Appendix 37

Whale Tail Water Management Infrastructure OMS Version 3

WHALE TAIL MINE

WATER MANAGEMENT INFRASTRUCTURE

Operation, Maintenance and Surveillance Manual

Prepared by
Agnico Eagle Mines Limited

Version 3
December 2022

WATER MANAGEMENT INFRASTRUCTURE

OPERATION, MAINTENANCE AND

SURVEILLANCE MANUAL

WHALE TAIL MINE

AGNICO EAGLE MINES LIMITED

DOCUMENT CONTROL

Version	Date (YMD)	Section	Page	Revision
1	March 2019	All	All	
2	November 2021	All	All	
3	December 2022	All	All	Updated surveillance procedures

Approved by:

12-19-2022

Thomas Lepine
Engineer of Record - Nunavut

Eric Haley
Environment & Critical Infrastructure Superintendent

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SECTION 1 • INTRODUCTION

1.1 OBJECTIVE OF THE OMS MANUAL

This Operation, Maintenance, and Surveillance Manual has been prepared by Agnico Eagle Mines Limited (AEM) and is to be used for the operation, maintenance, and surveillance (OMS) of the water management infrastructure at the Whale Tail Mine.

This manual is intended as a practical document used by the personnel involved with the Water Management Infrastructure at the Whale Tail Mine. It incorporates Industry Standards as well as the AEM Corporate Standard and Policy on Water Management.

The objectives of this OMS manual are to define and describe:

- Roles, responsibilities, and level of authority of personnel who perform activities related to the water management infrastructure
- The infrastructures covered in the scope of this OMS manual
- Plans, procedures, and processes for:
    - The operation, maintenance, and surveillance of the Whale Tail Mine water management infrastructure to ensure that it functions in accordance with their design, meets performance objectives, and links to emergency response planning
    - Evaluating performance of the structures, and reporting performance results
    - Managing change

This manual contains protocols and information that will assist AEM to operate, maintain, and monitor the water management infrastructure in a safe manner and identify early signs of malfunction.

Elements related to design, construction, and closure of water management infrastructure, infrastructure related to management of underground water, and infrastructure related to water treatment are out of scope of this manual.

1.2 CONTROL OF DOCUMENTED INFORMATION

This OMS manual is a controlled document. The latest version of this document is available in Intelex.

The Responsible Person (RP) is in charge of the preparation, update and distribution of this manual. Any change to this OMS manual must be submitted to and approved by the RP who will be responsible to update the OMS manual in Intelex.

It is each user’s responsibility to ensure that they are using the latest version of this document.

The RP is responsible to communicate any change to this manual by e-mail to the distribution list in Table 1-1. They are responsible for maintaining an up-to-date distribution list of this manual.

Table 1-1 : OMS Manual Distribution List

Position	**Name**
General Manager	Alexandre Cauchon
General Superintendent	Michel Lavoie / Pierre McMullen / Martin Gaumont
Environment & Critical Infrastructure Superintendent	Eric Haley
Engineering Superintendent	Mathieu Hotte
Maintenance Superintendent	Dave Jean
Energy & Infrastructures Superintendent	Guillaume Gemme
Health & Safety Superintendent	Patrick Goldfinch
Engineer of Record, Nunavut Division	Thomas Lepine
MDRB – Meadowbank Dike Review Board	Anthony Rattue / Kevin Hawton

1.3 MANAGEMENT OF CHANGE

This manual will be reviewed on an annual basis and revised as necessary to accommodate changes in the condition and operation of the facilities. The RP will be responsible to coordinate this review process.

In conducting the review and update of the OMS manual the following must be considered:

- Performance of the structures
- Current life cycle of the structures
- Change since the last review (site condition, critical control, risk profile, personnel, methodology, and technology for OMS activities)

In addition to the annually scheduled review, a review may be triggered by a significant event or may need to be updated in response to:

- Planned changes, such as change in surveillance instrumentation or methodologies, or introduction of new instrumentation methodology
- Changes in personnel or roles referred to in the OMS manual
- Other changes that may occur that need to be addressed prior to the next scheduled review of the OMS manual

The update needs to be completed in a timely manner following the document control criteria specified in Section 1.2.

As a good practice, the RP should organize on a yearly basis a session to present the changes in the OMS manual to the persons in its distribution list.

1.4 REQUIRED LEVELS OF KNOWLEDGE

To ensure safe operation of these structures, the personnel involved in the OMS activity must have a good comprehension of this manual and the factors that can impact the performance of these structures.

It is the responsibility of each person in the distribution list of this manual to be familiar with its content. They must also ensure that everyone under their supervision whose duty involves tasks related to the operation, maintenance, or surveillance of any component associated with the Whale Tail Water Management Infrastructure have the appropriate level of knowledge and the resources to comply with the protocol presented in this document.

Table 1-2 below indicates a summary of the required level of knowledge of this Manual. General Knowledge refers to having read and understood the information. Detailed Knowledge refers to having sufficient understanding, training, and knowledge of the processes within a section to be able to carry them out as required.

Records that the requirements of this manual have been reviewed and that each person involved in OMS activity understands the processes and procedures relevant to their task should be kept up to date by each department and updated each time a new manual revision is done. This can be done by using a sign-off sheet.

Table 1-2 : Summary of Required Level of Knowledge of this Manual

Position or Task	Level of Knowledge	Objective
In the Manual Distribution List	General Knowledge of All Sections Detailed Knowledge of Section 1 and 2	• Understand their R&R related to OMS process • Ensure that the task are delegated to the people directly performing the activity and that they have the proper resources to accomplish them • Ensure that required training is provided
Supervise or Perform Operation Task	Detailed Knowledge of Section 5 General Knowledge of Section 3, Table 7-3, and Section 7.3.1	• Have an in depth understanding of the Operation Process and their requirement • Be able to recognize visible sign of deficiency and to know how to communicate those
Supervise or Perform Maintenance Task	Detailed Knowledge of Section 6 General Knowledge of Section 3, Table 7-3, and Section 7.3.1	• Have an in depth understanding of the Maintenance Process and their requirement • Be able to recognize visible sign of deficiency and to know how to communicate those
Supervise or Perform Surveillance Task	General Knowledge of All Sections Detailed Knowledge of Sections 3, 5, 6, & 7	• Have an in depth understanding of the Surveillance Process and their requirement • Be able to recognise when there is a deficiency in an operation and maintenance process
Work routinely brings them in the vicinity of the structures for task not directly linked to Operation, Maintenance, or Surveillance	General Knowledge of Section 3, Table 7-3, and Section 7.3.1	• Understand how their work might impact the structure • Be able to recognize visible sign of deficiency and to know how to communicate those

1.5 ALIGNMENT WITH POLICIES, GUIDELINES, AND REQUIREMENTS

This OMS manual aligns with the following regulator requirements, guidelines, and Standards. These documents can be found on Intelex:

- AEM, Corporate Standard on Water Management (AEM, 2021)
- AEM, Corporate Standard on Tailings Management (AEM, 2021)
- AEM, Water Management Policy (AEM, 2021)
- AEM, Sustainable Development Policy (AEM, 2019)

- Canadian Dam Association 'Dam Safety Guidelines' (CDA 2013) and 'Application of Dam Safety Guidelines to Mining Dams' (CDA 2019)
- Mining Association of Canada 'Guide to the Management of Tailings Facility' (MAC, Version 3.1 2019)
- Mining Association of Canada 'Developing an Operation, Maintenance and Surveillance Manual for Tailings and Water Management Facilities' (Mac, Second edition 2019)
- Mining Association of Canada 'Toward Sustainable Mining Protocol, Water Stewardship' (MAC, November 2018)
- Mining Association of Canada 'Toward Sustainable Mining Protocol, Tailings Management' (MAC, November 2019)
- Nunavut Water Board, Meadowbank Water License (No. 2AMMEA0815)

1.6 LINKAGE WITH EMERGENCY RESPONSE PLAN

An emergency is a situation that poses an impending or immediate risk to health, life, property, or the environment and which requires urgent intervention to prevent or limit the expected outcome.

This OMS manual addresses conditions related to operation under normal or unusual conditions, as opposed to emergency situations. An Emergency Preparedness Plan and an Emergency Response Plan (EPP/ERP) describes measures the Owner and, in some cases, external parties will take to prepare for an emergency, and to respond if an emergency occurs.

An OMS and ERP manual must be aligned. As a result, this OMS manual contains the following information (refer to Section 4 and 5):

- Performance, occurrences, or observations that would result in an emergency being declared
- Roles and responsibilities of key personnel in transition from normal or unusual conditions to an emergency
- Actions to be taken to transition from normal or unusual conditions to an emergency situation

Once an emergency has been declared, reference must be made to the Emergency Response Plan (reference included in Table 1-3). The most recent version of the ERP can be found on Intelex and in the Emergency Control Room.

Table 1-3 : Emergency Response Reference Documents

Document	Current Revision
Emergency Response Plan	Updated by AEM. Version 17, October 2021. (Intelex)

SECTION 2 • ROLES AND RESPONSIBILITIES

The roles and responsibilities of the key personnel involved in the Whale Tail Water Management Infrastructure are shown in Table 2-1. Contact information for each position is indicated in Table 2-2. Terms of reference for the Accountable Executive Officer, Responsible Person, Engineer of Record and Independent Reviewer are on Intelex.

2.1 TRAINING AND QUALIFICATION

Personnel who have tasks directly related to the Whale Tail Water Management Infrastructure need to be qualified for the task and receive and maintain sufficient training to ensure they can perform their required roles and responsibilities. Defining the required qualifications and ensuring proper training and qualification of personnel is a responsibility defined in Table 2-1.

Qualification requirements of personnel is managed on a by department basis and are captured in the R&R of each position and are ensured as part of the HR Process to be fulfilled for each position.

Training requirements and records are defined and managed on a by department basis.

Table 2-1 : Responsibilities of Key Members of the OMS Related to Whale Tail Water Management Infrastructure

Role	Responsibilities
Accountable Executive Officer (AEO)	As emphasized by MAC (2017), the accountability for decisions related to tailings management rests with the Owner's Board of Directors or Governance Level. The Board of Directors or Governance Level is expected to designate an Accountable Executive Officer (AEO) for tailings management. More specifically, the following responsibilities are assigned to the AEO: • Needs to be aware of key outcomes of water management risk assessment and of how these risks are being managed • Has accountability and responsibility for putting in place appropriate management structure • Assign responsibility and appropriate budgetary authority for water management • Define the personnel duties, responsibility, and reporting relationships, supported by job description and organisational charts to implement the water management system through all stages in the facility life cycles • Provide assurance to AEM and its Community of Interest that the Dewatering Dikes are managed responsibly
General Manager	• Identify the scope of work and budget requirement for all aspects of water management • Approve budget for OMS related activity • Establish an organizational structure with Roles and Responsibilities that meets the Governance Standard on Critical Infrastructure • Identify and retain a Responsible Person (RP) • Liaise with independent reviewer (MDRB) as required
General Superintendents	• Ensure the OMS responsibilities delegated to the departments they oversee are carried out as described in this section of the OMS Manual
Engineer of Record (EoR)	The function of the EoR is to support AEM in ensuring that mine waste and water management infrastructure are designed and operated properly. The owner, in assuring that these facilities are safe, has the responsibility to identify and retain an EoR, who provides technical direction on behalf of the owner. Having an EoR for mine waste and water infrastructure is recognized as one of the best practices for responsible management of mine waste and water management facilities. • Support and give technical advice to the RP and the AEO on geotechnical and operational challenges • Participate, if possible, in Dam Safety Inspections and associated reports for facilities that include retention structures/dams/dikes • Verify if the TSF, WRSF, and Water Retaining Infrastructures are designed and are operating in accordance with the best standards in the industry and the AEM corporate standards • Verify if the waste and water management plans are developed and followed to ensure safety of the operation and the business • Review and provide agreement on the procedural documents related to waste and water management (including OMS, ERP, and TARP) • Be available for the Independent Review (IR) Panel • Participate in IR meetings and assist the RP in their preparation if required • Participate in the facility's risk assessments • Be available for dam safety reviews • Identify other internal or external professionals (such as hydrogeologists, geologists, hydrologists, etc.) to provide their support when required • Propose a schedule of site visits and required meetings during the course of the year

Role	Responsibilities
Responsible Person (RP)	The Responsible Person(s) identifies the scope of work and budget requirements (subject to final approval) for all aspects of water and tailings management, including the Engineer of Record (EoR), and will delegate specific tasks and responsibilities for aspects of water and tailings management to qualified personnel. The RP is directly responsible for the management of critical infrastructure on a specific site with the objective of compliance with the Governance. The management of critical infrastructure includes design, construction, operation, and closure. • Ensure the implementation and sustainability of the Governance model at the site level • Management of critical infrastructure, as well as appurtenant structures that may affect the critical infrastructure • The management of personnel, budget, and external resources for the critical infrastructure (external resources include the Design Engineer (DE), Independent Review Board (IRB) and any other necessary consultants/contactors) • Close collaboration with the EoR and communication with the Design Engineer and Independent Review Board IRB) • Preparation for, and coordination of, IRB meetings and site visits • Preparation for, and coordination of, annual geotechnical inspections • Responding to, and implementation of, the recommendations of the IRB • Annual review and update of the OMS Manual in collaboration with the EoR • Continued application of the requirements of the OMS • In collaboration with the EoR, preparation of an annual report on the status of the critical infrastructure • Management of all documents and data related to design, construction, operation, closure, surveillance, and monitoring in a secure, accessible, and permanent manner • Revise and update the OMS Manual to reflect as-built conditions and any other changes. Review and update the OMS manual into Intelex. Maintain up to date distribution list of the OMS Manual
Independent Review Board (IRB) – Meadowbank Dike Review Board (MDRB)	IR Panels are a mechanism to obtain independent, expert commentary, advice, guidance and where appropriate, recommendations to assist owners/operators in identifying, understanding, and managing risks associated with TSF, WRSF, WSF, HLF, and water-retaining infrastructures. The Independent Reviewer(s) does not have decision-making authority. Accountability and responsibility for decisions rests with AEM. • Review mine waste management strategy (including tailings and waste rock storage facilities) • Review water management infrastructure designs and performance (including water retaining infrastructures) • Review on-going construction works and monitoring data • Comment on implementation progress of proposed mine waste management improvement measures • Provide opinions and guidance to the operation on the physical integrity, safety, behavior, and performance of the confinement systems for mine waste and water retaining infrastructures • Comment on management systems, emergency preparedness, and overall management approach of the different mine waste management facilities and water retaining infrastructures
Design Engineer	• Advise on contemplated changes to the structure operation • Advise on structure performance and mitigation work as required • Present, as required, during independent review board site visit and meeting to provide input and context on the structure performance

<table>
<tr><th>Role</th><th>Responsibilities</th></tr>
<tr><td>Environment & Critical Infrastructure Superintendent</td><td>The Environment Department ensures compliance with Environment Regulations and the Water License and is the owner of the water and tailings management infrastructures outside of the process plant. They ensure reporting and liaison with the the NIRB, NWB, NGO’s and other government agencies. The Environment & Critical Infrastructure Superintendent is in charge of the Environment & Critical Infrastructure Department and ensures that:
The Environment team has sufficient resources (qualified manpower, material, budget, training) to fulfill the OMS obligation defined in this manual
A structure is in place that defines the R&R, qualification, training requirement and a staffing strategy to fulfill the obligation of the OMS Manual
Environment review of monitoring data for compliance with Water License and regulations and to determine dike performance with respect to design parameters
The Environment team carries out the surveillance of the structures as required in the OMS Manual (visual inspection and instrument monitoring)
The Environment team identifies and performs the maintenance work (predictive, preventive, and corrective) on the earthwork and instrumentation system
The Environment team reviews and analyses the surveillance data to evaluate dike performance with respect to design parameters and that surveillance reporting is distributed. The Environment team ensures that the other OMS tasks related to a dewatering dike component are planned and have an owner (i.e., pump and pipe, access, maintenance)</td></tr>
<tr><td>Energy & Infrastructures Superintendent</td><td>The E&I Department has the manpower and equipment to manage roads, electricity, and dewatering at the Meadowbank Site. They fulfill the planning done in collaboration with the Water & Tailings team to ensure the fulfilment of the OMS requirements. The E&I Superintendent is in charge of the E&I Department and ensures that:
The E&I team has sufficient resources (qualified manpower, material, budget, training) to fulfill the OMS obligation defined in this manual
A structure is in place that define the R&R, qualification, training requirement, and a staffing strategy to fulfill the obligation of the OMS Manual
E&I maintains access to the structures and seepage collection systems as per Engineering Planning. This includes making road repairs, controlling dust, and managing snow and water
E&I installs, operates, maintains, and monitors all the components of pumps and piping systems associated with dewatering dikes as defined in the OMS Manual. This work is planned in collaboration with the Environment & Critical Infrastructure Department
Update and maintain a list of operational pumping equipment</td></tr>
<tr><td>Maintenance Superintendent</td><td>The Maintenance Department has the manpower and equipment to maintain mobile equipment and pumps. They fulfill maintenance of some of the mechanical equipment components of the dewatering dikes as requested by the E&I department. The Maintenance Superintendent is in charge of the Maintenance Department and ensures that:
Preventive, predictive, and corrective maintenance is carried out regularly on pumping equipment as requested by E&I
Records are kept of maintenance performance on pumping equipment</td></tr>
<tr><td>Health and Safety Superintendent</td><td>The Health and Safety Department is responsible to update and manage the site wide emergency response plan. The Health and Safety Superintendent is in charge of the Health and Safety Department and ensures that:
The emergency response plan is updated and is aligned with the OMS manual
The trigger to raise an emergency defined in the OMS manual and the communication pathway to do so is understood and aligned with the ERP</td></tr>
</table>

Table 2-2 : Contact Information

Role	Name	Work Contact Info
Environment and Critical Infra VP / Accountable Executive Officer	Michel Julien	michel.julien@agnicoeagle.com 416-947-1212 x4013738 514-244-5876
Engineer of Record (EoR) / Technical Specialist, Environmental Management	Thomas Lepine	thomas.lepine@agnicoeagle.com 416-947-1212 x4013722 418-473-8077
Design Engineer – SNC Lavalin	Anh-Long Nguyen	anh-long.nguyen@snclavalin.com 514 393 8000 x54292 514-236-5422
Independent Reviewer / Meadowbank Dike Review Board (MDRB)	• Anthony Rattue • Kevin Hawton	anthony.rattue@bell.net khawton@knightpiesold.com
General Manager	Alexandre Cauchon	819-759-3555 x4606896
General Superintendent (Mine)	Martin Gaumont	819-856-4451
General Superintendent (Technical Services)	Pierre McMullen	819-759-3555 x4606721 819-860-2556
General Superintendent (Maintenance, E&I, Operation)	Michel Lavoie	819-759-3555 x4606555 819-355-0791
Engineering Superintendent	Mathieu Hotte	819-290-3614
Environnent & Critical Infrastructures Superintendant / Responsible Person	Eric Haley	819-651-1010
Energy & Infrastructures Superintendent	Guillaume Gemme	819-759-3555 x4606632 819-856-3073
Maintenance Superintendent	Dave Jean	819-759-3555 x4606722 819-354-9818
Health and Safety Superintendent	Patrick Goldfinch	819-759-3555 x4606720 514-231-6912

SECTION 3 • WATER MANAGEMENT INFRASTRUCTURE DESCRIPTION

The Whale Tail Mine is a deposit on the Amaruq property which is a satellite operation to the Meadowbank Mine. The Amaruq property is a 408 km² site located on Inuit Owned Land, approximately 150 km north of the Hamlet of Baker Lake and approximately 50 km northwest of the Meadowbank Mine in the Kivalliq region of Nunavut. A summary of the physical conditions of the site, as well as a summary of the geological and geotechnical conditions can be found in Section 3.1.

Public access to the site is restricted and safety restrictions have been put in place to restrict access to the water management infrastructure to only those who are required to work on them. Berms, delineators, and radio calling for permission to access are some of the methods used to restrict access. In general, only Environment and the Energy and Infrastructures pumping and electrical crews have regular access to the water management infrastructure.

The Whale Tail Mine includes the construction and operation of a series of water management infrastructure as described in Table 3-1. Appendix A provides the site layout. Appendix B of this document provides a summary of the design Factors of Safety for the dewatering dikes and Appendix C details the operation criteria of the water management structures.

Table 3-1 : Description of the Water Management Infrastructure of the Whale Tail Mine

Infrastructure	Function
Whale Tail Dike	Non-contact water retention and dewatering structure. WTD isolates the Whale Tail Pit mining activities from Whale Tail Lake
Mammoth Dike	Non-contact water retention structure. Isolates the Whale Tail Pit mining activities from Mammoth Lake
WRSF Dike	Contact water retention structure. Prevents contact water from snow melt and runoff from direct precipitation on the waste rock stockpile from reporting into Mammoth Lake by storing it in the WRSF pond
WRSF Pond and pumping infrastructure	Pond formed by the WRSF Dike. It stores contact water which is pumped to the attenuation pond
North-East Dike (**dismantled**)	Non-contact water retention structure. Prevents runoff from the watershed behind it from reporting into the Whale Tail Pit by accumulating the water in the NE pond. Dismantled in 2020.
IVR Dike D-1	Contact water retention structure. Prevents contact water from the IVR attenuation pond from reporting into the main camp area.
Whale Tail Attenuation Pond and pumping infrastructure	Pond formed by the dewatering of the Whale Tail North basin. It stores contact water which is pumped to a water treatment plant (WTP) and then discharged through an approved diffuser
IVR Attenuation Pond and pumping infrastructure	Pond formed by the dewatering of former lake A53. It stores contact water which is pumped to a water treatment plant (WTP) and then discharged through an approved diffuser
Saline Ditch	Collection ditch built in the periphery of the Underground WRSF, which purpose is to collect saline water runoff from the facility and redirect it by gravity to the AP5 quarry for recirculation.
South Whale Tail Diversion Channel (SWTDC)	Blasted channel in the south-western part of the Whale Tail Lake watershed. It allows non-contact water to be discharged by gravity from Whale Tail Lake to Mammoth Lake
IVR Diversion Channel	Excavated channel in the north-east part of the Whale Tail Mine site. It allows non-contact water to flow from the North-East watershed to Nemo Lake.

3.1 SITE CONDITIONS

The Whale Tail Mine is in an arid arctic environment that experiences extreme winter conditions, with an annual mean temperature of -11.3 degrees Celsius (°C). The monthly mean temperature ranges from -31.3°C in January to 11.6°C in June, with above-freezing mean temperatures from June to September.

The annual mean total precipitation at the mine site is 249 millimetres (mm), with 59 percent (%) of precipitation falling as rain, and 41% falling as snow. Mean annual losses were estimated to be 248 mm for lake evaporation, 80 mm for evapotranspiration, and 72 mm for sublimation.

The mine site is in an area of continuous permafrost and the depth of permafrost is estimated to be in the order of 425 m outside of the influence of waterbodies. The depth of the permafrost and active layer will vary based on proximity to the lakes, overburden thickness, vegetation, climate conditions, and slope direction. The typical depth of the active layer is 2 m in this region of Canada. Late-winter ice thickness on freshwater lakes is approximately 2.0 m. Ice covers usually appear by the end of October and are completely formed in early November. The spring ice melt typically begins in mid-June and is complete by early July.

The Whale Tail Mine site is a remote site that is only accessible from the all-weather access road from the town of Baker Lake (with entry gates at the mine and at Baker Lake) and then by the Whale Tail Mine Road, or by aerial link to the Meadowbank site with AEM hubs in Quebec. As such, access from unauthorized members of the public is very unlikely.

3.2 WHALE TAIL DIKE

Whale Tail Dike (WTD) isolates the Whale Tail Pit from Whale Tail Lake South. The South Whale Tail Channel is a diversion structure associated with this dike and is used to re-route water from Whale Tail South to Mammoth Lake.

Whale Tail Dike was constructed in the fall of 2018 and its initial grout curtain was made in the first quarter of 2019. During dewatering in 2019 it was observed that a high amount of seepage was coming from the structure. The amount was judged unsustainable to be managed by pumping. As a result, a remedial grouting campaign was performed between November 2019 and March 2020. The campaign was successful and met the objective of decreasing the seepage so it could be manageable by pumping.

WTD is approximately 835 m in length and was constructed within Whale Tail Lake on a shallow plateau of the lake floor. It consists of a wide rockfill shell, with downstream filters and a cement-bentonite cutoff wall built with secant piles that extend into the bedrock. The cutoff wall extends up to 12 m below lake level and is socketed 1.37 m in the bedrock on average. The dike has a 5 m grout blanket on the upstream side and a 10 m grout curtain on the downstream side from 0+180 to 0+516. The top of the secant pile is at El. 157 which is 1 m higher than the designed IDF water level. Thermal cover rockfill of 2.0 m thick was placed between the secant pile top elevation and the final crest elevation of the dike at 159 masl.

During dewatering, seepage was observed downstream of the Whale Tail Dike and the TARP level of the structure was raised to Yellow in May 2019. A detailed account of the seepage situation is provided in Section 3.2.1.

In August 2022 it was observed that the natural soil on the Eastern abutment had settled allowing water to ingress further into the East abutment which led to rapid thawing of the Eastern abutment foundation and the development of cracks on the crest and sloughing of the dike slope in that area. AEM initiated in the fall of 2022 the construction of an Eastern abutment thermal berm to stabilize the dike and re-establish permafrost in that sector. This plan was strongly supported by the Meadowbank Dike Review Board (MDRB) as per their recommendation received on September 16, 2022.

References to key documents for the design and construction of Whale Tail Dike are presented in Table 3-2. Table 3-3 summarizes the main highlights of Whale Tail Dike.

Figure 3-1 : Aerial View of Whale Tail Dike

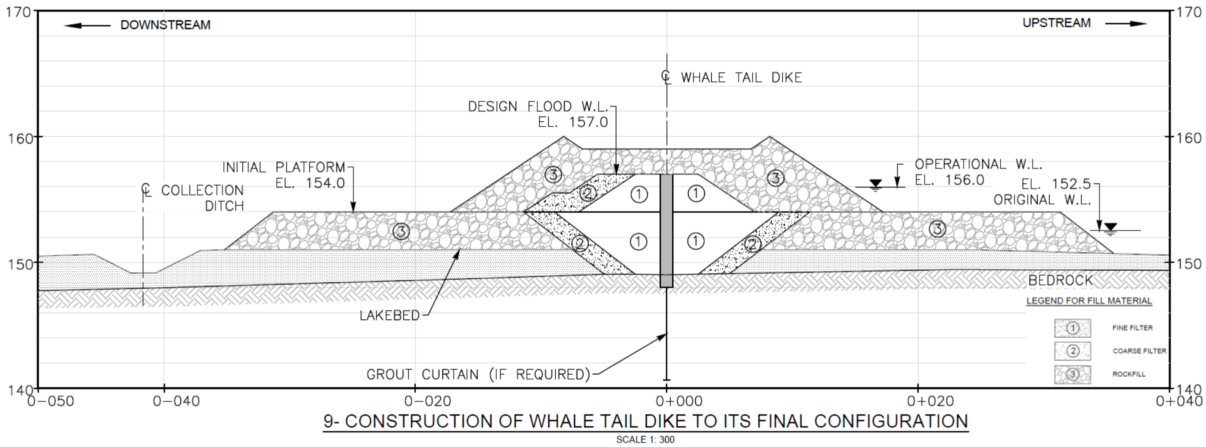


Figure 3-2 : Typical Cross-Section of Whale Tail Dike

Table 3-2 : Reference Documents for Whale Tail Dike Design and Construction

Dike	Type of Information	Reference Document	Link to retrieve document
Whale Tail Dike	Design Report	Dike Construction: Design Report of Whale Tail Dike (SNC, 2019) 6118-E-132-002-TCR-007_651298-2700-4GER-0001_02	..\..\1 - Whale Tail Dike\2- Detailled Engineering\1- WTD\3- Deliverable\1- Design Report\2- Design Report\Final\6118-E-132-002-TCR-007_651298-2700-4GER-0001_02.pdf
	Drawings	Dike Construction: Design Report of Whale Tail Dike (SNC, 2018) 651298-2500-4GDD-0000 to 0011	..\..\1 - Whale Tail Dike\2- Detailled Engineering\1-WTD\3- Deliverable\3- Drawings\Final\WTD Final Drawing_Combined.pdf
		Remedial Grouting: Remedial Work - Downstream and Upstream Blankets (SNC, 2019) 669034-2000-4GDD-0001 to 0003	\\CAMBFS01\Groups\Engineering\05- Geotechnic\14- Amaruq\01 - Dewatering Dikes\1 - Whale Tail Dike\2- Detailled Engineering\2- Remedial Grouting\3- Deliverable\3- Drawings
	Technical Specifications	Dike Construction: Technical Specifications for the Construction of Whale Tail Dike (SNC, 2020) 6118-E-132-002-SPT-001_651298-2400-40EF-0001-00	..\..\1 - Whale Tail Dike\2- Detailled Engineering\1-WTD\3- Deliverable\2- Specification\Draft\6118-E-132-002-SPT-001_651298-2400-40EF-0001-00_WTD Technical Specs.pdf
		Remedial Grouting: Technical Specifications for the Whale Tail Foundation Blanket Grouting (SNC, 2019) 669034-0000-40EF-0001	\\CAMBFS01\Groups\Engineering\05- Geotechnic\14- Amaruq\01 - Dewatering Dikes\1 - Whale Tail Dike\2- Detailled Engineering\2- Remedial Grouting\3- Deliverable\2- Specification\669034-0000-40EF-0001 WTD Foundation Blanket Grouting Technical Specs Rev 00.pdf
	As-Built	Dike Construction: As-built Report of Whale Tail Dike (SNC, 2020) 658309-0000-56ER-0001_00	\\CAMBFS01\Groups\Engineering\05- Geotechnic\14- Amaruq\01 - Dewatering Dikes\1 - Whale Tail Dike\3 - Construction\1- Dike construction 2018-2019\4- Deliverable\1- As-Built
		Remedial Grouting: Whale Tail Dike Remedial Drilling and Grouting Program As Built Report (SNC, 2020) 669034-0000-40ER-0001	\\CAMBFS01\Groups\Engineering\05- Geotechnic\14- Amaruq\01 - Dewatering Dikes\1 - Whale Tail Dike\3 - Construction\2- Remedial Grouting 2019-2020\4- Deliverable\1- As-Built Report

Table 3-3 : Whale Tail Dike Summary

<table>
<tr><th colspan="7">Whale Tail Dike</th></tr>
<tr><td colspan="7">Designer : SNC
Construction Period : 2018-2020
Operation Period : 2019 - 2026
Planned Closure Period : 2026-2042</td></tr>
<tr><th colspan="7">Design Criteria</th></tr>
<tr><th rowspan="2">Use</th><th rowspan="2">Water type</th><th rowspan="2">Classification (CDA, 2013)</th><th rowspan="2">Inflow Design Flood</th><th colspan="2">Water Level (m)</th><th rowspan="2">Crest Elevation (m) (max height)</th></tr>
<tr><th>Normal</th><th>Design Flood</th></tr>
<tr><td>Water Retention / Dewatering</td><td>Non-contact</td><td>High</td><td>1/3 between 1000-year and PMF[1]</td><td>156.0</td><td>157.0</td><td>159.0</td></tr>
<tr><td colspan="7">Built to dewater Whale Tail South Lake. Zoned rockfill dike with a core composed of a dynamically compacted fine filter and a cement-bentonite (CB) cutoff wall consisting of secant piles drilled through the densified fine filter core. The structure has been built to operate Whale Tail Pit and is in operation.</td></tr>
<tr><td colspan="7">Operation Highlight
• Seepage at D/S toe. Mitigated by remedial grouting of a downstream blanket (2019/2020).
• Seepage reports to WT Attenuation Pond (stable rate)
• Thermal degradation of the Eastern upstream abutment required the construction of a thermal berm in 2022</td></tr>
<tr><td colspan="7">Risk assessment for water management infrastructure performed in November 2022
Design Factor of Safety in Appendix B
Note 1: PMF means Probable Maximum Flood</td></tr>
</table>

The main highlights of the dike construction are summarized below:

- Two rockfill platforms were pushed in the lake to El. 154 m. The foundation preparation within the lake section of the key trench of WTD consisted of underwater excavation of the lakebed soils to the bedrock surface.From the initial platform the filter system and the rockfill was placed to El. 157 m. The filter material was densified using dynamic compaction.
- At the west abutment, the WTD alignment crosses an esker which extends well below lake level and contained a frozen core. The esker was excavated to about elevation 153 m. Below that elevation, a key trench to the bedrock was progressively excavated in the thawed esker to expose its surface. At the east abutment, the active layer was removed during the summer season in order to reduce expected settlement and the impact of thaw settlement.
- The cement-bentonite (CB) cut-off wall was constructed at the centre of the Dike through the fine filter materials and extended to a minimum of 1 m into bedrock. The average rock socket depth was approximately 1.37 m with depths ranging from 0.47 m to 3.6 m. The drilled secant piles were backfilled with a 2.5:1:0.11 water:cement:bentonite ratio slurry (including a small dosage of superplasticizer).
- A 10 m depth curtain was initially constructed. During construction, permafrost bedrock conditions were observed in Thermistor strings from Stations 0+516 to 0+730 and the initial grout curtain was installed from Stations 0+180 to 0+516. To preserve the integrity of the cut-off wall, the curtain holes were cased through the fine filter materials approximately 0.3 m into bedrock using ODEX drilling methods with an off-set of ±0.7 m from the centreline of the Dike to the upstream (South Pond) side and extended ±10 m into the bedrock using top-hammer, water-flush drilling methods. The grouting was carried out at a Primary Hole spacing of 12 m

with Secondary and Tertiary Holes added by split-spacing method. The ±10 m deep curtain grouting was generally carried out in three (3) stages. The first two (2) stages were approximately 4.0 m long while the interface stage was about 2.0 m long.

3.2.1 Whale Tail Dike Seepage – Remedial Grouting (2019-2020)

Dewatering of the North Basin commenced in March 2019. During dewatering, seepage was observed downstream of the Whale Tail Dike and the TARP level of the structure was raised to Yellow in May 2019. Seepage measurements obtained by monitoring the daily dewatering rates as well as V-notch weirs along the downstream toe indicated that approximately 500 to 600 m^3/h was flowing into the northern catchment which was much higher than anticipated. This seepage flow was flagged as a risk to the mining operation as it was hard to manage with the WTP.

Willowstick™ profiling of the WTD, a geophysical resistivity surveying technique, indicated three potential flow paths through the bedrock foundation. Warming trends, indicative of the flow of water, were clearly evident with depth within the cut-off wall, at the base of the cut-off and within the near surface bedrock.

In response to the observed increase in seepage, AEM convened a Technical Grouting Committee where a phased mitigation approach was developed. The objective of the grouting program was to achieve a minimum of 40% reduction of the total observed seepage.

The remedial grouting work started in November 2019. A total of 206 blanket holes were drilled in bedrock downstream of the secant cut-off while because of observed success, only six (6) holes were drilled upstream. During the work a tendency towards decreasing grout takes between the Primary to the Quaternary order holes was observed, confirming the efficacy of the use of Celbex-assisted grouts, multiple rounds of re-grouting, and the split-spaced techniques employed. Grout takes decreased by 28% from Primary to Secondary, by 38% from Secondary to Tertiary and by 36% from Tertiary to Quaternary. The overall decrease from Primary holes to Quaternary holes is about 71%.

The remedial grouting program was adjourned on March 25, 2020. The seepage flow data measured between May and July 2020 in the V-Notch weirs installed within the seepage collection trench at the toe of the WTD, after completion of the remedial grouting campaign, are about one-third of what was observed the previous year during the same period. The total seepage measured is approximately 90 m^3/h within the trench in 2020 as compared to around 300 m^3/h as measured in 2019 – a reduction of 210 m3/h. Additionally, from the pumped volumes reporting to the Attenuation Pond on site, it has been estimated that the total seepage flowing towards the Attenuation Pond was approximately 150 to 270 m^3/h between April and July 2020, as compared to around 500 to 600 m3/h during the same period in 2019 – a total seepage reduction of >50%. Visually, there is also less seepage channels observed at the toe of the dike than what could be observed in 2019. The above data confirm that the objective of the campaign for reducing seepage water reporting to the Attenuation Pond was attained – the rehabilitation grouting program contributing 25% to 30% of the total seepage reduction observed after completing only Phase I of the remedial grouting.

3.2.2 Whale Tail Dike Seepage Station

Most of the seepage reporting at the toe of the structure is collected in a shallow channel which reports to the Whale Tail Attenuation Pond by gravity. There is a V-Notch weir installed in that channel that is used to monitor the seepage flow.

The seepage collection system is composed of four stations installed in areas of observed concentrated seepage, each equipped with a pumping system composed of a submersible pump installed in a sump within a perforated culvert. The purpose of the seepage collection system is to collect the surface seepage before it reports to the Whale Tail Attenuation Pond, convey seepage and runoff away from the downstream toe area and allow measurement of seepage through the dike. When the water quality meets the criteria for environmental discharge, the collected water will be returned directly to the environment, otherwise it will be directed to the Whale Tail Attenuation Pond for treatment.

The quality of the water reporting to the seepage stations has not met discharge criteria (high PH) to the environment. In 2020 it was decided to suspend the use of the pumping system and let the water report by gravity to the Whale Tail Attenuation Pond until the water quality of the seepage improves.

3.3 MAMMOTH DIKE

Mammoth Dike is a water retaining infrastructure built to isolate the Whale Tail Pit from Mammoth Lake. Mammoth Lake receives water from Whale Tail Lake through the SWTDC and treated water from site discharge through the Mammoth Lake diffuser. Water flows out of Mammoth Lake through its natural outlet.

The construction of Mammoth Dike occurred from February 2019 to March 2019 to maintain the frozen condition of the foundation. This structure is a zoned rockfill dike with a filter system. The low permeability element of the dike consists of a bituminous geomembrane (BGM) installed on the upstream face anchored in a key trench with fine filter amended with bentonite (FFAB). The key trench is approximately 3 m deep and is founded on bedrock. Blasting was required during the construction of this infrastructure.

References to key documents for the design and construction of Mammoth Dike are presented in Table 3-4. Table 3-5 summarizes the main highlights of Mammoth Dike.

In December 2019, the TARP level of Mammoth Dike was increased to yellow due to the water level in Mammoth Lake being over the normal dike operating level. The water level increase was due to pumping of water from Whale Tail Lake South to Mammoth Lake while the Mammoth Lake outlet was frozen, preventing water from flowing to the nearby lakes. Following this event, the hydrology was reviewed to understand the impact of having a higher starting water level in Mammoth Lake at freshet. This action led to a re-evaluation of the operating guideline of Mammoth Dike and lowering the TARP level back to green

In May 2020, the TARP level of Mammoth Dike was increased to yellow due to the water level in Mammoth Lake being over the normal dike operating level when water was discharged to the lake while its outlet was still frozen. The water discharge to Mammoth Lake was stopped and water from the attenuation pond was transferred to Whale Tail South. The TARP level of the structure was brought down to Green once the lake outlet thawed and the water level decreased.

Table 3-4 : Reference Documents for Mammoth Dike Design and Construction

Dike	Type of Information	Document Reference	Link to Retrieve Document
Mammoth Dike	Design Report	Design Report of Mammoth Dike (SNC, 2018) 6118-E-132-002-TCR-015_651298-5000-40ER-0001_01	..\..\2- Mammoth Dike\2- Detailled Engineering\3-Reporting\1-Design Report\6118-E-132-002-TCR-015_651298-5000-40ER-0001_00-Mammoth Dike Detailed Design Final_Rev 00.pdf
	Drawings	Design Report of Mammoth Dike (SNC, 2018) 651298-500-4GDD-0000 to 0005	..\..\2- Mammoth Dike\2- Detailled Engineering\3-Reporting\3-Drawings\Final
	Technical Specifications	Technical Specifications for the Construction of Mammoth Dike (SNC, 2018) 6118-E-132-002-SPT-005_651298-5000-4GEF-0001-00	..\..\2- Mammoth Dike\2- Detailled Engineering\3-Reporting\2-Specification\6118-E-132-002-SPT-005_651298-5000-4GEF-0001-00_Mammoth Specifications.pdf
	As-Built	North East Dike, WRSF Dike and Mammoth Dike As-Built Report (SNC, 2019) 658309-0000-56ER-0002_00	..\..\2- Mammoth Dike\3- Construction\4-Deliverable\1- As-Built Report\658309-0000-56ER-0002_00 North East Dike, WRSF Dike and Mammoth Dike As-Built Report.pdf

Table 3-5 : Mammoth Dike Summary

Mammoth Dike						
Designer : SNC **Construction Period :** 2018-2019 **Operation Period :** 2019 - 2026 **Planned Closure Period :** 2026-2042						
Design Criteria						
Use	**Water type**	**Classification (CDA, 2013)**	**Inflow Design Flood**	**Water Level (m)**		**Crest Elevation (m) (max height)**
				Normal	**Design Flood**	
Water Retention	Non-Contact	High	1/3 (1,000-PMF)[1]	Low or no water	153.5	155.0
Built to protect Whale Tail Pit from Mammoth Lake water inflow. Zoned rockfill dike with a filter system and a bituminous geomembrane (BGM) installed on the upstream face anchored in a key trench with fine filter amended with bentonite (FFAB).						
Operation Highlight • In December 2019 and May 2020, the Mammoth Lake level exceeded the normal operational level (frozen outlet). Pumping from Whale Tail South was stopped until the level was back to normal.						
Risk assessment for water management infrastructure performed in November 2022 Design Factor of Safety in Appendix B Note 1: PMF means Probable Maximum Flood						

Figure 3-3 : Aerial View of Mammoth Dike

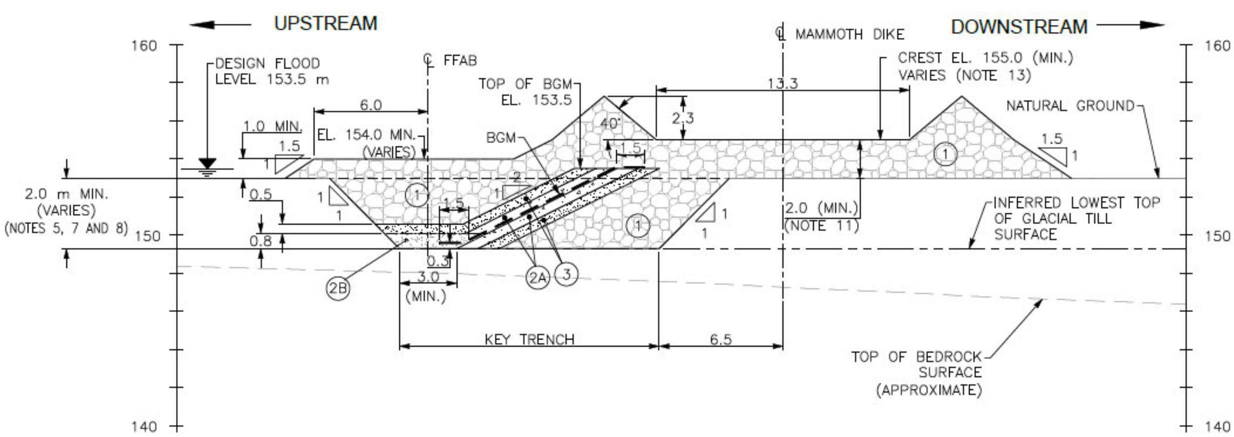


Figure 3-4 : Typical Cross-Section of Mammoth Dike

3.4 WRSF DIKE

WRSF Dike is a water retention infrastructure designed to prevent contact water from the Whale Tail waste rock storage facility (WRSF) accumulating in the WRSF pond from reporting to Mammoth Lake. The water collected in the WRSF pond located upstream of the dike is pumped to the Attenuation Pond and treated prior to being discharged. An area of approximately 109 ha drains towards the WRSF pond. The WRSF Dike is located south of the Whale Tail WRSF.

Foundation excavation in the key trench area was done in the fall of 2018 to avoid blasting and aggrade frost penetration. The construction of WRSF Dike mainly occurred from January to February 2019 to maintain the frozen condition of the foundation. This structure is a zoned rockfill dike with a filter system. The low permeability element of the dike consists of a bituminous geomembrane (BGM) installed on the upstream face anchored in a key trench with fine filter amended with bentonite (FFAB). The key trench is 3 m deep approximately and founded on frozen glacial till or bedrock.

In August 2019, the TARP level of the WRSF Dike was increased to yellow due to seepage observed toward Mammoth Lake. The situation was remediated by building a thermal berm in the winter of 2020 and by lowering the operating level of the pond. These strategies were successful in preventing seepage in 2020 and the TARP level of the structure is now Green.

References to key documents for the design and construction of WRSF Dike are presented in Table 3-6. Table 3-7 summarizes the main highlights of WRSF Dike.

Figure 3-5 : Aerial View of WRSF Dike

Table 3-6 : Reference Documents for WRSF Dike Design and Construction

Dike	Type of Information	Document Reference	Link to Retrieve Document
WRSF Dike	Design Report	Dike construction: Design Report of WRSF Dike (SNC, 2018) 651298-6000-40ER-0001_00 GH	..\..\3- WRSF Dike\1-Detailled Engineering\1- WRSF Dike\3-Reporting\1-Design Report\1-Design Report\651298-6000-40ER-0001_00 GH WRSF Dike Detailed Design.pdf
		Thermal berm: Design Report: WRSF Dike Upstream Mitigation Measures (AEM, 2020)	\\Cambfs01\groups\Engineering\05-Geotechnic\14- Amaruq\01 - Dewatering Dikes\3- WRSF Dike\1-Detailled Engineering\2- Seepage Mitigation\3-Deliverable\1- Design Report\US Berm\ WRSF Dike upstream mitigation design report_Rev1_Signed.pdf
	Drawings	Dike construction: Design Report of WRSF Dike (SNC, 2018)	511298-6000-4GDD-0000 to 0005 ..\..\3- WRSF Dike\1-Detailled Engineering\1- WRSF Dike\3-Reporting\3- Drawings\Final\Final\Pages from 651298-6000-40ER-0001_00 GH WRSF Dike Detailed Design_DRAWINGS.pdf
		Thermal berm: Key Capping Drawings - WRSF Dike Construction (AEM, 2020)	\\Cambfs01\groups\Engineering\05-Geotechnic\14- Amaruq\01 - Dewatering Dikes\3- WRSF Dike\1-Detailled Engineering\2- Seepage Mitigation\3-Deliverable\2- Drawings\US Berm\CON-QT-142_WRSF KEY CAPPING THEO QTY_REV4.pdf
	Technical Specifications	Technical Specifications for the Construction of WRSF Dike (SNC, 2018) 6118-E-132-002-SPT-003_651298-6000-4GEF-0001-00	..\..\3- WRSF Dike\1-Detailled Engineering\1- WRSF Dike\3-Reporting\2- Specification\6118-E-132-002-SPT-003_651298-6000-4GEF-0001-PB_AEM_MG.PDF
	As-Built	Dike construction: North East Dike, WRSF Dike and Mammoth Dike As-Built Report (SNC, 2019) 658309-0000-56ER-0002_00	..\..\3- WRSF Dike\2- Construction\1-Dike Construction 2018-2019\4-Deliverable\1- As-Built Report\658309-0000-56ER-0002_00 North East Dike, WRSF Dike and Mammoth Dike As-Built Report.pdf
		Thermal berm: WRSF Dike Mitigation As-Built Report (AEM, 2020)	\\Cambfs01\groups\Engineering\05-Geotechnic\14- Amaruq\01 - Dewatering Dikes\3- WRSF Dike\2- Construction\2-US Berm & DS System 2020\4-Deliverable\1- As-Built Report\Thermal berm As-built report_final_signed.pdf

Table 3-7 : WRSF Dike Summary

<table>
<tr><th colspan="8">WRSF Dike</th></tr>
<tr><td colspan="8">Designer : SNC
Construction Period : 2018-2019
Operation Period : 2019 - 2026
Planned Closure Period : 2026-2042</td></tr>
<tr><th colspan="8">Design Criteria</th></tr>
<tr><th rowspan="2">Use</th><th rowspan="2">Water type</th><th rowspan="2">Classification (CDA, 2013)</th><th rowspan="2">Inflow Design Flood</th><th colspan="2">Water Level (m)</th><th rowspan="2">Crest Elevation (m) (max height)</th></tr>
<tr><th>Normal</th><th>Design Flood</th></tr>
<tr><td>Runoff storage</td><td>Contact</td><td>Low</td><td>100</td><td>155.0</td><td>157.8</td><td>158.4</td></tr>
<tr><td colspan="7">Built to protect Mammoth Lake from WRSF contact water runoff. Zoned rockfill dike with a filter system and a bituminous geomembrane (BGM) installed on the upstream face anchored in a key trench with fine filter amended with bentonite (FFAB).</td></tr>
<tr><td colspan="7">Operation Highlight
In August 2019, seepage was noted at the D/S toe. WRSF Pond was emptied to manage the seepage.
Construction of a thermal berm on U/S side to promote freeze-back of the foundation and lowering of WRSF pond operational levels. No seepage since then.</td></tr>
<tr><td colspan="7">Risk assessment for water management infrastructure performed in November 2022
Design Factor of Safety in Appendix B</td></tr>
</table>

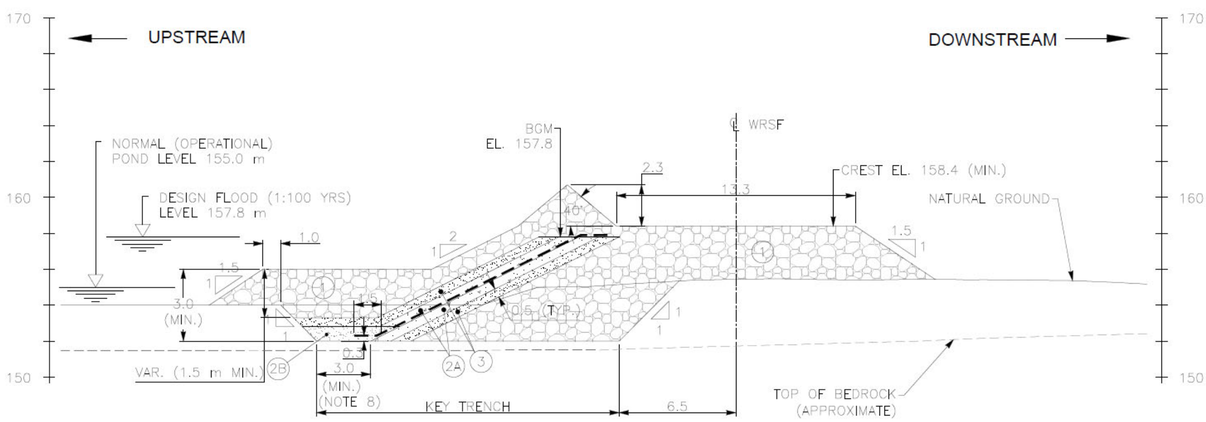


Figure 3-6 : Typical Cross-Sections of WRSF Dike (Without Thermal Berm)

3.4.1 WRSF Dike Seepage and Remediation (2019-2020)

In August 2019 the TARP level of the WRSF Dike was increased to yellow due to seepage observed at the downstream toe. Review of the thermistor data indicated that the most likely cause for the seepage observed was thawing of the foundation key trench caused by water ponding over it for an extended period of time. The seepage at the downstream toe was estimated to be around 100 m³/h. Tension cracks along the downstream crest of the dike were also observed. This event was disclosed to the relevant authorities and measures were taken to lower the WRSF pond level. Once the WRSF pond level was lowered the seepage was no longer observed. The risk associated with this event is potential contaminant release to Mammoth Lake and the area downstream of the dike as well as possible damage to the dike. Analyses performed after the event showed that this release did not cause an impact to the water quality of Mammoth Lake.

The TARP level of the WRSF Dike was decreased to green in May 2020 once the remediation work was completed. No seepage was observed since then and the thermistor response has demonstrated the success of the mitigation measures implemented.

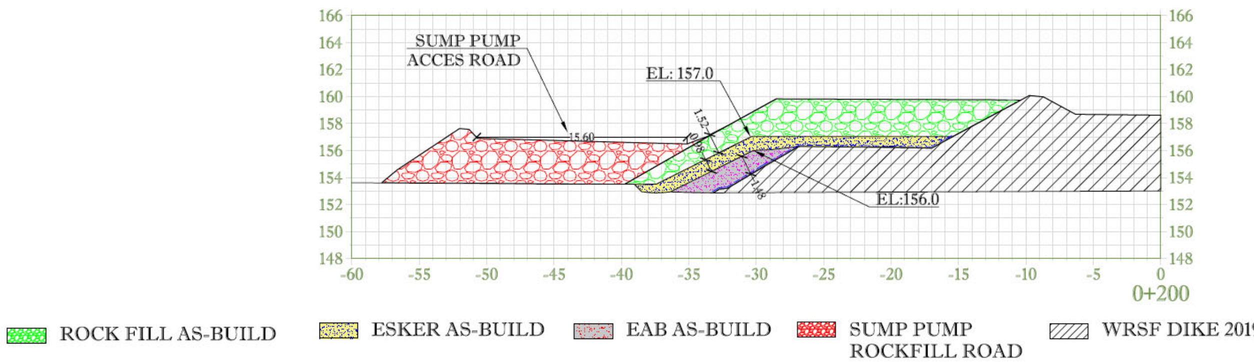


Figure 3-7 : Typical Cross-Sections of WRSF Dike Thermal Berm

3.5 NORTH-EAST DIKE (DISMANTLED)

The North-East Dike (NE) Dike was designed to prevent non-contact water from the Nemo Lake watershed from reporting into Whale Tail Pit. The NE Dike was located north of the Whale Tail Pit. Water from the NE Pond on the upstream side of the dike was periodically pumped out and treated for suspended solids prior to being discharged to the environment.

The construction of NE Dike occurred from January to February 2019 to maintain the frozen condition of the foundation. This structure is a zoned rockfill dike with a filter system. The low permeability element of the dike consists of a bituminous geomembrane (BGM) installed on the upstream face anchored in a key trench with fine filter amended with bentonite (FFAB). The key trench is excavated in frozen glacial till or bedrock.

This structure has been dismantled in September 2020 in the framework of the development of the IVR Pit area. References to key documents for the design and construction of North-East Dike are presented in Table 3-8. Table 3-9 summarizes the main highlights of North-East Dike.

Table 3-8 : Reference Documents for North-East Dike Design and Construction

Dike	Type of Information	Document Reference	Link to Retrieve Document
North-East Dike	Design Report	Design Report of North-East Dike (SNC, 2018) 6118-E-132-002-TCR-012_651298-7000-40ER-0001-02	..\..\4- North East dike\1-Detailled Engineering\3- Deliverable\1-Design Report\6118-E-132-002-TCR-012_651298-7000-40ER-0001-02 _ NE Dike design report.pdf
	Drawings	Design Report of North-East Dike (SNC, 2018) 651298-7000-4GDD-0000 to 0005	..\..\4- North East dike\1-Detailled Engineering\3- Deliverable\3-Drawings\Final\651298-7000-4GDD-NE Dike combined.pdf
	Technical Specifications	Technical Specifications for the Construction of North-East Dike (SNC, 2018) 6118-E-132-002-SPT-002_651298-7000-4GEF-0001-01	..\..\4- North East dike\1-Detailled Engineering\3- Deliverable\2-Specification\6118-E-132-002-SPT-002_651298-7000-4GEF-0001-01_NE Dike spec_no drawings.pdf
	As-Built	North East Dike, WRSF Dike and Mammoth Dike As-Built Report (SNC, 2019) 658309-0000-56ER-0002_00	..\..\4- North East dike\2- Construction\4-Deliverable\1- As-Built Report\658309-0000-56ER-0002_00 North East Dike, WRSF Dike and Mammoth Dike As-Built Report.pdf
	Dismantling Criteria	NE Dismantling Criteria Memo	\\Cambfs01\groups\Engineering\05-Geotechnic\14- Amaruq\01 - Dewatering Dikes\4- North East dike\4- Dismantling

Table 3-9 : North-East Dike Summary

<table>
<tr><th colspan="7">North-East Dike</th></tr>
<tr><td colspan="7">Designer : SNC
Construction Period : 2018-2019
Operation Period : 2019 - 2026
Planned Closure Period : 2026-2042</td></tr>
<tr><th colspan="7">Design Criteria</th></tr>
<tr><th rowspan="2">Use</th><th rowspan="2">Water type</th><th rowspan="2">Classification (CDA, 2013)</th><th rowspan="2">Inflow Design Flood</th><th colspan="2">Water Level (m)</th><th rowspan="2">Crest Elevation (m) (max height)</th></tr>
<tr><th>Normal</th><th>Design Flood</th></tr>
<tr><td>Runoff storage</td><td>Non-contact</td><td>Significant</td><td>100 – 1000 yr</td><td>No water</td><td>156.7 (1)</td><td>157.5</td></tr>
<tr><td colspan="7">Built to prevent non-contact water from the Nemo Lake watershed from reporting into Whale Tail Pit. Zoned rockfill dike with a filter system and a bituminous geomembrane (BGM) installed on the upstream face anchored in a key trench with fine filter amended with bentonite (FFAB).</td></tr>
<tr><td colspan="7">Operation Highlight
Localized depressions and tension cracks were observed on the upstream platform of the dike (within the liner thermal cover), as well as minor seepage on the downstream side of the structure. The TARP level was raised to yellow in July 2019, then orange
Dismantled in September 2020.</td></tr>
<tr><td colspan="7">Design Factor of Safety in Appendix B</td></tr>
</table>

Note 1: Above this elevation, water is discharged towards Nemo Lake. The integrity of the dike will not be at risk of failure.

Figure 3-8 : Aerial View of North-East Dike (before dismantling)

3.6 IVR DIKE D-1

IVR Dike D-1 is a contact water retaining infrastructure built to contain the IVR Attenuation Pond. It is located East of the Whale Tail Pit. The structure includes an emergency spillway to release the water to the Whale Tail Attenuation Pond.

The construction of IVR Dike D-1 was completed in Q2 2021. The structure was constructed as a zoned rockfill dike with a filter system. The low permeability element of the dike consists of a bituminous geomembrane (BGM) installed on the upstream face anchored in a 3 m deep key trench located below the centerline of the structure surrounded by fine filter amended with bentonite (FFAB). The key trench is excavated in frozen glacial till or bedrock. To improve the thermal condition of the key trench a rockfill and esker thermal berm was placed on the upstream side.

During the 2022 freshet, localised deformation of the crest was observed on the area located above the upstream hinge of the liner. The settlement had a magnitude of 0.2-0.3 m over an area about 150m long, 6-8m wide and extending from STA 0+100 to 0+300. It had an offset of about 14m upstream of the centerline. The TARP level was raised to yellow in September 2022 to increase inspection and monitoring. The IVR Dike foundation remained in frozen conditions. It is believed that the observed settlement is related to a surficial mechanism linked to the thawing of the esker material placed above the liner in winter condition and does not affect the integrity of liner or the key trench.

References to key documents for the design and construction of IVR Dike D-1 are presented in Table 3-10.

Table 3-11 summarizes the main highlights of IVR Dike D-1.

Table 3-10 : Reference Documents for IVR Dike D-1 Design and Construction

Dike	Type of Information	Document Reference	Link to Retrieve Document
IVR-D1	Design Report	Design Report of the IVR Attenuation Pond Dike D-1 (SNC, 2020) 668284-5000-4GER-0001	\\CAMBFS01\Groups\Engineering\05-Geotechnic\14- Amaruq\01 - Dewatering Dikes\5- IVR Dike D1&D2\2- Detailed Engineering\3- Deliverable\1- Design Report\6127-695-REP-005_R0 (668284-5000-4GER-0001_00 IVR D-1 Dike Design Report).pdf
	Drawings	IVR Dike D-1 Construction Drawings (SNC, 2020) 668284-5000-4GDD-0005 61-695-210-200 to 211	\\CAMBFS01\Groups\Engineering\05-Geotechnic\14- Amaruq\01 - Dewatering Dikes\5- IVR Dike D1&D2\2- Detailed Engineering\3- Deliverable\2- Drawings
	Technical Specifications	Technical Specifications for the Construction of IVR D-1 Dike (SNC, 2020) 668284-5000-40EF-0001	\\Cambfs01\groups\Engineering\05-Geotechnic\14- Amaruq\01 - Dewatering Dikes\5- IVR Dike D1&D2\2- Detailed Engineering\3- Deliverable\3-Specification\6127-C-230-003-SPT-001_R00 (668284-5000-40EF-0001).pdf
	As-Built	2021 Construction As-Built Report IVR D-1 Dike (Golder, 2021) 21452873-1604-R-Rev1	\\Cambfs01\groups\Engineering\05-Geotechnic\14- Amaruq\01 - Dewatering Dikes\5- IVR Dike D1\3- Construction\4-Deliverable\1- As-Built Report\2AM-WTP1830 Whale Tail IVR D1 Dike Construction Summary Report.pdf

Table 3-11 : IVR Dike D-1 Summary

IVR Dike D-1						
Designer : SNC **Construction Period :** 2021 **Operation Period :** 2021- 2026 **Planned Closure Period :** 2026-2042						
Design Criteria						
Use	**Water type**	**Classification (CDA, 2013)**	**Inflow Design Flood**	**Water Level (m)**		**Crest Elevation (m) (max height)**
				Normal	**Design Flood**	
Water Retention	Contact	High	1/3 (1,000-PMF)[1]	163.2	164.7	165.5
Built to prevent contact water from the IVR attenuation pond from reporting into the main camp area. Zoned rockfill dike with a filter system and a LLDPE geomembrane installed on the upstream face anchored in a key trench with fine filter amended with bentonite (FFAB) and an upstream esker and rockfill thermal berm.						

Operation Highlight
• Operational since freshet 2021. • Deformation of the crest and vertical settlement was observed on the area located above the upstream hinge of the liner in the summer of 2022.
Risk assessment for water management infrastructure performed in November 2022 Design Factor of Safety in Appendix B Note 1: PMF means Probable Maximum Flood

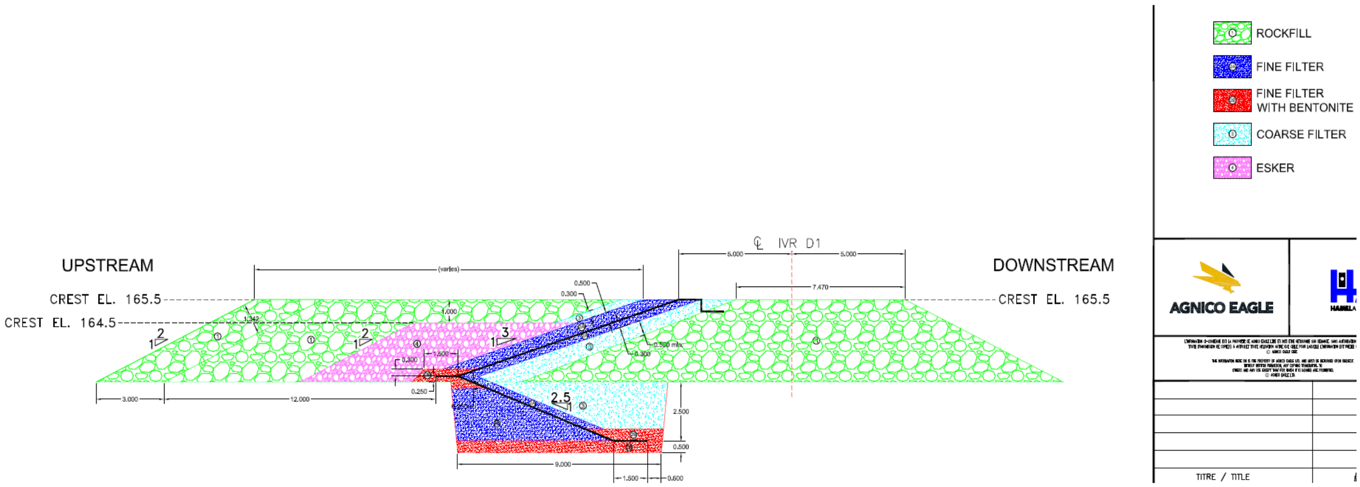


Figure 3-9 : Typical Cross-Section of IVR Dike D-1 (0+080 to 0+320)

3.7 SOUTH WHALE TAIL CHANNEL

The South Whale Tail Diversion Channel (SWTDC) is a blasted channel in the south-western part of the Whale Tail Lake watershed. It allows non-contact water to be discharged by gravity from Whale Tail Lake to Mammoth Lake.

The construction of SWTDC occurred from January to April 2020 and it was commissioned during freshet 2020.

The inlet of the SWTDC is at El. 155.3 m. The channel has a trapezoidal shape with lateral slopes of 3H:1V, a base width of 5.0 m, and a bed-slope of 0.3%. The SWTDC was constructed using a protective riprap layer consisting of rockfill on the bottom and the sides of the channel to avoid erosion and limit TSS in the water. The riprap has a thickness of 0.5 m and consists of blasted rock with a diameter of 100 – 300 mm. Two transition materials consisting of fine and coarse filter with a 0.3 m thickness each were installed between the overburden and the riprap for particle retention between the foundation soil and the riprap. A layer of geotextile was placed between the coarse filter and the riprap to avoid migration of fine particles from the filters that could increase turbidity. The part of the access road crossing Lake A45 was modified to add a filtering element to prevent the A45 lakebed sediment to flow in the channel and create turbidity while ensuring that water from Lake A45 could reach the channel.

References to key documents for the design and construction of the SWTDC are presented in Table 3-12. Table 3-13 summarizes the main design criteria of the SWTDC.

Table 3-12 : Reference Documents for SWTDC Design and Construction

Channel	Type of Information	Document Reference	Link to Retrieve Document
SWTDC	Design Report	Design Report of South Whale Tail Diversion Channel (SNC, 2020) 669635-2000-40ER-0001-00	..\..\03- Channel\1- South Whale Tail Channel\1-Engineering Study\2-Detailled Eng\3- Deliverable\Design Report\Final\Rev 1\669635-2000-40ER-0001-00_SWTDC Design Report.pdf
	Drawings	Design Report of South Whale Tail Diversion Channel (SNC, 2020) ACAD-669635-2000-4GDD-0001 to 0004	..\..\03- Channel\1- South Whale Tail Channel\1-Engineering Study\2-Detailled Eng\3-Deliverable\Drawings\FINAL
	Technical Specifications	Technical Specifications for the Construction of South Whale Tail Diversion Channel (SNC, 2019) 651298-2900-40EF-0001_00	..\..\03- Channel\1- South Whale Tail Channel\1-Engineering Study\2-Detailled Eng\3- Deliverable\Technical Specifications\651298-2900-40EF-0001_00_SWTDC_With drawings_-signed.pdf
	As-Built	SWTDC Construction Report (SNC, 2020) 667648-3000-40ER-0001	\\Cambfs01\groups\Engineering\05-Geotechnic\14- Amaruq\03- Channel\1-South Whale Tail Channel\2-Construction\4- Reporting\1- As-Built Report\ 667648-3000-40ER-0001 SWTDC Construction Report_01 (signed) (1).pdf

Table 3-13 : Design Criteria for SWTDC

<table>
<tr><th colspan="7">South Whale Tail Diversion Channel</th></tr>
<tr><td colspan="7">Designer : SNC
Construction Period : 2020
Operation Period : 2020 - 2026
Planned Closure Period : 2026-2042</td></tr>
<tr><th colspan="7">Design Criteria (same as Whale Tail Dike)</th></tr>
<tr><th rowspan="2">Use</th><th rowspan="2">Water type</th><th rowspan="2">Base Width</th><th rowspan="2">Inflow Design Flood</th><th colspan="2">Water Level (m)</th><th rowspan="2">Crest Elevation (m) (max height)</th></tr>
<tr><th>Maximum</th><th>Design Flood</th></tr>
<tr><td>Water Conveyance</td><td>Non-contact</td><td>5 m</td><td>1/3 between 1000-year and PMF[1]</td><td>156.0</td><td>157.0</td><td>155.3</td></tr>
<tr><td colspan="7">Built to convey non-contact water by gravity from Whale Tail Lake to Mammoth Lake.</td></tr>
</table>

Risk assessment performed during design in 2020. Operation risk assessment for water management infrastructure performed in 2022 Note 1: PMF means Probable Maximum Flood

Figure 3-10 : Plan View of SWTDC

3.8 IVR DIVERSION CHANNEL

The IVR Diversion Channel (IVR DC) is an excavated channel in the north-east part of the Whale Tail Mine site. It allows non-contact water to flow from the North-East watershed to Nemo Lake. Its objective is to reduce the amount of contact water reporting to IVR Pit.

The construction of the IVR DC occurred from September to October 2020 and it was commissioned during freshet 2021. The channel has a trapezoidal shape with lateral slopes of 2H:1V to 3H:1V, a base width of 3.0 m, and a bed-slope of 0.3%, in combination with a pervious rockfill perimeter berm that is delimiting the west boundary of the channel and also acts as an access road. The IVR DC was constructed with a layer of fine filter material placed on top of the excavated foundation followed by geotextile and overlain by riprap.

The channel was extended by about 15 m upstream to accommodate natural water ponds in the topography. Two layers of geotextile were installed since the available geotextile was thinner then requested by the design.

References to key documents for the design and construction of the IVR DC are presented in Table 3-14. Table 3-15 summarizes the main design criteria of the IVR DC.

Table 3-14 : Reference Documents for IVR DC Design and Construction

Channel	Type of Information	Document Reference	Link to Retrieve Document
IVR DC	Design Report	Design Report for IVR Diversion (SNC, 2020) 668284-7000-4GER-00010	\\CAMBFS01\Groups\Engineering\05-Geotechnic\14- Amaruq\03- Channel\4-IVR Diversion\2- Detailled Eng\3-Deliverable\1- Design Report\6127-695-132-REP-004_01 (668284-7000-4GER-0001).pdf
	Drawings	Drawings from Design Report for IVR Diversion (SNC, 2020) 61-695-230-201_R1	\\CAMBFS01\Groups\Engineering\05-Geotechnic\14- Amaruq\03- Channel\4-IVR Diversion\2- Detailled Eng\3-Deliverable\2- Drawings
	Technical Specifications	Technical Specifications from Design Report for IVR Diversion (SNC, 2020) 668284-7000-4GER-00010	\\CAMBFS01\Groups\Engineering\05-Geotechnic\14- Amaruq\03- Channel\4-IVR Diversion\2- Detailled Eng\3-Deliverable\3- Specification\6127-C-230-003-SPT-002_R0 (668284-7000-40EF-0001_00).pdf
	As-Built	Construction Summary Report - IVR Diversion Channel (SNC, 2021) 6127-695-132-REP-012_R2	\\CAMBFS01\Groups\Engineering\05-Geotechnic\14- Amaruq\03- Channel\4-IVR Diversion\3- Construction\4-Deliverable\1- As-Built Report\6127-695-132-REP-012_R2.pdf

Table 3-15 : Design Criteria for IVR DC

IVR Diversion Channel				
Designer : SNC **Construction Period :** 2020 **Operation Period :** 2020 - 2026 **Planned Closure Period :** 2026-2042				
Design Criteria				
Use	**Water type**	**Inflow Design Flood**	**Freeboard (m)**	**Base width (m)**
Water Conveyance	Non-contact	1:100	0.3	3
Built to convey non-contact water to flow from the North-East watershed to Nemo Lake.				

Risk assessment for water management infrastructure performed in November 2022

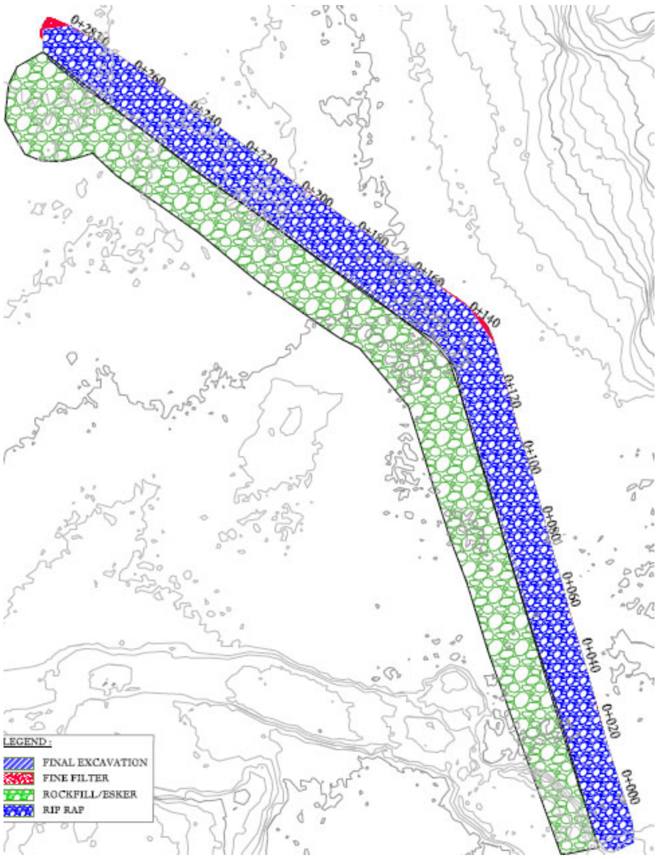


Figure 3-11 : Plan View of IVR Diversion

3.9 SALINE DITCH

The Saline Ditch are collection ditch built in the periphery of the Underground WRSF and underground ore stockpile. Their purpose is to collect saline water runoff from these facilities and redirect it by gravity to GSP1 for containment.

The construction of the Underground WRSF Saline Ditch was conducted from September 5th to September 26th, 2018, and from September 20th to November 10th in 2019. It consists of a ditch surrounding Pad D (Underground WRSF) with a bituminous geomembrane as a low permeability element. The ditch was built in two segments each having a 1 % longitudinal slope. The first segment is from Sta. 0+000 to 0+430 and is located along a segment of Road 3. The second segment is from Sta 0+440 to 0+680 and goes around the underground ramp portal and ends at a culvert inlet. The membrane is installed on a 300 mm subgrade bedding and is anchored on both crests. The geomembrane is then protected by a layer of 300 mm fine filter material and by a layer of 300 mm of coarse filter material.

The construction of the Underground Ore Stockpile Saline ditch was done from September 24, 2021, to October 14, 2021. It consists of a ditch surrounding the underground ore stockpile with a bituminous geomembrane as a low permeability element. The ditch was excavated as one segment having a minimum 0.3 % longitudinal slope from Sta 0+000 to Sta 0+350. The depth of excavation varied from 1.7 to 2 m. The membrane is installed on a 200 mm subgrade bedding and is anchored at both crests. The geomembrane was then protected by a layer of 300 mm of fine filter and by a layer of coarse filter.

References to key documents for the design and construction of the Saline Ditch are presented in

Table 3-16.

Table 3-16 : Reference Documents for Saline Ditch Design and Construction

Channel	Type of Information	Document Reference	Link to Retrieve Document
Underground WRSF Saline Ditch	Drawings	Plan view (SNC, 2017): 61-417-230-220_R2 Cross-sections (SNC, 2017): 61-417-230-226_R2	\\CAMBFS01\Groups\Engineering\05-Geotechnic\14- Amaruq\03-Channel\3- Saline Ditch\1-Engineering\1- Underground WRSF Saline Ditch
	As-Built	Pad D Saline Protection As-Built Report (AEM, 2020)	\\CAMBFS01\Groups\Engineering\05-Geotechnic\14- Amaruq\03-Channel\3- Saline Ditch\2-Construction\6- Deliverable\2- As-built\Saline protection As-built report - FINAL w appendices.pdf
Underground Ore Stockpile Saline Ditch	Design	Underground ore stockpile saline protection detailed engineering design (AEM, 2022)	\\CAMBFS01\Groups\Engineering\05-Geotechnic\14- Amaruq\03-Channel\5-UG Ore Stockpile Saline Ditch\1-Engineering\2- Deliverable
	Drawings	Plan view, profile & typical section underground ore stockpile road salt protection (AEM, 2021)	\\CAMBFS01\Groups\05-Geotechnic\14- Amaruq\03-Channel\5-UG Ore Stockpile Saline Ditch\1-Engineering\2-Deliverable\Drawings
	As-Built	UGSaline_AsBuiltReport_Final (AEM, 2022)	\\CAMBFS01\Groups\Engineering\05-Geotechnic\14- Amaruq\03-Channel\5-UG Ore Stockpile Saline Ditch\2-Construction\4- Deliverable

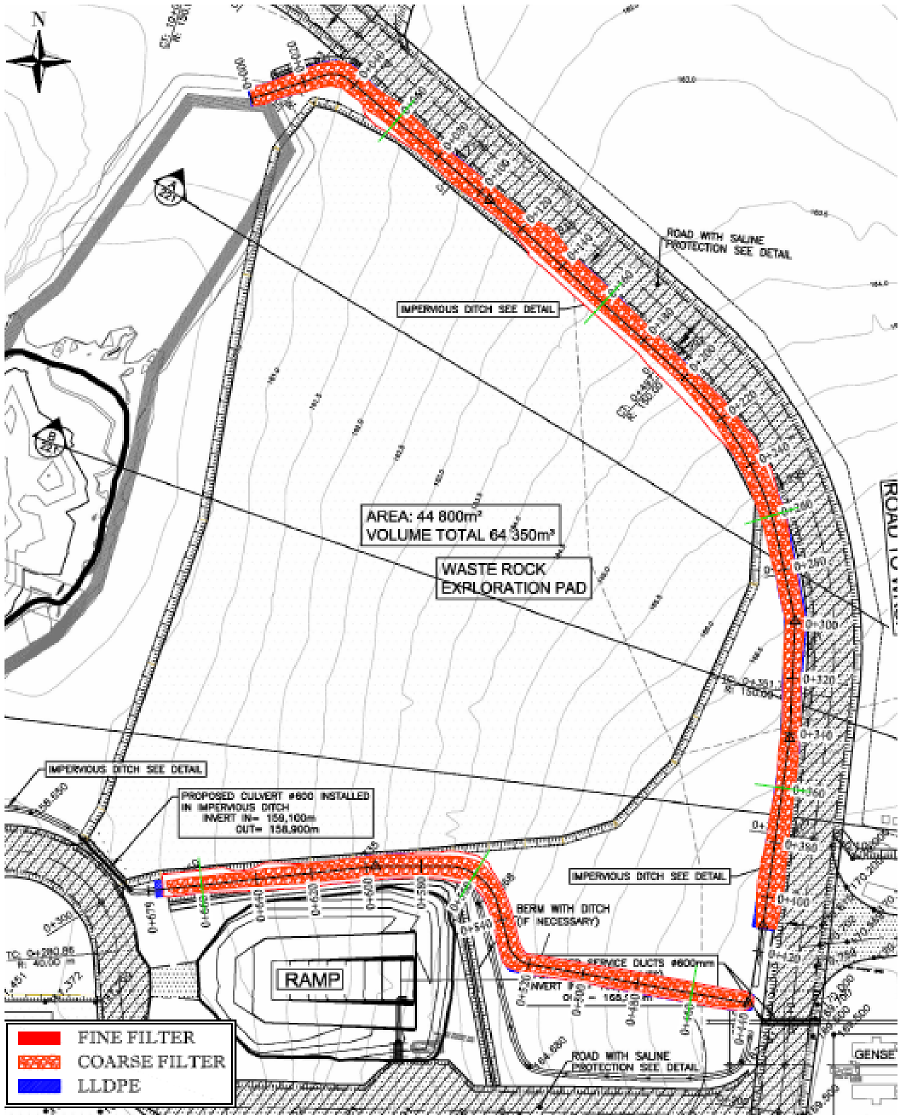


Figure 3-12 : Plan View of Underground WRSF Saline Ditch

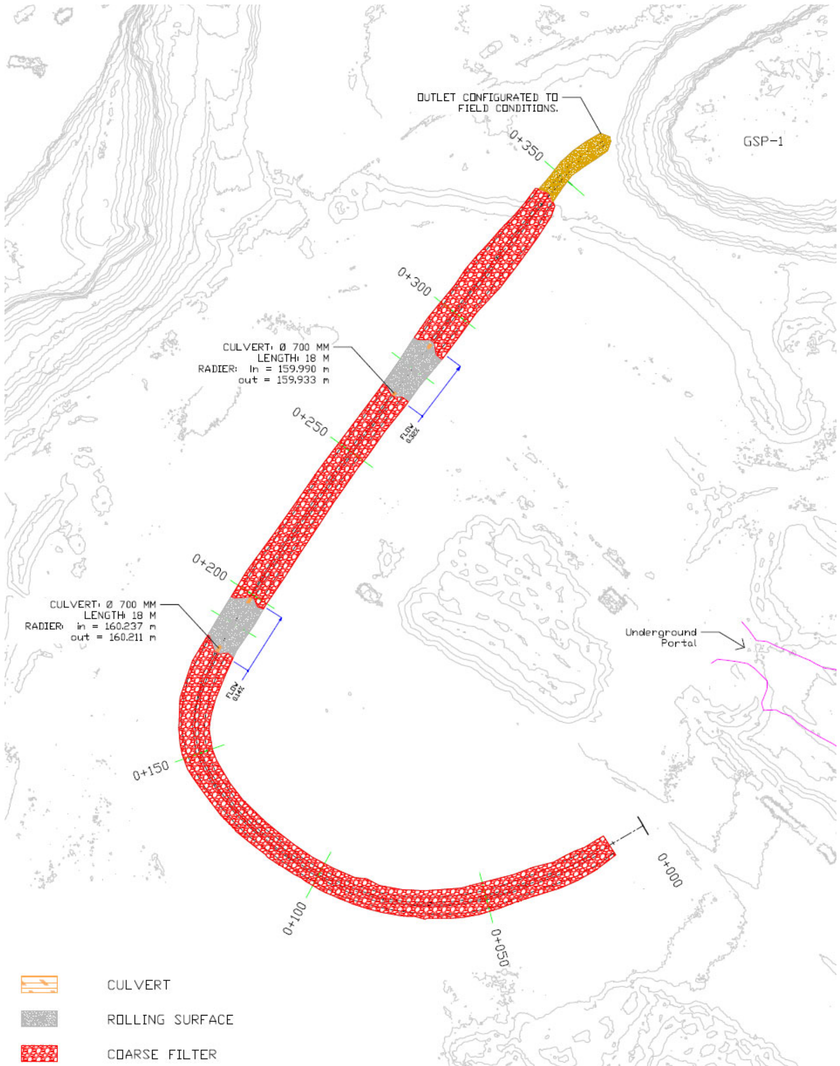


Figure 3-13 : Plan View of Underground Ore Stockpile Saline Ditch

3.10 SURFACE CONTACT WATER PUMPING INFRASTRUCTURE

The main areas of the Whale Tail Mine requiring surface contact water pumping infrastructure are:

- Whale Tail Attenuation Pond
- IVR Attenuation Pond
- WTP and diffusers
- WT WRSF / IVR WRSF
- WT Pit / IVR Pit Area

Appendix C shows the pumping flowchart of the project as well as the location of the pumping infrastructure and a summary of each of the pumping lines for each area. References to key documents for the design and construction of contact water pumping infrastructure are presented in Table 3-17. A reference is also included for the Operation and Maintenance Manual (OMM) manuals of the WTPs.

Table 3-17 : Key Reference Documents for Whale Tail Attenuation Pond and Pumping Infrastructure

Type of Information	Document Reference	Link to Retrieve Document
Detailed Engineering Report	Pumping System Phase 1 : Amaruq Water Management Pumping Infrastructure (SNC 2019) 651298-8000-40ER-0001_E00	..\..\..\04- Water Management\1- Engineering Study\2- Detailed Engineering Phase 1\5- Deliverable\1- Design Report\3- Detailled Eng Water Management Infra\651298-8000-40ER-0001_E00.pdf
	Hydrology Phase 1 : Whale Tail Water Management and Geotechnical Infrastructure (SNC 2018) 6118-E-132-002-TCR-010_651298-8000-4HER-0001-00-WMinfra	..\..\..\04- Water Management\1- Engineering Study\2- Detailed Engineering Phase 1\5- Deliverable\1- Design Report\3- Detailled Eng Water Management Infra\6118-E-132-002-TCR-010_651298-8000-4HER-0001_00_WMInfra.pdf
	Hydrology Phase 2 : Hydrological Analysis Update for the Water Management Infrastructure Design 6127-695-132-REP-001_R1	\\Cambfs01\groups\Engineering\05-Geotechnic\14-Amaruq\04- Water Management\1- Engineering Study\4 - Detailled Engineering Phase 2\3-Deliverable\1- Design Report\4- Hydrological Design Report
	Phase 2: Pumping System, Jetty and IVR Attn Pond Ramp : Design Report (SNC 2021) 668284-6000-40ER-0001	\\Cambfs01\groups\Engineering\05-Geotechnic\14-Amaruq\04- Water Management\1- Engineering Study\4 - Detailled Engineering Phase 2\3-Deliverable\1- Design Report\3- WMGI PH2\6127-695-132-REP-009_00 (668284-6000-40ER-0001).pdf
	Mammoth Diffuser (SNC 2019) 611298-8000-40ER-E02	..\..\..\04- Water Management\1- Engineering Study\2- Detailed Engineering Phase 1\5- Deliverable\1- Design Report\4- Diffuser\651298-8000-40ER-0002_E02 (Diffuser design).pdf
	WTS Diffuser : Whale Tail Diffuser (SNC 2020) 668284-9000-40ER-0001_01	\\Cambfs01\groups\Engineering\05-Geotechnic\14-Amaruq\04- Water Management\1- Engineering Study\4 - Detailled Engineering Phase 2\3-Deliverable\1- Design Report\2- WTS Diffuser\6127-695-132-REP-003_R1 (668284-9000-40ER-0001_01).pdf
	WT Attenuation Pond Ramp (AEM 2019) Attenuation Pond Ramp Detailed Eng	..\..\..\04- Water Management\1- Engineering Study\2- Detailed Engineering Phase 1\5- Deliverable\1- Design Report\5- Dewatering\Attenuation Pond Ramp Detailled Eng.pdf
	IVR WRSF Water Management (SNC 2021) :6127-695-132-REP-010_01	\\Cambfs01\groups\Engineering\05-Geotechnic\14-Amaruq\04- Water Management\1- Engineering Study\4 - Detailled Engineering Phase 2\3-Deliverable\1- Design Report\5- IVR WRSF Water Management
	Pit Dewatering System (AEM 2021)	\\Cambfs01\groups\Engineering\05-Geotechnic\14-Amaruq\04- Water Management\1- Engineering Study\8- Pit Dewatering\3- Deliverable\1- Design Report
Specification & Drawings	Installation Specifications Amaruq Ph1 : Water Management Pumping Infrastructure (SNC 2018) 651298-8000-40EF-0001	..\..\..\04- Water Management\1- Engineering Study\2- Detailed Engineering Phase 1\5- Deliverable\3- Specifications\Spec water manag infra 6118-E-132-002-SPT-004_R1.pdf
	Phase 2 Piping Specification (SNC 2020)	\\Cambfs01\groups\Engineering\05-Geotechnic\14-Amaruq\04- Water Management\1- Engineering Study\4 - Detailled Engineering Phase 2\3-Deliverable\3- Specification\3- PH2 Piping\wip20201204_6127-C-265-003-SPT-002_00 (668284-6000-40EF-0001).pdf

	WTS Diffuser Specification (SNC 2020)	\\Cambfs01\groups\Engineering\05-Geotechnic\14-Amaruq\04- Water Management\1- Engineering Study\4 - Detailled Engineering Phase 2\3-Deliverable\3- Specification\1- WTS Diffuser\6127-C-265-003-SPT-001_R0 (668284-9000-40EF-0001_00).pdf
WTP OMM Manual	ASWTP OMM Manual (AEM 2018)	..\..\..\..\..\..\Environment\LICENSE & REGULATORY\LICENSES & PERMITS\NWB\Licences\Whale Tail\2AM-WTP1826\Part D Item 1\AsWTP\OMM AsWTP\01-Application\2AM-WTP1826 Operation_Maintenance Manuel Asenic Water Treatment Plan-reduced.pdf
As-Built Report	WT Attenuation Pond Ramp	\\Cambfs01\groups\Engineering\05-Geotechnic\14-Amaruq\04- Water Management\2- Construction\2-PH 1 surface water management\2- 2019\4-Deliverable\1- As-Built Report\5- Attenuation Pond Ramp
	Mammoth Lake Diffuser	\\Cambfs01\groups\Engineering\05-Geotechnic\14-Amaruq\04- Water Management\2- Construction\2-PH 1 surface water management\2- 2019\4-Deliverable\1- As-Built Report\4-Diffuser Mammoth Lake
	WTS Diffuser	\\Cambfs01\groups\Engineering\05-Geotechnic\14-Amaruq\04- Water Management\2- Construction\5-PH2 Surface Water Management\4- Deliverable\1-As-Built Report\1- Diffuser WTS
	IVR WRSF Water Management System	\\Cambfs01\groups\Engineering\05-Geotechnic\14-Amaruq\04- Water Management\2- Construction\5-PH2 Surface Water Management\4- Deliverable\1-As-Built Report\3- IVR WRSF Water Management\
	IVR Attenuation Pond Ramp	\\Cambfs01\groups\Engineering\05-Geotechnic\14-Amaruq\04- Water Management\2- Construction\5-PH2 Surface Water Management\4- Deliverable\1-As-Built Report\4- IVR Attn Pond Ramp

3.10.1 Whale Tail Attenuation Pond and Pumping Infrastructure

The dewatered area of the North Whale Tail basin between the Whale Tail Dike and the Whale Tail Pit is referred to as the Whale Tail Attenuation Pond. The WT Attenuation Pond was commissioned in May 2020 with the completion of the dewatering. Until the commissioning of the IVR Attenuation Pond it was the main contact water management area on site where all surface contact water from the Whale Tail site was directed prior to being sent to the WTP and discharged to the environment. With the commissioning of IVR Attenuation Pond this location is now a secondary attenuation pond. Water from the WT Attenuation Pond can either be transferred to the IVR Attenuation Pond or sent to the WTP.

A ramp is built to allow pumping of the water from the attenuation pond to the WTP. This ramp has multiple levels to position pumping units to operate the pond at different water levels. The initial ramp was built in winter on ice and required mitigation in the summer of 2019 as instability was observed in it during the initial dewatering. Remediation work was performed by adding material and its performance has been satisfactory since then.

3.10.2 IVR Attenuation Pond and Pumping Infrastructure

The dewatered area of former lake A53 is referred to as the IVR Attenuation Pond. It was commissioned in the summer of 2020. The construction of the dike IVR-D1 in the winter of 2020 has increased the capacity of this attenuation pond so that it become the main area to manage contact water on site. Contact water from the Whale Tail site is directed to this pond where it is stored prior to being sent to the water treatment plant (WTP) and discharged through an approved diffuser.

An attenuation pond ramp was built to allow pumping of the water from the IVR attenuation pond to the WTP. This ramp was built in the fall of 2020 following the dewatering of Lake A53. This ramp is comprised of two levels to be able to operate the pond under various water level conditions.

3.10.3 WTP and Diffuser

The water can be discharged from the WT and IVR Attenuation Ponds to the environment through two approved diffuser locations (WTS or Mammoth Lake). Prior to being discharged the water quality must satisfy discharge criteria and is sent to the water treatment plant (WTP). The WTP is designed to treat TSS and arsenic. There is a header system at the intake of the WTP and at its exit that allows to select whether water pumped from the Attenuation pond bypasses the WTP treatment and whether the water exiting the WTP is sent to WTS or Mammoth Lake.

The first discharge location is Mammoth Lake. There are 3 diffusers in Mammoth Lake spaced 50 m apart. These diffusers were installed on ice in the winter of 2019 and were ballasted with boulders. 2 of these are designed to be used in the summer and one is designed to be used in the winter. The summer diffusers (Eastern and Western diffuser) are 311 m long and comprised of 10 discharge ports spaced 12.5 m apart. The winter diffuser (central diffuser) is 273 m long and comprised of 3 discharge ports spaced 14 m apart. During the initial commissioning of these diffuser in the summer of 2019 it was observed that the Western and Eastern diffusers did not sink as planned and kept afloat and drifted. They were reinstalled back into their original alignment and successfully sunk in August 2019.

The second discharge location is WTS. There are 2 diffusers in WTS spaced 108 to 130 m apart. These diffusers were installed in open water conditions in the fall of 2020 and were ballasted with concrete blocks. One diffuser is designed to be used in summer conditions and one in winter conditions. Each diffuser consists of 7 discharge ports spaced out at 14 m intervals. The winter diffuser is also equipped with heat trace channels from the shore going into the lake designed to keep the diffuser thawed in winter conditions and to unfreeze the diffuser if it froze. The heat trace portion of the line ballasted in the lake is 73 m long. In the winter of 2021, an operational issue with the winter diffuser caused it to float to the surface and drift away in the summer of 2021. It was reinstalled back in its original alignment and successfully sunk in the fall of 2021.

3.10.4 WT / IVR WRSF Area

The waste rock storage facilities on site are the WT WRSF and the IVR WRSF. The waste rock storage facility runoff water needs to be managed so that it is sent to one of the two Attenuation Ponds on site.

The WT WRSF is contained within watershed that either drain to the WT WRSF Pond or toward the IVR Pit. Water reporting to the WT WRSF Pond is pumped to either the WT or IVR Attenuation Pond. There is an access road around the WT WRSF used to visually inspect the facility and 4 sumps are established around the facility in low spots to ensure that water can't accumulate at the toe of the WT WRSF and escape the watershed. Water from these sumps is pumped toward the WRSF Pond.

The IVR WRSF is contained within watershed that drain either toward the IVR Attenuation Pond or IVR Pit. 4 sumps were installed around the IVR WRSF and an access road was built to access these and inspect the area where water could potentially accumulate at the toe of the structure and escape the watershed. Water from these sumps is pumped toward the IVR Attenuation Pond.

During the initial lift placement of IVR WRSF in 2021 and 2022 a series of overpush incidents lead to localised non-conformity to the water management system. In some areas, sumps were partially backfilled and in other areas there was no longer room between the toe of the WRSF and the road for inspection. A plan is ongoing with the objective of remediating these areas before freshet 2023.

3.10.5 WT / IVR Pit Area

Water from the pits is sent to one of the site Attenuation Ponds. The IVR Pit is contained within permafrost and water management is only required at freshet. The WT Pit is located within a closed talik and there is constant inflow reporting to the pit from the South Wall (i.e., near the WT Attenuation Pond).

3.11 INSTRUMENTATION

The water management infrastructures are instrumented to continuously monitor performance. In-situ instruments are installed within the structures and their foundations (piezometers, thermistors, SAA inclinometers).

Water levels in the ponds are monitored by piezometers whose readings are confirmed with periodic water surveys.

Reference documents for the instrumentation installed on the water management infrastructures is summarized in Table 3-18. The summary of the instruments installed is summarized in Table 3-19.

Table 3-18 : Reference Documents for Instrumentation

Type of Information	Information Location
Instrumentation Campaign As-Builts	..\..\..\14- Amaruq\05- Field Campaign
Instruments Database	\\Cambfs01\groups\Engineering\05-Geotechnic\11-Instrumentation\1- Instruments\ALL Instruments Databases
Instrument Maps and Typical Cross-Sections	Instruments-instruments summary folder for each structure on the network

Table 3-19 : Instrumentation Summary for the Water Management Infrastructure

Structure	Piezometer	Thermistors	Inclinometer
Whale Tail Dike	44 + 2 (lake)	38 + 2 (lake)	4
Mammoth Dike	1 (lake)	3	-
WRSF Dike	-	9	-
IVR Dike D-1	-	7	-
WRSF Pond	1	-	-
Whale Tail Attenuation Pond	1	-	-
IVR Attenuation Pond	1	-	-

SECTION 4 • DEWATERING

Both dewatering dikes of the project (WT Dike and Mammoth Dike) are now in the operational phase as the dewatering of the project is complete.

4.1 PHASE 1 – WTN DEWATERING (2019-2020)

The objective of the Phase 1 dewatering was to dewater Whale Tail North to free the footprint of Whale Tail Pit. The dewatering started in March 2019 and was completed in May 2020 with Whale Tail North becoming the Whale Tail Attenuation Pond. Water from WTN was discharged to WTS and Mammoth Lake through a temporary dewatering diffuser. The dewatering period was initially supposed to be completed in the summer of 2019 but had to be extended until the completion of the WTD remedial grouting campaign due to the high seepage flow through WTD.

4.2 PHASE 2 – IVR AREA DEWATERING (2020)

The objective of the Phase 2 dewatering was to dewater the lakes A47, A49, A 49-A, A-P21, A50, A51, A52 and A53 in order to free the IVR Pit footprint, to allow the construction of the IVR WRSF, and to commission the IVR Attenuation Pond in the footprint of former lake A53. The Phase 2 dewatering started in July 2020 and was completed in October 2020. Water was sent to the Whale Tail Attenuation Pond and discharged through the permanent diffuser in Mammoth Lake.

Table 4-1 : Reference Documents for Phase 1 Dewatering

Type of Information	Reference	Link to Retrieve Document
Detailed Engineering Report	Whale Tail North Dewatering 60 Days Notice (AEM, 2018)	..\..\..\04- Water Management\1- Engineering Study\2- Detailed Engineering Phase 1\5- Deliverable\1- Design Report\5- Dewatering\Part D Item 1 - 60 day notice - V0.pdf
	Dewatering Phase Pumping System Design Report (SNC, 2020) 668284-8000-40ER-0001	\\cambfs01\groups\Engineering\05-Geotechnic\14-Amaruq\04- Water Management\1- Engineering Study\4 - Detailled Engineering Phase 2\3- Deliverable\1- Design Report\1- IVRLake Dewatering\6127-648-132-REP-001_R2 (668284-8000-40ER-0001).pdf
As-Built Report	Whale Tail North Basin Dewatering Construction Report (AEM, 2020)	\\Cambfs01\groups\Engineering\05-Geotechnic\14-Amaruq\04- Water Management\2- Construction\1-Dewatering PH1\4- Deliverable\1- As-Built Report\Whale Tail North Dewatering As-built report_final_Mark_signed.pdf
	Dewatering Phase 2 Construction Report (AEM, 2021)	\\CAMBFS01\Groups\Engineering\05-Geotechnic\14-Amaruq\04- Water Management\2- Construction\4-Dewatering PH2\4- Deliverable\1- As-Built Report\Agnico Eagle Whale Tail Dewatering Phase 2 Construction Summary Report.pdf

SECTION 5 • OPERATIONS

The following section outlines the key operational procedures that need to be observed and followed during operation of the Whale Tail water management infrastructures in accordance with their performance objectives.

5.1 REFERENCES

References to key documents for the operation of the Whale Tail water management infrastructure are presented in Table 5-1.

Table 5-1 : Key Reference Documents for Operation of Whale Tail Water Management Infrastructure

Type of Information	Reference	Link to Retrieve Document
Whale Tail Mine – Annual Water Balance	AEM (2022)	\\Cambfs01\groups\Engineering\12- Annual Report\2021\1- Annual Report 2021\4- Water Management Plan Update\2- Amq\Appendix B & C\Appendix C 2021 WT Water Balance.pdf
Whale Tail Mine - Water Management Plan	V9 – AEM (2022)	\\cambfs01\groups\Engineering\12- Annual Report\2021\1- Annual Report 2021\4- Water Management Plan Update\2- Amq\AMQ_WaterMgmtPlan_9_final w appendices.pdf
Whale Tail Pit Water Quality Model	Golder (2022) 21508120-552-RPT-RevB	\\cambfs01\groups\Engineering\12- Annual Report\2021\1- Annual Report 2021\2- Water Quality Forecast Amq\3- Deliverable\Golder Closure WQF\WhaleTail-2021AnnualRpt-WaterQuality_RevB_March2022.pdf
Mammoth Lake level re-assessment	SNC (2020) 671528-7000-4HER-01	\\Cambfs01\groups\Engineering\05- Geotechnic\14- Amaruq\04- Water Management\1- Engineering Study\6- Mammoth Lake freshet 2020-2021\3- Deliverable
Power BI Dashboard on Water Management	-	https://app.powerbi.com/groups/me/apps/e2b8b538-784c-43d5-9ed2-3b213d5f1d3b/reports/4284becf-d88d-479d-b81b-eb133449a879/ReportSection81fc7fbdeaab99c7dc96

5.2 SUMMARY OF PERFORMANCE OBJECTIVES AND OPERATIONAL CONTROL

The performance objectives with respect to the failure modes are summarized in Table 5-2. The operational controls for the Whale Tail water management infrastructure during operation are summarized in Table 5-3 and described further in this Section.

Table 5-2 : Performance Objectives in Terms of Failure Modes of the Whale Tail Mine Water Management Infrastructure

Type of structure	Failure mode	Inferred mechanism	Causes	Consequences	Performance objective and indicator
Water Retaining Dikes	Overtopping of low-permeability element (cut-off wall or liner)	Reservoir level exceeds low-permeability element elevation	• Poor management of reservoir level • Subsidence of low-permeability element • PMF flood (really low probability event)	Uncontrolled inflow into site	• Adequate reservoir level (monitoring by survey and PZ) • No subsidence of the crest (visual inspections & drone survey)
	Internal erosion of dike or foundation	• Erosion of engineered fill leading to deformation of cut-off wall or liner • Erosion of cut-off wall • Damage in liner (hole or tear) • Erosion of foundation soils	• Excessive hydraulic gradient • Pre-existing seepage channels • Inadequate construction materials or foundation soils (unlikely due to appropriate design and QA/QC) • Damage to liner due to operations around the dike (unlikely because liner is protected)	Seepage, partial loss of containment, inflow into site. Possible progressive degradation of dike and later risk of destabilization.	• Good, stable condition of fill and foundation at the toe (visual inspections) • Stable, manageable seepage (visual inspections, flowmeter monitoring) • Stable thermal and piezometric regime in foundation (piezometers and thermistors monitoring, refer to TARP in Section 5.6)
	Instability due to foundation failure	Failure of foundation soils against shear stress	• Inadequate foundation shear strength • Excessive pore-water pressure • Erosion of soils (refer to previous failure mode)	Dam breach, uncontrolled inflow into site, partial or total loss of containment	• Good, stable condition of foundation at the toe (visual inspections) • Stable thermal and piezometric regime in foundation, acceptable pore-pressure levels (piezometers and thermistors monitoring refer to TARP in Section 5.6)
	Instability due to deformation of	Failure of construction	• Excessive deformation of engineering fill,	Dam breach, uncontrolled inflow into site,	• Good, stable condition of all elements of the dike (visual inspections)

Type of structure	Failure mode	Inferred mechanism	Causes	Consequences	Performance objective and indicator
	dike and slope failure	material against shear stress	cut-off wall or liner • Erosion of soils (refer to previous failure mode)	partial or total loss of containment	• Acceptable levels of deformation (inclinometers monitoring, refer to TARP in Section 5.6)
	Unmanageable seepage to site / uncontrolled discharge to Env	Seepage through the structure higher than design intent that can't be managed by a collection system	• Excessive hydraulic gradient • Pre-existing seepage channels • Inadequate seepage collection system • Damage to liner • Permafrost degradation	Unmanageable inflow / uncontrolled outflow	• Manageable seepage (visual inspections, flowmeter monitoring, pumping capacity) • Stable thermal and piezometric regime in foundation (piezometers and thermistors monitoring refer to TARP in Section 5.6)
Channels	Overtopping of channel slopes / overtopping of WTD cut-off wall	Insufficient capacity to convey water through the channel	• Blockage by debris • Erosion of slope materials • Ice / snow blockage	Uncontrolled inflow to site / Uncontrolled outflow to Env	• Good condition (unobstructed) of the channels, inlets and outlets (visual inspections) • Normal water levels in channels and upstream area (freeboard monitoring, refer to TARP in Section 5.6) • Proper snow removal strategy prior to freshet
	Excessive turbidity in water discharge into environment	Erosion of materials or foundation	• Inadequate materials • Exposed foundation • Failure of turbidity control systems (turbidity barriers)	Unacceptable water quality released into environment	Good condition (no erosion) of the channel materials (visual inspections)
Attenuation ponds	Overflowing	Excessive water level/volumes	• Insufficient water treatment rate / damaged pumping system / blocked diffuser	Uncontrolled outflow into the site	• Normal water levels in Attenuation Ponds (water level monitoring, refer to TARP in Section 5.6) • Good condition of pumping infrastructure

Type of structure	Failure mode	Inferred mechanism	Causes	Consequences	Performance objective and indicator
			• Excessive inflow into the pond from pumping • Extreme flood or seepage reporting to the pond		(visual inspection and maintenance)
	Instability of ramp due to foundation failure	Failure of foundation soils against shear stress	• Inadequate foundation shear strength • Excessive pore-water pressure • Erosion of soils	Interruption of pumping	• Good, stable condition of structure (visual inspections)
Diffusers	Water quality not met in diffusion zone	Inadequate diffusion in the mixing zone	• Inadequate performance of diffuser	Unacceptable water quality in the mixing zone	• Acceptable water quality results in receiving environment (measured and forecasted) • Good condition of diffuser (visual inspection)
WRSF Area	Loss of containment from the WRSF watershed	Inadequate water management	• Insufficient pumping rate / damaged pumping system • Excessive inflow reporting to the watershed • Change in the layout of the WRSF/ sump position at inadequate location	Uncontrolled release of contact water in the environment	• Good condition of pumping infrastructure (visual inspection and maintenance) • Observation that water is not ponding near the limit of the watershed • Water level in the sumps and pond around the WRSF
Pit Area	Flooding of pit floor	Inadequate water management	• Insufficient pumping rate / damaged pumping system • Excessive inflow reporting to the Pit	Loss of Mining productivity	• Good condition of pumping infrastructure (visual inspection and maintenance) • Water level in the sumps and pond of the Pit Area

Table 5-3 : Operational Control of the Whale Tail Water Management Infrastructure

Water Management
• Operational freeboard (Section 5.3) • Water balance calibration (Section 5.4) • Water discharge, volume, and quality (Section 5.4) • Seepage control and collection (Section 5.5)
Surveillance
• Surveillance requirements for operational performance indicator (Section 5.6) • Threshold for performance criteria to trigger pre-defined actions (Section 5.6)

5.3 OPERATING LEVEL & FREEBOARD

Operating level and freeboard are monitored by water level survey and piezometric monitoring. The design criteria for minimum freeboard and operational criteria for the relevant water management infrastructure are presented in Table 5-4. The TARP category associated with each water level range are a summary of the response and are included in the same table. Refer to Section 5.7 for the communication protocol and Appendix C for a summary of the pond Operational Guidelines and the list of specific action to take. The freeboard may change due to fluctuations in lake levels or due to settlement of the dikes or channel slopes. Maintenance may be required to restore loss of freeboard due to settlement.

Table 5-4 : Dike Freeboard and Pond Operational Levels

Structure	Freeboard		Operation water level (m)		Critical water level (m)	Emergency water level (m)
	To the Dike Crest (m)	To the Dike Cut-off Wall or Liner (m)	Normal	Maximum		
Whale Tail Dike	2.7	0.7	<155.8	155.8-156.3	156.3-157	>157
Mammoth Dike	1.7	0.2	<153	153-153.3	153.3-153.5	>153.5
WRSF Dike	2.4	1.0	<154	154-156	156-157	>157
IVR Dike D-1	2.3	0.7 (to spillway invert)	<163.2	163.2-164.2	164.3-164.79	>=164.8
WT Attenuation Pond	-		<143.5	143.5–145.5	145.5-146	>146
GSP-1	-		<154	154-155	155-160.5	>160.5
Corresponding TARP Category	N/A		Green	Yellow	Orange (risk of overtopping)	Red (overtopping and uncontrolled inflow)
Response	N/A		Standard operations.	Inform stakeholders (Section 5-7) Refer to Appendix C for specific action	Immediately take action to stop increase. Inform stakeholders (Section 5-7) Refer to Appendix C for specific action	Trigger ERP (Section 5-7)

5.4 WATER MANAGEMENT

Water management activity includes the movement of water and ensuring that water quality meets the discharge criteria. Water is moved around site using pumps and pipes. The main sources of water to manage are: WTD seepage, runoff water from the Pits, the WRSFs, runoff from the industrial area and the Attenuation Pond areas. The movement of water on site is monitored using flowmeters and are recorded in the site wide water balance. The water balance is calibrated monthly. Water quality is monitored to ensure that any discharge to the environment respects the water license criteria and the water quality model is updated annually and calibrated as required. Information on water management at the Whale Tail Site is documented in the Whale Tail Water Management Plan which is reviewed on a yearly basis.

The water management strategy for the Whale Tail Mine can be found in the water balance and the site water flowchart which is included in Appendix C.

5.5 SEEPAGE MANAGEMENT

Seepage through a dewatering dike must be managed in a controlled fashion. This is attained by using a system of collection ditches and sumps at the downstream toe of the structure to capture the seepage into a contact water retention pond. The water quality is monitored, and it will be directed to an approved discharge point. Table 5-5 summarizes the current seepage control measures in place. More details on these systems can be found in Section 3.

If seepage is observed through a structure but this seepage naturally reports to a contact water retention pond (i.e., seepage from Whale Tail Dike reporting to the attenuation pond) then a seepage collection system is not necessarily required.

The quantity and quality of seepage from a water management infrastructure must be monitored as per the requirements outlined in Section 7.

Currently there is one seepage collection system built at WTD Dike and an access to the downstream area of WRSF Dike to pump seepage if required following the event of summer 2019. The seepage system at WTD is not operational due to issues with water quality. No seepage was reported at the WRSF downstream area since 2019.

The amount of seepage that can be tolerated is dependent on the structure design intent and the capacity of the collection system in place. These values are considered to determine the seepage indicator in the TARP level presented in Section 5.6.

Table 5-5 : Summary of Seepage Management

Structure	Seepage Expected From Design	Performance Indicator	Status	Water Collection System	Seepage Quality
Whale Tail Dike	Yes, talik. (900 to 2,000 m^3/day from design report)	Seepage rate measured in V-notch and from seepage station flowmeter	68 to 89 m^3/h (1,632 to 2,136 m^3/day) in V-notch in (summer of 2020)	4 pumping stations constructed. Can pump to Whale Tail South. System is not operational due to water quality issue.	Generally clear but high pH (about 9)
WRSF Dike	No (permafrost condition)	Observation of seepage	No seepage following remediation measure	Downstream access road to a low spot for installation of a submersible pump	Clear in 2019. No seepage since then

5.6 OPERATING PROCEDURE DURING OPERATION OF WHALE TAIL WATER MANAGEMENT INFRASTRUCTURE

Table 5-6 to Table 5-11 below present performance indicators for each of the Whale Tail water management infrastructures and the Trigger Action Response Plan (TARP) if the associated performance criteria deviate from the defined range.

Table 5-6 : Threshold Criteria and Pre-Defined Action During Operation of Whale Tail Dike

	Failure mode	Observation	Threshold Criteria During Operation			
			Green **Normal Operating Range**	**Yellow** **Areas of Concern**	**Orange** **High Risk Situation**	**Red** **Emergency Situation**
Criteria	Overtopping of cut-off wall because of excessive reservoir level, leading to uncontrolled inflow into site	Whale Tail South Elevation (dike freeboard) (after SWTC construction)	Normal operation range: < 155.8 masl	> 155.8 to < 156.3 m	> 156.3 to < 157 m	> 157 masl Core or crest overtopping
	Internal erosion of dike or foundation, leading to partial loss of containment (seepage through wall or foundation)	Sinkhole on crest	None visible / inactive	Localized depression > 5 m outside from centreline	Sinkhole identified	Development of sinkhole Dike stability or cutoff integrity is compromised
		Temperature variation along centreline (based on thermistors and piezometers)	Temperature measurement stable, seasonal trend observed	Unexplained thermal trend observed	Thermal trends are explained and demonstrate an upset in the structure condition	N/A
	Unmanageable seepage to site (can also be indicative of internal erosion failure mode depending on seepage flowpath)	Seepage to manage	Within historical flow < 250 m^3/ h and managed by pumping	Inflow higher than historical flow after remedial grouting campaign but manageable with available pumping capacity >250 m^3/h or Sudden or cumulative increase < 25 % in over 3 days (not related to freshet inflow)	Inflow higher than historical flow prior to remedial grouting campaign > 600 m^3/h or Sudden or cumulative increase > 25 % in over 3 days (not related to freshet inflow)	Inflow is unmanageable with current pumping capacity
		Seepage water quality (turbidity)	No observation of turbidity in seepage	Turbidity observed in seepage water (single TSS event of 30 mg/L)	Sustained high turbidity over 30 mg/L in seepage water	Turbidity is linked with erosion of cut-off-wall
	Instability due to foundation failure, leading to dam breach and total or partial loss of containment	Pore water pressure (based on piezometers)	Pore water pressure stable or seasonal	Unexplained piezometric trend observed	Piezometric trends are explained and demonstrates an upset in the structure condition	N/A
		Sloughing along downstream rockfill embankment face and downstream toe	None visible / inactive	Visible displacement or bulging	Toe displacement related to a sloughing slide from near downstream crest to 5 m from centreline Bulging > 1 m in height	Toe displacement related to a sloughing slide reaching 5 m from centreline Bulging greater than 4m in height. Continued event.
	Instability due to deformation and slope failure, leading to dam breach and total or partial loss of containment	Tension crack on the crest (outside cutoff area)	None visible / inactive	< 0.1 m wide & < 5 m length < 1.0 m deep	> 0.1 m and < 0.2 m wide & > 5 m and < 10 m length along the dike > 1.0 m deep	> 0.2 m wide > 10 m length along the dike > 2.0 m deep Dike stability is compromised
		Tension crack within 3 m each side of the cutoff wall at crest	None visible / inactive	< 0.1 m wide < 0.1 m deep	> 0.1 m wide and < 0.2 m wide > 0.1 m and < 0.3 m deep	> 0.2 m wide > 0.3 m deep Cutoff integrity is compromised
		Cut-off wall lateral cumulative deformation (based on inclinometer) Rate of deformation to be examined as well	< 50 mm	Between 50 mm and 100 mm	> 100 mm	N/A
		Cumulative vertical crest movement	< 0.2 m	> 0.2 and < 1 m or Stable trend	> 1 m with increasing rate of settlement	> 2 m with increasing rate of settlement
Action Required			• Continue operation, maintenance, surveillance, and monitoring as per standard operating procedure	• If event is related to water level refer to Appendix C • If event is referring to seepage rate increase pumping capacity or repair system • Document location, photograph, survey, and increase inspection and instrument monitoring in area of concern (refer to Section 7) • Implement engineering review. • Implement communication plan (section 5-7)	• Continue measures of Yellow Level • Plan and take appropriate mitigation measures with engineering review. (See Appendix D). • Reassess thresholds and conditions for red category (emergency situation) taking into account the changing conditions presently observed and interactions of various items.	• Evacuation of personnel and equipment from downstream area. • Close access to dike crest • Implement Emergency Response Plan (Section 5-7)

Table 5-7 : Threshold Criteria and Pre-Defined Action During Operation of Mammoth Dike

	Failure mode	Observation	Threshold Criteria During Operation			
			Green **Normal Operating Range**	**Yellow** **Areas of concern**	**Orange** **High Risk Situation**	**Red** **Emergency Situation**
Criteria	Overtopping of cut-off wall because of excessive reservoir level, leading to uncontrolled inflow into site	Mammoth Lake elevation (dike freeboard)	Normal operation range: < 153.0 masl	Design flood range: > 153.0 and < 153.3 masl	> 153.3 and < 153.5 masl	> 153.5 masl
	Internal erosion of dike or foundation, leading to partial loss of containment (seepage through wall or foundation)	Sinkhole on crest	None visible / inactive	> 5 m outside from centreline, localized depression	Within 5 m from centreline, sinkhole identified	Within 5 m from centreline and associated with seepage increase. Continued event
		Temperature variation (based on thermistors)	Temperature measurement stable and similar variation at surface from previous years.	Warming trend in the permafrost or increase in active layer (permafrost degradation)	Thawing of the dike key trench	-
	Unmanageable seepage to site (can also be indicative of internal erosion failure mode depending on seepage flowpath)	Seepage through dike	None	Inflow < 300 m^3/day and managed by pumping (FOS >2) or Sudden or cumulative increase < 25 % in over 3 days (not related to freshet inflow)	Inflow > 300 m^3/day and managed by pumping (FOS >2) or Sudden or cumulative increase > 25 % in over 3 days (not related to freshet inflow)	Inflow is unmanageable with pumping capacity (FOS < 1)
		Seepage water quality (turbidity)	-	Turbidity observed in seepage water (single TSS event of 30 mg/L)	Sustained high turbidity over 30 mg/L in seepage water	N/A
	Instability due to foundation failure, leading to dam breach and total or partial loss of containment	Sloughing along downstream rockfill embankment face and downstream toe	None visible / inactive	Visible displacement or bulging	Toe displacement related to a sloughing slide from near downstream crest to 5 m from centreline Bulging > 1 m in height	Toe displacement related to a sloughing slide reaching 5 m from centreline Bulging greater than 4m in height. Continued event.
	Instability due to deformation and slope failure, leading to dam breach and total or partial loss of containment	Tension crack on the crest	None visible / inactive	< 0.1 m wide & < 5 m length < 1.0 m deep	> 0.1 m and < 0.2 m wide & > 5 m and < 10 m length along the dike > 1.0 m deep	> 0.2 m wide > 10 m length along the dike > 2.0 m deep Dike stability is compromised
		Cumulative vertical crest movement	< 0.2 m	> 0.2 and < 1 m or Stable trend	> 1 m with increasing rate of settlement	> 2 m with increasing rate of settlement
Action Required			• Continue operation, maintenance, surveillance, and monitoring as per standard operating procedure	• If event is related to water level refer to Appendix C • If event is referring to seepage rate increase pumping capacity or repair system • Document location, photograph, survey, and increase inspection and instrument monitoring in area of concern (refer to Section 7) • Implement engineering review. • Implement communication plan (section 5-7)	• Continue measures of Yellow Level • Plan and take appropriate mitigation measures with engineering review. (See Appendix D). • Reassess thresholds and conditions for red category (emergency situation) taking into account the changing conditions presently observed and interactions of various items.	• Evacuation of personnel and equipment from downstream area. • Close access to dike crest • Implement Emergency Response Plan (Section 5-7)

Table 5-8 : Threshold Criteria and Pre-Defined Action During Operation of WRSF Dike

	Failure mode	Observation	Threshold Criteria During Operation			
			Green **Normal Operating Range**	**Yellow** **Areas of concern**	**Orange** **High Risk Situation**	**Red** **Emergency Situation**
Criteria	Overtopping of cut-off wall because of excessive reservoir level, leading to uncontrolled inflow into site	WRSF Pond elevation (dike freeboard)	Normal operation range: < 154.0 masl	Design flood range: > 154 and < 156 masl	> 156 and < 157 masl	> 157 masl
	Internal erosion of dike or foundation, leading to partial loss of containment (seepage through wall or foundation	Sinkhole on crest	None visible / inactive	> 5 m outside from centreline, localized depression	Within 5 m from centreline, sinkhole identified	Within 5 m from centreline and associated with seepage increase. Continued event
		Temperature variation (based on thermistors)	Temperature measurement stable and similar variation at surface from previous years.	Warming trend in the permafrost or increase in active layer (permafrost degradation)	Thawing of the dike key trench	-
	Unmanageable seepage to site (can also be indicative of internal erosion failure mode depending on seepage flowpath)	Seepage through dike	None	Inflow < 300 m^3/day and managed by pumping (FOS >2) or Sudden or cumulative increase < 25 % in over 3 days (not related to freshet inflow)	Inflow > 300 m^3/day and managed by pumping (FOS >2) or Sudden or cumulative increase > 25 % in over 3 days (not related to freshet inflow) Or Uncontrolled release to Environment	Inflow is unmanageable with pumping capacity (FOS < 1)
		Seepage water quality (turbidity)	-	Turbidity observed in seepage water (single TSS event of 30 mg/L)	Sustained high turbidity over 30 mg/L in seepage water	N/A
	Instability due to foundation failure, leading to dam breach and total or partial loss of containment	Sloughing along downstream rockfill embankment face and downstream toe	None visible / inactive	Visible displacement or bulging	Toe displacement related to a sloughing slide from near downstream crest to 5 m from centreline Bulging > 1 m in height	Toe displacement related to a sloughing slide reaching 5 m from centreline Bulging greater than 4m in height. Continued event.
	Instability due to deformation and slope failure, leading to dam breach and total or partial loss of containment	Tension crack on the crest	None visible / inactive	< 0.1 m wide & < 5 m length < 1.0 m deep	> 0.1 m and < 0.2 m wide & > 5 m and < 10 m length along the dike > 1.0 m deep	> 0.2 m wide > 10 m length along the dike > 2.0 m deep Dike stability is compromised
		Cumulative vertical crest movement	< 0.2 m	> 0.2 and < 1 m or Stable trend	> 1 m with increasing rate of settlement	> 2 m with increasing rate of settlement
Action Required			• Continue operation, maintenance, surveillance, and monitoring as per standard operating procedure	• If event is related to water level refer to Appendix C • If event is referring to seepage rate increase pumping capacity or repair system • Document location, photograph, survey, and increase inspection and instrument monitoring in area of concern (refer to Section 7) • Implement engineering review. • Implement communication plan (section 5-7)	• If seepage is released to Environment empty the pond totally • Continue measures of Yellow Level • Plan and take appropriate mitigation measures with engineering review. (See Appendix D). • Reassess thresholds and conditions for red category (emergency situation) taking into account the changing conditions presently observed and interactions of various items.	• Close access to dike crest • Implement Emergency Response Plan (Section 5-7)

Table 5-9 : Threshold Criteria and Pre-Defined Action During Operation of IVR Dike D-1

	Failure mode	Observation	Threshold Criteria During Operation			
			Green **Normal Operating Range**	**Yellow** **Areas of concern**	**Orange** **High Risk Situation**	**Red** **Emergency Situation**
Criteria	Overtopping of cut-off wall because of excessive reservoir level, leading to uncontrolled inflow into site	IVR Attenuation Pond elevation (dike freeboard)	Normal operation range: < 163.2 masl	Design flood range: > 163.2 and < 164.2 masl	> 164.2 and < 164.8 masl	> 164.8 masl
	Internal erosion of dike or foundation, leading to partial loss of containment (seepage through wall or foundation	Sinkhole on crest	None visible / inactive	> 5 m outside from centreline, localized depression	Within 5 m from centreline, sinkhole identified	Within 5 m from centreline and associated with seepage increase. Continued event
		Temperature variation (based on thermistors)	Temperature measurement stable and similar variation at surface from previous years.	Warming trend in the permafrost or increase in active layer (permafrost degradation)	Thawing of the dike key trench	-
	Unmanageable seepage to site (can also be indicative of internal erosion failure mode depending on seepage flowpath)	Seepage through dike	None	Inflow < 300 m^3/day and managed by pumping (FOS >2) or Sudden or cumulative increase < 25 % in over 3 days (not related to freshet inflow)	Inflow > 300 m^3/day and managed by pumping (FOS >2) or Sudden or cumulative increase > 25 % in over 3 days (not related to freshet inflow)	Inflow is unmanageable with pumping capacity (FOS < 1)
		Seepage water quality (turbidity)	-	Turbidity observed in seepage water (single TSS event of 30 mg/L)	Sustained high turbidity over 30 mg/L in seepage water	N/A
	Instability due to foundation failure, leading to dam breach and total or partial loss of containment	Sloughing along downstream rockfill embankment face and downstream toe	None visible / inactive	Visible displacement or bulging	Toe displacement related to a sloughing slide from near downstream crest to 5 m from centreline Bulging > 1 m in height	Toe displacement related to a sloughing slide reaching 5 m from centreline Bulging greater than 4m in height. Continued event.
	Instability due to deformation and slope failure, leading to dam breach and total or partial loss of containment	Tension crack on the crest	None visible / inactive	< 0.1 m wide & < 5 m length < 1.0 m deep	> 0.1 m and < 0.2 m wide & > 5 m and < 10 m length along the dike > 1.0 m deep	> 0.2 m wide > 10 m length along the dike > 2.0 m deep Dike stability is compromised
		Cumulative vertical crest movement	< 0.2 m	> 0.2 and < 1 m or Stable trend	> 1 m with increasing rate of settlement	> 2 m with increasing rate of settlement
Action Required			• Continue operation, maintenance, surveillance, and monitoring as per standard operating procedure	• If event is related to water level refer to Appendix C • If event is referring to seepage rate increase pumping capacity or repair system • Document location, photograph, survey, and increase inspection and instrument monitoring in area of concern (refer to Section 7) • Implement engineering review. • Implement communication plan (section 5-7)	• Continue measures of Yellow Level • Plan and take appropriate mitigation measures with engineering review. (See Appendix D). • Reassess thresholds and conditions for red category (emergency situation) taking into account the changing conditions presently observed and interactions of various items.	• If spillway is triggered assess spillway condition, water flow path, and WT Attenuation Pond capacity to determine whether to trigger the other action • Evacuation of personnel and equipment from downstream area. • Close access to dike crest • Implement Emergency Response Plan (Section 5-7)

Table 5-10 : Threshold Criteria and Pre-Defined Action During Operation of the SWTDC, IVRDC and Saline Ditch

	Failure mode	Observation	Threshold Criteria During Operation			
			Green **Normal Operating Range**	**Yellow** **Areas of concern**	**Orange** **High Risk Situation**	**Red** **Emergency Situation**
Criteria	Overtopping of channel slopes	Sloughing along channel slopes	None visible / inactive	Visible displacement or bulging	Displacement related to a sloughing slide Bulging > 1 m in height	Displacement related to a sloughing slide Bulging greater than 4m in height. Continued event
		Cumulative vertical crest movement	< 0.2 m	> 0.2 and < 1 m or Stable trend	> 1 m with increasing rate of settlement	> 2 m with increasing rate of settlement
		Blockage of the channel	None visible	Accumulation of debris or ice blockage in the channel during open water season, water still flowing well	Accumulation of debris or ice blockage in the channel during open water season, water still flowing through but reduced flow and elevated water level behind the blockage compared to historical level, uncontrolled release to site	Accumulation of debris or ice blockage in the channel during open water season, no water flowing through, observation of uncontrolled release to Environment
	Excessive turbidity or poor water quality in water discharge into environment	Channel water quality (turbidity)	No observation of turbidity in channel	Turbidity observed in channel water (single TSS event of 30 mg/L)	Sustained high turbidity over 30 mg/L in channel water	Turbidity is linked with erosion of channel or outlet
		Water quality in the receiving environment and at outlet	Water quality at outlet met receiving environment criteria and Water quality of the receiving environment follows water quality forecast	Water quality at outlet met receiving environment criteria and Water quality of the receiving environment shows a trend that water quality is deteriorating	Water quality at outlet does not meet receiving environment criteria	-
Action Required			• Continue operation, maintenance, surveillance, and monitoring as per standard operating procedure	• If event is related to water level refer to Appendix C • If event is related to turbidity install turbidity control measure • Document location, photograph, survey, and increase inspection and instrument monitoring in area of concern (refer to Section 7) • Implement engineering review. • Implement communication plan (section 5-7)	• Continue measures of Yellow Level • If event is linked to snow blockage remove obstruction or install pumping system to help transfer • Reassess thresholds and conditions for red category (emergency situation) taking into account the changing conditions presently observed and interactions of various items.	• Implement Emergency Response Plan (Section 5-7)

Table 5-11 : Threshold Criteria and Pre-Defined Action During Operation of Whale Tail and IVR Attenuation Ponds and Pumping Infrastructure

	Failure mode	Observation	Threshold Criteria During Operation Green Normal Operating Range	 Yellow Areas of concern	 Orange High Risk Situation	 Red Emergency Situation
Criteria	Overflowing of the attenuation pond because of uncontrolled water level (refer to IVR Dike D-1 for IVR Attenuation Pond level)	Whale Tail Attenuation Pond elevation (storage capacity)	Normal operation range: < 143.5	Maximum operating range: >143.5 and < 145.5 masl	> 145.5 and < 146 masl without overflowing in pit	Pit crest overflow: > 146 masl
	Overflowing of the attenuation pond because of excessive inflow	Water movement and inflow	Inflow are as expected or can be managed without modifying water management strategy and Elevation of each pumping point is within the predicted range of the water balance	Unexpected inflow that are manageable by modifying the water management strategy	Inflow that are manageable for the moment but cannot be sustained	Water cannot be stored / discharged from the Whale Tail site.
		Water quality in the receiving environment and at discharge	Water quality at discharge met receiving environment criteria and Water quality of the receiving environment follows water quality forecast	Water quality at discharge met receiving environment criteria and Water quality of the receiving environment shows a trend that water quality is deteriorating higher than the forecast and will not allow for discharge eventually	Water quality at discharge does not meet receiving environment criteria or Water quality of one receiving environment no longer allows for discharge with similar trend forecasted in the other	Water quality of all the receiving environment no longer allows discharge (no more discharge allowable)
	Overflowing of the attenuation pond because of failure of pumping infrastructure	Tension cracks on the attenuation pond ramp	None visible / inactive	< 0.1 m wide & < 5 m length < 1.0 m deep	> 0.1 m and < 0.2 m wide & > 5 m and < 10 m length along the dike > 1.0 m deep	> 0.2 m wide > 10 m length along the dike > 2.0 m deep Ramp stability is compromised
		Cumulative vertical crest movement of attenuation pond ramp	None visible / inactive	< 0.2 m SA: Apply steps outlined in Section 7.5.1 in case of instrument measurement outside normal range	> 0.2 m and < 1 m increasing rate of settlement	> 1 m increasing rate of settlement Ramp stability is compromised
Action Required			• Continue operation, maintenance, surveillance, and monitoring as per standard operating procedure	• If event is related to water level refer to Appendix C • If event is related to water quality review WTP performance and water quality forecast • If event is related to inflow review the site wide water balance • Document location, photograph, survey, and increase inspection and instrument monitoring in area of concern (refer to Section 7) • Implement engineering review. • Implement communication plan (section 5-7)	• Continue measures of Yellow Level • If event is related to water movement or water quality refer to adaptive water management plan • Reassess thresholds and conditions for red category (emergency situation) taking into account the changing conditions presently observed and interactions of various items.	• If event is related to water movement or water quality refer to adaptive water management plan • Implement Emergency Response Plan (Section 5-7)

5.7 COMMUNICATION AND DECISION MAKING

Figure 5-1 indicates the communication and decision processes when the threshold criteria are met and when pre-defined actions need to be implemented. Table 5-12 indicates the communication procedure to follow when changing the TARP level.

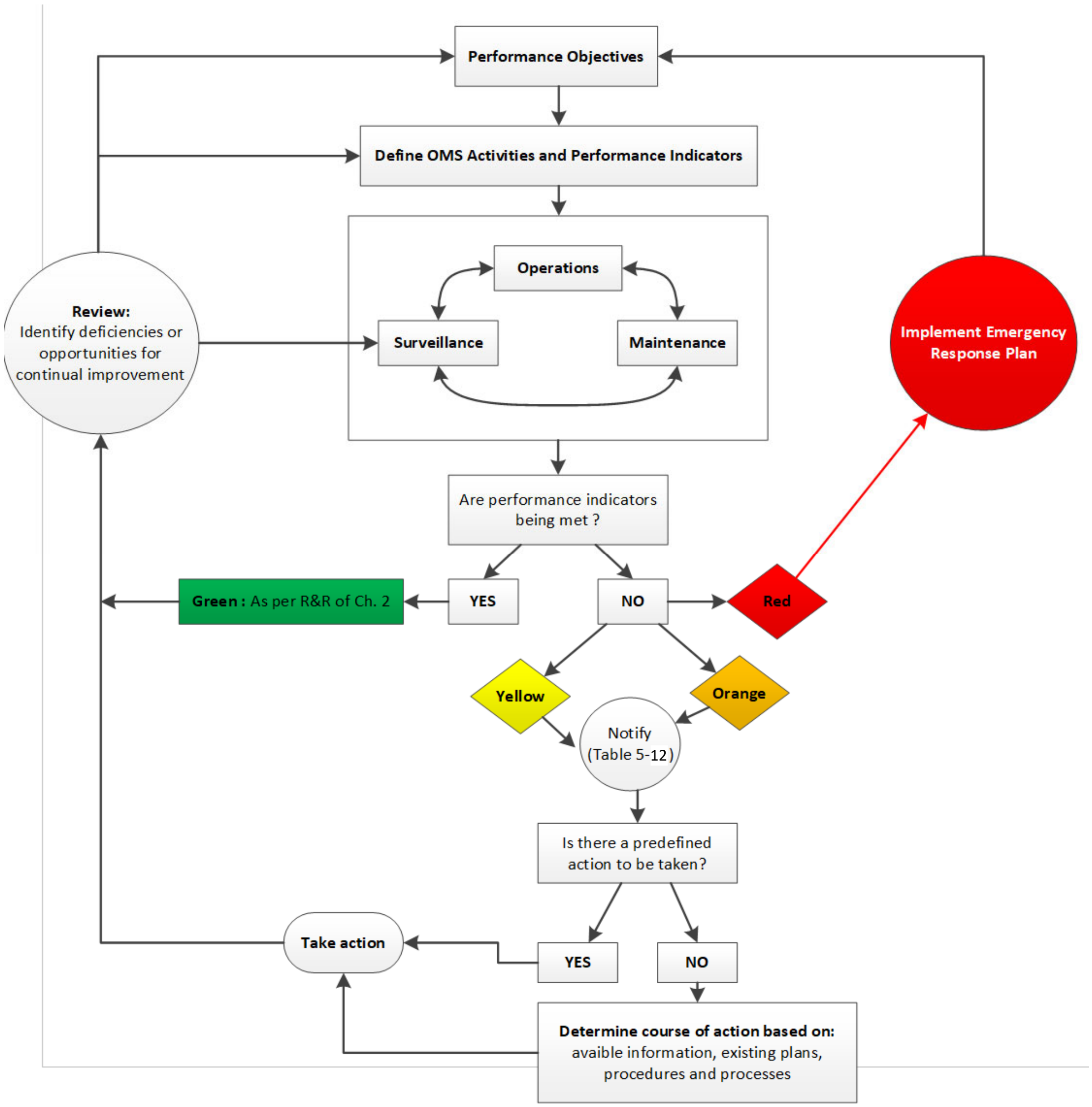


Figure 5-1 : Communication and Decision Process for Water Management Infrastructure TARP

Table 5-12 : Communication Procedure to Change TARP Level

Category	Notify	Timeline	Method of Communication
Green	On-Site team → Responsible person → • Independent Review Board • Designer • General Manager • EOR • AEO	The triggers are back to green for more than 2 weeks	Phone Call and E-mail to inform on status change. RP and EOR must agree to change status Brief memo sent by e-mail to officialise TARP change
Yellow	On-Site team → Responsible person → • Water & Tailings G.S • EOR	Within 24 hours of the TARP level condition being met	Phone Call and E-mail to inform on status change. RP and EOR must agree to change status. If RP can't be joined the on-site team will try to contact these people in this order: Water & Tailings GS, EOR, AEO
	Responsible person → • Independent Review Board • Designer • General Manager • EOR	Within 72 hours of the TARP level change	Brief memo sent by e-mail to officialise TARP change Meeting to be set to explain situation if required
	EOR → • AEO	Within 1 week of TARP level change	Left to the EOR discretion
Orange	On-Site team → Responsible person → • Water & Tailings GS • EOR	Immediately upon discovering TARP level triggers change	Phone Call, E-mail, and meeting to inform on status change. If RP can't be joined the on-site team will try to contact these people in this order: Water & Tailings GS, EOR, AEO
	Responsible person → • Independent Review Board • Water & Tailings GS • Designer • General Manager • EOR • AEO • Health & Safety Superintendent	Within 24 hours of the TARP level change	Brief memo sent by e-mail to officialise TARP change Meeting to be set to explain situation
RED	On-Site team → Emergencies Response Team Once an emergency is declared refer to the ERP. Emergency response is out of scope of this document	Immediately when the emergency is discovered. If there is currently a risk to Env or Health and Safety	Code 1 – Code 1 – Code 1 in all pit operation and road channel Or at Emergencies 460-6911
		Immediately when the emergency is discovered. If there is imminent risk to Env or Health and Safety	Phone call to Emergency Measure Counselor (460-6809) & Health and Safety Superintendent

SECTION 6 • MAINTENANCE

This section identifies all infrastructures within the scope of this manual that have maintenance requirements and identifies all preventative, predictive, and corrective maintenance activities.

6.1 PREVENTATIVE, PREDICTIVE AND CORRECTIVE MAINTENANCE

Maintenance is divided into preventative (planned), predictive, and corrective.

Preventative maintenances are planned, recurring maintenance activities conducted at a fixed or approximate frequency and not typically arising from results of surveillance activities. Examples of such maintenance includes calibration and maintenance of surveillance equipment or regularly changing oil on a pump as per the manufacturer’s requirement.

Predictive maintenances are pre-defined maintenances conducted in response to results of surveillance activities that measure the condition of a specific component against performance criteria.

Corrective maintenance of a component of the water management system is to prevent further deterioration and ensure their performance in conformance with performance objectives. The need for corrective maintenance is based on surveillance activities, with surveillance results identifying the need and urgency of maintenance.

6.2 REFERENCES

References to key documents for the maintenance of the Whale Tail water management infrastructure are presented in Table 6-1.

Table 6-1 : Reference Documents for Maintenance of Whale Tail Water Management Infrastructure

Type of information	Link to Retrieve Information
Maintenance log of water management infrastructure	Located in the Operation folder for each structure (for example: ..\..\..\01 - Dewatering Dikes\1 - Whale Tail Dike\5 - Operation\3- Maintenance Log)
Maintenance log of pumping equipment	I:\MAINTENANCE\G dore\PWA-COM-LGT hrs reading.xlsx P:\EnergyInfra\08-PowerHouse\2 EQUIPMENT\2 GENERATORS
Maintenance log of geotechnical instrumentation	Located in the Instrument Analysis Log for each structure ..\..\..\..\..\05-Geotechnic\11-Instrumentation\12-Instrumentation_Analysis
Pump allocation tool	\\Cambfs01\groups\Engineering\05-Geotechnic\14-Amaruq\04- Water Management\3- Operation\11-Planning\4- Freshet\3 - Freshet 2022\2-Technical\Archive\ PumpAllocation_AMQ_MBK_JG.xlsx
Godwin pump parts and schematics site	https://xylem.sysonline.com/Login.aspx Username: 6184 Password: Parts2019
Geotechnical instrument and data logger inventory	\\Cambfs01\groups\Engineering\05-Geotechnic\11-Instrumentation\1- Instruments\ALL Instruments Databases

6.3 COMPONENTS OF THE WATER MANAGEMENT INFRASTRUCTURES REQUIRING MAINTENANCE

Table 6-2 indicates all the components of the Whale Tail water management infrastructure that require maintenance.

Table 6-2 : Components of the Water Management Infrastructure Requiring Maintenance

Water Management Infrastructure
• Dike embankment (i.e., repair erosion) • Dike crest (i.e., fill inactive tension cracks, repair crest settlement) • Seepage collection sump (i.e., reprofile slope, increase sump volume) • Ditches and diversions (i.e., snow removal, repair erosion)
Pumping infrastructure
• Pumps (mechanical and electrical maintenance) • Pipes (steaming, drain line, repair leak)
Surveillance
• Geotechnical instruments (thermistors, piezometers, inclinometers, survey monuments) • Data acquisition system • Flowmeter
Other
• Dike crest access roads • Access to sumps

6.3.1 Maintenance Components Outside the Scope of this OMS Manual

The following component maintenance activities are outside of the scope of this OMS manual. For more information, the superintendent of the department responsible for this maintenance can be contacted:

- Electrical systems and supply – E&I
- Maintenance of heavy equipment and light vehicles – Maintenance
- Communication infrastructures – IT
- Road used to access the infrastructures – Mine
- Water treatment plant – E&I

6.4 DESCRIPTION OF MAINTENANCE ACTIVITIES

Table 6-3 summarizes the description of maintenance activities for each component of the Whale Tail water management infrastructure. Each component has activities as well as a trigger for that maintenance and a person in charge of this activity. It is the duty of the person responsible for the maintenance activity to ensure that the person doing the maintenance has the qualifications and competencies required to conduct the maintenance and is following the proper safety procedure. The person in charge of the activity must also ensure that the proper documentation and reporting requirements are followed.

Table 6-3 : Description of Maintenance Activities for Components of Water Management Infrastructure

Component	Type of Maintenance	Nature of the Activity	Frequency of Maintenance (preventative) OR Trigger of Maintenance (predictive and corrective)	Accountable for the activity→ Responsible for the Activity	Documentation Required	Reporting Requirement
Water Management Infrastructure						
Dike embankment – repair erosion	Corrective	Gullies and depressions to be filled with rockfill and re-sloped	Following a visual inspection showing erosion	Environment & Critical Infrastructure Superintendent → Water & Geotechnical Coordinator	Photo & survey of corrective work	Water & Geotechnical Coordinator to update the maintenance log of the structure. Survey of work to be added to structure layout
Dike crest – fill inactive tension cracks	Corrective	Inactive tension cracks to be filled with bentonite to prevent widening due to water infiltration	Following consecutive visual inspection showing inactive tension cracks (more than 1 month)	Environment & Critical Infrastructure Superintendent → Water & Geotechnical Coordinator	Photo & survey of corrective work	Water & Geotechnical Coordinator to update the maintenance log of the structure. Survey of work to be added to structure layout
Dike crest – compensate settlement	Corrective	Add rockfill to increase the height of the dike following observation of settlement	Following a visual inspection showing settlement that needs to be compensated (i.e., loss of freeboard)	Environment & Critical Infrastructure Superintendent → Water & Geotechnical Coordinator	Photo & survey of corrective work	Water & Geotechnical Coordinator to update the maintenance log of the structure. Survey of work to be added to structure layout
Seepage collection sump – increase volume	Predictive	Excavate an additional sump or increase the capacity of an existing sump	Following a re-assessment of the required sump capacity	Environment & Critical Infrastructure Superintendent → Water & Geotechnical Coordinator	Photo & surveying of predictive work	Water & Geotechnical Coordinator to ask for update of status map. Survey of work to be added to structure layout
Seepage collection sump – broken culvert / frozen sump	Corrective	Unfreeze culvert, repair culvert, or install a new sump	Following a visual inspection showing problem with the collection culvert	Environment & Critical Infrastructure Superintendent → Water & Geotechnical Coordinator	Photo of corrective work	Water & Geotechnical Coordinator to update the maintenance log of the structure.
Seepage collection sump – reprofile sump	Corrective	Excavate flatter slope for the sump or add material against the slope to reprofile them	Following a visual inspection showing instable sump slope	Environment & Critical Infrastructure Superintendent → Water & Geotechnical Coordinator	Photo of corrective work	Water & Geotechnical Coordinator to update the maintenance log of the structure.
Ditches – snow removal	Predictive	Use an excavator to remove snow in the ditch	Every year prior to freshet to ensure that ditch is clear of snow obstruction. Refer to Freshet Action Plan	Environment & Critical Infrastructure Superintendent → Water & Geotechnical Coordinator	Photo of predictive work	Water Eng to track the work in freshet readiness meeting. Information to be add to weekly freshet inspection report
Ditches – clean debris and sediment accumulation	Corrective	Remove any debris and accumulation of sediment that can hinder flow	Following a visual inspection showing accumulation of debris and sediment that can hinder flow	Environment & Critical Infrastructure Superintendent → Water & Geotechnical Coordinator	Photo of corrective work	Water & Geotechnical Coordinator to update the maintenance log of the structure.
Ditches – repair erosion of granular layer	Corrective	Add granular material to repair erosion of the ditches	Following a visual inspection showing erosion of the ditches	Environment & Critical Infrastructure Superintendent → Water & Geotechnical Coordinator	Photo of corrective work	Water & Geotechnical Coordinator to update the maintenance log of the structure
Ditches – release of TSS from the ditches	Corrective	Corrective action to mitigate release of TSS from ditches. Can include placement of sill curtain or temporary by-passing of the ditches using pump	Following sampling of a high turbidity event from the diches	Environment & Critical Infrastructure Superintendent → Environment Coordinator	Water sample results Photo of remediation work	Documented in Freshet Action Plan
Pumping Infrastructure						
Pumps and Genset – maintenance as per manufacturer specification (i.e., change oil, look for wear and tear, calibration)	Preventative	Do PM on the pumping unit as per manufacturer recommendation	As per manufacturer specification	Maintenance Superintendent → Pump mechanics	Equipment log Maintenance record	Maintenance to update the pump maintenance log or Genset maintenance log
Pumps and Genset – maintenance when deficiency are observed (cavitation, breakdown, electrical trouble)	Corrective	Troubleshoot the pump problem so that it is once again operational	Following a visual inspection of deficiency	Maintenance Superintendent → Pump mechanics	Equipment log Maintenance record	Maintenance to update the pump maintenance log or Genset maintenance log
Pumps – winterization of unit used in winter	Preventative	Ensure that pumps used in winter have been winterized	Once a new pump is received on site that will be used in winter. During initial reception of pump	Maintenance Superintendent → Pump mechanics	Maintenance record	Maintenance to update the pump maintenance log
Pipe – drain the line	Preventative	Ensure that the line is empty of water when it is stopped in winter	Every time pumping is interrupted in winter	E&I Superintendent → E&I Operation G.S	Pigging radius notice	-
Pipe – unfreezing a line	Corrective	Steaming the line to unfreeze it in winter	Following visual inspection of a frozen line	E&I Superintendent → E&I Operation G.S	-	-
Pipe – maintenance when deficiency is observed (leak, pipe burst)	Corrective	Replacing a deficient part of a line with new pipe	Following visual inspection of pipe deficiency	E&I Superintendent → E&I Operation G.S	How much pipe was replaced, what was installed and where it aome from	Update of pipe management database
Surveillance						
Geotechnical instrument – loss of reading	Corrective	Investigate the status of an instrument that no longer gave data	When an instrument no longer gave data for an unknown reason	Environment & Critical Infrastructure Superintendent →	Update status in instrument database	Update of the Instrument Analysis Log by the Project Tech

Component	Type of Maintenance	Nature of the Activity	Frequency of Maintenance (preventative) OR Trigger of Maintenance (predictive and corrective)	Accountable for the activity→ Responsible for the Activity	Documentation Required	Reporting Requirement
				Water & Geotechnical Coordinator		
Geotechnical instrument – unusual reading	Corrective	Investigate the status of an instrument that gave unusual data	When an instrument gave unusual data	Environment & Critical Infrastructure Superintendent → Water & Geotechnical Coordinator	Update status in instrument database	Update of the Instrument Analysis Log by the Project Tech
Geotechnical instrument – replacement	Corrective	Replace an instrument that no longer works	Following an assessment that an instrument needs to be replaced to ensure proper coverage of the surveillance system	Environment & Critical Infrastructure Superintendent → Water & Geotechnical Coordinator	Instrument installation as-built report Update spare inventory Calibration sheet Initial instrument reading	Update of the Instrument Analysis Log by the Project Tech
Survey Instrument – repair of equipment (drone, survey rod, scanner)	Corrective	Fix a problem with the survey equipment (could require sending it for repair)	Following an assessment that there is an issue with the equipment	Engineering Superintendent → Survey Leader	-	-
Survey Instrument – Calibration of drone data	Preventative	Confirm the accuracy of the drone survey with rod or scan survey	Once a year per structure	Environment & Critical Infrastructure Superintendent → Water & Geotechnical Coordinator	Survey data and drone data	Both data in the survey file
Geotechnical instrument – calibration of inclinometer probe	Preventative	Send the inclinometer probe to be calibrated	Yearly	Environment & Critical Infrastructure Superintendent → Water & Geotechnical Coordinator	Calibration sheet	Update of the Instrument Analysis Log by the Project Tech
Data acquisition system – maintenance	Preventative	Do maintenance of datalogger (i.e., battery, solar panel, shack)	Yearly	Environment & Critical Infrastructure Superintendent → Water & Geotechnical Coordinator	List of items maintained	Update of the Instrument Analysis Log by the Project Tech
Datalogger – battery change	Predictive	Change battery when the battery level alarm gets triggered	When the battery alarm is triggered in VDV	Environment & Critical Infrastructure Superintendent → Water & Geotechnical Coordinator	Update status in instrument database	Update of the Instrument Analysis Log by the Project Tech
Datalogger – troubleshooting	Corrective	Repair of a datalogger deficiency	When a datalogger is suspected of being deficient	Environment & Critical Infrastructure Superintendent → Water & Geotechnical Coordinator	Update status in instrument database	Update of the Instrument Analysis Log by the Project Tech
Flowmeter – calibration	Preventative	Calibrate the flowmeter as per License requirement	Yearly	E&I Superintendent → E&I Operation G.S	Calibration sheet	WO record
Flowmeter – deficient reading	Corrective	Repair of a flowmeter deficiency	When a flowmeter is suspected on providing anomalous data	E&I Superintendent → E&I Operation G.S	Maintenance report	WO record
Other						
Dike crest access, sump access, access road	Predictive	Snow clearing, maintaining roadway, grading access as per snow management map	As required to maintain access	E&I Superintendent → E&I Operation G.S	-	-

SECTION 7 • SURVEILLANCE

Surveillance involves the inspection and monitoring (i.e., collection of qualitative and quantitative observations and data) of the Water Management Infrastructure. Surveillance also includes the timely documentation, analysis, and communication of surveillance results, to inform decision making and verify whether performance objectives including critical controls are being met.

There are two types of surveillance activities which are further discussed in this section:

- Site observation and inspection
- Instrument monitoring

7.1 REFERENCE

References to key documents for site observation and inspection of the Whale Tail water management infrastructure are presented in Table 7-1. References to key documents for instrument monitoring are presented in Table 7-2.

Table 7-1 : Key Reference Documents for Inspection of the Whale Tail Water Management Infrastructure

Type of information	Document #	Document Title and Link
Inspection form templates	-	\\Cambfs01\groups\Engineering\05-Geotechnic\10-Inspection\8- Inspection Form Template
Whale Tail Dike Dewatering inspection report	-	..\..\1 - Whale Tail Dike\4- Dewatering\1-Dewatering Inspection
Whale Tail Dike inspection report	WTD-VIR	..\..\1 - Whale Tail Dike\5 - Operation\1-Inspection
Mammoth Dike inspection report	MD-VIR	..\..\2- Mammoth Dike\4-Operation\1-Inspection\
WRSF Dike inspection report	WRSF-VIR	..\..\3- WRSF Dike\3- Operation\1- Inspection
NE Dike inspection report	NED-VIR	..\..\4- North East dike\3-Operation\1-Inspection
IVR Dike D-1 inspection report	IVR-VIR	..\..\5- IVR Dike D1\4- Operation\1-Inspection
SWTDC inspection report	SWTDC-VIR	..\..\03- Channel\1- South Whale Tail Channel\3- Operation\1- Inspection
Saline Ditch inspection report	UGWRSFSAL-VIR	..\..\03- Channel\3-UG-WRSF Saline Ditch\3-Operation\1- Inspection
IVR Diversion Ditch inspection report	IVRDC-VIR	\..\03- Channel\4- IVR Diversion\4-Operation\1- Inspection
Attenuation pond and piping infrastructure inspection report	Dewatering Infrastructure -VIR	..\..\..\04- Water Management\3- Operation\4-Inspection
Annual dike safety inspection (annual geotechnical inspection)	-	.\..\..\..\10-Inspection\Annual Geotechnical Inspection
Freshet Inspection	-	\\Cambfs01\groups\Engineering\05-Geotechnic\05-WaterManagement\2022\04 - Freshet Inspections
Minute of MDRB Meeting	MDRB #30 (most recent)	\\CAMBFS01\Groups\Engineering\05-Geotechnic\13-MDRB
Inspection Recommendation Implementation Log	-	\\Cambfs01\groups\Engineering\05-Geotechnic\10-Inspection\Surveillance Recommendation Implementation Plan

Table 7-2 : Reference Documents for Instrument Monitoring of Whale Tail Water Management Infrastructure

Type of Information	Link to Retrieve Information
Dewatering Monitoring Report	..\..\1 - Whale Tail Dike\4- Dewatering\2- Dewatering Report
Geotechnical Instruments Map	Instruments – Instruments Summary folder for each structure on the network
Instrument Analysis Log	\\Cambfs01\groups\Engineering\05-Geotechnic\11-Instrumentation\12- Instrumentation_Analysis
Instrument alert trigger and review frequency (2253121 Instrumentation compilation and trigger)	P:\Engineering\05-Geotechnic\11-Instrumentation\12-Instrumentation_Analysis
Access to Instrument Data	VDV (http://cambeng2:8080/)
Water Quality Result Database	EQuiS
Blast Vibration Log	..\..\..\..\05-Geotechnic\99-Archive\Blast Monitoring\Events
Environment Calendar	Tracks field activities P:\Environment\INSPECTIONS AND FORMS\2022
Morning Management Meeting Water Level Tab	On Teams
Whale Tail Dike V-Notch Reading	\\CAMBFS01\Groups\Engineering\05-Geotechnic\14-Amaruq\01 - Dewatering Dikes\1 - Whale Tail Dike\4-Dewatering\5- Seepage Assessment\8- Seepage Measurement\WTD_V-Notch_Monitoring-V20200719LC.xlsx
Water Level Survey File	\\Cambfs01\groups \\CAMBFS01\Groups\\Environment\INSPECTIONS AND FORMS\Water

7.2 PRIORITY LISTING

Any recommendation or action to be taken following a surveillance activity must be assigned a priority and an Owner and be followed up on depending on its priority. The priority scale of Table 7-3 must be used for this. These recommendations must also be tracked using the Inspection Recommendation Implementation Log.

Table 7-3 : Surveillance Activity Recommendation Priority Listing

Priority #	Description	Timeline to Address
P-1	A high priority or actual structure safety issue considered immediately dangerous to life, health, or the environment; or a significant risk of regulatory enforcement	Immediately to 1 week
P-2	If not corrected could likely result in structure safety issues leading to injury, environmental impact, or significant regulatory enforcement; or a repetitive deficiency that demonstrates a systematic breakdown of procedures	1 week to 3 months
P-3	Single occurrences or deficiencies or non-conformance that alone would not be expected to result in structure safety issues	3 months to 6 months
P-4	Best Management Practice – further improvements are necessary to meet industry best practices or reduce potential risks	>6 months

7.3 SITE OBSERVATIONS AND INSPECTIONS

The purpose of site observations and inspections is to identify warning signs of the development of potentially adverse conditions that could lead to a failure or some other form of loss of control. Site observations and inspections include the direct observations by personnel on or adjacent to the Dewatering Dikes and water management infrastructure and may also include observations from helicopter or photos taken from an unmanned airborne vehicle (UAV, satellites).

Site observations and inspections are used to identify and track visible changes in the condition of the water management infrastructure. Changes that may be observed throughout site observations and inspections are included in Table 7-4.

Table 7-4 : Changes Possibly Observed Through Site Observation and Inspection of the Whale Tail Water Management Infrastructure

Changes related to physical risk of dike, road, ramp
• Change in freeboard • Deformation or change in condition at the crest, slopes, and toes (i.e., bulges, cracks, sinkholes, sloughing, settlement) • Newly formed or expanding areas of erosion • Evidence of piping or unexpected water movement through water containment structures • Changes in the seepage quantity (pumping rate) and quality (turbidity)
Changes related to physical risk of ditch
• Newly formed or expanding areas of erosion • Newly formed obstructions to flow (i.e., boulder, sediments, snow) • Newly formed slope instability
Changes related to water storage and transport
• Change in sump level • Discovering using a staff gauge (when applicable) that the pond is not being operated within its normal operating condition • Changes in the seepage quantity (pumping rate) and quality (turbidity) • Change in the condition of the piping for water transport • Sign of leaks from water line • Change in the condition of pumps
Changes related to surveillance instrumentation
• Change in the condition of surveillance instruments and associated protection around instruments (i.e., cover, barriers to prevent vehicle damage) • Change in condition of power supplies for instruments (i.e., solar panel) • Change in condition of communication infrastructures associated with instruments (i.e., antenna, datalogger)

7.3.1 Site Observation

Site observation is conducted by personnel working on or adjacent to the water management infrastructure as part of their daily activities, maintaining awareness of the facility while performing their duties. Trained personnel such as geotechnical technicians should be on the lookout for signs of changing conditions as indicated in Table 7-4 since adverse conditions can develop rapidly between inspections. It is recommended that training be provided once a year to crews working around the structures, such as during a toolbox meeting around the start of freshet. Photos to show examples of cracks, sinkholes, and other signs of changing conditions can be presented to ensure workers know what to look out for during their activities. All adverse or changing conditions from site observation should be documented by photographs and reported to the geotechnical team. Observation of new observation during a site observation could trigger a special inspection.

7.3.2 Inspection Program

Inspections are conducted by the Environment department or other personnel with appropriate training and competency and are more rigorous than site observations.

The inspection program consists of several types of inspections such as routine and special visual inspections, dike safety inspections, and dam safety reviews. The following sub-sections describe in more detail the scope, frequency, and person responsible for each type of inspection.

7.3.2.1 Routine Visual Inspection and Reporting

Routine visual inspections are conducted on a pre-defined schedule and may target specific activities. Their objective is to identify any conditions that might indicate change in the Water Management Infrastructure performance and therefore require follow-up. The inspections need to cover the aspects described in Table 7-4. Of significance are new occurrences or noted changes in seepage, erosion, sinkholes, boils, slope slumping, settlement, displacement, or cracking of structure components. These inspections are conducted during dewatering and operation.

There are two approved inspection forms for inspection: an integrated inspection form and a detailed inspection form. The detailed form is used for monthly inspection while the integrated form is used for weekly inspection during freshet (during period of flow) or when required to document an ad-hoc inspection. These forms can be found at the location indicated in Table 7-1. All areas of the form must be filled.

The person responsible for the inspection must:

- Perform the inspection as per the OMS frequency. All components of the structure must be accessed on foot and the performance visually assessed (access, earthwork, sump, pumping system, instruments).
- Take pictures to supplement the inspection. As much as possible, these are to be taken from the same vantage points during each inspection so that changes in conditions can be readily identified. All areas having abnormal condition (active or inactive or no longer visible) must be photographed. Photos must be annotated or captioned and must include a date stamp.
- Store electronically all relevant photos and the inspection form (even those not included in the report)
- Fill all information on the proper inspection form (integrated or visual inspection form). A proper inspection form includes:
    - Summary of visual observations during the inspection (including inactive features)
    - Discussion on the progress of former inspection observations
    - Documentation of the performance indicator versus the threshold criteria (water level, seepage rate, visual observation)
    - Map of where the visual observations are located (including past observation with date)
    - Representative photos with captions and a clear way of locating where they are taken

  - Action items to be taken following the inspection (operation, maintenance, or surveillance) with a Priority listing as well as an Owner
- Update the Environment Calendar that tracks field activities
- Sign the inspection form as the person having done the inspection and ensure that the reviewer is aware that the document is ready to be reviewed

During the review process, the reviewer must:

- Ensure that all required information is present as per requirement of section above
- Ensure that the indicator does not trigger a change in alert level
- Approve the action items and ensure that they are assigned an Owner.
- Update the inspection recommendation tracking tool accordingly
- Sign the inspection form as a reviewer
- Update the Environment Calendar that tracks field activities
- Review and approve proposed recommendation and ensure that the Inspection Recommendation Implementation Plan is updated. If there is a change in recommendation status ensure that the recommendations are distributed to the appropriate stakeholder based on R&R defined in Section 2.
- Ensure the inspection results are distributed to the EOR, the Meadowbank Geotechnical Engineering e-mail list, and to those responsible for action items

The frequency for inspection of a structure will vary based on its TARP level and needs to be updated in the Instrument Analysis Log if it changes.

For the structures that have an orange TARP level, the weekly update needs to be written with the following information:

- Context on why the structure is at the orange level
- Change in condition since the last weekly report
- Description of the mitigation plan and what actions have been taken since the last update report
- Discussion on the results of the instrumentation data.

Table 7-5 summarizes the inspection documentation and the responsibilities of those involved with creating them and reviewing them. Table 7-6 summarizes the routine visual inspection roles and responsibilities, suggested frequency, and scope in function of the alert level of the structure.

Table 7-5 : Summary of Inspection Documentation Responsibilities

Routine Visual inspection type	Documentation to be generated	Documentation content	Inspection officer responsibilities	Reviewing officer responsibilities
Monthly visual inspection	Visual inspection report	- Summary of visual observations during the inspection (including inactive features) - Discussion on the progress of former inspection observations - Documentation of the performance indicator versus the threshold criteria (water level, seepage rate, visual observation) - Map of where the visual observations are located (including past observation with date) - Representative photos with caption and a clear way of locating where they are taken - Action items to be taken following the inspection (operation, maintenance, or surveillance) with a Priority listing as well as an Owner.	- Perform the inspection as per the OMS frequency. All components of the structure must be accessed on foot and the performance visually assessed (access, earthwork, sump, pumping system, instruments). - Immediately report adverse conditions to the Water & Geotech Coordinator - Take pictures to supplement the inspection. As much as possible, these are to be taken from the same vantage points during each inspection so that changes in conditions can be readily identified. All areas having abnormal condition (active or inactive or no longer visible) must be photographed. Photos must be annotated or captioned and must include a date stamp. - Store electronically all photos and the inspection form (even those not included in the report) - Fill all information in the proper inspection form - Update the surveillance activity tracking tool - Sign the inspection form as the person having done the inspection and ensure that the reviewer is aware that the document is ready to be reviewed	- Ensure that all required information is present as per requirement - Ensure that the indicators do not trigger a change in alert level - Review and approve the action items and ensure that they are assigned an Owner. - Update the inspection recommendation tracking tool accordingly - Sign the inspection form as a reviewer - Update the surveillance activity tracking tool - Distribute the inspection results to the EOR, the Meadowbank Geotechnical Engineering e-mail list and to responsible of action item
Weekly inspection (freshet)	Integrated freshet inspection checklist	- Summary of visual observations during the inspection	- Perform the inspection as per the OMS frequency. All components of the structure must be accessed on foot and the performance visually assessed (access, earthwork, sump, pumping system, instruments). - Use and fill in the integrated freshet inspection checklist - Immediately report adverse conditions to the Water & Geotech Coordinator - Take pictures to supplement the inspection. - Store electronically all photos - Record the inspection observations by filling the Environment freshet inspection file - Notify the Water & Geotech Coordinator if actions or further investigation are required	- Update the inspection recommendation tracking tool if required - Ensure that the indicators do not trigger a change in alert level - Ensure a special visual inspection is conducted if change in conditions are noted as detailed in section 6.3.2.2
Weekly Yellow TARP inspection	Weekly structure-specific inspection report	- Summary of visual observations during the inspection (including inactive features) - Discussion on the progress of former inspection observations - Discussion on the progress of the conditions that are related to the yellow TARP level change - Documentation of the performance indicator versus the threshold criteria (water level, seepage rate, visual observation) - Map of where the visual observations are located (including past observation with date) - Representative photos with caption and a clear way of locating where they are taken - Action items to be taken following the inspection (operation, maintenance, or surveillance) with a Priority listing as well as an Owner.	- Perform the inspection as per the OMS frequency. All components of the structure must be accessed on foot and the performance visually assessed (access, earthwork, sump, pumping system, instruments). - Pay a special attention to the conditions in relation to what triggered the change in TARP level. - Immediately report adverse conditions to the Water & Geotech Coordinator - Take pictures to supplement the inspection. As much as possible, these are to be taken from the same vantage points during each inspection so that changes in conditions can be readily identified. All areas having abnormal condition (active or inactive or no longer visible) must be photographed. Photos must be annotated or captioned and must include a date stamp. - Store electronically all photos and the inspection form (even those not included in the report) - Fill all information in the proper inspection form - Update the surveillance activity tracking tool - Sign the inspection form as the person having done the inspection and ensure that the reviewer is aware that the document is ready to be reviewed	- Ensure that all required information is present as per requirement - Ensure that the indicators do not trigger a change in alert level - Review and approve the action items and ensure that they are assigned an Owner. - Update the inspection recommendation tracking tool accordingly - Sign the inspection form as a reviewer - Update the surveillance activity tracking tool - Distribute the inspection results to the EOR, the Meadowbank Geotechnical Engineering e-mail list and to responsible of action item

Table 7-6 : Summary of Routine Inspection Requirements (frequency, reporting, distribution)

TARP Level	Person Responsible	Inspection Frequency	Reporting	Inspection Reviewer	Distribution List
Green	Environment Technician	Monthly from Mid-May to Mid-October IVR Dike and Whale Tail Dike: Monthly	Visual inspection form	Water & Geotechnical Coordinator	Meadowbank Geotechnical Eng e-mail list, EOR, recommendation Owner
		Weekly during period of flow (from May to October)	Integrated Inspection form for each component (pond, dike, channel)		
Yellow		Monthly	Visual inspection form		
		Weekly	Specific simplified inspection form		
Orange	Water & Geotechnical Coordinator	Weekly	Report on summary of surveillance activity + status of mitigation action	Water & Tailings G.S and/or EOR (left at EOR discretion)	Meadowbank Geotechnical Eng e-mail list, EOR, recommendation Owner + Weekly Update sent to: Designer, MDRB, General Superintendent Technical Services
		Monthly	Visual inspection form		
		Daily	Integrated Inspection form		

7.3.2.2 Special Visual Inspection

Special inspections are conducted during and after unusual or extreme events that may impact the facility or after a site observation noticed a change in condition that is deemed significant to the Water & Geotechnical Coordinator. Special inspections are conducted by qualified personnel from the Environment Team. The Engineer of Record or the Independent Review Board or the Designer could be asked to join these inspections based on the circumstance of the event (left at the RP and EOR discretion). This inspection will be recorded using the inspection form using the same procedure for review and documentation. A memo might also accompany these inspections based on the circumstances of the event (left at the EOR and RP discretion).

Special visual inspections must be done on each structure after each of these events:

- At the end of dewatering once the downstream toe is exposed
- Following a blast that exceeds the vibration limits of the structure
- After an earthquake
- After a high intensity rainfall event (higher than a 1:2 years recurrence (25 mm in 24 hr)

7.3.2.3 Annual Geotechnical Inspection

The Annual Geotechnical Inspection is a requirement of the Water License. It is a more comprehensive technical inspection, integrating inspections and results of monitoring instruments. This inspection is conducted annually by an external geotechnical engineer to have a more complete understanding of the facility performance and to identify deficiencies in performance or opportunity for improvement. This will also provide information to be used to revise the OMS manual.

For the Whale Tail water management infrastructure, such inspection must occur on an annual basis by the end of the flow period (July to September). The following components need to be inspected during this review:

- All components of Whale Tail Dike, Mammoth Dike, WRSF Dike, IVR Dike D-1
- Whale Tail and IVR Attenuation ponds and pumping infrastructure
- Ditches and channels (SWTDC, IVRDC, Saline Ditch)

In addition to field inspection the following points should be addressed during the review:

- Review of inspection reports performed since the last review
- Review of instruments data
- Identify deficiencies in performance or opportunity for improvement
- Review performance indicator, operational control, and operational threshold criteria
- Review and provide recommendations regarding the OMS for the following year

After each annual inspection, a report must be submitted to the Responsible Person which includes the results of the inspection and addresses all points above. These reports will be stored electronically. The recommendation must respect the priority nomenclature. The Responsible Person will ensure that an action plan is developed to address the recommendations and will transmit the report and the action plan to the EOR.

7.3.2.4 EOR Inspection

As per AEM Governance on Critical Infrastructure, on an annual basis the EOR will perform a site visit to inspect the infrastructure and review the various components of the water and tailings management system. The results of this inspection will be summarized in an annual statement transmitted to the RP and the AEO. The RP will ensure that an action plan is developed to address the recommendations of the EOR inspection.

7.3.2.5 Independent Review Board Meeting (MDRB)

The name of the Independent Review Board for the Meadowbank Complex is the Meadowbank Dike Review Board (MDRB).

An annual MDRB meeting will be held every year. The following topics are part of the annual MDRB scope of work:

- Site visit (between June and October) of all infrastructure covered by the scope of the MDRB
- Review of mine waste management strategy (including tailings and waste rock storage facilities)
- Review water management infrastructure designs and performance (including water retaining infrastructures)
- Review of on-going construction works and monitoring data
- Comment on implementation progress of proposed mine waste management improvement measures
- Provide opinions and guidance to the operation on the physical integrity, safety, behavior, and performance of the confinement systems for mine waste and water retaining infrastructures
- Comment on management systems, emergency preparedness, and overall management approach of the different mine waste management facilities and water retaining infrastructures

Other events that could trigger a MDRB meeting are:

- Presentation of design of new critical infrastructure
- Major modifications to the design or design criteria
- Discovery of unusual conditions that can compromise the integrity of the Dewatering Dikes
- After extreme hydrological or seismic events
- Decommissioning

The MDRB will submit a report outlining their observations and recommendations following each meeting. The RP will ensure that an action plan is developed to address the recommendations and will transmit the report and the action plan to the EOR.

7.3.2.6 Independent Dike Safety Review (DSR)

Independent dike safety reviews (DSR) are carried out by an independent third party with the EOR to review all aspects of the design, construction, operation, maintenance, processes, and other systems affecting dike safety, including the dike safety management system. The DSR defines and encompasses all components of the "dike system" under evaluation including the dikes, foundations, abutments, instrumentation, and seepage collection works.

A DSR will be organized as per the MAC proposed frequency by the Responsible Person and will be done according to the Dam Safety Guideline (CDA, 2013). No DSRs have been performed so far for the Whale Tail water management infrastructure. The next DSR should be done in 2024.

7.4 INSTRUMENT MONITORING PROGRAM – DATA ACQUISTION

Instrument monitoring provides information on parameters or characteristics that cannot be detected through site observation or inspections, cannot be observed with sufficient precision and accuracy, or need to be monitored at high frequency or continuously.

The objective of instrument monitoring is to collect data to be used to assess the performance of the infrastructures against the performance objectives and indicators and the critical controls (refer to Table 5-2). Instrument monitoring and inspections work together as a comprehensive data set to enable assessment of the water management infrastructure performance and to provide a basis for informed decision making. All are essential, and none of these forms of surveillance can be neglected if performance objectives are to be met and risks are to be managed.

More information on the type of in-situ instruments installed on each structure, how they were installed, and their location can be found in Section 3-11 of this OMS manual.

Table 7-7 indicates the type of information collected through instrument monitoring and how it is collected. Table 7-8 summarizes the data acquisition programs related to instrument monitoring. Table 7-8 also goes over the required water level surveys at the Whale Tail Mine; this information is used by the Water & Tailings Engineer to update the water movement log and water balance and is vital information for ensuring the freeboard of the Dewatering Dikes is respected.

Table 7-7 : Information Collected Using Instrument Monitoring

Direct collection of information
• In-situ thermistors to measure temperature profile within the structure and its foundation • In-situ piezometer to measure pore-water pressure providing information about flow of water through the structure and foundation stability • In-situ shape array inclinometer (SAA) to provide information on deformation within the cut-off wall • Airborne survey to monitor vertical settlement and deformation • Survey of dike crest to provide validation on settlement and deformation • Blast monitor to inform on potential impact of blasting vibration on the structure • Flow meters and seepage monitoring stations to inform on volume of water movement • Surveys conducted to measure ice cover, water level, and update height and slope of containment structure
Collection of information from remote sensing
• Data acquired from airborne survey to generate detailed topographic map
Collection of information based on laboratory analyses
• Water quality analysis of seepage and surface runoff reporting to sump • Water quality analysis of water discharged through diffuser to inform on Environmental compliance • Water quality analysis of water stored in the various ponds on site to inform on water movement decisions
Collection of information related to the conduct of OMS activities
• Automatic data collection and transmission system for in-situ instruments (datalogger, solar panel, antenna, battery)

Table 7-8 : Summaries of Data Acquisition Programs Related to Instrument Monitoring of the Whale Tail Water Management Infrastructure

Instrument Monitoring	Location of Monitoring (3)	Parameter Measured	Acquisition Methodology	Standard Acquisition Frequency	Acquisition Responsible	Documentation Methodology (1)	Documentation Responsible
Thermistors	Whale Tail Dike, WRSF Dike, Mammoth Dike, IVR Dike	Temperature (^{0}C) point for each bead on the chain	In-situ instrument connected to automatic data acquisition and transmission system	New data are acquired and transmitted to VDV every 3 hrs	Environment Superintendent → Water & Geotechnical Coordinator	Data are documented in VDV (2)	Water & Geotechnical Coordinator
Piezometer	Whale Tail Dike, Whale Tail South, Whale Tail Attenuation Pond, Mammoth Lake	Pressure (kPa) point for each instrument	In-situ instrument connected to automatic data acquisition and transmission system	New data are acquired and transmitted to VDV every 3 hrs	Environment Superintendent → Water & Geotechnical Coordinator	Data are documented in VDV (2)	Water & Geotechnical Coordinator
Shape Array Accelerometer (SAA)	Whale Tail Dike	Displacement in mm	In-situ instrument connected to automatic data acquisition and transmission system	New data are acquired and transmitted to VDV every 3 hrs	Geotechnical Technician	Data are documented in VDV (2)	Water & Geotechnical Coordinator
Blast Monitor	-	Peak particle velocity (PPV) measured by the blast monitor (mm/s)	Placement of blast monitor at a predetermined area on the dike	Before each blast in the blast radius of the dike	Environment Superintendent → Water & Geotechnical Coordinator	Update the blast vibration log.	Water & Geotechnical Coordinator
Flow Meter	WRSF pond	Volume of water pumped (m^3)	Flowmeter connected to HMI system (remote data acquisition)	Daily when pump is operating Or Continuously if connected to HMI	E&I Superintendent→ E&I Operation G.S	Pumpsheet reading entered in water balance Or Historian (if connected to HMI)	E&I Operation G.S
Seepage Monitoring Station (manual reading with a V notch)	Where unpumped seepage is observed (WTD)	Seepage flow (m^3/s)	Using a bucket and a stopwatch	Monthly during period of flow	Environment Superintendent → Water & Geotechnical Coordinator	Documented within measurement spreadsheet	Water & Geotechnical Coordinator
Survey Shot	Attenuation Ponds: Whale Tail, IVR Lakes: Whale Tail South (A17), Mammoth Lake (a16), Nemo Lake Ponds: WRSF, GSP-1	Elevation of the water level (minimum precision of 3 mm required)	Take a water/ice level at a predetermined area	From May to September; once per week for all water bodies, (except WRSF Pond, GSP-1, A45, Nemo Lake, (monthly)), From October to April: monthly to confirm PZ reading	Environment Superintendent → Water & Geotechnical Coordinator	Water Level Survey file	Water & Geotechnical Coordinator
Airborne Survey	All water management infrastructure	Topographic aerial survey made using drone. Measurement of structure settlement	Take a drone survey	Once in June and once in September at WTD & IVR Dike	Environment Superintendent → Water & Geotechnical Coordinator	Within drone survey database	Water & Geotechnical Coordinator
Water Quality (4)	Refer to Water Management Plan	Parameters indicated within water management plan	Water quality sample taken and sent for laboratory analyses	Acquisition frequency within water management plan	Environment General Supervisor	Within Env water quality database	Environment General Supervisor

(1) Refer to section 7.7 for more information on reporting methodology and the frequency of reporting
(2) Refer to section 7.7 on how to present instrumentation data from VDV in a report
(3) Exact location of each instrument can be found in the instrumentation database
(4) Location of water quality sampling points can be found in the water management plan

7.5 ADDING INSTRUMENTS TO THE MONITORING PROGRAM

Any addition to the monitoring program must be validated by the Acquisition Responsible. The addition of a new type of monitoring needs to be validated by the Water & Tailings Superintendent. In-situ instrument installation must be recorded in an as-built report and added to the instrumentation database and map. After each installation of instrumentation, the following must be done:

- Document the calibration sheet and initial data reading
- Document instrument specification (manufacturer sheet)
- Document information to which datalogger the instrument is connected
- Survey instrument coordinates (x,y,z)
- If the instrument is drilled, a schematic view of the depth of the instrument versus the stratigraphy must be produced
- Photo of installation must be documented
- Update the structure layout with the location of the new instruments
- Update the instrument database of the structure

7.6 ANALYSIS OF SURVEILLANCE RESULTS

For the effective use of surveillance results in decision making, results must be collated, examined, analyzed, and reported in a timely and effective manner.

For visual inspections, the process of analyzing the data and communicating the results is described in Section 7.4 and happens while the inspection is done, and the report is sent. The information gained from the analysis of these results is then compared during the inspection and review to the TARP criteria which will then indicate the action to take if performance indicators are not met.

For the instrumentation monitoring to be effective, the data must be reviewed, analyzed, and reported at the proper frequency. Table 7-9 summarizes the requirements for review, analyses, and reporting of instrumentation data.

The person performing an instrumentation data review needs to update the Instrument Analysis Log each time an instrument result has been analyzed and reviewed.

7.6.1 Procedure to Review PZ and TH Data

While the use of an automatic data acquisition system eases the collection and review of instruments data there are certain pitfalls that need to be avoided to ensure a proper analysis. When doing a formal instrument review according to Table 7-9 it is important to fill in the instrumentation analysis tool and to ensure the following:

Piezometer:

- When reviewing PZ data it is important to look at the associated temperature of the instrument. A PZ which ever recorded data below 0 degrees should be considered unreliable. A frozen piezometer's data should not be relied upon
- When reviewing PZ data it is important to understand the piezometric regime of the instrument and what is the expected pressure profile. PZ data should be analyzed in context

of where the instruments are installed and on the expected reading. It is not recommended to only look at the variation of the reading and all piezometers should have readings associated with a trigger. If there is no trigger for the instrument and only a differential reading is examined (fall and rise) then the following must be taken into account in the review and analysis:
    - Ensure that the vertical scale is adequate. The scale used must allow to notice change at the scale of a decimeter. A 1 m change rise or fall is a very significant event that must be examined. If the vertical scale is too big a significant increase can easily be masked
    - Ensure that the data are reviewed at various timescales. When reviewing instrument data the data should be looked at a multi-year scale (to see cyclical trends), a monthly scale and a weekly scale
    - Try to correlate increases and decreases in piezometric readings with change in the environment (change in water level, change in pumping activity, freezing of the ground, nearby blasting, progression of a nearby excavation)
- Piezometers must be analyzed in groups and arrays, rather than only one by one. It is important to compare a piezometer to others in the same section or in the same area, to understand how stable or evolving is the flow regime. One should make sure that all gradients (across the structure, vertical and lateral) are stable over time. Changes in gradient magnitude or direction are indicators of flow regime changes that can result in internal erosion processes

Thermistor:

To effectively review TH data it is important to understand what the purpose is. Displacement graphs showing a TH profile at a set time in function of the elevation should not solely be used for such review. It is important to also consider the graph of the thermal profile (colour map).

- When reviewing a TH installed in a structure that must maintain a key trench in permafrost to perform (WRSF Dike, Mammoth Dike, IVR Dike D-1) the objective of the TH is to ensure that the design intent is met. The TH review needs to focus on the active layer depth and behaviour of the permafrost (aggradation, degradation, stable). It is especially important to look at the thermal profile located in the low permeability element of the design (key trench). If a permafrost degradation trend beyond the active layer is observed progressing toward the key trench it must be raised as a concern. To review the performance of these structures thermal graphs are really effective and displacement graphs should not be relied on alone.
- When reviewing a TH installed in talik or in a structure that does not require permafrost condition to perform (Whale Tail Dike) the objective of the TH is to identify potential seepage pathways (correlation between lake temperature and TH reading) as well as to monitor the evolution of the thermal condition (as some PZ behaviour can be explained by change in thermal profile). The review of the instrument must focus on the link between the lake temperature and the TH temperature (as well as the delay in correlation) as well as the general progression of the thermal profile over multiple years. To do this review a combination of displacement graph and thermal profile should be used. Trend of permafrost aggradation should be looked for while reviewing such instruments.

Table 7-9 : Requirements for Review, Analysis, and Reporting of Instrument Data

Instrumentation	TARP Level	Expected Range of Observation	Responsible for Review & Analysis	Frequency of Review	Responsible for Documentation	Documentation Frequency	Reporting Strategy
Piezometer, Thermistor, SAA, Survey Monument	Green	Defined in TARP of each structure	Water & Geotechnical Coordinator	Bi-Weekly, monthly, quarterly or yearly. As defined in the instrument alert level and review frequency document	Water & Geotechnical Coordinator	As defined in the instrument alert level and review frequency document	Annual Geotechnical Report and MDRB Presentation
	Yellow	Defined in TARP of each structure	Water & Geotechnical Coordinator	Weekly (for instrument related to the TARP increase failure mode)	Water & Geotechnical Coordinator	Weekly (for instrument related to the TARP increase failure mode)	
	Orange	Defined in TARP of each structure	Water & Geotechnical Coordinator (can't be delegated)	Daily (for instrument related to the TARP increase failure mode)	Water & Geotechnical Coordinator (can't be delegated)	Daily (for instrument related to the TARP increase failure mode)	
Water Level	Any -	Defined in TARP of each structure and in Appendix C	Water & Geotechnical Coordinator	Daily	Water & Geotechnical Coordinator	Daily water level update in the E&I management meeting minute file	Annual Geotechnical Report and MDRB Presentation
						Monthly water level updated in inspection report of each structure in relation to trigger level	
Blast Monitor	Any	PPV> 50 mm/s	Water & Geotechnical Coordinator	After retrieving a blast monitor on a water management structure	Water & Geotechnical Coordinator	Documented in the Annual Geotechnical Report	Annual Geotechnical Report
Flow Meter / Seepage Monitoring	Green	Defined in TARP of each structure	Water & Geotechnical Coordinator	Weekly	Water & Geotechnical Coordinator	Documented in each inspection form	Annual Geotechnical Report and MDRB Presentation
	Yellow	Defined in TARP of each structure	Water & Geotechnical Coordinator	Weekly	Water & Geotechnical Coordinator	Documented in each inspection form	
	Orange	Defined in TARP of each structure	Water & Geotechnical Coordinator (can't be delegated)	Daily	Water & Geotechnical Coordinator (can't be delegated)	Included within weekly update report	
Water Quality	Any	Defined in Water Management Plan	Environment Coordinator	As per water management plan	Environment General Supervisor	As per water management plan	As per water management plan
Settlement / Deformation	Any	Defined in TARP of each structure	Water & Geotechnical Coordinator	After each survey	Water & Geotechnical Coordinator	Included within inspection report of the period	Annual Geotechnical Report and MDRB Presentation

7.6.2 Procedure If Data Exceeds Expected Range of Observation

If data exceeding the expected range of observation or anomalous data readings are observed or an instrument alert is triggered, the following actions need to be taken by the person reviewing the instrument:

Anomalous instrumentation data examples are presented in Table 7-10. These anomalies could happen without triggering a TARP level change and need to be investigated and recorded in the instrumentation analysis tool:

- Re-read to check the reading (if the reading is from VDV, take a manual reading in the field)
- If the instrument is connected to a datalogger ask the Project technician to check readout equipment to verify that it is functioning correctly and to verify calibration
- If instrument has stopped functioning, notify the Water & Geotechnical Coordinator immediately. If considered critical, a replacement instrument should be installed
- If an anomalous reading is confirmed, a detailed review of the effects of the reading should be carried out and design or remedial actions should be implemented if determined necessary by the Water & Geotechnical Coordinator. Any malfunctioning instrument or frozen piezometer must be documented
- In the case of valid data that would exceed the TARP level perform a special inspection if possible
- If the triggered alert is judged to be within normal range the alert threshold should be increased and documented. Modified alert level review needs to be approved by the Water & Geotechnical Coordinator and is to be included in the scope of the external geotechnical inspection.

Before modifying the TARP level due to in-situ instrumentation or readings that cannot be confirmed by visual observation, the EOR must be consulted for further guidance.

7.6.2.1 Blast Monitoring

If a reading exceeding the PPV limit for a water management structure (50 mm/s) is observed, this event must be communicated to the drill and blast engineer who will need to ensure that the blasting pattern is modified to avoid re-occurrence of this event. Afterward a special inspection will need to be done on the structure to look for changes in condition.

If more than one occurrence of blast vibration exceeding the limit is observed within a 2-week period, the Environment Superintendent needs to be notified of the situation.

Table 7-10 : Examples of Anomalous Data and Some Common Causes

Thermistors
• Increase or decrease in measurements (over two or more readings) that cannot be explained by seasonal temperature variations • Progressive loss of data (starting from the bottom and progressing). This is usually a sign of water infiltration • Observation of a spike in temperature in one bead. This is usually due to a capacitive effect • Loss of data (could be a transmission error, faulty hardware, a sheared cable, or no more battery power)
Piezometer
• Increase or decrease in pore water pressure measurements that cannot be explained by seasonal lake level variations (verify that the instrument has not been installed in a casing). Also verify if the trend is seasonal. This sometimes can be observed in the winter in instruments installed in a former talik area that are freezing back • Sharp increase in reading. Verify that the instrument is not frozen. If multiple instruments are impacted at the same time, verify the barometer reading • Loss of data (could be a transmission error, faulty hardware, a sheared cable, or no more battery power). Especially true if several instruments are lost at the same time or if it is the winter
Inclinometer
• Cumulative increases in displacement (greater than 3 cm) • Erratic movement. This is usually a sign of water infiltration
Survey Monument
• Accelerating displacement rate of the survey monuments (x, y, z directions) (over two or more readings) (could be due to a prism shooting error or problem with the total station) • Widespread difference in settlement between two drone reading. This is probably a reading error and ask for a manual check of the reading
Blast Monitor
• Vibrations during a blast are not observed (the blast was cancelled, the blast monitor was not properly installed, or vibrations were too weak to be recorded)
Flowmeter, Survey Shot, and Staff Gauge
• Sudden change in staff gauge reading or reading that seems not to reflect the probable water elevation. This could be due to a settlement or displacement of the staff gauge • Increase or decrease of a flowmeter reading that are inconsistent with pumping rate or rainfall or observed water level • Survey elevation that has a sharp fluctuation from last reading. This can be caused by the reading not being taken at the right location, wave actions, or daily variances in GPS signal

7.7 INSTRUMENTATION MONITORING DOCUMENTATION AND REPORTING

Instrumentation monitoring results and analysis are documented in the Instrumentation Analysis Log of each structure.

Instrumentation data reporting is done through the Annual Inspection Report Process and during the MDRB annual presentation. Instrumentation reports might also be required to be done for specific structures by the RP or EOR following changes in observed condition or before/after a change in TARP Level.

The goal of instrumentation reporting is to present a summary of the instrument monitoring done for the period as well as the item of interest for the performance of the structure. It is not required in an instrumentation report to present all instrumentation graphs in a structure but the summary of the instrumentation analysis and monitoring trends for the period need to be summarized. Graphs should only be presented if they are there to support the analysis (show cyclical trend, show trend being closely followed, show example of a type of trend that can be observed in several instruments). Table 7-11 describes how instrumentation graphs should be reported when they are included in the report.

Instrumentation reports need to include the following information:

- Layout of each structure covered by the report showing all the instruments installed on the structure
- Table presenting all the instruments installed on each structure, their status and pertinent installation information
- Summary of the monitoring done on the structure for the period and if surveillance objectives were met for the period
- Indicator on the instrumentation system on the structure (how many instruments installed and how many are operational). The report must include a discussion on whether the coverage is sufficient or whether it is recommended to replace instruments to maintain coverage in some areas
- Analysis of each type of instruments trend (PZ, TH, inclinometer, water level, seepage) and how the data relate to the performance objective and indicator of the structure
- Discussion on anomalous trends and their potential cause
- Graph relevant to the analysis. The graph needs to be presented in a way that allows for data interpretation without referring to other documents. The graph also needs to follow the guidelines of Table 7-11. In general, it is expected to present one graph per type of trend observed for operational instruments. Non-operational instrument graphs should not be presented
- Actionable recommendation having priority, owner, and due date
- The graph needs to present data for a minimum period of 1 year. Higher recurrence should be presented if clarity of the presented information allows it

Table 7-11 : Data Presentation for Instrumentation Monitoring Report

Thermistor

- Temperature vs. depth plots over time presented as colour maps should be the main way to present thermal data if the goal is to present general thermal trends
- The plot needs to indicate relevant stratigraphy and their depth
- In vertical displacement plots the thermistor string reference number and date of each measurements presented should be included. The number of readings presented need to be minimized so that it is easy to understand why this plot is presented. Otherwise use a colour map plot. This plot is best used when looking at a sudden thermal change over a small period of time
- Historical plot needs to be presented with a cross-section of the installation (if on a structure) as well as a plan view showing the instrument location. These plots are best used to present the potential seepage location and should be accompanied with the lake temperature data

Piezometer

- Plots of total head as elevation versus time: These plots are very scale sensitive and are generally not the best to show several instruments having different scales of readings
- When presenting PZ reading to assess the effectiveness of a cut-off wall it is important to present the various PZ reading for a horizontal cross-section through the cut-off wall
- Plot needs to be presented with a cross-section of the installation showing lithology with depth as well as a plan view showing the instrument location
- The plot needs to indicate the instrument number, the dates of each measurement, and mention if the temperature read by the instrument is less than 0 degrees

Inclinometer

- Cumulative displacement plots (to view total displacement)
- Incremental displacement plots (to present increasing or accelerating movements between readings)
- Cumulative displacement at crest versus time
- Time plots at zones of identified displacement
- The plot needs to indicate the SAA number, what is considered positive and negative displacement, and the dates of each measurement
- Both elevations and depths should be presented together with the lithology
- A plan view needs to be included showing the instruments locations

Settlement Map

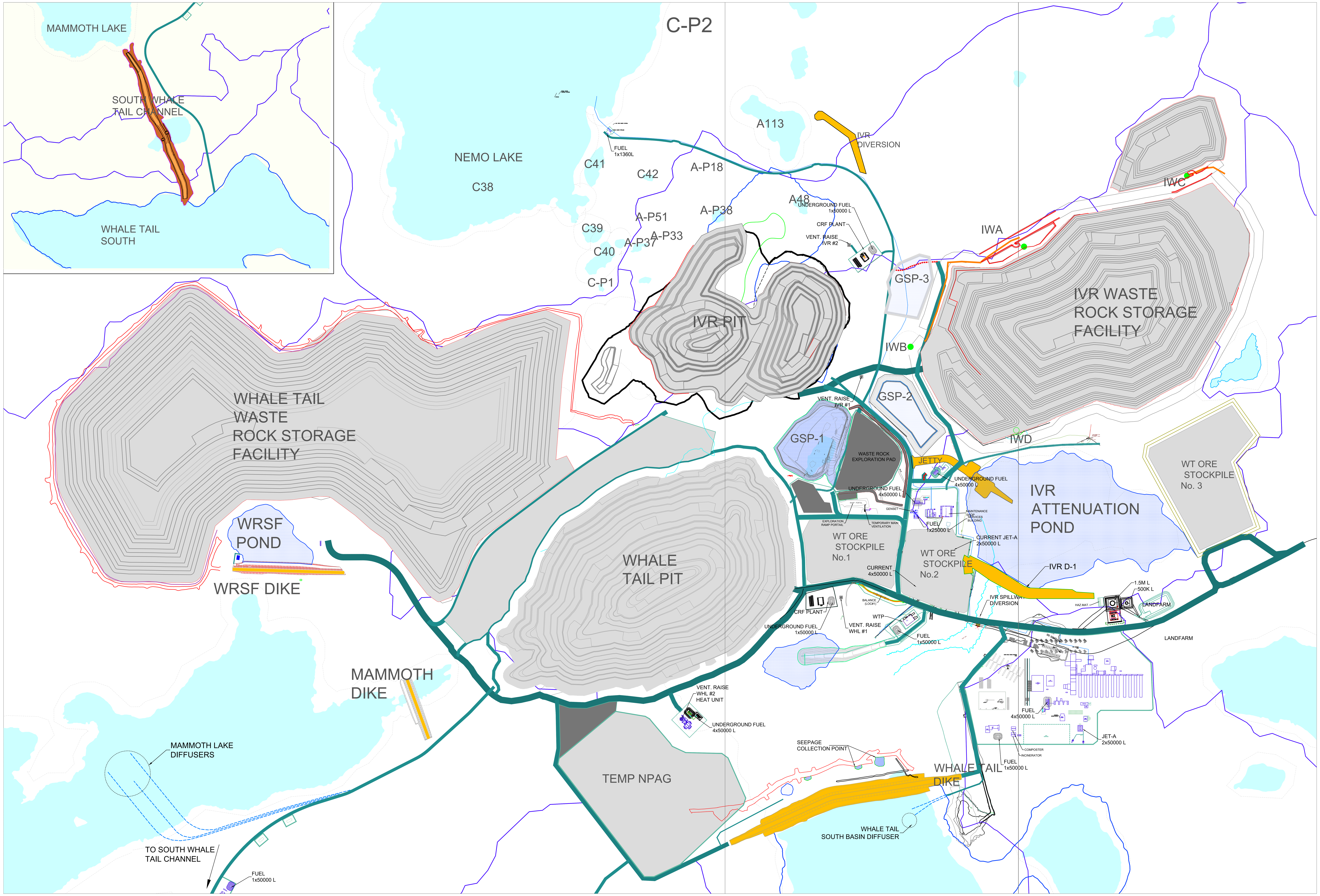
- It is recommended to provide a plan view colour map of the settlement using a calibrated drone survey.
- If presenting settlement monument survey the following info must be included:
    - Total net movement plots (to present total displacement)
    - Vertical displacement plots
    - Lateral displacement plots parallel and perpendicular to the dike axis
    - The plot needs to indicate the survey monument number, what is considered positive and negative displacement and the dates of each measurement
    - A plan view needs to be included showing the instruments locations

7.8 DATA MANAGEMENT

An electronic library or database, which is easily accessible, shall be set up to catalogue and store inspection documents, maintenance reports, and instrumentation measurements. Section 7.1 indicates where each of these items must be stored.

Appendix A

SITE LAYOUT



NO. DESSIN
DRAWING NO.

FORMAT ARCHD

PLAN CLÉ / KEY PLAN

Baker Lake
Wind Frequency by Direction
Winter

NOTES GÉNÉRALES / GENERAL NOTES

LEGEND

- WATERSHED

DESSINS EN RÉFÉRENCE / REFERENCE DRAWINGS

TITRE / TITLE	# DWG

AGNICO EAGLE

REV.	DATE	DESCRIPTION	PAR/BY	APP.	CLIENT

REVISIONS

TITRE / TITLE
AGNICO EAGLE – MEADOWBANK DIVISION
AMARUQ MINE PROJECT

GENERAL ARRANGEMENT
EXPANSION PROJECT 2025

DESSINÉ PAR / DRAWN BY	THOMAS DAHM	DATE 2021–03–02
VERIFIÉ PAR / CHECKED BY		
APPROUVÉ PAR / APPROVED BY	FREDERICK L BOLDUC	2021–03–26
ÉCHELLE / SCALE	DATE 2021–03–02	
NO. DESSIN / DRAWING NO.		
NO. PROJET / PROJECT NO.	REVISION	FEUILLE / SHT / –

AE-CART-ARCH D

Appendix B

DESIGN CRITERIA AND ANNUAL PROBABILITY OF FAILURE

1.0 Whale Tail Dike

The design report for Whale Tail Dike (SNC, 2017) indicates that FOS associated with the surficial slip surface are marginally lower than the corresponding stability criteria, but the depth of these slip surfaces is between 0.5 and 1 m in these situations. The FOS for such shallow slip surfaces is known to be very conservative because the friction angle of rockfill is generally greater at low confining pressures (Terzaghi, Peck and Mesri, 1996).

Table B-1: Factors of safety under static loading conditions (upstream stability)

Scenario	Upstream water level (m)	Downstream water level (m)	Stability criteria	FOS		Appendix A
				Surficial slip surface	Global slip surface	
End of construction	152.5	152.5	FOS>1.3	1.44	1.75	A-1
Water level between 152.5 and 157.0 m	155 (see Fig. 3-3)	Dewatered	FOS>1.5	1.50	1.68	A-2

Table B-2: Factors of safety under static loading conditions (downstream stability)

Scenario	Upstream water level (m)	Downstream water level (m)	Stability criteria	FOS		Appendix A
				Surficial slip surface	Global slip surface	
End of construction	152.5	152.5	1.3	1.44	1.76	A-3
During operations	152.5 - 157	Dewatered	1.5	1.54	1.78	A-4

Table B-3: Factors of safety under pseudo-static loading conditions (upstream stability)

Scenario	Upstream water level (m)	Downstream water level (m)	Stability criteria	FOS		Appendix A
				Surficial slip surface	Global slip surface	
End of construction	152.5	152.5	1.0	1.37	1.66	A-5
Water level between 152.5 and 157.0 m	155 (see Fig. 3-4)	Dewatered		1.43	1.57	A-6

Table B-3: Factors of safety under pseudo-static loading conditions (downstream stability)

Scenario	Upstream water level (m)	Downstream water level (m)	Stability criteria	FOS		Appendix A
				Surficial slip surface	Global slip surface	
End of construction	152.5	152.5	1.0	1.37	1.66	A-7
During operations	152.5 - 157	Dewatered		1.47	1.69	A-8

2.0 Mammoth Dike

Table B-4: Factors of safety under static and pseudo-static loading conditions

Analysis	FS obtained	FS required	Figure
Static Loading – Downstream Slope	1.58	1.50	1
Pseudo-Static Loading – Downstream Slope – 1/2500 AEP	1.52	1.20 -1.30	2
Static loading – Upstream Slope	Local: 2.6 Global: 4.73	1.50	3
Pseudo-Static Loading – 1/:2500 AEPs	Local: 2.39 Global: 3.91	1.0	4

3.0 WRSF Dike

No stability analyses were performed for WRSF Dike due to its foundation on frozen overburden or bedrock.

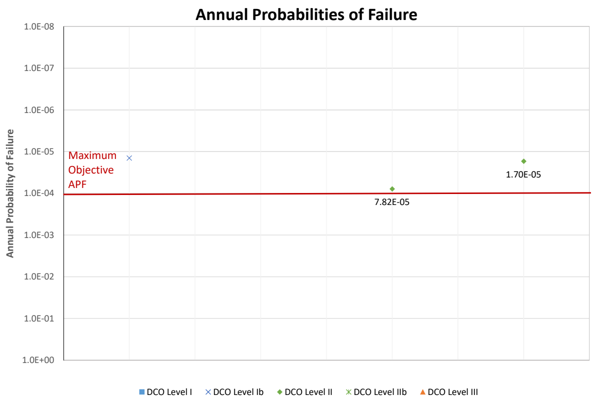
4.0 IVR Dike

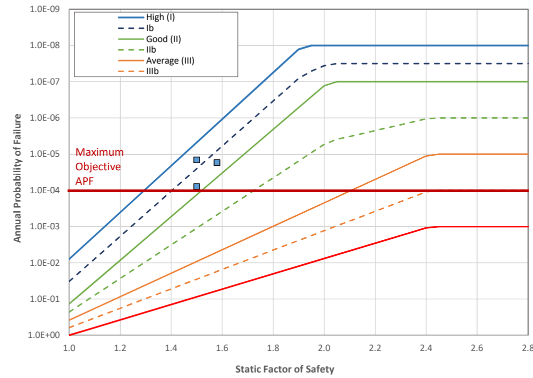
Table B-6: Factors of safety under static and pseudo-static loading conditions

Loading conditions	Slope	Water level	Factor of Safety required	FOS obtained	Figure
Static analysis – End of construction	Upstream	Natural ground = 162 m	1.3	1.58	B-1
	Downstream			1.88	B-2
Static analysis – long term	Upstream	Maximum operation level = 163.2 m	1.5	1.51	B-3
	Downstream			1.88	B-4
Static analysis – long term	Upstream	PMF flood = 165 m	1.5	1.74	B-5
	Downstream			1.88	B-6
Full or partial rapid drawdown	Upstream	163.2 to 162	1.2 to 1.3	1.31	B-7
Pseudo static – End of construction	Upstream	Natural ground = 162 m	1.0	1.47	B-8
	Downstream			1.75	B-9
Pseudo static – long term	Upstream	Maximum operation level = 163.2 m	1.0	1.39	B-10
	Downstream			1.61	B-11

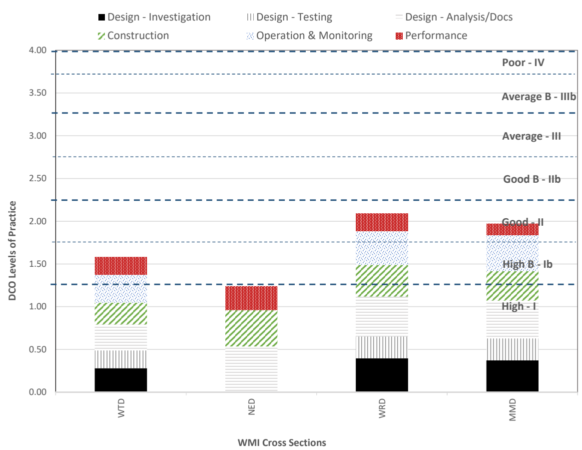
Comparisons on Amaruq WMIs

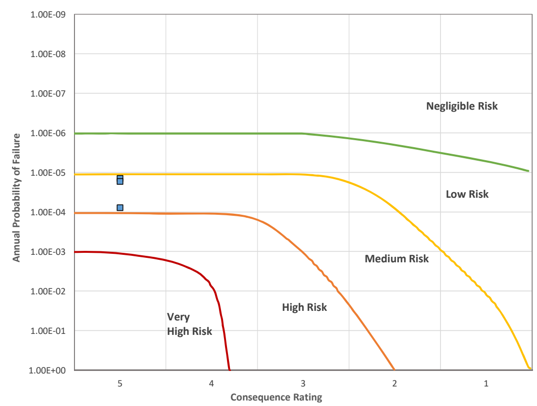
	Amaruq Water Management Infrastructures			
Infrastructures	**WTD**	**NED**	**WRD**	**MMD**
FOS Static (Average conditions)	1.50	1.50	1.50	1.58
Design - Investigation	0.28	#N/A	0.40	0.37
Design - Testing	0.21	#N/A	0.26	0.26
Design - Analysis/Docs	0.30	0.53	0.47	0.44
Construction	0.26	0.43	0.37	0.35
Operation & Monitoring	0.33	#N/A	0.40	0.42
Performance	0.21	0.28	0.21	0.14
DCO Level	**1.58**	**#N/A**	**2.09**	**1.97**
PoF	**1.43E-05**	**#N/A**	**7.82E-05**	**1.70E-05**
Low PoF	**9.28E-06**	**#N/A**	**2.82E-05**	**1.20E-05**
High PoF	**1.93E-05**	**#N/A**	**1.28E-04**	**2.20E-05**
Health & Safety Consequence Rating	5	1	2	5
Material Damage Consequence Rating	5	1	2	5
Environment Consequence Rating	5	1	5	2
Community Consequence Rating	5	1	5	5
Consequence Rating	**5**	**1**	**5**	**5**





	WTD	NED	WRD	MMD
Level I	1.58	#N/A	2.09	1.97
PoF		#N/A		
Level Ib	1.58	#N/A	2.09	1.97
PoF	1.43E-05	#N/A		
Level II	1.58	#N/A	2.09	1.97
PoF		#N/A	7.82E-05	1.70E-05
Level IIb	1.58	#N/A	2.09	1.97
PoF		#N/A		
Level III	1.58	#N/A	2.09	1.97
PoF		#N/A		

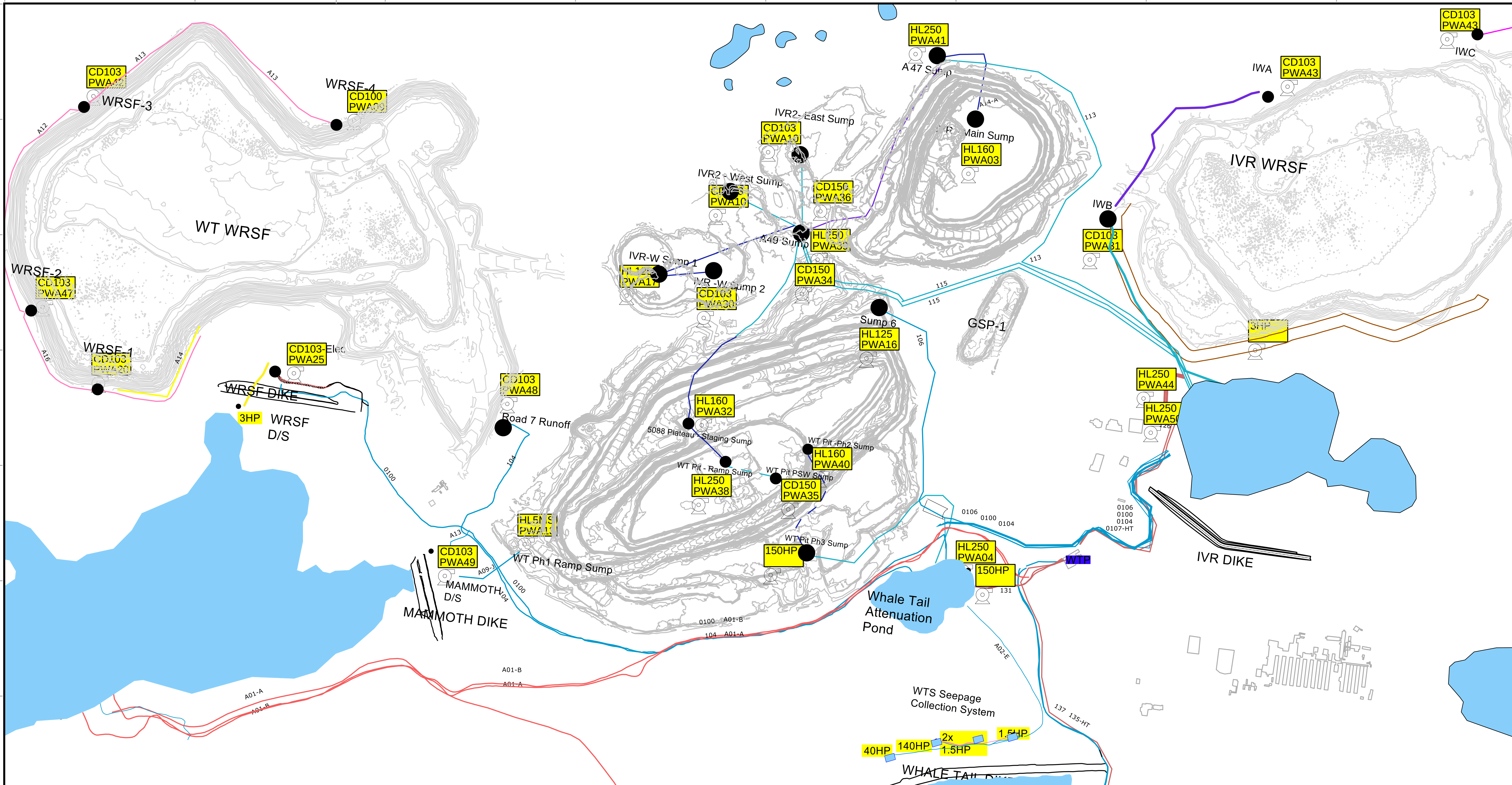




Appendix C

WATER MANAGEMENT OPERATIONAL GUIDELINES

FORMAT ANSI B – LANDSCAPE



Description	Color
4" HDPE DR11	
4" HDPE DR17	
4" Layflat	
8" HDPE DR11	
8" HDPE DR17	
12" MineFlex	
14" HDPE DR11	
14" HDPE DR17	
6" HDPE DR17	

LEGEND Survey Lines - March 2022

AGNICO EAGLE
MEADOWBANK

DRAWN BY	Nicole.Brisson	DATE	2021-01-12
MODIFY BY	Nicole Brisson	DATE	2022-03-08

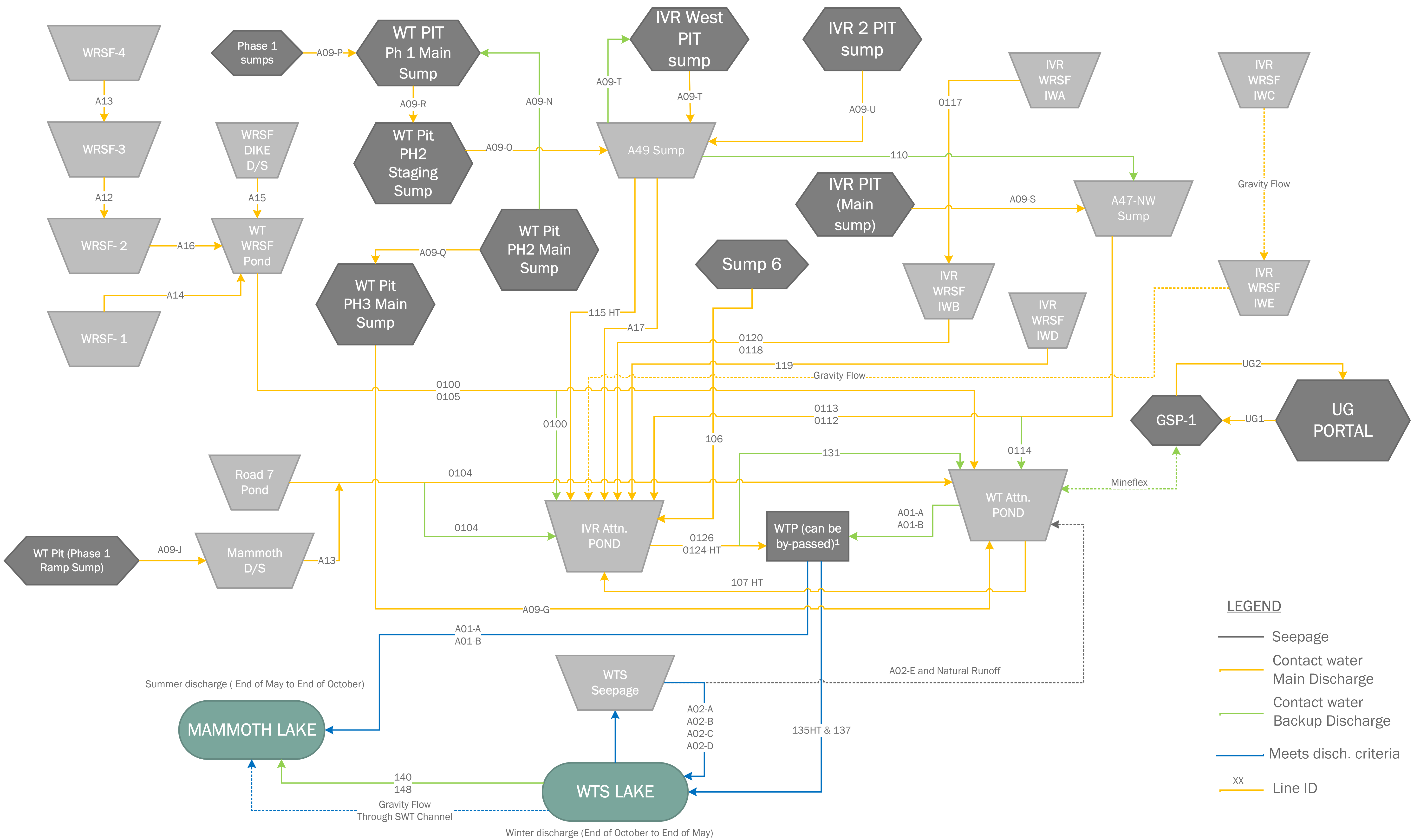
TITLE
AMARUQ
FRESHET 2022 PLAN

SCALE 1:10000 | DATE 3/8/2022 | FILE AMQ–Freshet2022–Map

DEPARTMENT ENGINEERING | REVISION | SHEET 1 / 1

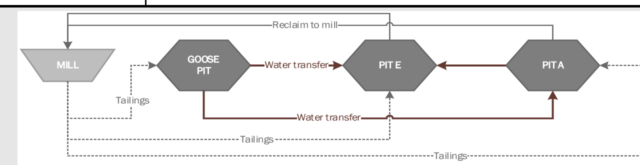
C:\ Users\ nicole.brisson\ Desktop\ AMQ-Freshet2022-Map.dcf

Amaruq 2022 Detailed Freshet Flowsheet



Updated by : Camille Pelletier
Date: 2022-03-06

¹ WTP can be by-passed if water quality in pond meet discharge criteria

WATER BODY	OPERATIONAL LEVELS	DISCHARGE: STANDARD OPERATION	DISCHARGE: ALTERNATE SCENARIOS	RESPONSE: WITHIN OP. LEVELS	RESPONSE: ABOVE MAX	RESPONSE: ABOVE CRITICAL	RESPONSE: OTHER CRITICAL LEVELS
MEADOWBANK							
Central Dike D/S pond	WEST ROAD 116 CRITICAL 115.5 MAX 115.1 MIN 114.8 APPROX BOTTOM 107.0	Pit A	A) Pit E B) South Cell	Resume or maintain standard operations.	* Lower water level to operational level within 3 days. * Increase pumping using current infrastucture or implement mitigation plan. * Inform stakeholder as per communication chart. * E&I and Env to develop path forward with Environment & Critical Infrastructure Superintendent.	Risk of flooding of the pump pad. Immediately lower water to operational levels. * Inform stakeholder as per communication chart. * Environment & Critical Infrastructure Superintendent to develop action plan.	**BASE OF WEST ROAD** Flooding of pump pad and potential for West Road instability and uncontrolled flow into Portage Pit A. * Deploy measure to ensure infrastructure integrity.
South Cell	DIKE LINER ELEVATION 145 CRITICAL 144.0 MAX 143.0 APPROX BOTTOM 136.5	Central Dike D/S pond	Pit A	Resume or maintain standard operations.	* Lower water level to operational level within 30 days. * Increase pumping using current infrastucture or reduce inflows or implement mitigation plan. * Inform stakeholder as per communication chart. * E&I and Env to develop path forward with Environment & Critical Infrastructure	Non-respect of freeboard with potential for structure overtopping and spill. * Immediately lower water to operational levels. * Inform stakeholder as per communication chart. * Environment & Critical Infrastructure Superintendent to develop action plan.	**South Cell Dike Liner Elevation** Dike crest overtopping, spill into site. * Deploy mesure to contain spill, ensure structure integrity and ensure worker safety.
North Cell	DIKE LINER ELEVATION 150 CRITICAL 149.0 MAX 148.0 APPROX BOTTOM 136.5	South Cell	None	Resume or maintain standard operations.	* Lower water level to operational level within 30 days. * Increase pumping using current infrastucture or reduce inflows or implement mitigation plan. * Inform stakeholder as per communication chart. * E&I and Env to develop path forward with Environment & Critical Infrastructure	Non-respect of freeboard with potential for structure overtopping and spill. * Immediately lower water to operational levels. * Inform stakeholder as per communication chart. * Environment & Critical Infrastructure Superintendent to develop action plan.	**North Cell Dike Liner Elevation** Dike crest overtopping, spill into site. * Deploy mesure to contain spill, ensure structure integrity and ensure worker safety.
In-pit Tailings Ponds	EAST DIKE CORE 135.6 EAST DIKE CRITICAL LEVEL 133.5 CRITICAL 133.0 MAX 132.7 Goose & Portage pits connection 131 West Road Low point 126.4 Central Dike D/S Zone 116 Pit E & Pit A connection 87 APPROX BOTTOM -24			Resume or maintain standard operations. * West Road needs to be raised to maintain a 4m freeboard. Lowest point is at El. 126.4 (needs to be raised prior to El. 122.4). * Pit A & E connect at El. 87. * Portage & Goose Pit connect at El. 131. * Need to raise other accesses prior to reaching El. 131. * Need to re-assess CD D/S prior to El. 116 m.	* Lower water level to operational level within 30 days. *Increase pumping using available infrastructure or modify deposition strategy. *If Second Portage Lake is lower than the pond level, take lake samples daily to monitor water quality. * Inform stakeholder as per communication chart. * E&I and Env to develop path forward with Environment & Critical Infrastructure Superintendent.	* Increased risk of contaminant release in Second Portage Laike. * Immediately take action to stop water level raise. * Take samples daily to monitor water quality until pond level is below lake level. * Inform stakeholder as per communication chart. * Environment & Critical Infrastructure Superintendent to develop action plan.	**East Dike Critical level** Increased risk of East Dike overtopping. * Immediately take action to stop increase. * Inform stakeholder as per communication chart. * Environment & Critical Infrastructure Superintendent to develop action plan. **East Dike Core** Overtopping of dike core: Release of contaminant out of the site. * Deploy measure to ensure structure integrity and protect Environment
Second Portage Lake	EAST DIKE CORE 135.6 CRITICAL 134.8 MAX 134.1 APPROX BOTTOM 120	None		Resume or maintain standard operations.	* Investigate cause. * Inform stakeholder as per communication chart. * Engineering, E&I and Env to develop path forward with Water & Tailings Superintendent.	Increase risk of East Dike overtopping. * Immediately take action to stop increase. * Inform stakeholder as per communication chart. * Environment & Critical Infrastructure Superintendent to develop action plan.	**EAST DIKE CORE** Overtopping of East Dike core. Uncontrolled inflow into site. * Deploy measure to ensure structure integrity and protect worker
Third Portage Lake	South Camp Dike Thermal Cap 136.6 CRITICAL 136.3 MAX 135.6 APPROX BOTTOM 102	None		Resume or maintain standard operations.	* Investigate cause. * Inform stakeholder as per communication chart. * Liner installed at El.136.1 m. * E&I and Env to develop path forward with Environment & Critical Infrastructure Superintendent..	Increased risk of South Camp Dike overtopping and thawing of thermal cap. * Immediately take action to stop increase. * Inform stakeholder as per communication chart. * Environment & Critical Infrastructure Superintendent to develop action plan.	**South Camp Dike Thermal Cap** Overtopping of thermal cap of South Camp Dike. Uncontrolled inflow into site. * Deploy measure to ensure structure integrity and protect worker
Wally Lake	VAULT DIKE THERMAL CAP 142.5 CRITICAL 142.2 MAX OP 141.5 APPROX BOTTOM 120	None		Resume or maintain standard operations. * Liner installed up to El. 141 m.	* Investigate cause. * Inform stakeholder as per communication chart. * Liner installed at El.136.1 m. * E&I and Env to develop path forward with Environment & Critical Infrastructure Superintendent.	Increased risk of South Camp Dike overtopping and thawing of thermal cap. * Immediately take action to stop increase. * Inform stakeholder as per communication chart. * Environment & Critical Infrastructure Superintendent to develop action plan.	**VAULT DIKE THERMAL CAP** Overtopping of thermal cap of South Camp Dike. Uncontrolled inflow into site. * Deploy measure to ensure structure integrity and protect worker
AMARUQ							
Whale Tail Attenuation Pond	PIT CREST 146 UPPER PUMP PAD 146.5 CRITICAL 145.5 MAX 143.5 LOWER PUMP PAD 143.0 MAX (LOWER PAD) 142.0 APPROX BOTTOM 135.0	**Summer:** IVR Attenuation Pond **Winter:** WTS Lake Diffuser via WTP or IVR attenuation pond	Condition 1 / Condition 2 / Discharge location A) Water meets discharge criteria / Summer (May to October) / Mammoth Lake diffuser B) / WTS diffuser available / WTS Diffuser C) / GPS-1 available / GSP-1 D) / / Mammoth Watershed or WTS watershed E) WTP is in function / Summer (May to October) / WTP > to Mammoth Lake diffuser F) / WTS diffuser available / WTP > to WTS Diffuser G) / GPS-1 available / WTP > to GSP-1 H) / Water meets discharge criteria / WTP > to Mammoth Watershed or WTS watershed I) GPS-1 available / / GSP-1 J) / Water meets discharge criteria / WTP > to Mammoth Watershed or WTS watershed K) None / / Whale Tail Pit	Resume or maintain standard operations.	* Lower water level to operational level within 15 days. * Increase pumping from WT ATTN pond using current infrastucture or reduce inflows into WT ATTN pond or implement mitigation plan. * Inform stakeholder as per communication chart. E&I and Env to develop path forward with Environment & Critical Infrastructure Superintendent.	Risk of flooding of the upper pump pad. Immediately lower water to operational levels. * Inform stakeholder as per communication chart. * Environment & Critical Infrastructure Superintendent to develop action plan.	**PIT CREST ELEVATION** Uncontrolled release into Whale Tail Pit. Deploy measures to ensure worker safety.
IVR Attenuation Pond	IVR DIKE SPILLWAY 164.8 CRITICAL 164.3 MAX 163.2 UPPER PUMP PAD 165.5 LOWER PUMP PAD 163.8 APPROX BOTTOM 159.0	WTP to Mammoth lake or to WTS lake diffusers	Condition 1 / Condition 2 / Discharge location A) Water meets discharge criteria / Summer (May to October) / Mammoth Lake diffuser B) / WTS diffuser available / WTS Diffuser C) / / Whale Tail Attenuation Pond D) / / Mammoth Watershed or WTS watershed	Resume or maintain standard operations. 163.2 is the design max operating level (SNC).	Lower water level to operational level within 15 days. * Increase pumping using current infrastucture or reduce inflows into IVR Attenuation pond or implement mitigation plan. * Inform stakeholder as per communication chart. E&I and Env to develop path forward with Environment & Critical Infrastructure Superintendent.	Risk of activating the emergency spillway. * Immediately lower water to operational levels. * Inform stakeholder as per communication chart. * Environment & Critical Infrastructure Superintendent to develop action plan.	**IVR DIKE SPILLWAY ELEVATION** Spillway active and realease of water into Whale Tail Attenuation Pond. * Monitor spillway condition and closely monitor WT Attn pond level. * Ensure water from IWD does not enter into the IVR WRSF. * Assess spillway condition after use
WRSF Pond	LINER ELEVATION 157 CRITICAL 156.0 MAX 154.0 APPROX BOTTOM 153.5	Whale Tail Attenuation Pond	IVR Attenuation Pond	Resume or maintain standard operations. Due to limited capacity this system require close operational follow-up.	* Lower water level to operational level within 7 days. * Increase pumping using current infrastucture or reduce inflows into WRSF pond or implement mitigation plan. * Inform stakeholder as per communication chart. E&I and Env to develop path forward with Environment & Critical Infrastructure Superintendent.	Increased risk of WRSF dike foundation thawing leading to seepage to Mammoth Lake. *Immediately lower water to operational levels. * Inform stakeholder as per communication chart. * Environment & Critical Infrastructure Superintendent to develop action plan.	**LINER ELEVATION** Liner overtopping and uncontrolled relase into enviroment . * Deploy measure to ensure structure integrity and prevent damage to environment.
GSP-1 (AP5)	CREST ELEVATION 160.5 CRITICAL 155.0 MAX 154.0 APPROX BOTTOM 142.3	Whale Tail Attenuation Pond if TDS content is compliant		Resume or maintain standard operations. This location must be empty prior to freshet if TDS criteria are met.	* Lower water level to operational level within 30 days. * Increase pumping using current infrastucture or implement mitigation plan. * Inform stakeholder as per communication chart. E&I and Env to develop path forward with Environment & Critical Infrastructure Superintendent.	Risk of seepage through the till and till slope instability. * Immediately lower water to operational levels. * Inform stakeholder as per communication chart. * Environment & Critical Infrastructure Superintendent to develop action plan.	**CREST ELEVATION** Uncontrolled release into site. *Deploy measure to ensure worker safety
Mammoth Lake	MAMMOTH DIKE LINER 153.5 CRITICAL 153.3 MAX 153.0 MAMMOTH OUTLET 152.7 MIN 152.2 APPROX BOTTOM 135.1	If Mammoth Lake outlet (152.68) is obstructed, clear obstruction or conduct investigation		Resume or maintain standard operations. * Prior to freshet the level must not be above El. 152.5 m. * At freshet the rate of rise should be less than 0.05 m/day. *Go to yellow if rate of rise is 0.06 to 0.1 for more than 3 consecutive days *Mammoth Lake outlet is at 152.68.	* Investigate cause. * If possible, reduce inflows into Mammoth Lake * Inform stakeholder as per communication chart. E&I and Env to develop path forward with Environment & Critical Infrastructure Superintendent.	Increased risk of Mammoth Dike liner overtopping leading to pit inflow. * Immediately take action to stop increase. Could include outlet work. * Inform stakeholder as per communication chart. * Environment & Critical Infrastructure Superintendent to develop action plan.	**MAMMOTH DIKE LINER ELEVATION** Liner overtopping and uncontrolled release to Whale Tail Pit. * Deploy measures to ensure structure integrity and ensure worker safety.
Whale Tail Lake (WTS)	WTD SECANT WALL TOP 157 CRITICAL 156.3 MAX 155.8 MIN 152.5 SWTC INLET 155.3 APPROX BOTTOM 136.0	Mammoth Lake via SWTC	A) Whale Tail Attenuation Pond B) Mammoth Watershed Discharge	Resume or maintain standard operations. SWTC inlet at El. 155.3 m	* Ensure that water level is reduced to operational level within 15 days. * Investigate cause. * If possible, reduce inflows into WTS Lake. * Inform stakeholder as per communication chart. E&I and Env to develop path forward with Environment & Critical Infrastructure Superintendent.	Increased risk of WTD core overtopping. * Immediately lower water to operational level. Could include work at SWTC. * Inform stakeholder as per communication chart. * Environment & Critical Infrastructure Superintendent to develop action plan.	**WTD SECANT PILE WALL TOP ELEVATION** WTD secant wall overtopping and uncontrolled release downstream to WT Attenuation Pond. * Deploy measures to ensure structure integrity and ensure worker safety.

Appendix D

POTENTIAL MITIGATION FOR UNUSUAL CONDITIONS

Potential Mitigation Plans for Unusual Conditions on Water Management Infrastructures

Unusual Condition	Area / Cause		Comments / Monitoring	Contingency or Corrective Action
Overtopping and Subsidence	1a	Water level rise / storm event	Lake levels and crest elevations are monitored as part the water management infrastructure surveillance program. Outflow channels are inspected during thaw, open water season, and during ice break-up.	Add additional pumping unit. If rise is caused by a channel obstruction, remove the obstruction.
	1b	Dam crest settlement	This scenario requires extensive loss of support in the foundation since the rockfill of the dikes is essentially not settlement prone itself after construction and dewatering. For foundation settlement of this magnitude to occur, a piping event must develop or there is an unexpected layer of compressible soil in the foundation. The situation would develop slowly with crest settlement evident at least several weeks before a run-away event develops. Easily observed cracks should be evident. Monitoring of the crest settlement is conducted routinely.	The crest is wide and constructed of coarse rockfill. Significant damage to the dike is not credible, based on performance of other rockfill structures subjected to overtopping or flow through events. Rockfill can be placed to raise the dike crest and compensate settlement. Operations in the area may need to be suspended, but there will be considerable warning time given the slow development of the scenario.
	1c	Wave action	Large freeboard and wide crest zone make this a low concern	Rip-rap can be added and/or the dam crest can be raised.
Internal Erosion	2a	Dike section: Cut-off wall/geomembrane is defective, allowing high water flow. This defect occurs at a location where the core allows high flows and where the fills/geomembrane are defective; the combination allows erosion of the cut-off and/or the Core Backfill.	The cut-off wall/geomembrane and/or core backfill will develop a progressively increasing void ratio, thereby increasing the rate of water flow through the dike. This is not a catastrophic failure mode but could lead to an inability to manage water on site	Monitor seepage from downstream face for rate of seepage and for presence of sediment in seepage. Identify zone of seepage and establish a seepage capture and monitoring station with sufficient pumping capacity. Re-evaluate the impact of this water inflow on the site wide water balance.
	2b	Dike section: geomembrane is defective.	Results in increasing the rate of water flow through the dike. This is not a catastrophic failure mode as the rockfill will be stable and at its worst would lead to temporary suspension of operations.	Monitor seepage from downstream face for rate of seepage and for presence of sediment in seepage. Identify zone of seepage and establish a seepage capture and monitoring station with sufficient pumping capacity. Re-evaluate the impact of this water inflow on the site wide water balance.
	2c	Foundation till is possibly non-uniform with more transmissive zones and not self-filtering. It is possible that one of these zones may align with defective construction of the cut-off wall allowing high flows. Seepage would lead to erosion of the cut-off into the downstream rockfill. Seepage could also erode the foundation tills at the downstream toe or into the downstream rockfill because of the lack of filtering.	Limited seepage at the toe or into the rockfill would accelerate into a large inflow and could lead to the undermining of the dike if no action was taken. This is a credible catastrophic mode if increased seepage is not detected in time. No particular instrumentation is needed as this failure mode will show itself as localized and increasing seepage. It could be detected by walk-over inspection by an experienced engineer or technician.	Remedial action could comprise a reverse filter and rockfill buttress depending on location of the flow and configuration of the foundation, freezing, or grouting, if identified in time. In the worst case, the pit may be deliberately flooded in a controlled manner, the cut-off repaired, and the pit dewatered. Other options are to build an additional dike downstream or increasing pumping.

Unusual Condition	Area / Cause		Comments / Monitoring	Contingency or Corrective Action
Seepage	3a	Within the embankment	Seepage on its own is not a credible failure scenario. The downstream rockfill shell has extremely high flow through capacity. The rockfill zone is both large and pervious, so that seepage will not daylight and lead to instability.	Monitor seepage from downstream face for rate of seepage and for presence of sediment in seepage. Identify zone of seepage and establish a seepage capture and monitoring station with sufficient pumping capacity. Re-evaluate the impact of this water inflow on the site wide water balance.
	3b	Within the foundation	Defective construction of cut-off leading to transfer of an unexpectedly high fraction of the reservoir head into the downstream part of the dike foundation or leading to a piping event as described in internal erosion (2c). If this mechanism arises it should show itself during initial dewatering or very shortly thereafter.	Monitor seepage from downstream face for rate of seepage and for presence of sediment in seepage. Identify zone of seepage and establish a seepage capture and monitoring station with sufficient pumping capacity. Re-evaluate the impact of this water inflow on the site wide water balance. Re-assess stability (numerical modelling) and construct a stabilizing berm.
Structural - Slope Instability	4a	Normal operation: slope failure	The rockfill shoulders of the dike are wide and have high shear strength Slope failure requires failure in the foundation which would extend into the overlying dike. Sliding failure is considered unlikely given the low horizontal forces generated by the water and ice relative to the normal frictional force due to the weight of the dikes and the frictional angles of foundational materials. This mechanism should develop during construction or dewatering, due to the increase in load and associated pore water pressure development. Initial stages of failure should be observable as tension cracks in the dike crest. Walk-over inspection of the dike by a trained inspector is an appropriate monitoring strategy in addition to the instrumentation. Survey of crest face and toe is conducted.	Re-assess stability (numerical modelling) and construct a stabilizing berm if required. Fill inactive tension cracks with bentonite.
	4b	Earthquake induced: slope failure	Site is in a low seismic zone. Dam consisting of massive rock zone has a low sensitivity to seismic motion.	Perform an inspection and repair damage.
	4c	Erosion; washout, ice scour	Crest – minimum 50 m section. Downstream – large quarry rock face.	Repair erosion by placing additional rockfill and material.
Structural – Lateral Movement	5a	Failure of cut-off wall	Differential horizontal movement of the dike due to dewatering, water or ice loading or pit wall failure may create a breach in the cut-off wall. Ice and water forces are not credible due to the ratio of frictional forces generated by the weight of the dike versus ice loads and water pressure. Large inflows through the breach may occur consequently if the cut-off wall breached. Pit would flood requiring suspension of operations. Potential for loss of life of workers inside dikes. Inclinometer, settlement prism, drone, and monument monitoring is done routinely.	Repair the cutoff wall.
Subsidence	6	Foundation soils	Foundation soils consolidated unexpectedly during dike construction or dewatering. A significant quantity of clay would be required to generate settlement resulting in a water release event. Prism, drone, and monument monitoring is done routinely.	A 1 m core settlement would be required to allow water to flow through the rockfill and over the settled cut-off. This flow would not cause failure of the rockfill shells. It would also be readily repaired by excavating rockfill above the cut-off wall and placing more till.
Premature Closure	7	Corporate bankruptcy or early resource depletion	Bond is provided for this eventuality. Design of rehabilitation is the same as rehabilitation at closure of project.	This would trigger the closure plan.
Pump and Pipeline Failure	8	Pumping infrastructures	Freezing protection is provided by heat tracing and insulation. Pipelines monitored by pump pressures at plant and frequent site inspection.	Replace defect in pipeline. Repair the pump and use another pump in the meantime.