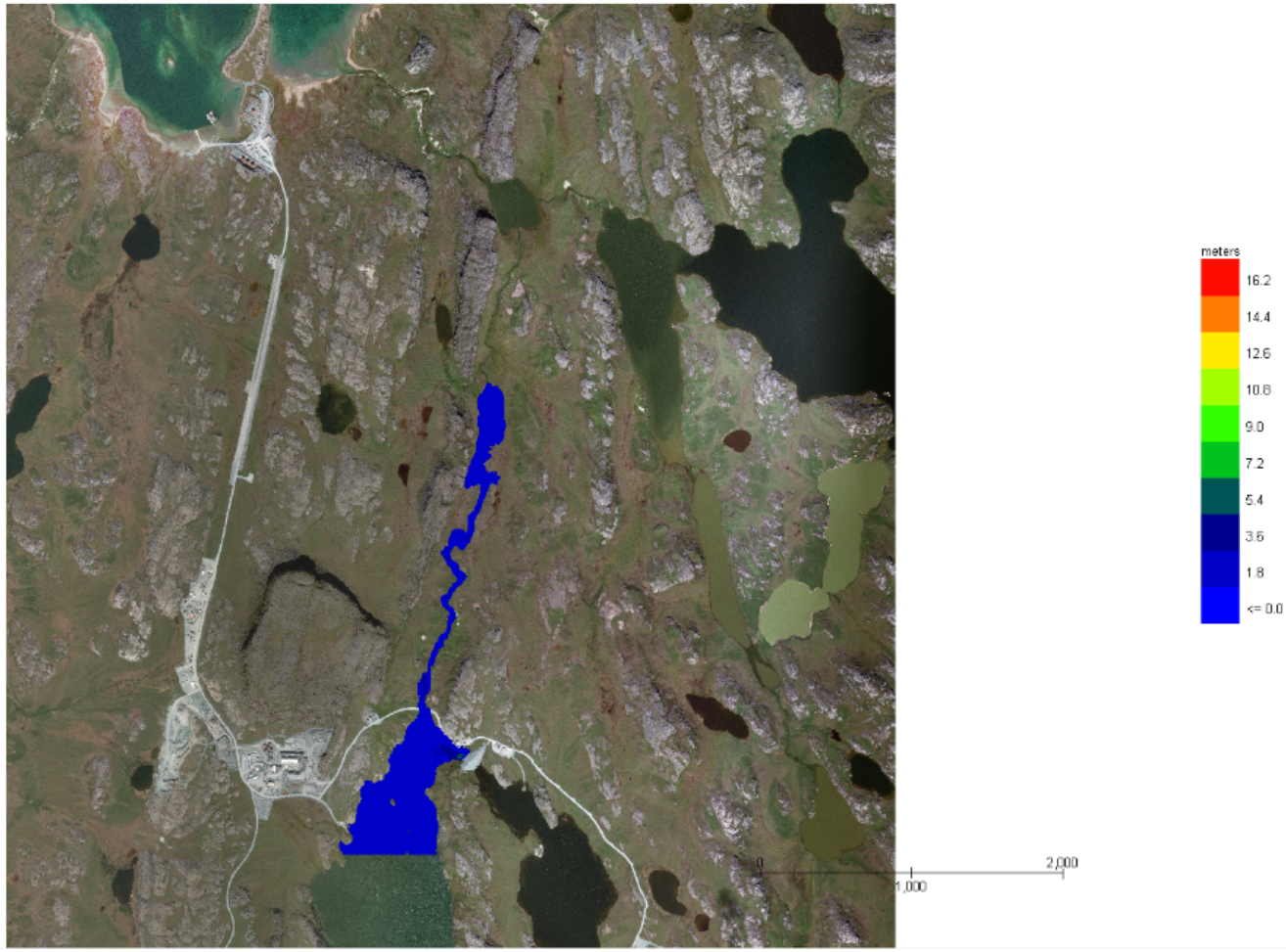
Grid Element Flow Depth (3600 sec.) [1:0:0]



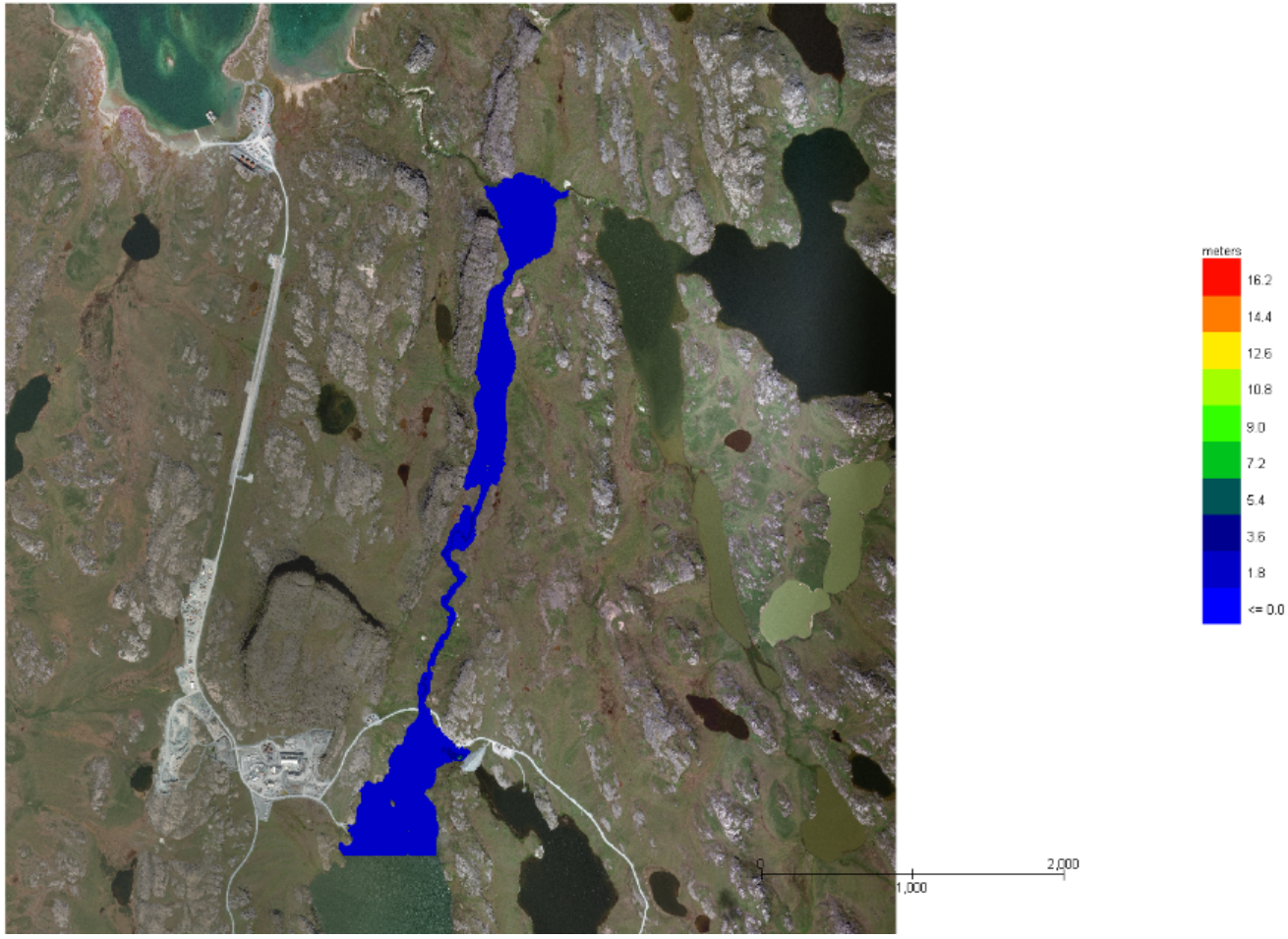
Grid Element Flow Depth (7200 sec.) [2:0:0]



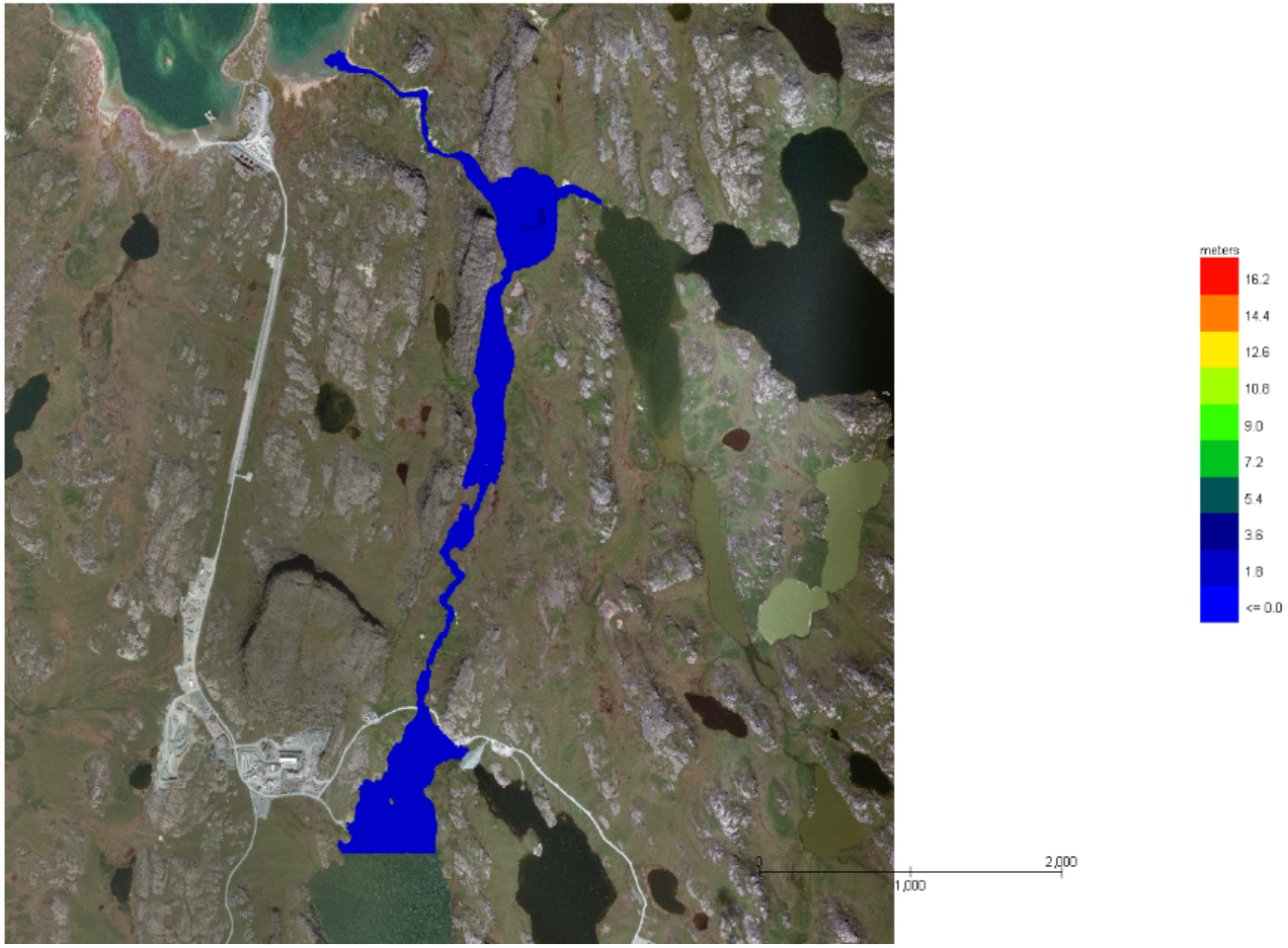
Grid Element Flow Depth (14400 sec.) [4:0:0]



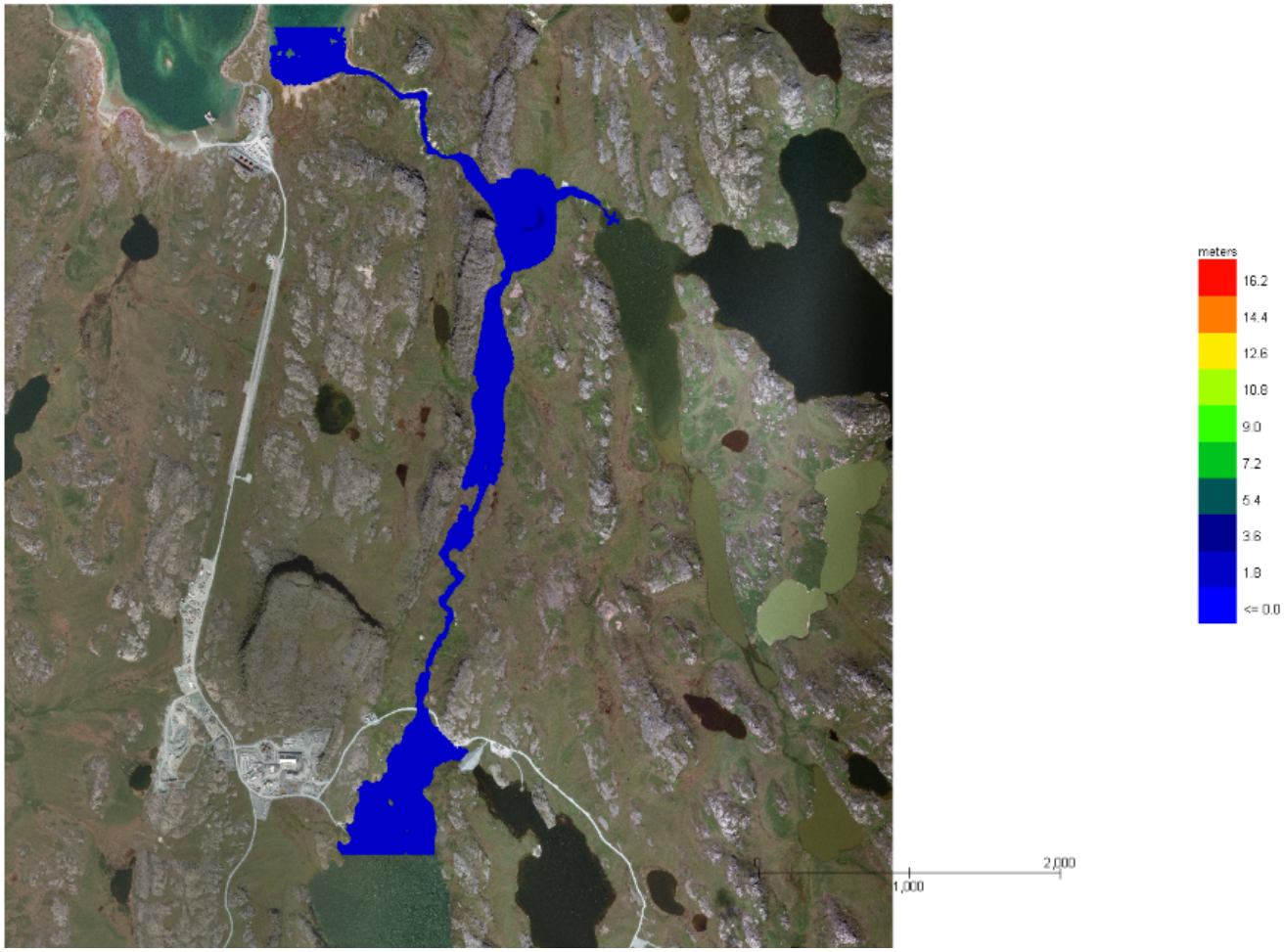
Grid Element Flow Depth (21600 sec.) [6:0:0]



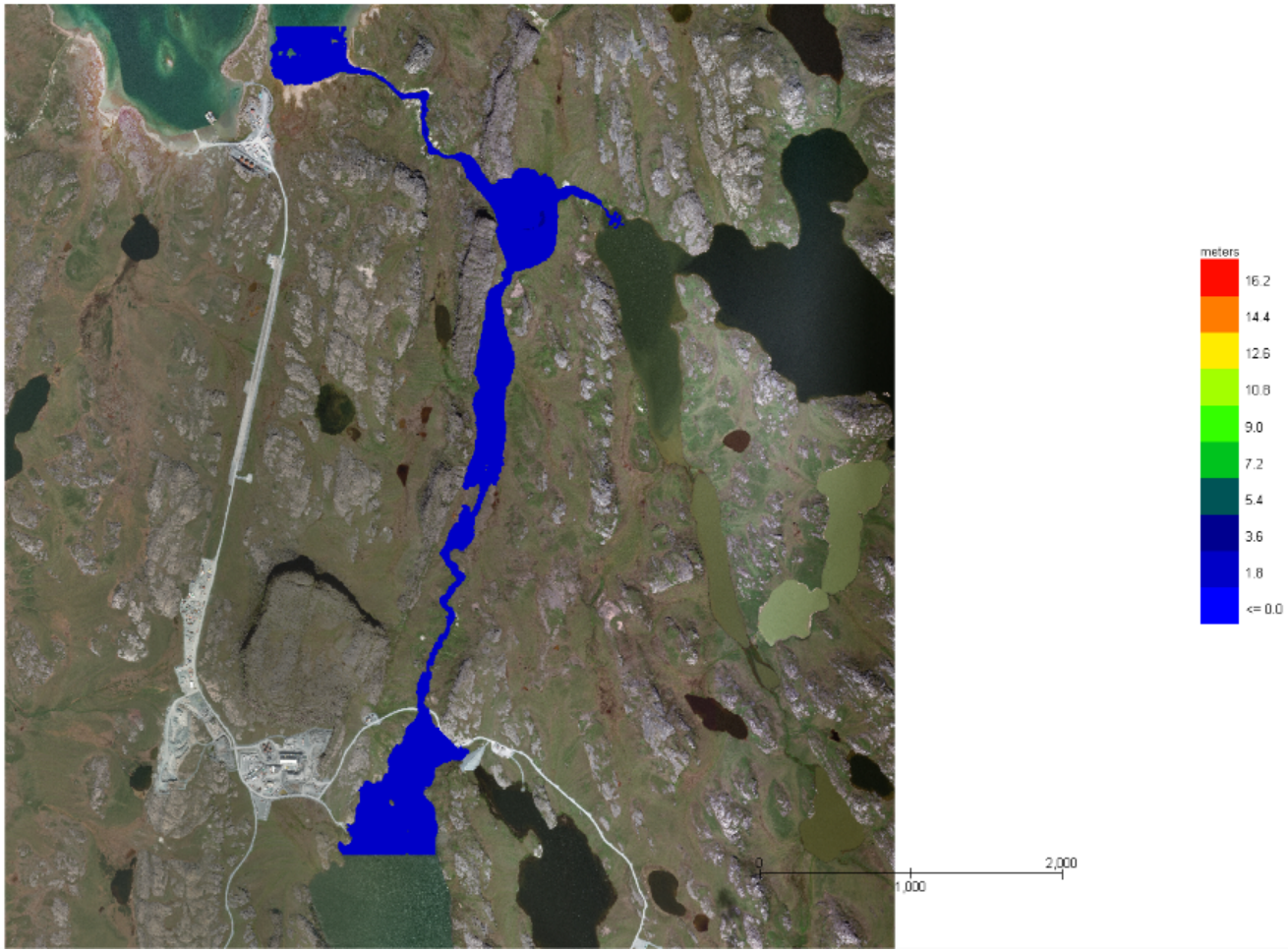
Grid Element Flow Depth (28800 sec.) [8:0:0]



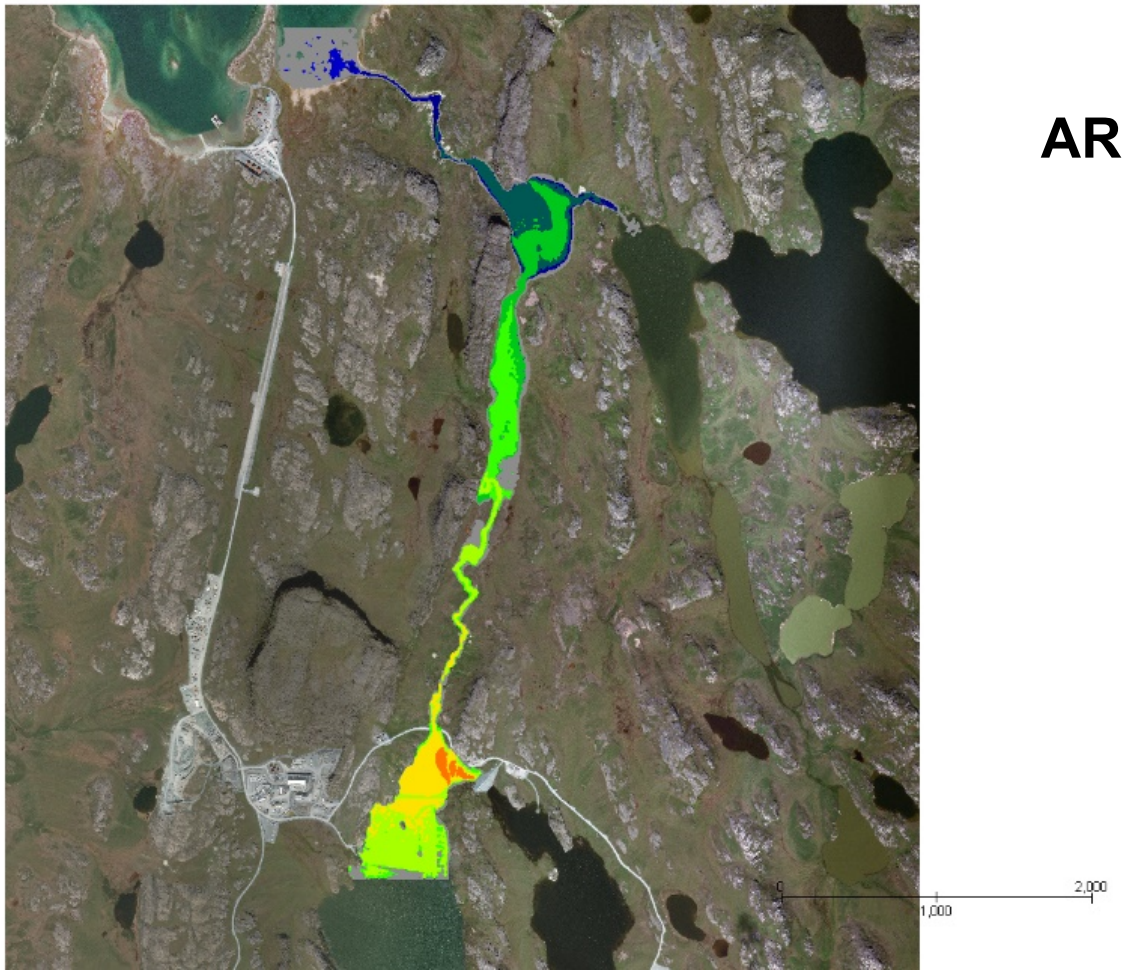
Grid Element Flow Depth (36000 sec.) [10:0:0]



Grid Element Flow Depth (43200 sec.) [12:0:0]



Grid Element Time to One Foot
(From simulation time 0.0 or initial breach discharge)



ARRIVAL TIME

(~hrs)

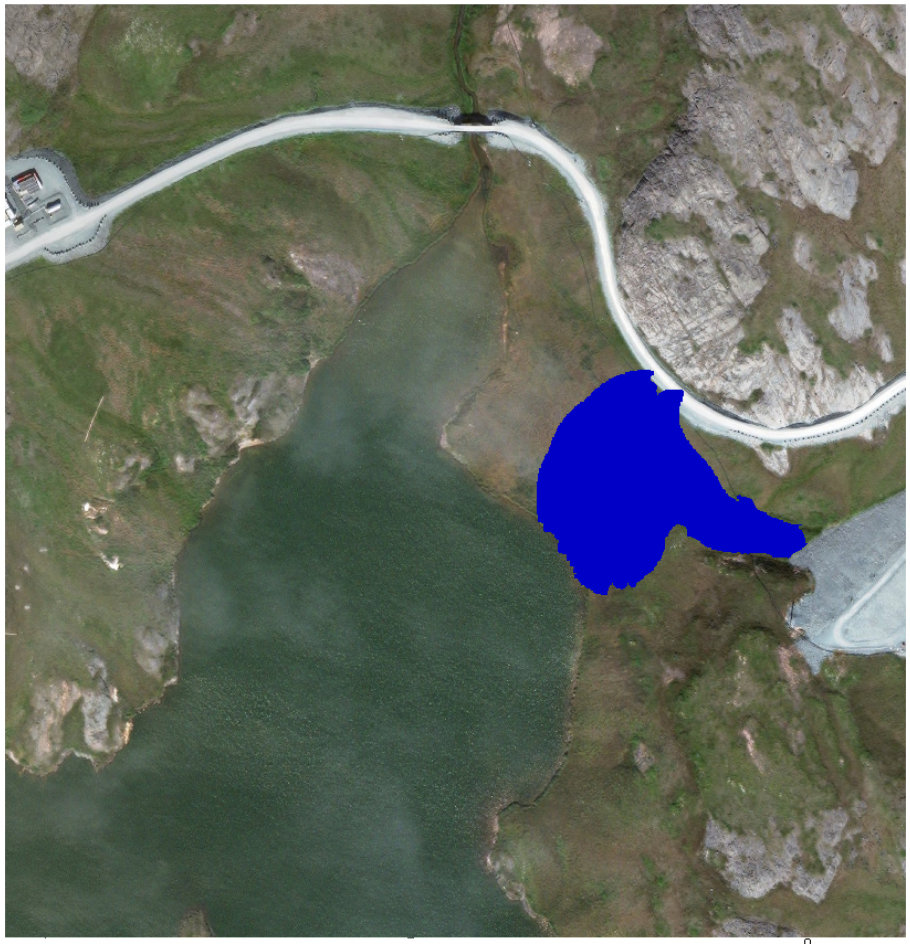


North Dam – Detailed / Local Model (focus on bridge)

Grid Element Flow Depth (360 sec.) [0:6:0]

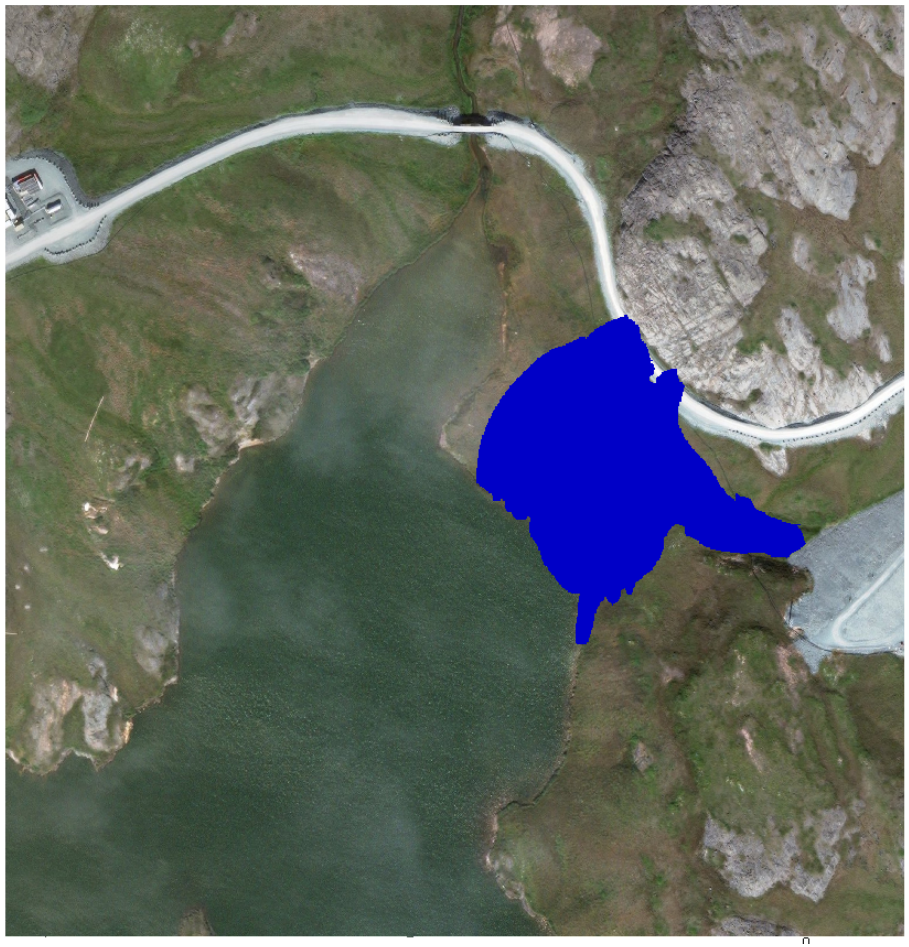


Grid Element Flow Depth (720 sec.) [0:12:0]

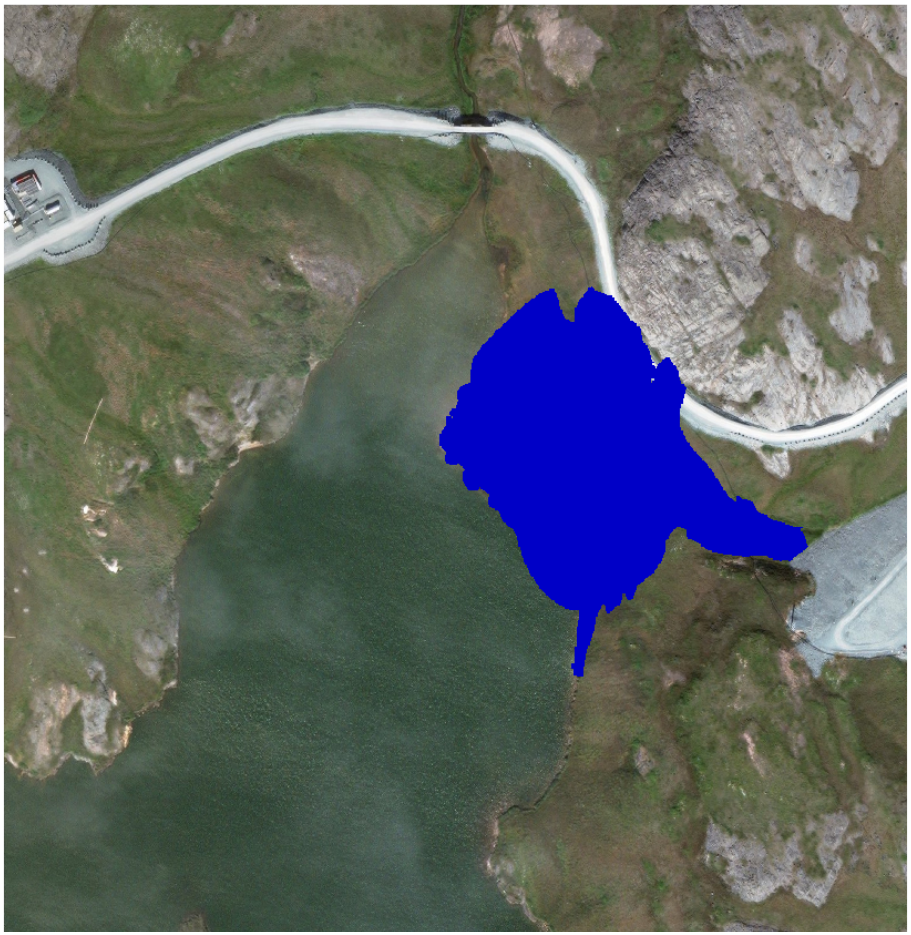


~ 12 mins

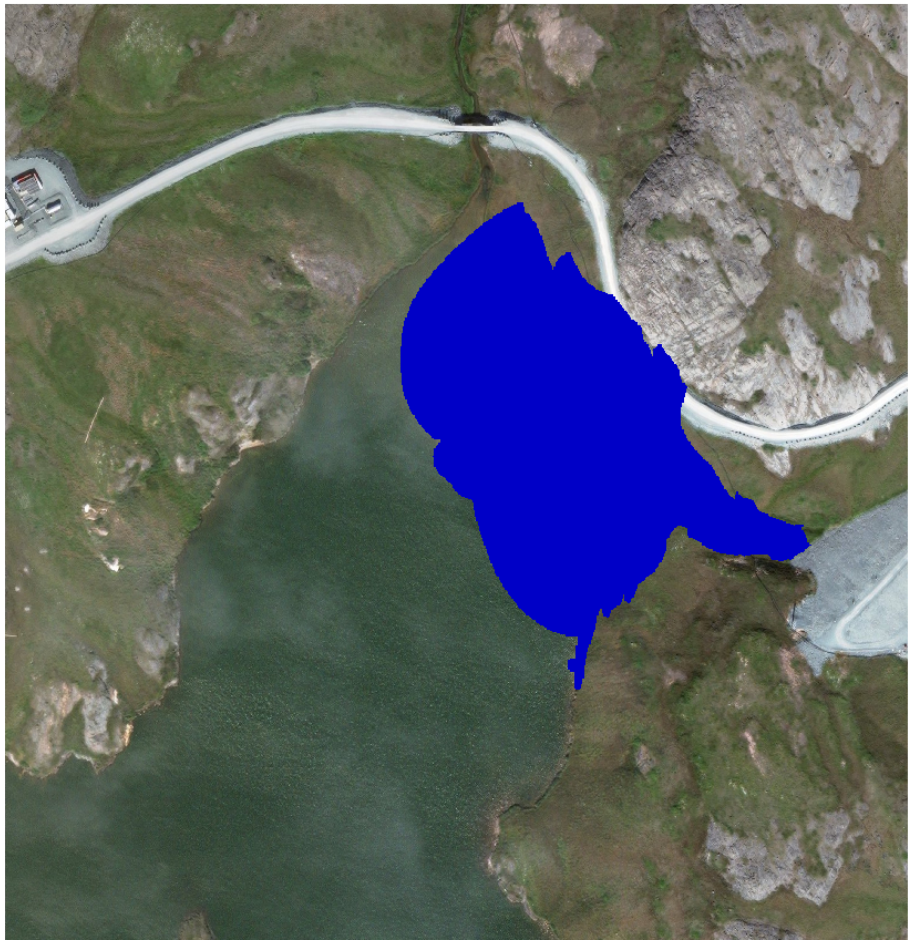
Grid Element Flow Depth (1080 sec.) [0:18:0]



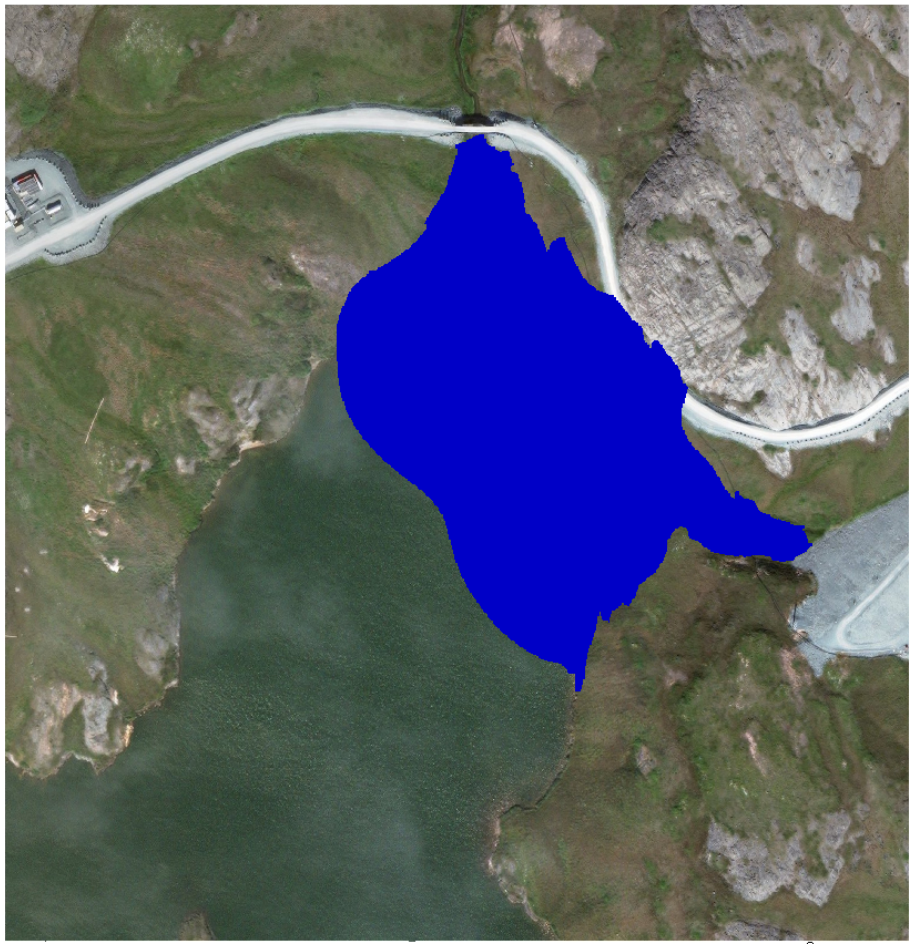
Grid Element Flow Depth (1440 sec.) [0:24:0]



Grid Element Flow Depth (2160 sec.) [0:36:0]

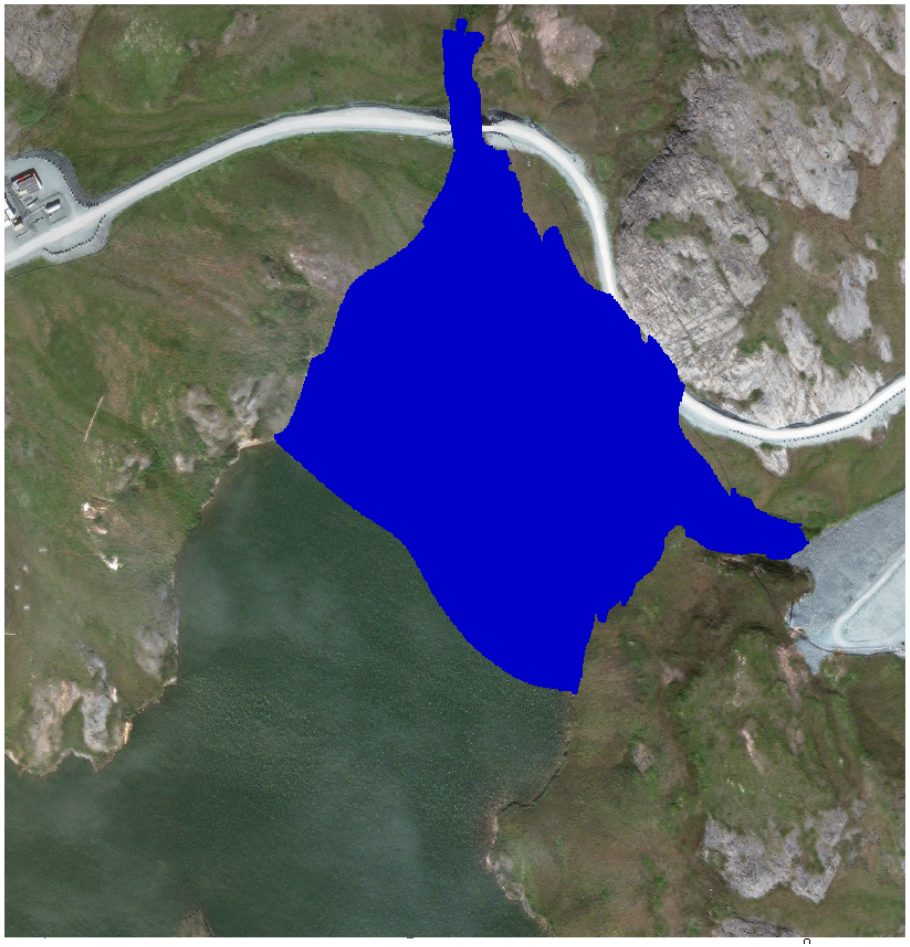


Grid Element Flow Depth (2880 sec.) [0:48:0]



~ 48 mins

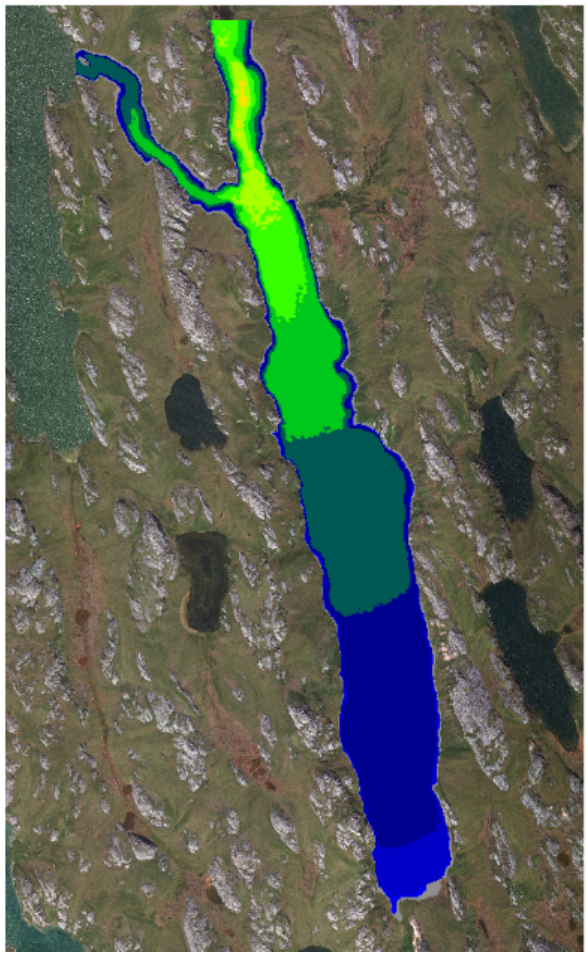
Grid Element Flow Depth (3600 sec.) [1:0:0]



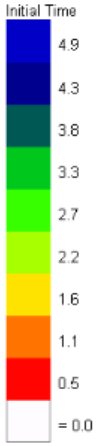
~ 60 mins

South Dam - General / Global Model (to Doris Lake)

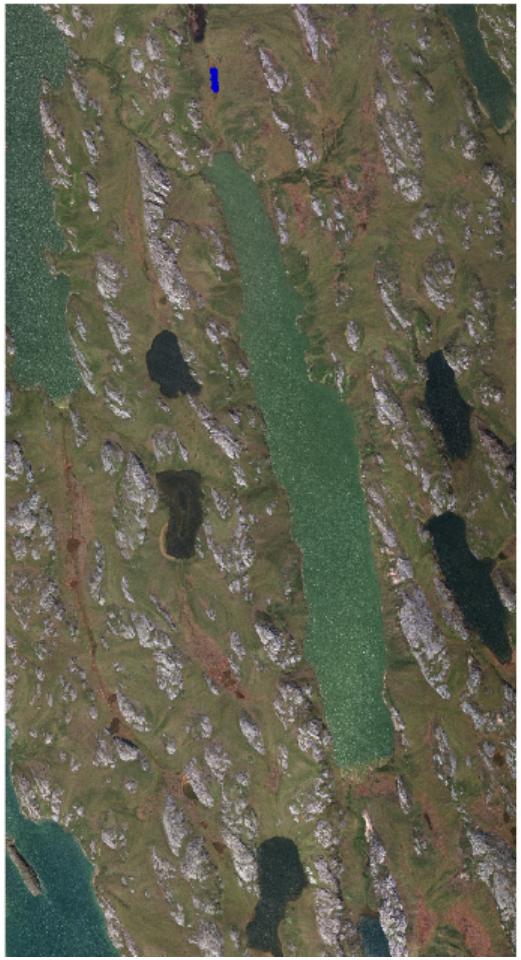
Grid Element Time to One Foot
(From simulation time 0.0 or initial breach discharge)

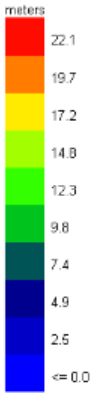


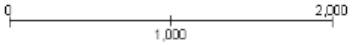
ARRIVAL TIME
(~hrs)



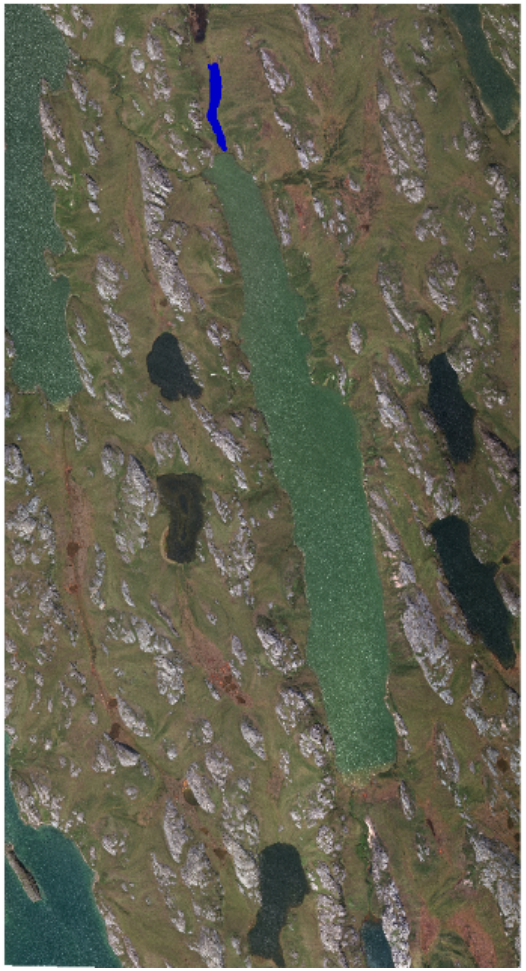
Grid Element Flow Depth (1800 sec.) [0:30:0]

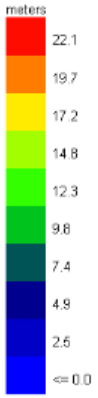






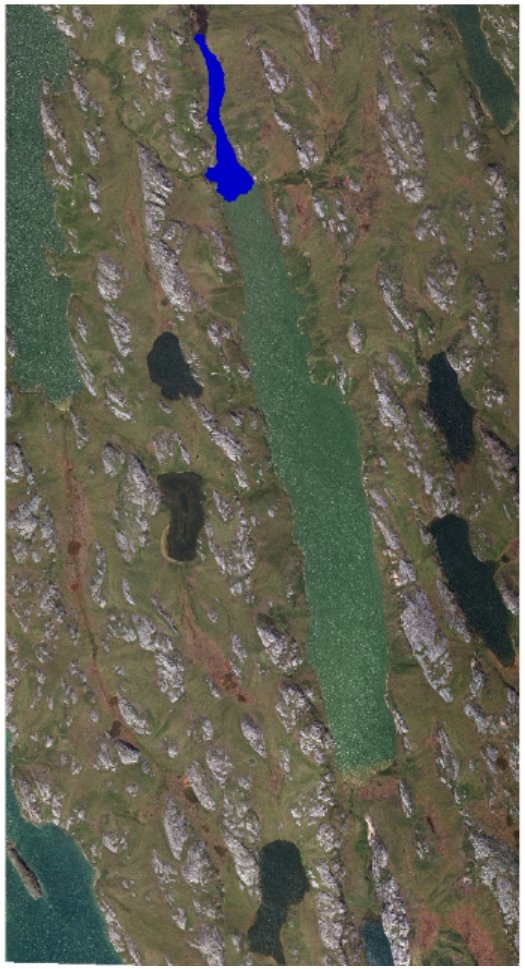
Grid Element Flow Depth (3600 sec.) [1:0:0]

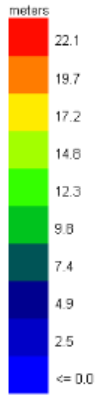


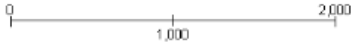




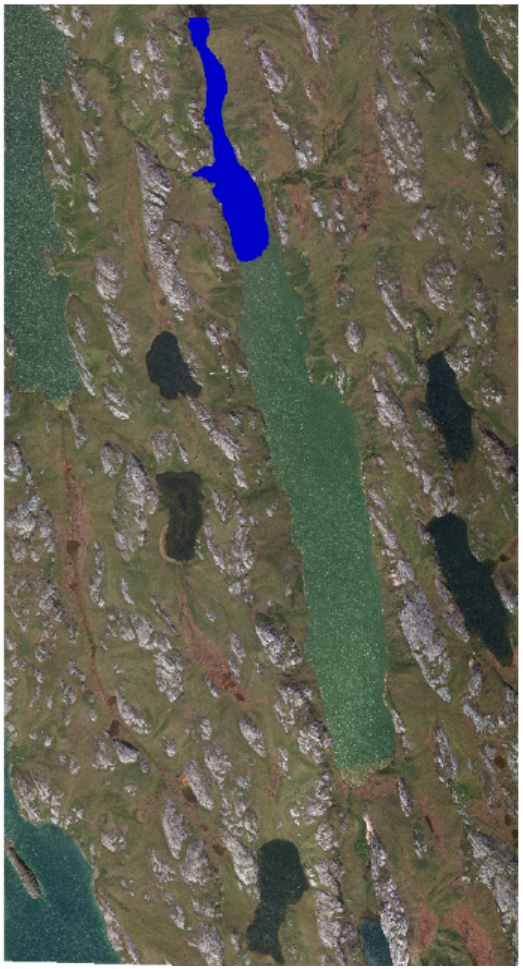
Grid Element Flow Depth (5400 sec.) [1:30:0]

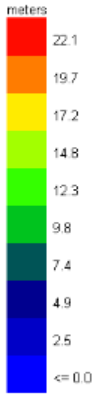


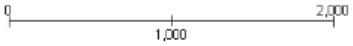




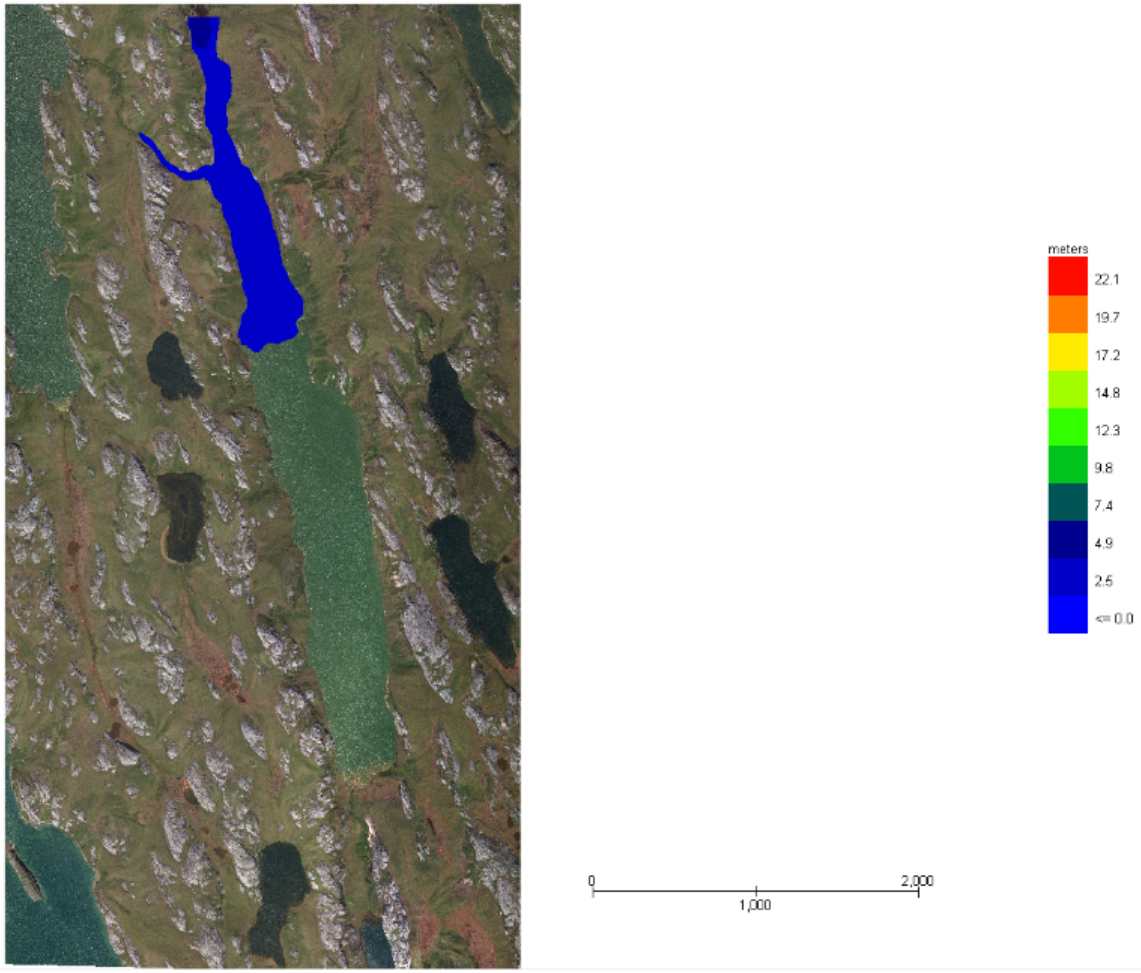
G Grid Element Flow Depth (7200 sec.) [2:0:0]



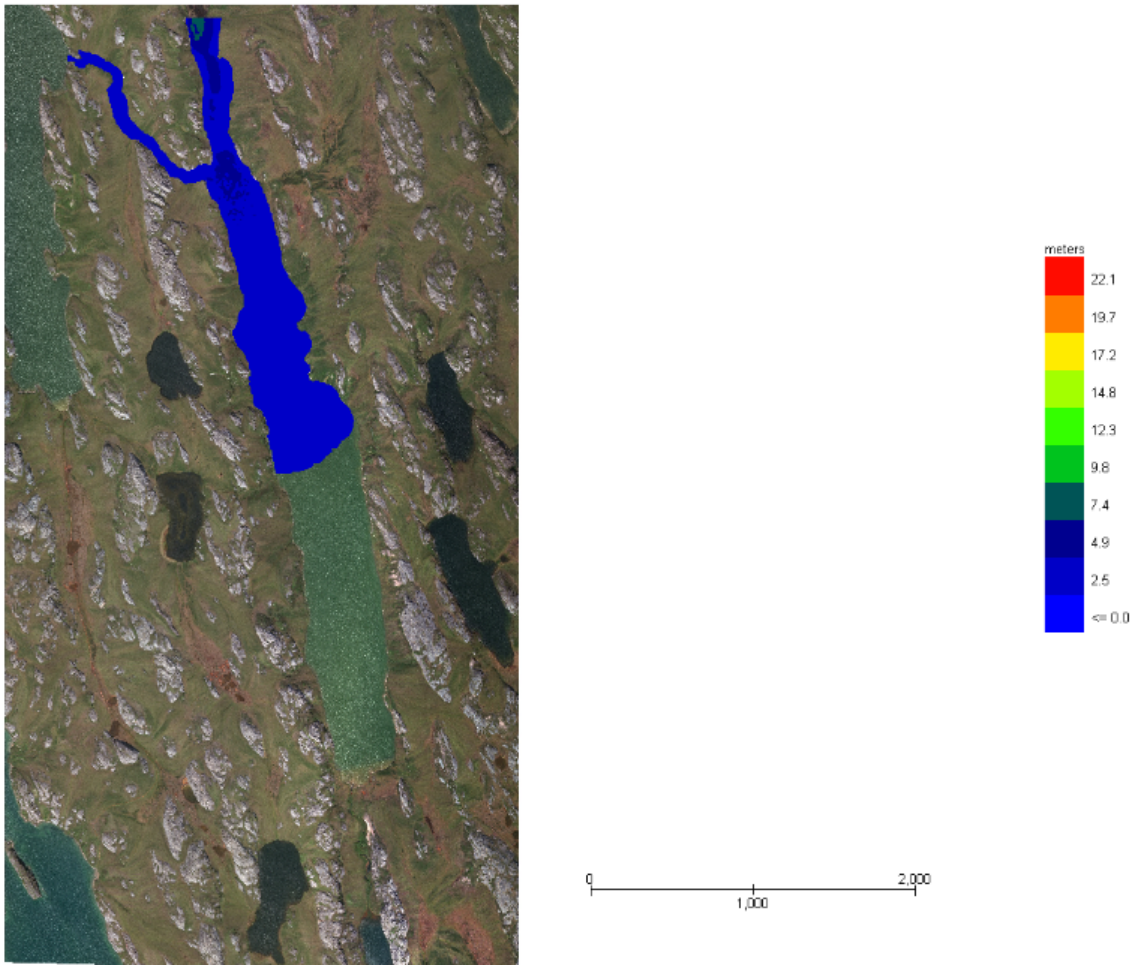




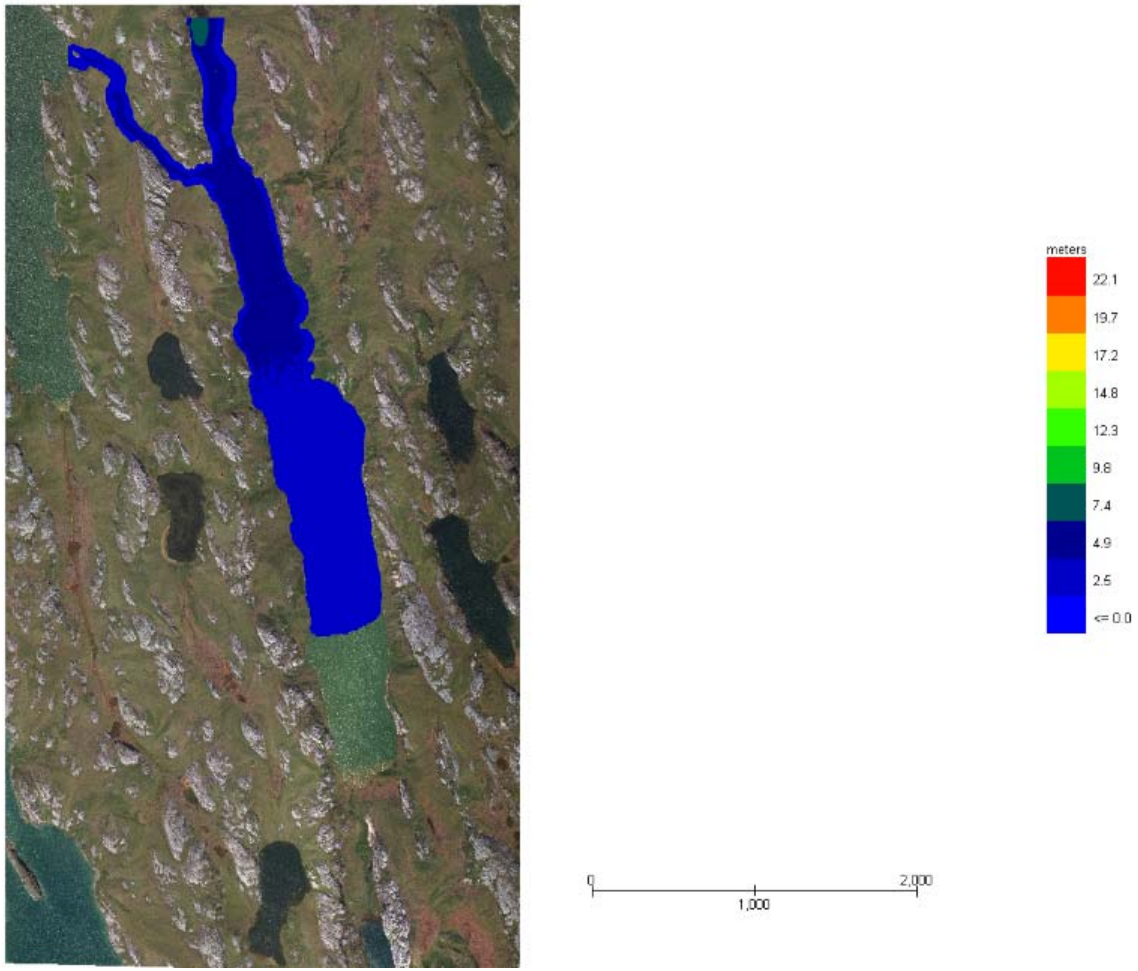
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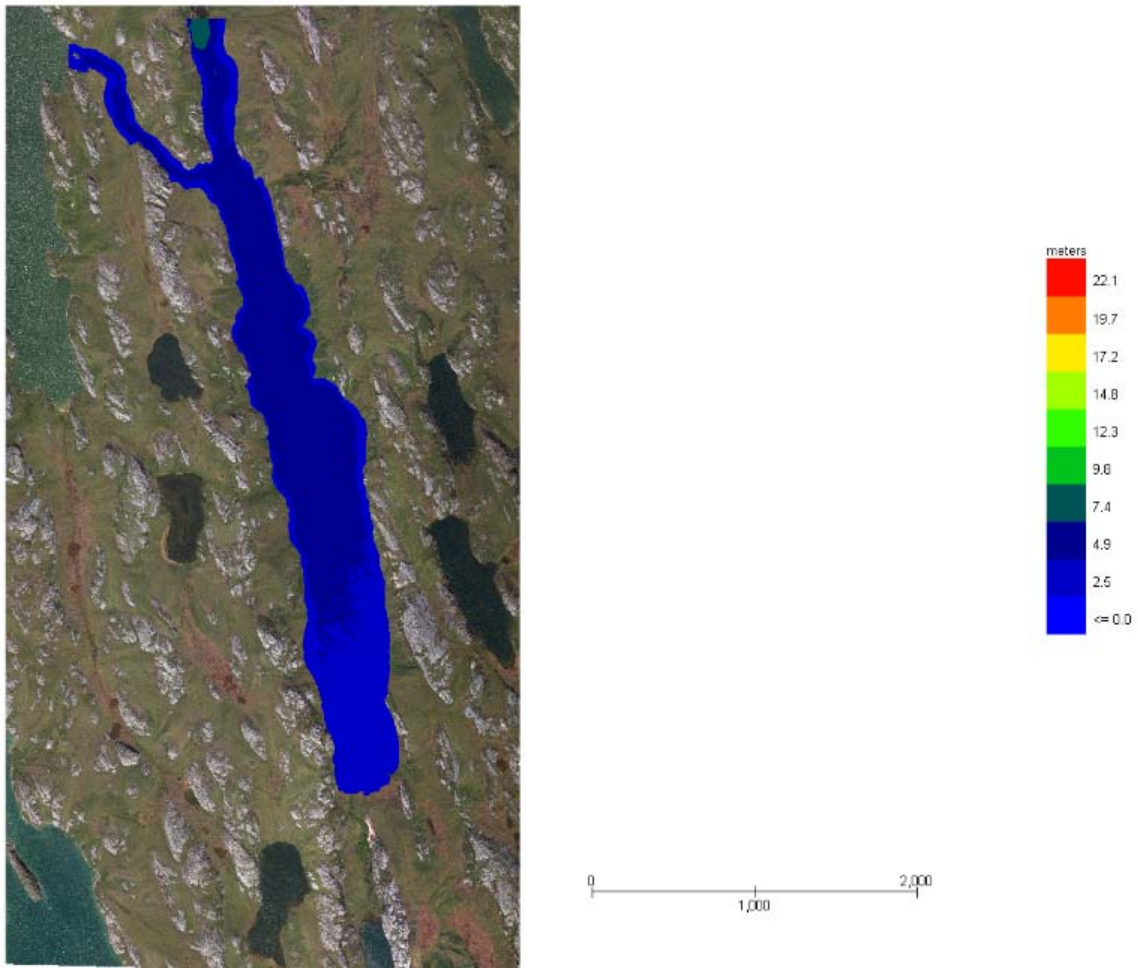
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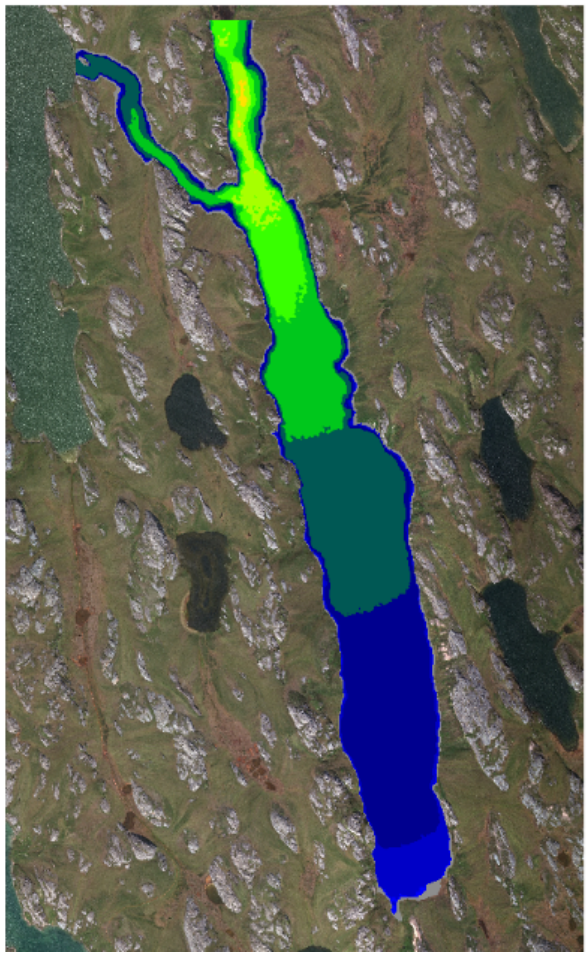
GRID ELEMENT FLOW DEPTH 12600 Sec [03:30:00]



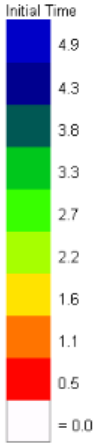
GRID ELEMENT FLOW DEPTH 14400 Sec [04:00:00]



Grid Element Time to One Foot
(From simulation time 0.0 or initial breach discharge)



ARRIVAL TIME
(~hrs)

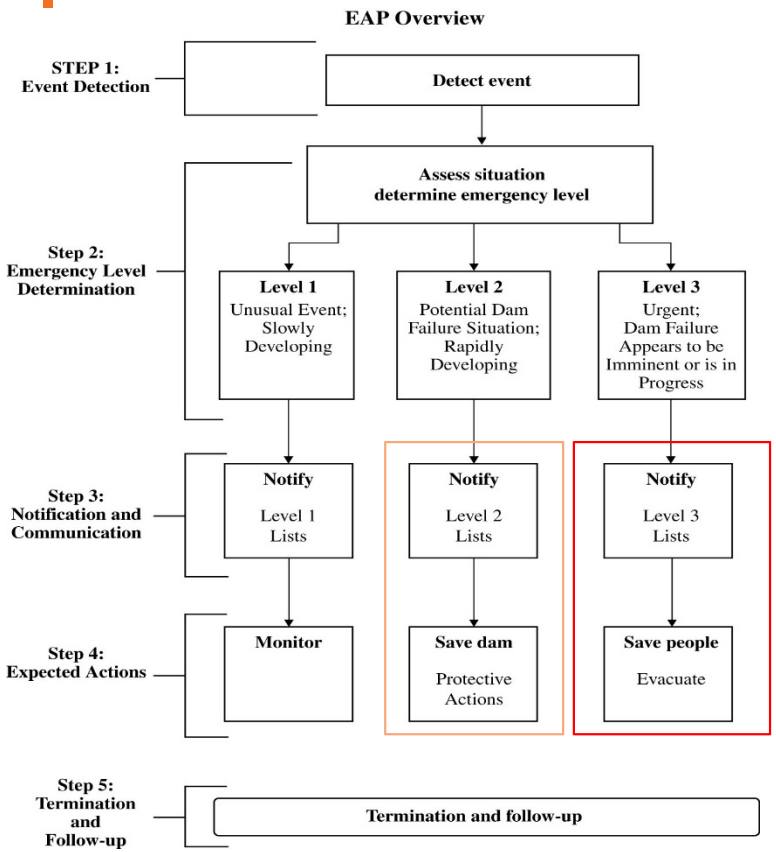


7 Summary of ERP (Dam) Scenarios

Informed from Inundation Maps

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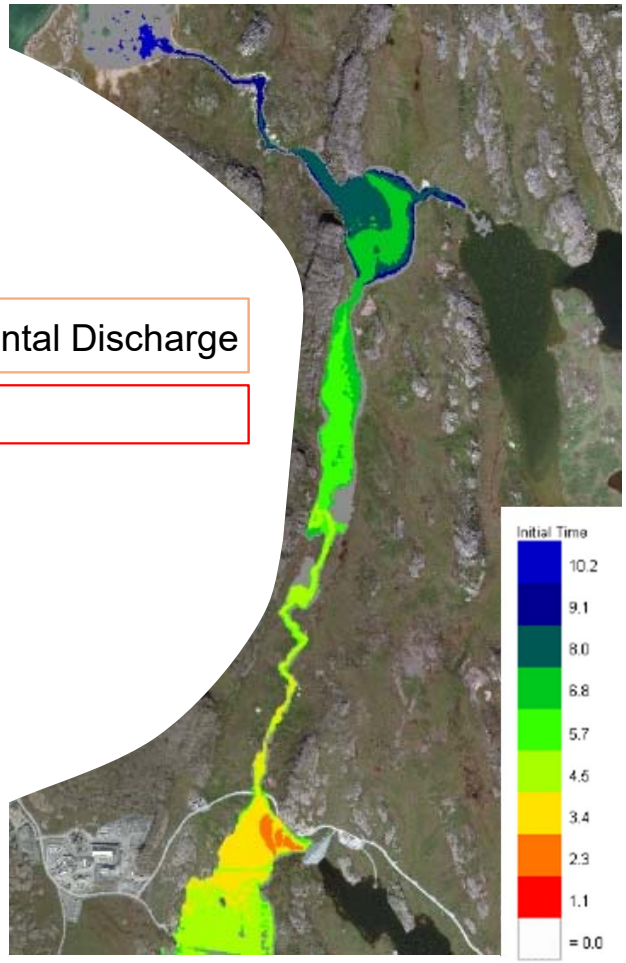
North Dam



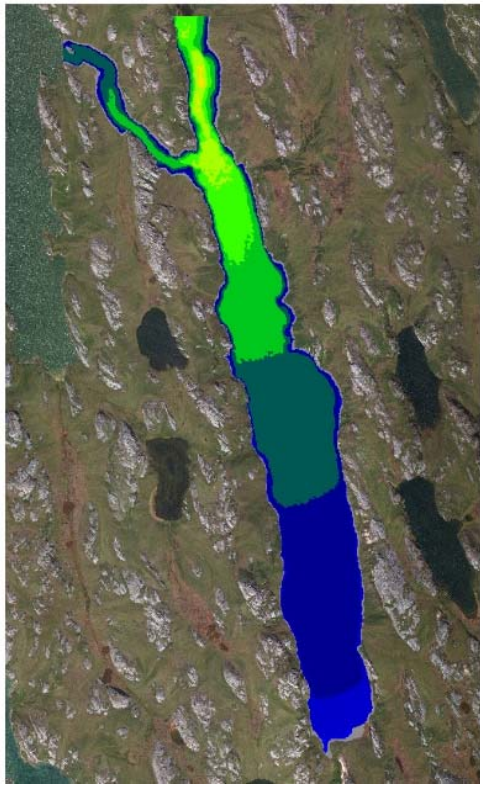
Ref: *BC MFLNRO – Guide & Template for Preparing Dam Emergency Plan in British Columbia, 2016*

Main scenarios are:

- Undesirable Environmental Discharge
- Breach of North Dam.
  - Breach travels North



South Dam



Main scenario is:

- Breach of South Dam
  - Breach travels south

5 Discussions on ERP (Dam) Scenarios

Dam Break or Uncontrolled Environmental Discharge

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North Dam

North Dam – Undesirable Environmental Discharge

To avoid compromising the dam stability, supernatant water would either be pumped:

- To the downstream side of the dam into Doris Lake, and then Doris creek, and conceivably (at lower concentrations) reach the entire north downstream catchment all the way to Roberts Bay; or
- Pumped via the Roberts Bay Discharge system out to the ocean (Roberts Bay)



North Dam

North Dam –Breach

Breaching of the North Dam would reach:

- Tail Lake outflow,
- Doris Lake, Doris Creek,
- and Little Roberts Lake further downstream.

Supernatant Water
Supernatant water could conceivably reach the entire north downstream catchment all the way to Roberts Bay.

Tailings Solids
Based on the current deposition plans (off the South and West dams on the south end of the TIA) there is no conceivable chance of tailings solids being released as a result of a breach of the North Dam.

Note: under a conservative case where the largest possible volume of supernatant water (over 12 Mm^3) is discharged rapidly over a period of less than 8hrs, then the Doris Creek Bridge would also be damaged.



South Dam

South Dam –Breach

Breaching of the South Dam would reach

- Ogama Lake,
- Ogama Lake outflow, and
- Subsequently, Doris Lake.

Supernatant Water

Supernatant water would eventually progress all the way along the drainage network to Roberts Bay. This being noted primary impact to Ogama the Doris Lake (after this quite diluted)

Tailings Solids

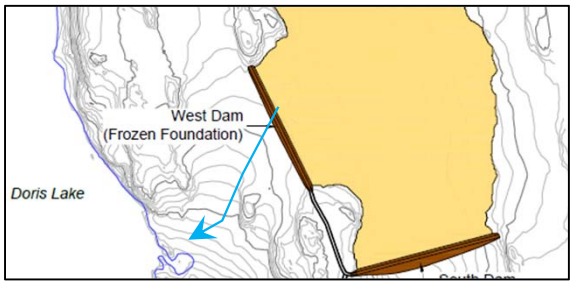
A breach of the South Dam could result in tailings solids releasing

- into Ogama Lake and
- though a remote chance, into the Ogama Lake outflow and ultimately Doris Lake.

Tailings solids would not be expected to be transported any further than Doris Lake, with most tailings between the South Dam and down to and into Ogama Lake.



West Dam

West Dam – Breach		
Tailings breaching the West Dam would reach Doris Lake.  	**Supernatant Water** Supernatant water could progress all the way along the drainage network to Roberts Bay.	**Tailings Solids** Tailings solids could reach Doris Lake, but at a location about 3.5 km away from the Doris Lake outflow. It is not expected the solids would migrate any further.

General Note:

- Once the West Dam (Phase 2) is built on site an updated extreme failure mode of ‘West Dam – Breach’ will be required to be added to this OMS and the site ERP.

6 Discussions on ERP (Pipelines and Pumping) Scenarios

Malfunctions, Leaks, Burst Punctures

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Pipelines and Pumping

7.1 Pipeline Burst, Leak, or Puncture

Notification

The table below identifies who should be informed when a puncture or burst in the TIA pipeline system is observed.

If you are a…	then immediately notify the…
TIA operator	mill manager.
non-TIA management person	surface operations supervisor.
surface operations supervisor	mill manager.

Inspection by Mill Manager

After inspecting the pipeline, can a repair be made without ceasing operations?

- If yes, see if an alternately pipeline can be used until the current line is repair.
- If yes, and an alternate pipeline is not above, coordinate an emergency mill shutdown complete repairs.
- If no, order repairs.

Repairs

Repairs are performed by the TIA operator or specialist contractor. Tailings in any damaged lines may be emptied into the Emergency Tailings Catch Basis if / as required to help facilitate repairs.

From latest version of TMAC Doris TIA OMS (updates in progress)

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Pipelines and Pumping

7.2 Heat Trace Cable Malfunction

When Required?	Heat tracing is only required for • no-flow conditions under freezing temperatures, • flow conditions below −30°C, and • shutdowns greater than 24 hours. Therefore, heat tracing is normally switched off, and preventative maintenance is carried out to maintain flow in all pipes.
Notification	The TIA operator should notify the mill manager immediately when a malfunction in the heat tracing cable is observed during required operating periods.
Inspection by Mill Manager	After inspecting the pipeline, determine the extent of the malfunction and time required for repair. Then, coordinate the repair.
Repairs	Repairs are performed by the TIA operator or specialist contractor.

From latest version of TMAC Doris TIA OMS (updates in progress)

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Pipelines and Pumping

7.3 Pumping or Reclaim System Malfunction

Notification

The table below identifies who should be informed if TIA or Roberts Bay Discharge system pipeline system malfunctions, fails or shuts off

If you are a…	then immediately notify the…
TIA operator	mill manager.
non-TIA management person	surface operations supervisor.
surface operations supervisor	mill manager.

Inspection by Mill Manager

After inspecting the pump, can a repair be made without ceasing operations?

- If yes, coordinate an emergency mill shutdown and complete repairs.
- If no, order repairs or install new pump / system.

Repairs

Repairs are performed by the TIA operator or specialist contractor.

From latest version of TMAC Doris TIA OMS (updates in progress)

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Attachment 2

Recommendations and TMAC Responses – TIA (TMAC, 2020)

Table 1 *2019 Tailings Impoundment Area Annual Geotechnical Inspection Report Recommendations and TMAC Response*

Inspection Item	2019 Recommendations	TMAC Response
General TIA Management Recommendations		
Third Party Dam Safety Review	Conduct an independent third-party Dam Safety Review for both the North and South Dams in the summer of 2021.	An independent third-party Dam Safety Review is scheduled to be conducted for both the North and South Dams in the summer of 2021
Tailings Operating, Maintenance and Surveillance (OMS) Manual and Emergency Response Plan (ERP)	An update to the OMS manual is in progress by SRK and will be submitted by Q4, 2020. This update is aimed to be a notable improvement to the current OMS. This noted, additional updates are expected in Q3 and Q4 2020. The focus of the OMS updates in Q3 and Q4 will be further refinement of the Trigger Action Response Plans (TARPs). The OMS for this facility will be a 'living' document that is expected to be reviewed annually.	N/A
	TMAC should ensure all staff are properly informed and trained on the contents of the OMS Manual.	TMAC conducts regular review of the OMS manual with key staff including emergency response scenarios. Components of the OMS manual are included with new hire orientations.
	At the time of writing this report, TMAC was in the process of developing a standalone 'Hope Bay Project Dam Emergency Plan', rather than updates to the ERP, to address dam emergencies. It will incorporate inundation mapping and dam break scenarios. The standalone dam emergency plan will be released upon completion of the OMS update to ensure alignment. An Emergency Reponses Plan exists for the site; however, this document was lacking sufficient detail for a specific emergency at the TIA, if one were to occur. In 2019 SRK visited site and held a session with site personnel to go over preliminary dam break inundation maps completed by SRK and to provide inputs into what should be included in the site ERP updates to ensure the TIA is properly covered in this document. An update to the ERP is recommended in 2020 to provide additional details for the TIA.	TMAC engaged SRK to assist with a dam break analysis of the North and South Dams to assist with updating the emergency response planning. TMAC is developing a standalone 'Hope Bay Project Dam Emergency Plan' to address dam emergencies.
TIA Responsible Parties	TMAC must agree on the roles and responsibilities for the TIA, train and inform personnel of their duties, and operate the facility accordingly. This will be an ongoing recommendation that is expected to be repeated annually. The roles and responsibilities for the TIA will be defined in	No discrepancies exist regarding the lines of responsibilities as they are defined in the TIA OMS. TIA OMS training and awareness will continue to provide for all departments and individuals

Inspection Item	2019 Recommendations	TMAC Response
	the OMS update, to be released in 2020.	responsible for operation of the facility.
Monitoring Standard Operating Procedures (SOPs)	Update the Monitoring SOP to include South Dam monitoring requirements. SRK is currently preparing a separate SOP for the South Dam, and one already exists for the North Dam. A draft version of the South Dam SOP was submitted to TMAC in June 2020 and a final version is expected in July 2020.	TMAC will adhere to the updated Monitoring SOP upon issuance for use.
Compliance with Monitoring Requirements	Conduct monitoring in accordance with the Monitoring SOP, paying attention to those areas where conformance is not consistently met.	TMAC will carryout monitoring activities as per the Monitoring SOP. Any deviations from protocol will be communicated to the Engineer of Record (EOR).
North Dam Inspection and Review of Monitoring Data		
Ground Temperature Cables (GTCs)	There are no specific recommendations for the installed GTCs. However, TMAC should aim to improve performance tracking of the dataloggers at the South Dam and check to see if cables are being damaged by wildlife after spring melt in order to confirm that current cable protection is adequate.	In cooperation with the EOR, TMAC will continue to inspect and track the performance of all instrumentation on both the North and South Dams.
Thermosyphons	The 2018 recommendations were completed in 2019 and Arctic Foundations Canada (AFC) visited the site for an inspection. Additional details are provided in this 2019 AGI (see Appendix A).	N/A
CR1000 Datalogger Battery Voltage	The external CR1000 datalogger batteries should continue to be monitored and recharged annually or replaced as needed.	Battery charge data is reviewed monthly and batteries are maintained accordingly.
Inclinometers	The inclinometer and associated readout device should be recalibrated every 3 years as per recommended best practice. SRK was aware that TMAC sent this instrument for recalibration but due to COVID-19, the instrument calibration was unable to be performed and had to be returned from the out of country manufacturers. This recommendation should be revisited before the spring of 2021.	The inclinometer and readout device will be sent out for calibration upon the onset of winter when dam movement is less likely to occur.
Survey Monitoring Points	Backfill the erosion around survey monitoring point ND−DSP−100 at the North Dam.	Erosion observed at ND-DSP-100 has been backfilled.
	Continue to carefully observe the North Dam downstream shell settlement points ND-SSP-080-3 and ND-SSP-110-3 to determine if thaw settlement of the toe is causing undue deformation.	Routine inspections of the downstream dam shell including ND-SSP-080-3 and ND-SSP-110-3 will continue as recommended.
Creep Displacement	None.	N/A

Inspection Item	2019 Recommendations	TMAC Response
Walkover Surveys	The required weekly walkover surveys at the North Dam are not being completed in accordance with the SOP. This is an important surveillance activity as defined in the OMS Manual and needs to be complied with.	TMAC acknowledges that not all 52 weekly inspections were completed. Improvements have been made to close this gap each year and TMAC will continue to aim for full compliance with the recommended frequency.
North Dam Seepage	Continue water quality monitoring of North Dam seepage according to the methods outlined in SRK (2018b) (this was completed in 2019).	TMAC will adapt the North Dam Seepage program to include the additional recommendations.
	Conduct at least one additional frost probe survey along the same transects in early summer and early fall, following the same procedure as in 2018 and 2019. Based on current favourable results, SRK will revisit the requirements for the frost probe surveys as part of the 2020 AGI and determine if further surveys are required beyond 2020.	TMAC will continue with the recommended frost probe survey in 2020.
AGI Physical Inspection	None.	N/A
South Dam Inspection and Review of Monitoring Data		
Ground Temperature Cables (GTCs) and D405 Dataloggers	· Complete a walk over survey of the South Dam after spring melt and look for any exposed or damaged ground temperature cables. This will allow for preventative maintenance to be done if exposed cables are observed, which will help to limit the potential for damage from wildlife. · SRK to further assess, if repairs are not possible, replacement of Ground Temperature Cables SD-VTS-155-US, SDVTS-240-US and SD-VTS-240-DS will be required. · Manually download data from each datalogger once annually or as specified by the EOR.	TMAC will conduct survey of all GTC cables and report results to EOR, Maintenance and repairs will be conducted as required. Manually downloads will be collected annually.
Survey Monitoring Points	None.	N/A
Physical Inspection of the South Dam and Walkover Surveys	Start weekly walkover surveys of the South Dam in 2020. This is an important surveillance activity. Additional details will be provided to TMAC in the South Dam SOP.	Weekly walkover surveys started in 2020 and will continue as per the South Dam SOP.
TIA-Wide Monitoring		
Tailings Deposition System	TMAC should install the dedicated mine water discharge pipeline to the TIA as soon as possible to allow tailings deposition to recommence from the South Dam. It is critical that tailings deposition from South Dam recommence in order to maintain a beach length of at least 100 m at all times, for all TIA water levels. *UPDATE: this was*	N/A

Inspection Item	2019 Recommendations	TMAC Response
	addressed at the start of 2020 and is now complete. The Roberts Bay Discharge system is now operational.	
	Saline mine water may only be discharged together with tailings from, or within, 300 m of the South Dam provided the freezing point depression is less than 0.5oC (around 4,500 mg/L Cl maximum equivalent). If the freezing point depression exceeds 0.5oC, saline mine water may only be discharged with tailings at other designated tailings discharge points further than 300 m from the South Dam or directly into the Reclaim Pond. The freezing point depression calculation is provided in this AGI and will be incorporated by SRK into the updated OMS Manual (update currently in progress).	TMAC continues to analyze mine effluent and tailings to determine if the depression freezing point is less than 0.5°C as recommended by the EOR. Effluent or tailings that exceed the recommended freezing point are directed away from the South Dam maintaining the recommended 300m buffer.
	The tailings discharge system must be operated in accordance with the designated tailings discharge plan. Primary spigot moves should be expected around, or shortly afterwards, spring melt and again prior to winter freeze up.	Tailings deposition will be executed as per the guidance in the tailings deposition plan.
	Areas along the eastern shoreline of the TIA where tailings discharge has occurred at elevations above 36.5 m need to be carefully monitored to determine if permafrost damage is occurring due to tailings flow and vegetation dieback. Should any damage be noted, appropriate proactive mitigation may be required.	No vegetation dieback has been observed in these areas to date. TMAC will continue to monitor these areas and apply mitigate actions as required.
Emergency Dump Catch Basins	Repair the Western Emergency Dump Catch Basin at the earliest opportunity to ensure liner movement does not occur and impact the as-built storage capacity of this Emergency Catch Basin.	The tailings emergency catchment basin will be repaired at the earliest opportunity.
Pipelines (Reclaim, Tailings Deposition and TIA Discharge)	TMAC must carefully inspect all pipelines placed directly on the tundra for signs of vegetation dieback and associated flow path channelling. Where this is occurring, the pipeline must be relocated to follow existing all-weather road shoulders, and appropriate remediation needs to be put in place where damage has occurred. Going forward, TMAC should consider abandoning the practice of placing pipelines directly onto the tundra.	TMAC will continue to monitor all pipelines placed directly on the tundra for signs of tundra damage. To date, TMAC has not observed any issues with insulated lines on the tundra. If damage is observed, TMAC will take the appropriate action to prevent further damage to tundra and remediate where required.
	The permafrost thermal erosion feature that has developed along the northern shore of the TIA was backfilled by TMAC in 2019. This area should continue to be monitored to ensure that additional thermal erosion does not result in this area.	TMAC will continue to monitor the performance of the backfill and cover.
Shoreline Erosion	None.	N/A

Inspection Item	2019 Recommendations	TMAC Response
TIA Water Balance	It is of paramount importance that the Roberts Bay Discharge System Pipeline be completed during the summer of 2019. Further delay of this may result in reduced operations. *UPDATE: this was addressed at the start of 2020 and is **now complete**. The Roberts Bay Discharge system is now operational.*	N/A
Climate Data	None.	N/A
TIA Water Quality	No recommendations; however, the following comments are made below. · The water treatment plant for the TIA is required to be maintained in good operational condition so that discharge of supernatant water can occur once the Roberts Bay Discharge System Pipeline is operational, and allow treated water to be discharged in order to maintain water levels in the TIA below the full supply level. *UPDATE: as of the start of 2020 the Roberts Bay Discharge system and the connected water treatment plant is now operational.*	A water treatment facility was commissioned in November 2019 and is actively treating underground mine water. TIA discharge is currently occurring within the criteria outlined under the MDMER. TMAC will action water treatment for the TIA discharge water when required.
TIA Reclaim Water Pad / 710 Pumphouse Pad	Notable settlement was noted at the TIA Reclaim Jetty Pad (also referred to as the 710 Pumphouse pad). Upon visual inspection and from review of the as-built data, it looks like new ROQ material was placed off the edge of the pad in thick, end dumped lifts in order to widen the pad for the new 710 pumphouse. There are notable stability concerns with this pad as large settlements and notable cracking indicate that a failure of this pad (albeit slow) appears to be occurring. However, it should be noted that the rate of movement could increase suddenly causing a sudden failure, and this risk should not be ignored. Monitoring of this area (at least weekly during winter and daily during months with no ice cover on the lake) should be completed. It is recommended that remediation measures be completed for the pad in order to stabilize the fill and prevent further deformation. This is expected to consist of placing additional fill along the outside of the access road and pad to reduce the overall slope and provide additional confining stress at the toe of the pad (which is currently underwater). Rates of loading must be controlled and slow enough in order to avoid inducing excess pore pressures in the foundation. This means that it may take weeks to build this small additional fill and that the dumping faces should be spread	TMAC has been continuously monitoring settlement of the reclaim jetty. Fill will be placed along the toe of the jetty to improve slope stability in this area in 2020.

Inspection Item	2019 Recommendations	TMAC Response
	out as much as possible. Material should be end dumped back from the working face and spread with an excavator with the largest reach on site (to limit loading at the crest).	