Water Management Infrastructures - Operation, Maintenance and Surveillance Manual, Version 1

AGNICO EAGLE

WHALE TAIL PROJECT

WATER MANAGEMENT INFRASTRUCTURES

Operation, Maintenance and Surveillance Manual

Prepared by:
Agnico Eagle Mines Limited – Meadowbank Division

Version 1
March 2019

AMARUQ DIKES

OPERATION, MAINTENANCE AND

SURVEILLANCE MANUAL

WHALE TAIL PROJECT

AGNICO EAGLE MINES LIMITED

This Operation, Maintenance and Surveillance Manual has been prepared by Agnico Eagle Mines Limited with support from SNC-Lavallin and is to be used for the operation, maintenance and surveillance of Whale Tail water management infrastructures. All Users of this manual are responsible for ensuring that they are using the most recent revision of this document which can be found in Intelex or in paper version in the Engineering Superintendent office at Meadowbank.

IMPLEMENTATION SCHEDULE

This Plan is immediately implemented.

DISTRIBUTION LIST

AEM- General Mine Manager

AEM- Environment Superintendent

AEM- Mine Operations Superintendent

AEM- Engineering Superintendent

AEM- Energy & Infrastructure Superintendent

AEM – Maintenance Superintendent

AEM- Nunavut Division Engineer of Record

DOCUMENT CONTROL

Version	Date (YMD)	Section	Page	Revision
(Draft Version)	January 2019	All	All	Draft for Comments
1	March 2019	All	All	Final version for issuance

Approved by:

Luc Chouinard
Mine Manager

Pierre McMullen
Engineering Superintendent

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

SECTION 1 • INTRODUCTION

1.1 OBJECTIVE OF THE OMS MANUAL

The objective of this manual is to define the technical aspect related to the operation, maintenance and surveillance (OMS) of the water management infrastructure at the Whale Tail Pit Project operated by Agnico Eagle Mines Limited (AEM), Meadowbank Division.

This manual is intended as a practical document used by the personnel involved in with the Whale Tail Project water management infrastructure. It incorporates operating, maintenance and surveillance procedures recommended by the Canadian Dam Association (CDA) “Dam Safety Guidelines” (CDA 2013 & 2014) and the Mining Association of Canada (MAC) “Developing an Operation, Maintenance and Surveillance Manual for Tailings and Water Management Facilities” (MAC, 2018). This manual was written by the Meadowbank Engineering team with the support of SNC-Lavalin and the Nunavut Engineer of Record.

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 water management infrastructure covered in the scope of this OMS manual
- Plans, procedures and processes for :
    - The operation, maintenance and surveillance of the Whale Tail Project water management infrastructures to ensure that it functions in accordance with their design, meets performance objectives and link to emergency response planning
    - Evaluating performance of the structures, and report 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.

Element related to design, construction and closure of water management infrastructures, infrastructures related to management of underground water and 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 person responsible for the preparation, update and distribution of this manual is the Engineering Superintendent. Any change to this OMS manual must be submitted to and approved by the Engineering Superintendent who will be responsible to update the OMS manual in Intelex.

It is each user responsibility to ensure that they are using the latest version of this document. In case of issue with retrieving the electronic version of this document, the most up to date paper version of this document will always be kept in the Engineering Superintendent Office.

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

Table 1-1: OMS Manual Distribution List

Position	Name
General Mine Manager	Luc Chouinard
General Superintendant	Eric Côté / Jacques Proulx
Environment Superintendent	Nancy Duquet-Harvey
Mine Operations Superintendent	Yan Côté, Nicolas P. Deschamps (asst.)
Engineering Superintendent	Pierre McMullen, Miles Legault (asst.)
Maintenance Superintendant	Christian Quirion
Energy & Infrastructures Superintendent	Guillaume Gemme
Engineer of Record, Meadowbank Division	Thomas Lepine

1.3 MANAGEMENT OF CHANGE

This manual will be reviewed on an annual basis at the beginning of Q3 and revised as necessary to accommodate changes in the condition and operation of the facilities. The Engineering Superintendent will be responsible to coordinate this review process.

In conducting the review and update of the OMS manual the following must be taken into account:

- Performance of the structure
- Current life cycle of the structure
- 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 need to be completed in a timely manner following the document control criteria specified in Section 1.2.

As a good practice the Engineering Superintendent should organise on a yearly basis a session to present the change in the OMS manual to the person in its distribution list.

1.4 REQUIRED LEVELS OF KNOWLEDGE

To preserve the integrity of the operation of these structures, the personnel must have a good comprehension of the factor that can impact the performance of the water management infrastructures. It must also be know that any deviation can signify the emergence of a problem and the role that each person must have in the operation, maintenance and surveillance of these infrastructures.

It is the responsibility of each person in the distribution list of this manual to be familiar with it and understand its whole content. They also need to ensure that everyone under their supervision who's duty involve task related to the operation, maintenance or surveillance of any component of the water management infrastructures have the appropriate level of knowledge and the resources to comply with the protocol presented in this document.

1.5 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 address conditions related to operation under normal or upset conditions, as opposed to emergency situation. An Emergency Response Plan (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 observation that would results in an emergency being declared
- Roles and responsibilities of key personnel in transition from normal or upset conditions to an emergency
- Actions to be taken to transition from normal or upset conditions to an emergency situation

Once an emergency has been declared reference must be made to the Emergency Response Plan (Reference included in Table 1-2). The most recent version of the ERP can be found on Intelex and in the Engineering Superintendent Office

Table 1-2 Emergency Response Reference Documents

Document	Current Revision
Emergency Response Plan	Updated by AEM. Version 12, January 2018. (Intelex)

SECTION 2 • ROLES AND RESPONSIBILITIES

A functional chart for the water management infrastructure at the Whale Tail project is shown in Figure 2-1.

The roles and responsibilities of the key personnel involved in the water management infrastructure of the Whale Tail Project are shown in Table 2-1. Contact information for each position is indicated in Table 2-2.

Personnel who have task directly related to the water management infrastructure need to receive training when they start in the position to ensure they understand their roles and responsibility related to this OMS manual.

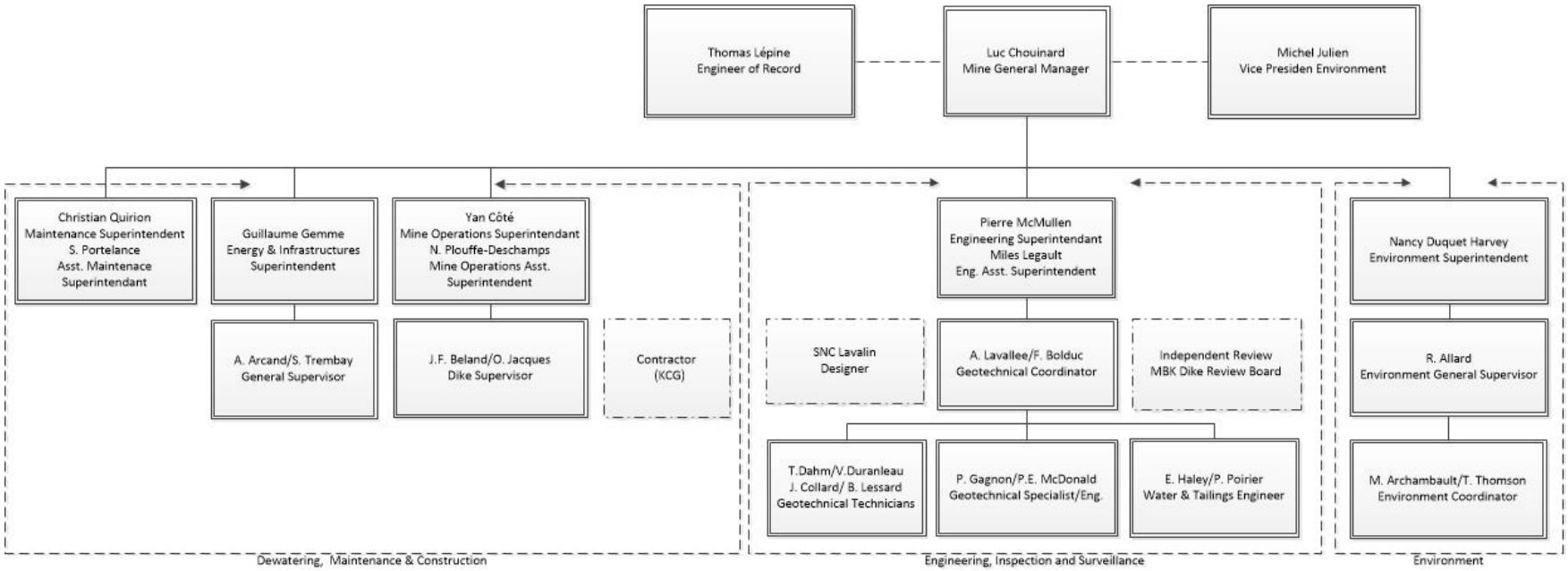

Figure 2-1: Organizational structure

Table 2-1: Responsibilities related to Whale Tail Water Management

Role	Responsibilities
Vice-President Environment	• Be aware of key outcome of water management risk assessment and 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 and defines the personnel duties, responsibility and reporting relationships, supported by job description and organisational charts to implements the water management system though all stages in the facility life cycles • Provide assurance to AEM and its Community of Interest that the water management infrastructure are managed responsibly
General Mine Manager	• Identifies the scope of work and budget requirement for all aspect of water management • Approve budget for OMS related activity • Establish an organisational structure with Roles and Responsibility that meets the operational needs • Delegate specific tasks and responsibilities for water management to qualified personnel • Liaise with independent reviewer (MDRB) as required
Engineer of Record (EoR)	• Input into the OMS activities in accordance with the design • Receive and review the OMS manual on a regular basis • Receive and review dewatering performance data at a frequency determined based on the risks • Either confirm operation is compliant or identify deviations from performance objectives and advise the Owner with recommendations • Advise on contemplated change on the structure operation • Maintain records relating to design construction and operation • Participate in inspection and independent review
Independent Reviewer – Meadowbank Dike Review Board (MDRB)	• Provide independent, objective, expert commentary, advice and recommendations, to assist in identifying, understanding, and managing risk associated with water management facilities
Engineering Superintendent	• Revise and update the OMS Manual to reflect as-built conditions and any other changes. • Review and update OMS manual into Intelex • Maintain up to date distribution list of the OMS Manual. • Establish a formal relationship with the EOR to ensure operation is compliant with design intent • Identify when/where contemplated operational changes are a potential deviation from the design intent and engage the EoR and Designer as part of processes to manage change

Role	Responsibilities
	• Coordinate work force as required for monitoring and maintenance.
Mine Operations Superintendent / Dike Supervisor	• Maintain access to the structure and seepage collection systems, including making road repairs, controlling dust and removing snow. • Carry out field maintenance related to earthwork as required, • Supervise Mine Contractor for aspect related to earthwork construction and maintenance
Geotechnical Coordinator	• Supervise the work of the geotechnical engineer, geotechnical technician and water and tailings engineer
Geotechnical Engineer	• Carry out inspections of the structures as required in the OMS Manual. • Carry out instrument monitoring as required in the OMS Manual. • Review and analyse surveillance data to evaluate dike performance with respect to design parameters. • Review and distribute surveillance reporting as required in the OMS Manual • Analyse geotechnical instrumentation monitoring data to evaluate dike performance with respect to design parameters
Geotechnical Technician	• Carry out inspections of the structures as required in the OMS Manual. • Monitor instrumentation as required in the OMS Manual. • Maintain instrumentation, readout units, data acquisition system and cabins • Responsible for data acquisition as required in the OMS manual • Prepare reports on instrumentation readings, dike performance, visual observations, etc. as required in the OMS Manual.
Water & Tailings Engineer	• Carry out inspections of the structures as required in the OMS Manual. • Carry out instrument monitoring as required in the OMS Manual. • Coordinate equipment, labour, materials and maintenance activities required for pumps and pipelines associated with dewatering, seepage collection systems and any runoff diversions. • Prepare reports on instrumentation readings, dike performance, visual observations, etc. as required in the OMS Manual.
Environment Department Superintendent / General Supervisor / Coordinator / Technician	• Ensure monitoring of water quality and total suspended solids as required in the water management plan • Review environmental monitoring data for compliance with Water License and regulations and to determine dike performance with respect to design parameters. • Liaise with external stakeholders including NIRB, Nunavut Water Board, NGO's, government agencies.

Role	Responsibilities
Energy & Infrastructures Superintendent / General Supervisor / Pump crew supervisor / electrical supervisor	• Installation and operation of pumps and pipeline (electrical, mechanical) • Maintain and service pumps and pipelines • Coordinate equipment, labour and materials for maintenance of electrical and mechanical equipment • Carry out field operations including pumping. • Carry out field maintenance on pumps and pipeline including electrical and mechanical repairs.
Mine Contractor	• Rent equipment and manpower for construction and maintenance of water management infrastructure
Design Engineer	• Advise on contemplated change to the structure design • Advisor on structure performance as required • Participate in inspection and independent review as required
Maintenance Superintendent/ Pump mechanics	• Ensure preventive maintenance is carried out regularly on each pumping equipment • Repair pumping equipment as required • Update and maintain a list of operational pumping equipment • Keep records of maintenance on pumping equipment

Table 2-2: OMS Manual Contact for each position

Role	Name	Work Contact Info
Vice-President Environment	Michel Julien	michel.julien@agnicoeagle.com 416-947-1212 x3738 514-244-5876
General Mine Manager	Luc Chouinard	819-759-3555 x4606896
Engineer of Record (EoR)	Thomas Lepine	thomas.lepine@agnicoeagle.com 416-947-1212 x3722 418-473-8077
Engineering Superintendent / Assistant	Pierre McMullen Miles Legault	819-759-3555 x4606721
Mine Operations Superintendent / Assistant	Yan Côté Nicolas Plouffe-Deschamps	819-759-3555 x4606832
Dike Supervisor	Jean-François Béland Olivier jacques	819-759-3555 x4606807
Geotechnical Coordinator	Frédérick L.Bolduc	819-759-3555 x4606837

Role	Name	Work Contact Info
	Alexandre Lavallée	
Geotechnical Engineer	Patrice Gagnon Pier-Eric McDonald	819-759-3555 x4606726
Geotechnical Technician	Vincent Duranleau Thomas Dahm Bruno Lessard Jerome Collard.	819-759-3555 x4606818 819-759-3555 x4606851
Water & Tailings Engineer	Eric Haley Pascal Poirier	819-759-3555 x4606752
Environment Superintendent	Nancy Duquette	819-759-3555 x4606980 x3175
Environment General Supervisor	Robin Allard	819-759-3555 x4606838
Environment Coordinator	Martin Archambault Tom Thomson	819-759-3555 x4606744
Energy & Infrastructures Superintendent	Guillaume Gemme	819-759-3555 x4606632
Maintenance Superintendent	Pierre Laberge Sylvain Portelance	819-759-3555 x4606722
Energy & Infrastructure General Supervisor	Alexandre Arcand Steven Tremblay	819-759-3555 x4606822
Pump crew supervisor	Shawn Valiquette	819-759-3555 x4606616
Electrical Supervisor	Alain Villeneuve	819-759-3555 x4606762
Mine Contractor	KCG	819-759-3555 x4606963 418-615-0559
Designer – SNC Lavalin	Yohan Jalbert	418-621-5500
Independent Reviewer – Meadowbank Dike Review Board (MDRB)	• Anthony Rattue • Don Hayley	anthony.rattue@bell.net don.hayley@icloud.com

SECTION 3 • WATER MANAGEMENT INFRASTRUCTURES DESCRIPTION

The Whale Tail Project 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 description of the physical conditions of the site, as well as a geological and geotechnical conditions can be found in the design document of each structure referred to in this section.

The Whale Tail Project includes the construction and operation of a series of water management infrastructure as shown in Figure 3-1. Table 3-1 indicate the water management infrastructure of the Whale Tail Project

Table 3-1: Description of the water management infrastructure of the Whale Tail Project

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 retentions 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 (NE)	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
NE Pond and pumping infrastructure	Pond formed by the NE dike. It stores non-contact water which is discharged to the environment or to the attenuation pond based on water quality
Attenuation Pond and pumping infrastructure	Pond formed by the dewatering of the Whale Tail North basin. It stores contact water which is pump to a water treatment plant (WTP) and then discharged through an approved diffuser

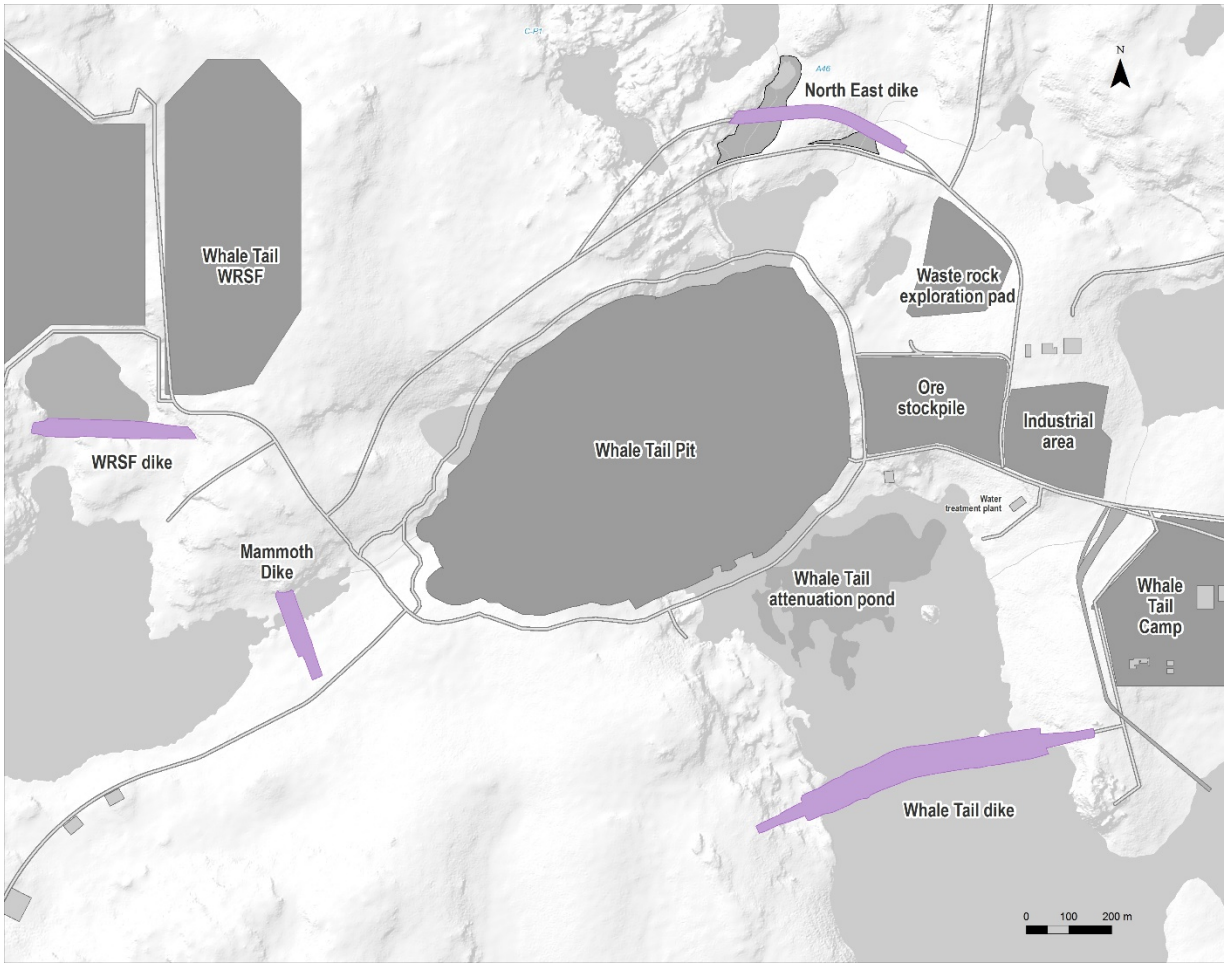

Figure 3-1: Site Plan and Water Management Infrastructure Location

3.1 WHALE TAIL DIKE

Whale Tail Dike (WTD) is a structure to isolate the Whale Tail Pit from Whale Tail Lake. WTD is located on a shallow plateau of the lake floor with an approximate 2 m depth of water. This plateau is located between deeper sections of the lake with water depths of about 12 m.

The downstream side of the dike will be dewatered and the upstream side of the dike will allow a 3.5 m raise of the water level at which time discharge will occur through the South Whale Tail Diversion Channel (SWTDC).

3.1.1 Whale Tail Dike - Design and Construction

Reference to key document for the design and construction of Whale Tail Dike are presented in Table 3-2. Table 3-3 summarise the main design criteria of WTD.

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	Design Report of Whale Tail Dike (SNC, 2018) 6118-E-132-002-TCR-007_651298-2700-4GER-0001_01	..\..\1 – Whale Tale Dike\2- Detailed Engineering\3- Deliverable\1-Design Report\2- Design Report\6118-E-132-002-TCR-007_651298-2700-4GER-0001_00.pdf
	Drawings	Design Report of Whale Tail Dike (SNC, 2018) 651298-2500-4GDD-0000 to 0011	..\..\1 – Whale Tale Dike\2- Detailed Engineering\3- Deliverable\3-Drawings\Final\WTD Final Drawing_Combined.pdf
	Technical Specifications	Technical Specifications for the Construction of Whale Tail Dike (SNC, 2018) 6118-E-132-002-SPT-001_651298-2400-40EF-0001-00	..\..\1 – Whale Tale Dike\2- Detailed Engineering\3- Deliverable\2-Specification\6118-E-132-002-SPT-001_651298-2400-40EF-0001-00_WTD Technical Specs.pdf
	As-built (to come 90 days after end of construction)	NA	NA

Table 3-3 Design criteria for Whale Tail Dike

Use	Water type	Classification (CDA, 2013)	Inflow Design Flood	Water Level (m)		Crest Elevation (m)
				Normal	Design Flood	
Water Retention / Dewatering	Non-contact	High	1/3 between 1000-year and PMF[1]	156.0	157.0	159.0
Note 1: PMF means Probable Maximum Flood						

The construction of Whale Tail Dike started on July 2018 and ended on February 2019. This structure is a zoned rockfill dike with a core composed of a dynamically compacted fine filter. The low permeability element of this structure is a cement-bentonite (CB) cutoff wall consisting of secant piles drilled through the densified fine filter core.

The main highlight of the dike construction are summarised below:

- The South Whale Tail Diversion Channel will reroute the water accumulation on the upstream of the dike. This channel is designed with the same design flood as for Whale Tail Dike and will be built before freshet 2020;
- The dike is made of NPAG and NML material;
- The cutoff wall was constructed through a central zone of granular material referred to as the fine filter zone. A coarse filter zone is provided between the fine filter and the end dumped upstream and downstream rockfill zones;
- 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 strategy the active layer was removed during the summer season in order to reduce expected settlement and the impact of thaw settlement;
- 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;
- A grout curtain was installed where the bedrock was in unfrozen condition. The grout holes were carried out from the crest at a 0.7 m upstream offset from the secant pile wall;

3.2 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, treated water from the Attenuation Pond and from the North-East Sector. Mammoth dike is located across the northeast finger of the Mammoth Lake.

3.2.1 Mammoth Dike – Design and Construction

Reference to key document for the design and construction of Mammoth Dike are presented in Table 3-4. Table 3-5 summarise the main design criteria of Mammoth Dike.

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- Detailed 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- Detailed 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- Detailed Engineering\3-Reporting\2-Specification\6118-E-132-002-SPT-005_651298-5000-4GEF-0001-00_Mammoth Specifications.pdf
	As-built (to come 90 after end of construction)	NA	NA

Table 3-5: Design Criteria for the Mammoth Dike

Use	Water Type	Classification (CDA, 2007/13)	Inflow Design Flood	Water Level (m)		Crest Elevation (m)
				Normal	Design Flood	
Water Retention	Non-Contact	High	1/3 (1,000-PMF)	Low or no water	153.5	155.0

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 consist 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.

The main highlight of the dike construction are summarised below:

- The dike was constructed with NPAG and NL material
- Blasting activity was required for foundation excavation

3.3 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.

3.3.1 WRSF Dike – Design and Construction

Reference to key document for the design and construction of WRSF Dike are presented in Table 3-6. Table 3-7 summarise the main design criteria 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	Design Report of WRSF Dike (SNC, 2018) 6118-E-132-002-TCR-014_651298-6000-40ER-0001_00	..\..\3- WRSF Dike\1-Detailled Engineering\3-Reporting\1-Design Report\651298-6000-40ER-0001_00 GH WRSF Dike Detailed Design.pdf
	Drawings	Design Report of WRSF Dike (SNC, 2018) 511298-6000-4GDD-0000 to 0005	..\..\3- WRSF Dike\1-Detailled Engineering\3-Reporting\3-Drawings\Final\Pages from 651298-6000-40ER-0001_00 GH WRSF Dike Detailed Design_DRAWINGS.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\3-Reporting\2-Specification\6118-E-132-002-SPT-003_651298-6000-4GEF-0001-PB_AEM_MG.PDF
	As-built (to come 90 days after end of construction)	NA	NA

Table 3-7: Design Criteria for the WRSF Dike

Use	Water Type	Classification (CDA, 2014)	Inflow Design Flood	Water Level (m)		Crest Elevation (m)
				Normal	Design Flood	
Runoff storage	Contact	Low	100	155.0	157.8	158.4

The construction of WRSF 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 consist 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.

The main highlight of the dike construction are summarised below:

- The dike is constructed with NPAG and NL material
- Foundation excavation in the key trench area was done in the fall of 2018 to avoid blasting and aggrade frost penetration

3.4 NORTH-EAST DIKE

The North-East Dike (NE) dike is designed to prevent non-contact water from the Nemo Lake watershed from reporting into Whale Tail Pit. The NE Dike is located south of the Whale Tail Pit.

Water from the pond that will be created on the upstream side of the dike will be periodically pumped out and treated for suspended solids prior to being discharged to the environment.

3.4.1 North-East Dike– Design and Construction

Reference to key document for the design and construction of NE Dike are presented in Table 3-8. Table 3-9 summarise the main design criteria of NE Dike.

Table 3-8: Summary of key reference documents for the dikes

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 (to come 90 days after construction)	NA	NA

Table 3-9: Design criteria for NE Dike

Use	Water Type	Classification (CDA, 2014)	Inflow Design Flood	Water Level (m)		Crest Elevation (m)
				Normal	Design Flood	
Runoff storage	Non-contact	Significant	100 – 1000 yr	No water	156.7 (1)	157.5
Note 1: Above this elevation, water is discharged towards Nemo Lake. The integrity of the dike will not be at risk of failure.						

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 consist 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.

The main highlight of the dike construction are summarised below:

- The dike is constructed with NPAG and NL material
- Due to the presence of a hill in the middle of its alignment, the dike is divided into two legs ; the East and West Legs;
- Foundation excavation in the key trench area was done in the fall of 2018 to avoid blasting and aggrade frost penetration

3.5 ATTENUATION POND AND PUMPING INFRASTRUCTURE

The dewatered part of the North Whale Tail basin between the Whale Tail Dike and the Whale Tail Pit is referred as the Whale Tail attenuation pond. All surface contact water from the Whale Tail site are directed in this pond where they are stored prior to being send to the water treatment plant (WTP) and discharged in Mammoth Lake through an approved diffuser. An attenuation pond ramp will be built to allow pumping of the water from the attenuation pond to the WTP

The majority of the water movement on the Whale Tail Project will be done by pumping. Figure 3-2 indicates the position of the attenuation pond and of the pumping infrastructure of the Whale Tail Project.

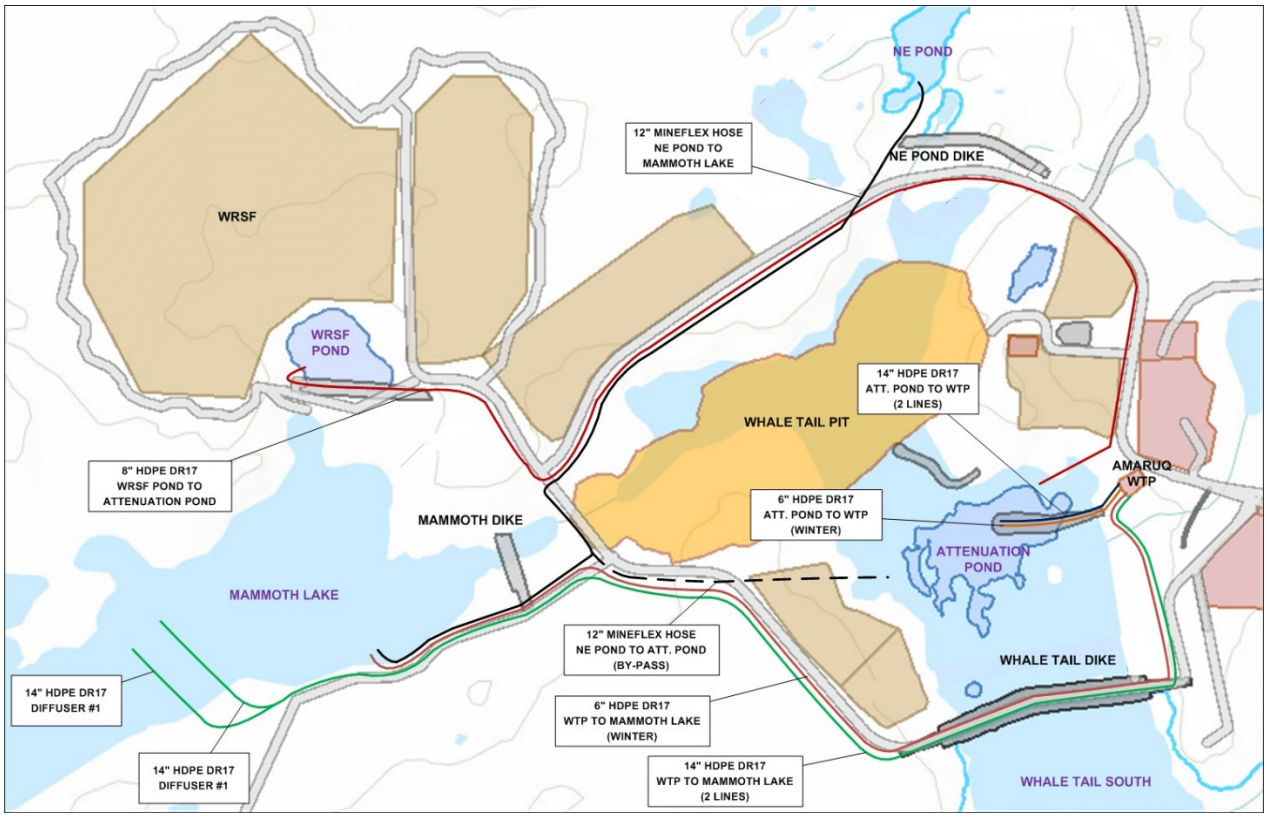

Figure 3-2 :Attenuation Pond and Pumping Infrastructure Layout

Reference to key document for the design and construction of the attenuation pond and pumping infrastructure of the Whale Tail Project are presented in Table 3-10. Reference is also given to the OMM manual of the WTP. A description of the permanent pumping setup installed is given in Table 3-11.

Table 3-10: Key reference documents for attenuation pond and pumping infrastructure

Type of information	Document Reference	Link to Retrieve Document
Detail Engineering Report	Amaruq water management pumping infrastructure (SNC 2018) 651298-8000-40ER-0001_E00	..\..\..\04- Water Management\1- Engineering Study\2- Detailed Engineering Phase 1\5- Deliverable\1- Design Report\3- Detailed Eng Water Management Infra\651298-8000-40ER-0001_E00.pdf
	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- Detailed Eng Water Management Infra
	Mammoth Diffuser (SNC 2018) 611298-8000-40ER-E01	..\..\..\04- Water Management\1- Engineering Study\2- Detailed Engineering Phase 1\5- Deliverable\1- Design Report\4- Diffuser
	Attenuation Pond Ramp	\\Cambfs01\groups\Engineering\05- Geotechnic\14- Amaruq\04- Water Management\1- Engineering Study\2- Detailed Engineering Phase 1\5- Deliverable\1- Design Report\5- Dewatering\Attenuation Pond Ramp Detailed Eng.pdf
Specification & Drawings	Installation Specifications Amaruq 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
OMS manual	Operation & Maintenance Manual Construction Water Treatment Plant (AEM June 2018)	..\..\..\04- Water Management\1- Engineering Study\2- Detailed Engineering Phase 1\5- Deliverable\1- Design Report\1-WTP\653281-0001-40ES-0001_0_OMS WTP.pdf
	ASWTP OMM manual (in progress)	\\Cambfs01\groups\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 pumping infrastructure (to come 90 days after end of construction)	NA	NA

Table 3-11: Characteristic of permanent pumping setup

Pumping Location	Pump and pipe	Description
WRSF Pond to Attenuation Pond	3 Godwin CD103 pumps 8'' HDPE DR11 pipe (800 m) + 8'' HDPE DR17 pipe (6575 m)	Pumping at freshet, pumping rate : 150 m^3/h
Attenuation Pond to AsWTP – Summer	Godwin HL250 pump 8'' HDPE DR17 pipe (900 m)	Total Flow Required : 950 to 1600 m^3/h
AsWTP – Summer to Mammoth Lake	2 Warman FAH pumps 8'' HDPE DR17 pipe (7620 m)	Total Flow Required : 950 to 1600 m^3/h
Attenuation Pond to AsWTP - Winter	Godwin CD103 pump 6'' HDPE DR17 insulated pipe (450 m)	Total Flow Required : 84 to 105 m^3/h
AsWTP – Winter to Mammoth Lake	Godwin CD103 pump 6'' HDPE DR17 insulated pipe (3290 m)	Total Flow Required : 84 to 105 m^3/h
NE Pond to Mammoth Lake/Whale Tail North Basin	Godwin HL250 pump Mineflew O&G, Fibers with an abrasion-resistant Polyurethane material 14'' pipe (4900 m)	Total Flow Required : 500 to 800 m^3/h

3.6 INSTRUMENTATION

The water management infrastructure will be instrumented to continuously monitor performance. In-situ instrumentation is installed within the structure and their foundation (piezometers, thermistors, and inclinometer).

Water levels in the ponds will be monitored by means of a visible staff gauge installed at a strategic location, piezometers and periodic water survey. The staff gauge will show the operational and design flood levels for ease of routine inspection.

Reference document for the instrumentation installed on the water management infrastructure is summarized in Table 3-12. The summary of the instrument installed is summarised in Table 3-13

Table 3-12: Reference documents for instrumentation

Type of Information	Reference Document	Link to retrieve document
Instrumentation campaign as-built (to come 90 days after completion of instrumentation)	AEM	NA
Instruments database (to come 30 days after completion of instrumentation)	AEM	..\..\..\09- Instrumentation\2- Master Instrument List
Instrumentation sheet calibration (to come 30 days after completion of instrumentation)	AEM	\\Cambfs01\groups\Engineering\05-Geotechnic\14- Amaruq\09-Instrumentation\6- Technical Documentation\4- Instrument Sheets (calibration)
Manufacturer data sheet	GKM	\\Cambfs01\groups\Engineering\05-Geotechnic\14- Amaruq\09-Instrumentation\6- Technical Documentation\1- Datasheets (manufacturer spec)
Instrument map and cross-section (to come 30 days after completion of instrumentation)	AEM	\\Cambfs01\groups\Engineering\05-Geotechnic\14- Amaruq\09-Instrumentation\1- Instruments Map

Table 3-13: Instrumentation summary on the water management infrastructure

Structure	Piezometer	Thermistors	Inclinometer	Survey Monument	Staff Gauge
Whale Tail Dike	27	11	4	-	-
Mammoth Dike	-	3	-	-	-
WRSF Dike	-	3	-	-	-
NE Dike	-	-	-	-	-
WRSF Pond	-	-	-	-	1
Attenuation pond	-	-	-	-	1
NE Pond	-	-	-	-	-

SECTION 4 • DEWATERING

The following section outlines the key operational procedure that need to be observed and followed during dewatering in accordance with the performance objective of the dewatering structure. The dewatering phase begins once the pumps start in the whale Tail North and ends while the Whale Tail South seep into the South Whale Tail Diversion Channel.

This section only applies to Whale Tail Dike which separates the Whale Tail Lake into the South basin and the North Basin. The North Basin will be dewatered to allow mining of the Whale Tail pit.

Dewatering of the Whale Tail Basin will occur from February 2019 to May 2019.The approximate volume to be dewatered is 3 Mm³ (SNC, 2018a).

4.1 REFERENCES

Reference to key document for the dewatering of Whale Tail North is presented in Table 4-1.

Table 4-1: Reference documents for Dewatering of Whale Tail North

Type of information	Reference	Link to Retrieve Document
WTD commissioning criteria	SNC 2018	..\..\1 - Whale Tale Dike\4- Dewatering\4- WTD commissioning criteria
Management approval to start dewatering activity of Whale Tail North (to come)	AEM	..\..\1 - Whale Tale Dike\4- Dewatering\4- WTD commissioning criteria
Details Engineering of dewatering infrastructure	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
Whale Tail North dewatering water level vs pumped volume	AEM	..\..\1 - Whale Tale Dike\4- Dewatering\3- Water level vs pumped volume\Whale Tail Dike Monitoring - Dewatering - (Piezo-Survey-Flowmeter).xlsx
Whale Tail North dewatering water movement tracking	AEM	..\..\..\04- Water Management\5- Water Movement\2019
Water Quality Monitoring and Management Plan for Dike Construction and dewatering	AEM 2018	..\..\..\04- Water Management\3- Management Plan\1- 2018\Appendix 8-A.2 Water Quality Monitoring and Management Plan for Dike Con....pdf
Whale Tail North dewatering as built report (to come 90 days after end of dewatering)	NA	NA

4.2 SUMMARY OF PERFORMANCE OBJECTIVE AND OPERATION CONTROL DURING DEWATERING

The performance objective and the operational criteria and control for the Whale Tail North Basin dewatering and the performance of Whale Tail Dike during the dewatering are summarized in Table 4-2.

Table 4-2: Performance objectives and operational criteria during dewatering of Whale Tail North

Ensure that Whale Tail Dike commissioning criteria are met before starting dewatering
• All dike construction activity on WTD has been finished (except the thermal cover that may be constructed after the initiation of the dewatering) and construction deviation have been reconciled • All required instrumentation have been installed and stabilized (SNC, 2019) • Management gave the approvals to start dewatering
Water Management During dewatering
• Freeboard is respected in Whale Tail South • Discharge location is based on established water quality criteria (South Whale Tail Basin or Mammoth Lake) (refer to 60 days' notice document) • Water quality at discharge (TSS) met the approved criteria (refer to water quality management plan and 60 days' notice document) • Water discharge volume is recorded (refer to water movement tracking and 60 days' notice document) • The dewatering system (pump, pipes, dewatering ramp) is operated and maintained as per the defined operating procedure (refer to Whale Tail North Operation procedure) • The water level of Whale Tail North and South is recorded and follow prediction taking into account pumping rate
Surveillance
• Proper surveillance (inspection and data review) of Whale Tail Dike performance occur by a qualified person and is documented during dewatering (refer to section 7) • The performance of Whale Tail Dike during dewatering is reviewed against the threshold for performance criteria and trigger pre-defined actions (refer to Table 4-2)
Other
• Prohibit access to all personnel on Whale Tail North ice during dewatering • Restrict access to the dewatering ramp and Whale Tail Dike to trained personnel only during dewatering activity

4.3 OPERATING PROCEDURE DURING WHALE TAIL NORTH DEWATERING

Table 4-3 below present performance indicator and the pre-defined action (TARP) to be taken if the associated performance criteria deviate from defined range.

Table 4-3: Threshold Criteria and pre-defined action during Dewatering

		Threshold Criteria During Dewatering			
		Green **Normal Operating Range**	**Yellow** **Areas of concern**	**Orange** **High Risk Situation**	**Red** **Emergency Situation**
Criteria and specific action (SA)	Commissioning Criteria of WTD	Required commissioning criteria have been met before initiating dewatering	Dewatering ongoing while required commissioning criteria were partially met but management gave go ahead for dewatering following deviation reconciliation	Dewatering ongoing while required commissioning criteria not met or partially met and no formal go ahead from management to initiate dewatering	NA
	Whale Tail South Elevation	< 153 masl	> 153 and < 154 masl	> 154 and < 157 masl	> 157 masl Core overtopping
	Whale Tail North Elevation	Water level decrease of WT North correlate with estimate level base on pumping	Minor discrepancy between WT North level and estimate level from pumping rate before freshet (<15%)	Significant discrepancy between WT North level and estimate level from pumping rate before freshet (>30 %)	Major discrepancy between WT North level and estimate level from pumping rate before freshet (>50 %) Dike cutoff integrity is compromised
	Water Quality (turbidity)	TSS level below discharge criteria without treatment No sign of turbidity from WTD Dike	TSS level above discharge criteria without treatment Minor sign of turbidity from WTD Dike SA : Discharge to Mammoth through WTP	TSS level above discharge criteria with treatment (non-compliance with Env commitment)	NA
	Sloughing along downstream rockfill embankment face	None visible	Single event observed	More than one events observed	Continued event(s) Dike stability or cutoff integrity is compromised
	Tension crack on the crest (outside cutoff area)	None visible	< 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 or cutoff integrity is compromised
	Tension crack within 3 m each side of the cutoff wall at crest	None visible	or < 0.1 m wide < 0.1 m	> 0.1 m wide and < 0.2 m wide > 0.1 m and < 0.3 m deep	or > 0.2 m wide > 0.3 m deep Dike stability or cutoff integrity is compromised
	Sinkhole on crest	None visible	Localised depression	Sinkhole identified	Development of sinkhole Dike stability or cutoff integrity is compromised
	Cut-off wall lateral cumulative deformation (based on inclinometer)	< 50 mm	Between 50 mm and 100 mm SA: Refer to 7.5.1	> 100 mm	NA
	Cumulative vertical crest movement	None visible	< 0.2 m SA: Apply step in case of instrument measurement outside normal range	> 0.2 m and < 1 m increasing rate of settlement	> 1 m increasing rate of settlement Dike stability or cutoff integrity is compromised
	Pore water pressure (based on piezometers)	Pore water pressure correlate with water level trend during dewatering	Unexplained piezometric trend observed SA: Refer to 7.5.1	Piezometric trends are explained and demonstrate an upset in the structure condition	NA
	Temperature variation along centreline (based on thermistors and piezometers)	Temperature measurement stable, seasonal trend observed	Unexplained thermal trend observed SA: Apply step in case of instrument measurement outside normal range	Thermal trends are explained and demonstrate an upset in the structure condition	NA
	Compliance to the surveillance program of the structure	Inspection done and reviewed at the frequency mentioned in Ch 7 And Instrument monitoring and analysis of data is done, documented and reviewed at the frequency mentioned in Ch 7	Dike inspection is done but not reviewed and documented at the frequency mentioned in Ch 7 Or Monitoring and analysis of data is done, but not documented and reviewed per the frequency mentioned in Ch 7	Dike inspection not done at the frequency mentioned in the OMS Or Monitoring and analysis of data is not done at the frequency mentioned in the OMS	NA
Action Required (general)		• Continue operation, maintenance, surveillance and monitoring as per standard operating procedure	• Identify potential cause • Develop mitigation plan and implement specific action. Use as reference contingency measures for different scenarios proposed (Appendix B) • Increase inspection and instrumentation monitoring frequency as Ch 7 • Implement engineering review	• Decision on stopping dewatering or not • Take appropriate corrective action based on mitigation plan and implement specific action • Increased inspection and instrumentation monitoring frequency as per Ch 7 • Reassess thresholds and conditions for red category (emergency situation)	• Stop dewatering • Implement emergency response plan • Emergency remedial work • Evacuate downstream area
		Take action and notify personnel as per decision framework of Figure 5-2			

SECTION 5 • OPERATIONS

The following section outlines the key operational procedure that need to be observed and followed during operation of the Amaruq water management infrastructure in accordance with the performance objective

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 Pit – Mean Annual Water Balance	Golder (2018) 1789310_204_RPT_Phase2_waterbalance_Rev1	..\..\..\04- Water Management\2- Water Balance\1- 2018\Golder WB_Final\1789310_204_RPT_Phase2_Water Balance_Rev1.pdf
Whale Tail Pit Water Management Plan	V3 – AEM (Oct 2018)	..\..\..\04- Water Management\3- Management Plan\2- 2019\655183-2000-40ER-001-00_WhaleTailPit_WaterMgmtPlan_V3.pdf
Whale Tail Pit Water Quality Model	Golder (2018) 1789310-R-Rev0_SiteWQmodel	\\Cambfs01\groups\Engineering\05-Geotechnic\14- Amaruq\04- Water Management\2- Water Balance\1-2018\Golder WB_Final\1789310-R-Rev 0_SiteWQModel_Nov2018.pdf

5.2 SUMMARY OF PERFORMANCE OBJECTIVE AND OPERATION CONTROL

The performance objective and the operational criteria for the Whale Tail water management infrastructure during operation are summarized in Table 5-2.

Table 5-2: Performance objectives and operational criteria of Whale Tail water management infrastructure

Water Management
• Operational freeboard of each water retention structure must be respected during operation (refer to section 5.2.1) • Water movement must respect the water balance for intake and discharge location (refer to water balance) • Water movement must be tracked and recorded on a monthly basis (volume, origin, destination) • The water management system (pump, pipes, WTP) must be operated and maintained as per the defined operating procedure • Any seepage must be captured by sump and pumped back to allowed location (or naturally report to an approved location)
Water Quality
• All water discharged in the environment must be through an approved diffuser • Water quality at discharge met the approved criteria (refer to water management plan) • Water quality forecast data is used to make informed water management strategy decision • Water quality and quantity of seepage water is monitored
Surveillance
• Proper surveillance (inspection and data review) of Whale Tail Dike performance occur and is documented during dewatering (refer to section 7) • The performance of Whale Tail Dike during dewatering is reviewed against the threshold for performance criteria and trigger pre-defined actions (refer to Table 5-4 to 5-8)

5.2.1 Freeboard

The minimum freeboards for the Whale Tail water management infrastructure are contained within the design report of each infrastructure and are summarized in Tables 5-3.

Note that AP-5 is related to underground water management which is out of scope of this manual. However as long as the water quality of AP-5 met criteria for discharge it will be discharged on an annual basis to Mammoth Lake through an approved diffuser.

Table 5-3: Water Elevation During Operation

Location	Maximum Water Level		
	Normal Operating level	Design Flood Event	Related water retaining structure Dike Crest Elevation (m)
Whale Tail South	156	157	159
Mammoth Lake	152.5	153.5	155
WRSF Pond	155.4	157.8	158.4
NE Pond	155.5	156.7	157.5
Whale Tail Attenuation Pond	142	145.5	NA
AP-5	153.5	155	NA

5.2.2 Seepage Management

If seepage is observed through a water management structure, a system of collection ditch and sump will be constructed at the downstream toe of the structure to capture the seepage into a contact water retention pond. The water quality will be monitored and it will be directed to the attenuation pond or pump back on the upstream side of the structure base on its quality.

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

The quantity and quality of each seepage from a water management infrastructure has to be monitored as per the requirement of section 7.

5.3 WATER MANAGEMENT

The water management strategy for the Whale Tail Project can be found in the water balance. A schematic version of the water movement strategy is summarised in Figure 5-1.

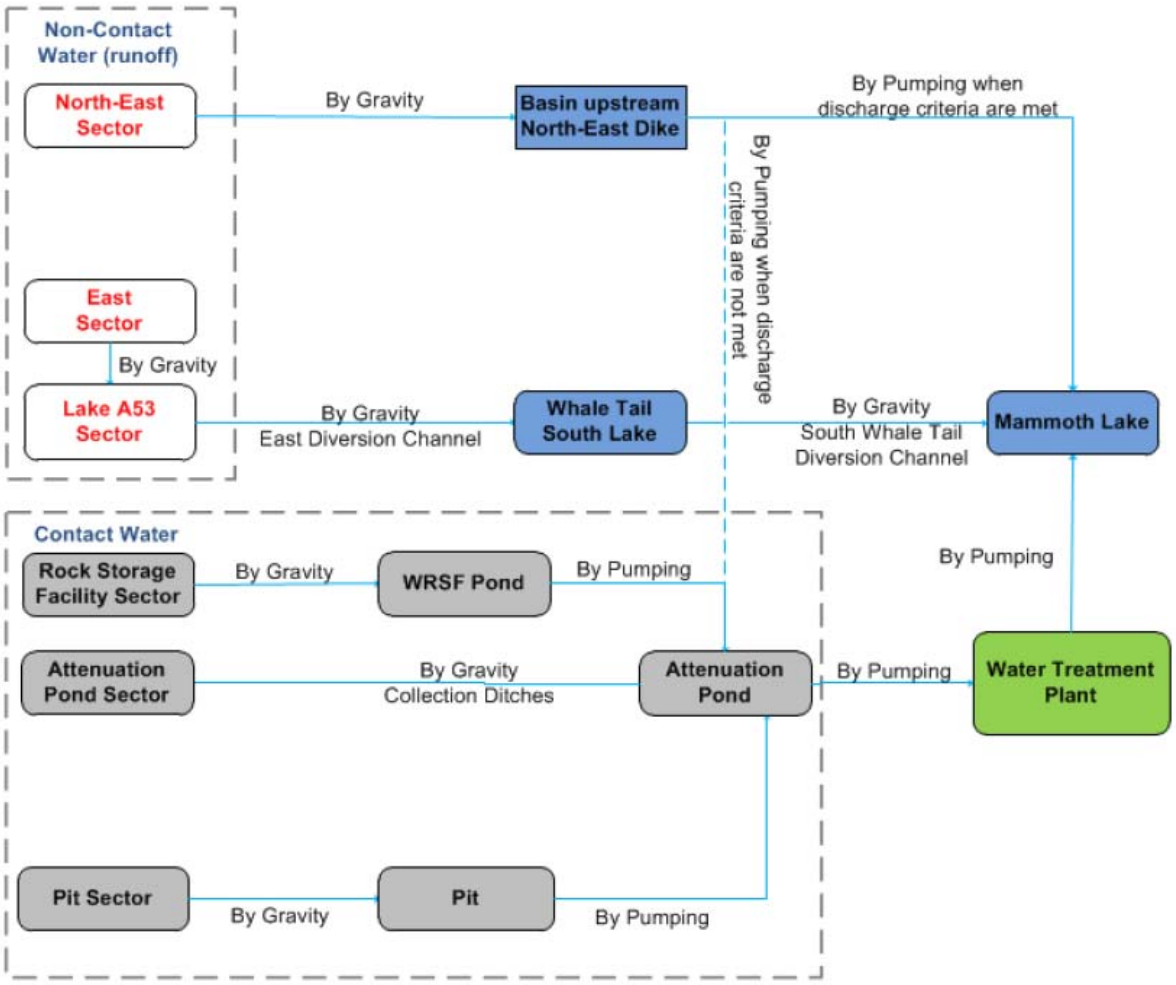

Figure 5-1: Flow Diagram of the Water Management Infrastructures (2019-2022)

5.4 OPERATING PROCEDURE DURING OPERATION OF WHALE TAIL WATER MANAGEMENT INFRASTRUCTURE

Table 5-4 to 5-8 below present performance indicator for each water management infrastructure and the Triger Action Response Plan (TARP) if the associated performance criteria deviate from defined range.

Table 5-4: Threshold Criteria and pre-defined action during operation of Whale Tail Dike

		Threshold Criteria During Operation			
		Green **Normal Operating Range**	**Yellow** **Areas of concern**	**Orange** **High Risk Situation**	**Red** **Emergency Situation**
Criteria and specific action (SA)	Whale Tail South Elevation (dike freeboard)	Normal operation range : < 156 masl	> 156 to < 156.5 m	> 156.5 to < 157 m	> 157 masl Core or crest overtopping
	Seepage to manage	Within design parameter < 2 000 m3 day and managed by pumping	Inflow higher than design parameter but manageable with a pumping capacity (FOS > 2) or Storage and discharge of this seepage is manageable without modifying water management strategy or Sudden or cumulative increase < 25 % in over 3 days	Inflow higher than design parameter and at the limit of the pumping capacity (FOS >1 and <2) or Storage and discharge of this seepage is manageable for the moment but cannot be sustained without modifying the water management strategy SA: increase pumping capacity & re-assess discharge and storage strategy	Inflow is unmanageable with pumping capacity (FOS < 1) or No more capacity on site for storage and discharge of this seepage water
	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	NA
	Sloughing along downstream rockfill embankment face and downstream toe	None visible	Single event observed	More than one events observed	Continued event(s) Dike stability or cutoff integrity is compromised
	Tension crack on the crest (outside cutoff area)	None visible	< 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	or < 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	or > 0.2 m wide > 0.3 m deep Cutoff integrity is compromised
	Sinkhole on crest	None visible	Localised depression > 5 m outside from centreline	Sinkhole identified	Development of sinkhole Dike stability or cutoff integrity is compromised
	Cut-off wall lateral cumulative deformation (based on inclinometer)	< 50 mm	Between 50 mm and 100 mm SA: Refer to 7.5.1	> 100 mm	NA
	Cumulative vertical crest movement	None visible	< 1 m or Stable trend SA: Refer to 7.5.1	> 1 m with increasing rate of settlement	> 2 m with increasing rate of settlement Dike stability or cutoff integrity is compromised
	Pore water pressure (based on piezometers)	Pore water pressure correlate with water level trend during dewatering	Unexplained piezometric trend observed SA: Refer to 7.5.1	Piezometric trends are explained and demonstrate an upset in the structure condition	NA
	Temperature variation along centreline (based on thermistors and piezometers)	Temperature measurement stable, seasonal trend observed	Unexplained thermal trend observed SA: Apply step in case of instrument measurement outside normal range	Thermal trends are explained and demonstrate an upset in the structure condition	NA
	The surveillance program of the structure is followed	Inspection done and reviewed at the frequency mentioned in Ch 7 And Instrument monitoring and analysis of data is done, documented and reviewed at the frequency mentioned in Ch 7	Dike inspection is done but not reviewed and documented at the frequency mentioned in Ch 7 Or Monitoring and analysis of data is done, but not documented and reviewed per the frequency mentioned in Ch 7	Dike inspection not done at the frequency mentioned in the OMS Or Monitoring and analysis of data is not done at the frequency mentioned in the OMS	NA
Action Required (general)		• Continue operation, maintenance, surveillance and monitoring as per standard operating procedure	• Identify potential cause • Develop mitigation plan and implement specific action. Use as reference contingency measures for different scenarios proposed (See Appendix B) • Increase inspection and instrumentation monitoring frequency as per Ch 7 • Implement engineering review	• Restrict access to Whale Tail Dike crest • Take appropriate corrective action based on approved mitigation plan and specific action. • Increase inspection and instrumentation monitoring frequency as per Ch 7 • Reassess thresholds and conditions for red category (emergency situation) taking into account the changing conditions presently observed and interactions of various items.	• Evacuate Whale Tail Pit • Close access to Whale Tail Dike crest • Implement emergency response plan
		Take action and notify personnel as per decision framework of Figure 5-2			

Table 5-5: Threshold Criteria and pre-defined action during operation of Mammoth Dike

		Threshold Criteria During Operation			
		Green **Normal Operating Range**	**Yellow** **Areas of concern**	**Orange** **High Risk Situation**	**Red** **Emergency Situation**
Criteria and specific action (SA)	Mammoth Lake elevation (dike freeboard)	Normal operation range : < 152.5 masl	Design flood range : > 152.5 and < 153.5 masl	> 153.5 masl without crest overtopping	Crest overtopping
	Seepage through dike	Within design parameter < 300 m3 day and managed by pumping	Inflow higher than design parameter but manageable with current pumping capacity (FOS > 2) or Storage and discharge of this seepage is manageable without modifying water management strategy or Sudden or cumulative increase < 25 % in over 3 days	Inflow higher than design parameter and at the limit of the current pumping capacity (FOS >1 and <2) or Storage and discharge of this seepage is manageable for the moment but cannot be sustained without modifying the water management strategy SA: increase pumping capacity & re-assess discharge and storage strategy	Inflow is unmanageable with pumping capacity (FOS < 1) or No more capacity on site for storage and discharge of this seepage water
	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	NA
	Sloughing along downstream rockfill embankment face and downstream toe	None visible	Single event observed	More than one events observed	Continued event(s) Dike stability is compromised
	Tension crack on the crest	None visible	< 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
	Sinkhole on crest	None visible	Localised depression	Sinkhole identified	Development of sinkhole Dike stability is compromised
	Cumulative vertical crest movement	None visible	< 1 m or Stable trend SA: Refer to 7.5.1	> 1 m with increasing rate of settlement	> 2 m with increasing rate of settlement Dike stability is compromised
	Temperature variation (based on thermistors)	Temperature measurement stable, seasonal trend observed	Unexplained thermal trend observed SA: Apply step in case of instrument measurement outside normal range	Thermal trends are explained and demonstrate an upset in the structure condition	NA
	The surveillance program of the structure is followed	Inspection done and reviewed at the frequency mentioned in Ch 7 And Instrument monitoring and analysis of data is done, documented and reviewed at the frequency mentioned in Ch 7	Dike inspection is done but not reviewed and documented at the frequency mentioned in Ch 7 Or Monitoring and analysis of data is done, but not documented and reviewed per the frequency mentioned in Ch 7	Dike inspection not done at the frequency mentioned in the OMS Or Monitoring and analysis of data is not done at the frequency mentioned in the OMS	NA
Action Required (general)		• Continue operation, maintenance, surveillance and monitoring as per standard operating procedure	• Identify potential cause • Develop mitigation plan and implement specific action. Use as reference contingency measures for different scenarios proposed (See Appendix B) • Increase inspection and instrumentation monitoring frequency as Ch 7 • Implement engineering review	• Restrict access to Mammoth Dike crest • Take appropriate corrective action based on approved mitigation plan. • Increase inspection and instrumentation monitoring frequency as per Ch 7 • Reassess thresholds and conditions for red category (emergency situation) taking into account the changing conditions presently observed and interactions of various items.	• Evacuate Whale Tail Pit • Close access to Mammoth Dike crest • Implement emergency response plan
		Take action and notify personnel as per decision framework of Figure 5-2			

Table 5-6: Threshold Criteria and pre-defined action during operation of WRSF Dike

		Threshold Criteria During Operation			
		Green **Normal Operating Range**	**Yellow** **Areas of concern**	**Orange** **High Risk Situation**	**Red** **Emergency Situation**
Criteria and specific action (SA)	WRSF Pond elevation (dike freeboard)	Normal operation range : < 155.4 masl	Design flood range : > 155.4 and < 157.8 masl	> 157.8 masl without crest overtopping	Crest overtopping
	Seepage through dike	Within design parameter < 300 m3 day and managed by pumping	Inflow higher than design parameter but captured in sump and manageable with current pumping capacity (FOS > 2) or Storage and discharge of this seepage is manageable without modifying water management strategy or Sudden or cumulative increase < 25 % in over 3 days	Inflow higher than design parameter but captured in sump and managed with a limited pumping capacity (FOS >1 and <2) or Storage and discharge of this seepage is manageable for the moment but cannot be sustained without modifying the water management strategy SA: increase pumping capacity & re-assess discharge and storage strategy	Inflow is unmanageable with pumping capacity (FOS < 1) Or No more capacity on site for storage and discharge of this seepage water
	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	NA
	Sloughing along downstream rockfill embankment face and downstream toe	None visible	Single event observed	More than one events observed	Continued event(s) Dike stability is compromised
	Tension crack on the crest	None visible	< 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
	Sinkhole on crest	None visible	Localised depression	Sinkhole identified	Development of sinkhole Dike stability is compromised
	Cumulative vertical crest movement	None visible	< 1 m or Stable trend SA: Refer to 7.5.1	> 1 m with increasing rate of settlement	> 2 m with increasing rate of settlement Dike stability is compromised
	Temperature variation (based on thermistors)	Temperature measurement stable, seasonal trend observed	Unexplained thermal trend observed SA: Apply step in case of instrument measurement outside normal range	Thermal trends are explained and demonstrate an upset in the structure condition	NA
	The surveillance program of the structure is followed	Inspection done and reviewed at the frequency mentioned in Ch 7 And Instrument monitoring and analysis of data is done, documented and reviewed at the frequency mentioned in Ch 7	Dike inspection is done but not reviewed and documented at the frequency mentioned in Ch 7 Or Monitoring and analysis of data is done, but not documented and reviewed per the frequency mentioned in Ch 7	Dike inspection not done at the frequency mentioned in the OMS Or Monitoring and analysis of data is not done at the frequency mentioned in the OMS	NA
Action Required (general)		• Continue operation, maintenance, surveillance and monitoring as per standard operating procedure	• Identify potential cause • Develop mitigation plan and implement specific action. Use as reference contingency measures for different scenarios proposed (See Appendix B) • Increase inspection and instrumentation monitoring frequency as Ch 7 • Implement engineering review	• Restrict access to WRSF Dike crest • Take appropriate corrective action based on approved mitigation plan. • Increase inspection and instrumentation monitoring frequency as per Ch 7 • 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
		Take action and notify personnel as per decision framework of Figure 5-2			

Table 5-7: Threshold Criteria and pre-defined action during operation of NE Dike

		Threshold Criteria During Operation			
		Green **Normal Operating Range**	**Yellow** **Areas of concern**	**Orange** **High Risk Situation**	**Red** **Emergency Situation**
Criteria and specific action (SA)	NE Pond elevation (dike freeboard)	Normal operation range : < 155.5	Design flood range :>155.5 and < 156.7 masl	> 156.7 masl without crest overtopping	Crest overtopping
	Seepage through dike	Within design parameter < 300 m3 day and managed by pumping	Inflow higher than design parameter but captured in sump and manageable with current pumping capacity (FOS > 2) or Storage and discharge of this seepage is manageable without modifying water management strategy or Sudden or cumulative increase < 25 % in over 3 days	Inflow higher than design parameter but captured in sump and managed with a limited pumping capacity (FOS >1 and <2) or Storage and discharge of this seepage is manageable for the moment but cannot be sustained without modifying the water management strategy SA: increase pumping capacity & re-assess discharge and storage strategy	Inflow is unmanageable with pumping capacity (FOS < 1) Or No more capacity on site for storage and discharge of this seepage water
	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	NA
	Sloughing along downstream rockfill embankment face and downstream toe	None visible	Single event observed	More than one events observed	Continued event(s) Dike stability is compromised
	Tension crack on the crest	None visible	< 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
	Sinkhole on crest	None visible	Localised depression	Sinkhole identified	Development of sinkhole Dike stability is compromised
	Cumulative vertical crest movement	None visible	< 1 m or Stable trend SA: Refer to 7.5.1	> 1 m with increasing rate of settlement	> 2 m with increasing rate of settlement Dike stability is compromised
	The surveillance program of the structure is followed	Inspection done and reviewed at the frequency mentioned in Ch 7 And Instrument monitoring and analysis of data is done, documented and reviewed at the frequency mentioned in Ch 7	Dike inspection is done but not reviewed and documented at the frequency mentioned in Ch 7 Or Monitoring and analysis of data is done, but not documented and reviewed per the frequency mentioned in Ch 7	Dike inspection not done at the frequency mentioned in the OMS Or Monitoring and analysis of data is not done at the frequency mentioned in the OMS	NA
Action Required (general)		• Continue operation, maintenance, surveillance and monitoring as per standard operating procedure	• Identify potential cause • Develop mitigation plan and implement specific action. Use as reference contingency measures for different scenarios proposed (See Appendix B) • Increase inspection and instrumentation monitoring frequency as Ch 7 • Implement engineering review	• Restrict access to NE Dike crest • Take appropriate corrective action based on approved mitigation plan. • Increase inspection and instrumentation monitoring frequency as per Ch 7 • Reassess thresholds and conditions for red category (emergency situation) taking into account the changing conditions presently observed and interactions of various items.	• Evacuate Whale Tail Pit • Implement emergency response plan
		Take action and notify personnel as per decision framework of Figure 5-2			

Table 5-8: Threshold Criteria and pre-defined action during operation of Attenuation Pond and Pumping Infrastructure

		Threshold Criteria During Operation			
		Green **Normal Operating Range**	**Yellow** **Areas of concern**	**Orange** **High Risk Situation**	**Red** **Emergency Situation**
Criteria and specific action (SA)	Attenuation Pond elevation (storage capacity)	Normal operation range : < 142	Maximum operating range :>142 and < 145 masl	> 145 masl without overflowing in pit	Pit crest overflow
	Tension cracks on the attenuation pond ramp	None visible	< 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	< 0.2 m SA: Apply step 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
	Water movement (pumping) follow the Water Balance	Water movement (origin / destination) follow the current water balance and Elevation of each pumping point is within the predicted range of the water balance	The water management data show that the water balance strategy of the water balance is not sustainable from a storage / discharge point of view SA: Modify the water balance and re-assess water management strategy	Water movement (origin/destination) cannot follow water balance due to operational constraint (i.e. capacity, water quality, water treatment)	Water cannot be stored / discharge from the Whale Tail site. The water balance is not applicable SA : Flood underground ramp
	Water movement (pumping) are recorded for volume, origin and destination	Water movement data are read and recorded at the specified frequency of the OMS	Water movement data are read on a non-compliant frequency and there are gap in the data	Water movement data are not read or recorded at the specified frequency of the OMS	NA
	Water quality in the receiving environment and at discharge	Water quality at discharge met receiving environment criteria and Water quality of the receiving environment follow water quality forecast	Water quality at discharge met receiving environment criteria And Water quality of the receiving environment show a trend that water quality is deteriorating higher than the forecast SA : Review diffuser and WTP performance	Water quality at discharge does not met receiving environment criteria SA : stop discharge SA : Review WTP performance	Water quality of the receiving environment no longer allow discharge (no more discharge allowable) SA : Flood underground ramp
	Water quality data is used to make informed water management decision	Water quality data is integrated within the water balance to make informed water movement strategy	Water quality data is not taken into account while deciding water movement	NA	NA
Action Required (general)		• Continue operation, maintenance, surveillance and monitoring as per standard operating procedure	• Identify potential cause • Develop mitigation plan and implement specific action. Use as reference contingency measures for different scenarios proposed (See Appendix B) • Increase inspection and instrumentation monitoring frequency as Ch 7 • Implement engineering review	• Take appropriate corrective action based on approved mitigation plan. • Increase inspection and instrumentation monitoring frequency as per Ch 7 • Reassess thresholds and conditions for red category (emergency situation) taking into account the changing conditions presently observed and interactions of various items.	• Evacuate Whale Tail pit • Implement emergency response plan
		Take action and notify personnel as per decision framework of Figure 5-2			

5.5 COMMUNICATION AND DECISION MAKING

Figure 5-2 indicates the communication and decision process when the threshold criteria are met and when pre-defined action need to be implemented.

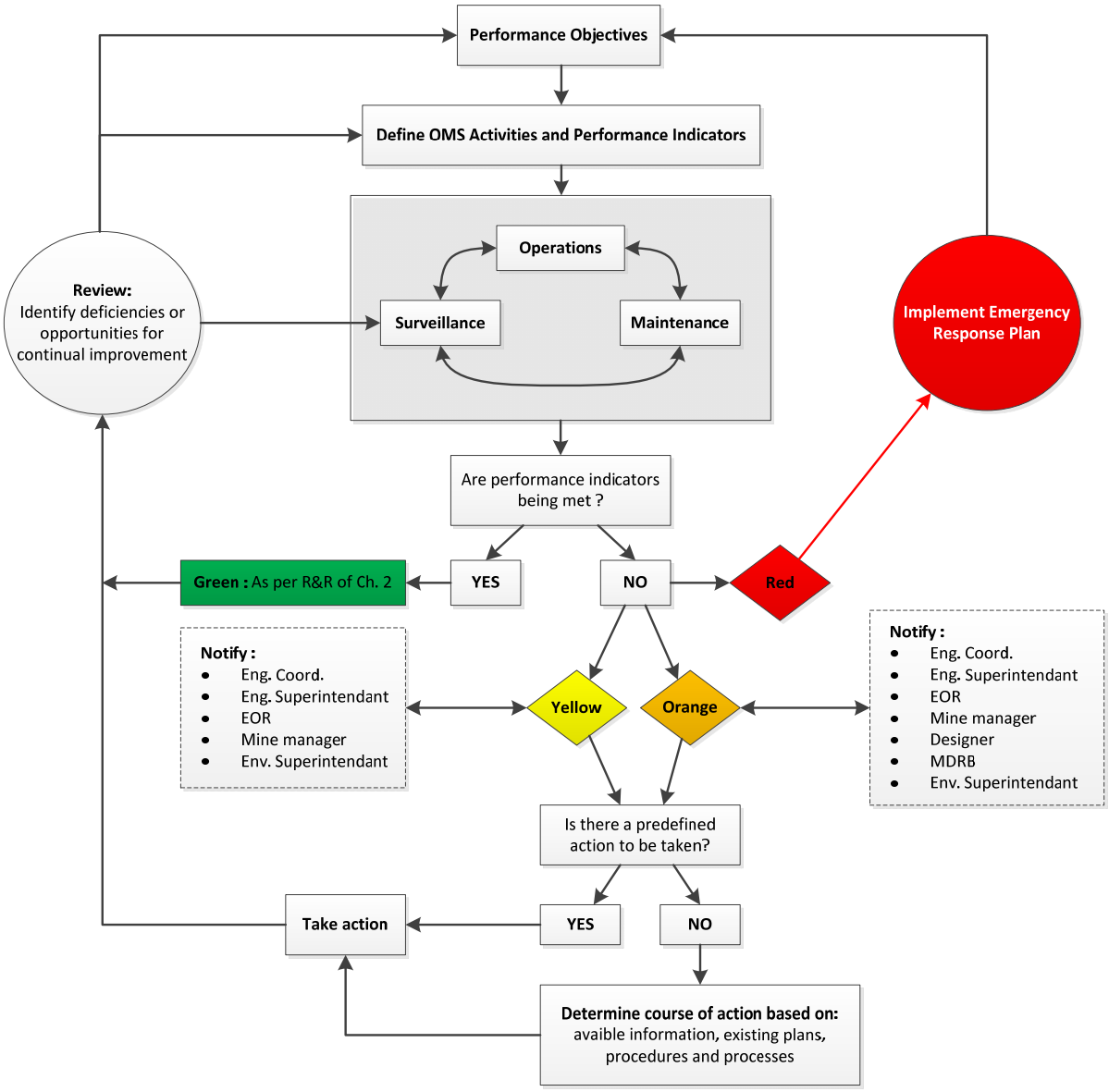

Figure 5-2: Communication and Decision Process for Water Management Infrastructure TARP

SECTION 6 • MAINTENANCE

This section identifies all infrastructures within the scope of this manual that has 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 maintenance is planned, recurring maintenance activities conducted at a fixed or approximate frequency and not typically arising from results of surveillance activities. Examples of such maintenance include calibration and maintenance of surveillance equipment or regularly changing oil on a pump as per manufacturer's requirement.

Predictive maintenance is pre-defined maintenance 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

Reference to key document for the maintenance of the Whale Tail water management infrastructure is 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 (to come)	In progress
Maintenance log of pumping equipment	\\CAMBFS01\Public\MAINTENANCE\G dore\PWA-COM-LGT hrs reading.xlsx \\Cambfs01\groups\EnergyInfra\08-PowerHouse\2 EQUIPMENT\2 GENERATORS
Maintenance log of geotechnical instrumentation (to come)	In progress
Pump allocation tool	..\..\..\04- Water Management\4- Water Management Infrastucture\3- 2019\1 - Planning\9-Procurement\Pump Allocation\AMQ Pump Allocation 2019-2020.pptx
Geotechnical instrument & Datalogger inventory	In progress

6.3 COMPONENT OF THE WATER MANAGEMENT INFRASTRUCTURE REQUIRING MAINTENANCE

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

Table 6-2: Component of the water management infrastructure requiring maintenance

Water Management Infrastructure
• Dike embankment (i.e. repair erosion) • Dike crest (i.e. fill inactive tension cracks) • 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 monument) • Data acquisition system • Flowmeter
Other
• Dike crest access road • Access to sump

6.3.1 Maintenance component that are 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 these 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 possesses activities as well as a trigger for that maintenance and a person responsible for this activity. It is the person responsible for the maintenance activity to ensure that the person doing the maintenance has the qualifications and competency required to conduct the maintenance and is following the proper safety procedure. The responsible person must also ensure that the proper documentation and reporting requirement are followed.

Table 6-3 :Description of maintenance activity for component of water management infrastructure

Component	Type of maintenance	Nature of the activity	Frequency of maintenance (preventative) OR Trigger of maintenance (predictive and corrective)	Responsible for the activity	Documentation Required	Reporting Requirement
Water Management Infrastructure						
Dike embankment Attenuation pond ramp repair erosion	Corrective	Gullies and depression to be filled with rockfill and re-sloped	Following a demand from engineering superintendent following a visual inspection showing erosion	Mine Superintendent (can use a contractor alternatively)	Photo of remediation work	Engineering to update the maintenance log of the structure
Dike crest / Attenuation pond ramp – fill inactive tension cracks	Corrective	Inactive tension cracks to be filled with bentonite to prevent widening due to water infiltration	Following a demand from engineering superintendent following a visual inspection showing inactive tension cracks	Geotechnical technician	Photo of remediation work	Engineering to update the maintenance log of the structure
Dike crest / Attenuation pond ramp compensate settlement	Corrective	Add rockfill to increase the height of the dike following observation of settlement	Following a demand from engineering superintendent following a visual inspection showing settlement that need to be compensated (i.e. loss of freeboard)	Mine Superintendent (can use a contractor alternatively)	Photo of remediation work Surveying of remediation work	Engineering to update the maintenance log of the structure and provide surveying
Seepage collection sump– increase volume	Predictive	Excavate an additional sump or increase the capacity of an existing sump	Following a demand from engineering superintendent following a re-assessment of the sump capacity	Mine Superintendent (can use a contractor alternatively)	Photo of remediation work Surveying of remediation work	Engineering to update the maintenance log of the structure and provide surveying
Seepage collection sump – reprofile sump	Corrective	Excavate flatter slope for the sump or add material against the slope to reprofile them	Following a demand from engineering superintendent following a visual inspection showing instable sump slope	Mine Superintendent (can use a contractor alternatively)	Photo of remediation work	Engineering to update the maintenance log of the structure and provide surveying
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. Demand will be formulated by the Engineering Superintendent	Energy & Infrastructure Superintendent	Photo of remediation work	Engineering to update the maintenance log of the structure
Ditches – clean debris and sediment accumulation	Corrective	Remove any debris and accumulation of sediment that can hinder flow	Following a demand from engineering superintendent following a visual inspection showing accumulation of debris and sediment	Energy & Infrastructure Superintendent	Photo of remediation work	Engineering 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 demand from engineering superintendent following a visual inspection showing erosion of the ditches	Energy & Infrastructure Superintendent	Photo of remediation work	Engineering 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 the ditches using pump	Following a demand from the environment superintendent following sampling of a high turbidity event from the diches	Environment Superintendent	Water sample results Photo of remediation work	Engineering to update the maintenance log of the structure
Pumping infrastructure						
Pumps and Genset – maintenance as per manufacturer specification	Preventative	Do PM on the pumping unit as per manufacturer recommendation	As per manufacturer specification	Pump mechanics	Equipment log Maintenance record	Maintenance to update the pump maintenance log or Genset maintenance log
Pumps and Genset – maintenance when deficiencies are observed (cavitation, breakdown, electrical trouble)	Corrective	Troubleshoot the pump problem so that it is once again operational	When the E&I Superintendent ask that a pump be fixed following a visual inspection of deficiencies	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 new pump is received on site that will be used in winter	Maintenance superintendent	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	Energy & Infrastructure Superintendent	-	-
Pipe – unfreezing a line	Corrective	Steaming the line to unfreeze it in winter	When the E&I Superintendent ask that a line be unfroze following visual inspection of a frozen line	Energy & Infrastructure Superintendent	-	-
Pipe – maintenance when deficiencies are observed (leak, pipe burst)	Corrective	Replacing a deficient part of a line with new pipe	When the E&I Superintendent ask that a line be repaired following visual inspection of pipe deficiency	Energy & Infrastructure Superintendent	-	-
Surveillance						

Component	Type of maintenance	Nature of the activity	Frequency of maintenance (preventative) OR Trigger of maintenance (predictive and corrective)	Responsible for the activity	Documentation Required	Reporting Requirement
Geotechnical Instrument – loss of reading	Corrective	Investigate the status of an instrument who no longer gave data	When an instrument no longer gave data for an unknown reason	Geotechnical technician	Update status in instrument database	Update of the geotechnical instrument database by the geotechnical technician
Geotechnical instrument – unusual reading	Corrective	Investigate the status of an instrument who gave unusual data	When an instrument gave an unusual data	Geotechnical technician	Update status in instrument database	Update of the geotechnical instrument database by the geotechnical technician
Geotechnical instrument – replacement	Corrective	Replace an instrument that no longer work	When the engineering superintendent as for a geotechnical instrument to be replaced	Geotechnical technician	Instrument installation as-built report Update spare inventory Calibration sheet Initial instrument reading	Update of the geotechnical instrument database by the geotechnical technician
Geotechnical instrument –calibration of total station	Preventative	Send the total station to be calibrated	yearly	Geotechnical technician	Calibration sheet	Update of the geotechnical instrument database by the geotechnical technician
Geotechnical instrument –calibration of inclinometer probe	Preventative	Send the inclinometer probe to be calibrated	yearly	Geotechnical technician	Calibration sheet	Update of the geotechnical instrument database by the geotechnical technician
Datalogger – maintenance	Preventative	Do maintenance of datalogger as per manufacturer specification	yearly	Geotechnical technician	Maintenance report	Update of the geotechnical instrument maintenance log by the geotechnical technician
Datalogger – battery change	Predictive	Change battery when the battery level alarm get triggered	When the battery alarm is triggered in VDV	Geotechnical technician	Maintenance report	Update of the geotechnical instrument maintenance log by the geotechnical technician
Datalogger – troubleshooting	Corrective	Repair of a dataloger deficiency	When a dataloger is suspected of being deficient	Geotechnical technician	Update status in instrument database	Update of the geotechnical instrument maintenance log by the geotechnical technician
Flowmeter – calibration	Preventative	Send the flowmeter to be calibrated	yearly	Energy & Infrastructure Superintendent	Calibration sheet	Update of the geotechnical instrument maintenance log by the geotechnical technician
Flowmeter – deficient reading	Corrective	Repair of a flowmeter deficiency	When the Engineering Superintendent ask that a flowmeter be troubleshoot based on irregular data	Energy & Infrastructure Superintendent	Update status in instrument database	Update of the geotechnical instrument database by the geotechnical technician
Other						
Dike crest access	Predictive	Snow clearing, maintaining roadway, grading access	As required to maintain access	Mine Superintendent	-	-
Access to sump	Predictive	Snow clearing, maintaining roadway, grading access	As required to maintain access	Mine Superintendent	-	-

SECTION 7 • SURVEILLANCE

Surveillance Involves the inspection and monitoring (i.e. collection of qualitative and quantitative observation and data) of activities related to water management infrastructures. Surveillance also includes the timely documentation, analysis and communication of surveillance results, to inform decision making and verify whether performance objective including critical controls are being met.

There are two types of surveillances activities which are further discussed in this chapter:

- Site observation and inspection
- Instrument monitoring

7.1 REFERENCE

Reference to key document for site observation & inspection of the Whale Tail water management infrastructure is presented in Table 7-1. Reference to key document for instrument monitoring is presented in Table 7-2.

Table 7-1: Key reference documents for Inspection of Whale Tail water management infrastructure

Type of information	Document #	Document Title and link
Simplified inspection form Template	-	OMS manual - Appendix A
Detailed visual inspection form template	-	OMS manual – Appendix A
Whale Tail Dike Dewatering inspection report		..\..\1 - Whale Tale Dike\4- Dewatering\1- Dewatering Inspection
Whale Tail Dike inspection report	WTD-VIR	..\..\1 - Whale Tale Dike\5 - Operation\1- Inspection
Mammoth Dike inspection report	MD-VIR	..\..\2- Mammoth Dike\4-Operation\1- Inspection\2019
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
Attenuation pond and piping infrastructure inspection report	Dewatering Infrastructure -VIR	..\..\..\04- Water Management\6- Inspection
Annual dike safety inspection (annual geotechnical inspection)	-	..\..\..\10- Audit & External Inspection\2- Annual Geotech Inspection

Table 7-2: Reference documents for Instrument monitoring of Whale Tail water management infrastructure

Type of information	Link to Retrieve Information
Surveillance signoff log of Whale Tail water management infrastructure	..\..\..\..\10-Inspection\Inspection Signoff
Dewatering monitoring Report	..\..\1 - Whale Tale Dike\4- Dewatering\2- Dewatering Report
Geotechnical Instruments map (to come 30 days after instrumentation campaign)	-
Access to instrument data (restricted access)	http://cambeng1/
Instrumentation Report	..\..\7 - Instrumentation Report
Water Quality Result database (restricted access)	https://gim.golder.com/Agnico/
Blast vibration log	\\Cambfs01\groups\Engineering\05-Geotechnic\14-Amaruq\01 - Dewatering Dikes\1 - Whale Tale Dike\7 - Instruments\2- Instrument Data

7.2 SITE OBSERVATIONS AND INSPECTIONS

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

Site observation and inspections are used to identify and track visible change in the condition of the water management infrastructure. Changes that may be observed throughout site observations and inspections are included in Table 7-3

Table 7-3: Changes that may be observed through site observation and inspection of 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. bulge, cracks, sinkhole, sloughing, settlement) • Newly form 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 form or expanding areas of erosion • Newly form of obstruction to flow (i.e. boulder, sediments, snow) • Newly form of slope instability
Changes related to water storage and transport
• Change in sump level • Verify using the staff gauge that the pond is operated within its normal operating condition • Changes in the seepage quantity (pumping rate) and quality (turbidity) • Condition of pipe for water transport • Sign of leaks from water line • Condition of pumps
Change related to surveillance instrumentation
• Condition of surveillance instruments and associate protection around instruments (i.e. cover, barriers to prevent vehicle damage) • Condition of power supplies for instruments (i.e. solar panel) • Condition of communication infrastructure associated with instruments (i.e. antenna, datalogger)

7.2.1 Site observation

Site observation is conducted by personnel working on or adjacent to water management infrastructure as part of their daily activities, maintaining awareness of the facility in the course of carrying their duties. Trained personnel such as geotechnical technician should be on the lookout for sign of changing condition as indicated in Table7-3 as adverse condition can develop rapidly between inspections. A simplified visual observation form can be used to document such observations but they do not need to be documented unless a new condition has been observed. Any new observation should be documented by photograph and reported to the geotechnical personnel or Engineering Superintendent.

7.2.2 Inspection program

Inspections are conducted by the engineering 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 inspection, dike safety inspection and dam safety review. The following sub-section describe in more details the scope, frequency and responsible for each type of inspection.

7.2.2.1 Routine Visual Inspection

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 inspection need to cover the aspect described in Table 7-2. Of particular significance are new occurrences or noted changed in seepage, erosion, sinkholes, boils, slope slumping, settlement, displacement, or cracking of structure components. These inspections are held during dewatering and operation.

There are two approved inspection form for inspection; a simplified one and a detailed one. The detailed form should be used for monthly inspection while the simplified one can be used when inspection are required at an increased frequency. All area of the form must be filled.

The person responsible for the inspection must:

- Do the inspection as per the required frequency
- Fill all information on the proper inspection form
- Take picture 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. Photos should be annotated or captioned and should include a date stamp.
- Store electronically all photo and inspection form
- Update the surveillance log
- Ensure that the reviewer is aware that the document is ready to be reviewed

During the review process, the reviewer must:

- Ensure that all require information is present
- Ensure that the observation does not trigger a change in alert level
- Sign the inspection form as a reviewer
- Update the surveillance log
- Distribute the inspection results

The frequency for inspection of a structure will vary based on its TARP level and need to be updated in the surveillance log.

Table 7-4 summarise the Routine & Special visual inspection R&R, suggested frequency and scope in function of the alert level of the structure

Table 7-4 : Summary of routine inspection requirements

Structure	TARP Level	Inspection Responsible	Scope of inspection	Inspection Frequency	Reporting	Inspection Reviewer	Distribution List
Whale Tail Dike – Dewatering	Green	Geotechnical Engineer	All of Table 7-2	Daily	Simplified inspection form	-	Engineering Geotechnical Team, EOR
			Physical risk and surveillance	Bi weekly	Detailed inspection form	Geotechnical Coordinator	
		Water & Tailings Engineer	Water Storage and transport	At startup and bi&weekly	Detailed inspection form	Geotechnical Coordinator	
	Yellow	Geotechnical Engineer	All of Table 7-2	Daily	Simplified inspection form	Geotechnical Coordinator	Engineering Geotechnical Team, EOR
				Weekly	Detailed inspection form		
	Orange	Geotechnical Engineer	All of Table 7-2	Daily	Simplified inspection form	EOR	Engineering Geotechnical Team, EOR, designer, Management
				Weekly	Detailed inspection form + report presenting instrumentation data + report on action taken		
Whale Tail Dike, Mammoth Dike, WRSF Dike, NE Dike - Operation	Green	Geotechnical Technician	Physical risk and surveillance	Monthly	Detailed inspection form	Geotechnical Engineer	Engineering Geotechnical Team, EOR
		Geotechnical Engineer		Bi-weekly (from May to October)	Simplified inspection form	-	
	Yellow	Geotechnical Technician	All of Table 7-2	Monthly	Detailed inspection form + presentation and analysis of instrumentation data	Geotechnical Engineer	Engineering Geotechnical Team, EOR
		Geotechnical Engineer		Weekly	Simplified inspection form	-	
	Orange	Geotechnical Technician	All of Table 7-2	Weekly	Report on summary of surveillance activity + status of mitigation action	Geotechnical Engineer	Engineering Geotechnical Team, EOR, designer, Management
				Monthly	Detailed inspection form + presentation and analysis of instrumentation data	Geotechnical Engineer	Engineering Geotechnical Team, EOR
		Geotechnical Engineer		Daily	Simplified inspection form	Geotechnical Coordinator	Engineering Geotechnical Team, EOR
Attenuation Pond and Pumping Infrastructure – Operation	Green	Water & Tailings Engineer	Water storage and transport + physical stability of ramp	Monthly	Detailed Inspection	Geotechnical Coordinator	Engineering Geotechnical Team, E&I, EOR,
		Geotechnical Engineer		Bi-weekly	Simplified inspection form		
	Yellow	Water & Tailings Engineer or Geotechnical Engineer	Water storage and transport + physical stability of ramp	Weekly in area of concern	Detailed Inspection	Geotechnical Coordinator	Engineering Geotechnical Team, E&I, EOR,
	Orange	Water & Tailings Engineer or Geotechnical Engineer	Water storage and transport + physical stability of ramp	Daily	Simplified inspection form	Geotechnical Coordinator	Engineering Geotechnical Team, EOR, designer, Management
				Weekly in area of concern	Detailed Inspection		

7.2.2.1 Special Visual Inspection

Special inspections are conducted during and after unusual or extreme events that may impact the facility. Special inspections are conducted by the geotechnical engineer or Engineer of Record using the detailed inspection form and using the same procedure for review and documentation. Special visual inspection must be done on each structure after each of these events:

- At the end of dewatering once downstream toe is exposed
- Following a blast that exceed the vibration limits of the structure
- After an earthquake
- After a high intensity rainfall event (higher than a 1:2 years recurrence)
- Immediately after a site observation notice a change in condition
- Prior or immediately after increasing or decreasing the TARP level of a structure

7.2.2.2 Dike Safety Inspection (annual geotechnical inspection)

A dike safety review is a more comprehensive technical inspection, integrating inspections and results of monitoring instrument. This type of inspection is conducted by an external geotechnical engineer and supported by the Engineer of Record to have a more complete understanding of the facility performance and identify deficiencies in performance or opportunity for improvement. This will provide information to be used to revise the OMS manual.

For Whale Tail water management infrastructure such inspection need to occur on an annual basis between the month of July and September. The following components need to be inspected during this review:

- Whale Tail Dike, Mammoth Dike, WRSF Dike, NE Dike
- Attenuation pond and pumping infrastructure
- Ditches and channel

In addition to field inspection done as part of the safety review the following point should be addressed during the review:

- Review of all inspections report performed since the last review
- Review of monitoring instruments data;
- Identify deficiencies in performance or opportunity for improvement
- Review OMS performance and operational criteria and confirm that these meet the performance objective of the design
- Review and provide recommendations regarding OMS for the following year.

After each safety inspection a report must be submitted to the Engineering Superintendent which includes the results of the inspection done and addressing all point above. These reports will be stored electronically

7.2.2.3 Independent Dam Safety Review

Independent dam safety review are carried out by an independent third party to review all aspects of the design, construction, operation, maintenance, processes and other systems affecting the dam's safety, including the dam safety management system. The review defines and encompasses all components of the "dam system" under evaluation including the dam, foundations, abutments, instrumentation and seepage collection works. The independent third party for the Whale Tail water management infrastructure is the Meadowbank Dike Review Board (MDRB).

Modification to the MDRB composition can only be made by the Engineer of Record.

The Meadowbank Dike Review Board (MDRB) is comprised of the following member.

- Anthony Rattue
- Don Haley

An annual MDRB meeting will be held every year at the Meadowbank site. Other events that could trigger a MDRB meeting are:

- Major modifications to the design or design criteria;
- Discovery of unusual conditions that can compromise the integrity the water management infrastructure;
- After extreme hydrological or seismic events; and
- Decommissioning.

During the annual MDRB meeting, a dam safety review will be carried out according to the recommendations laid out in the Dam Safety Guidelines (CDA, 2013).

This review will include, but is not limited to:

- Review of the dikes classification;
- Site inspection;
- Review of design and construction records;
- Review of monitoring practices and the instrumentation records
- Assessment of the operation of the facilities;
- Provide recommendation on operation, maintenance and surveillance based on the results of the instrumentation readings, construction records and site observations;

7.3 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 infrastructure against the performance objectives and indicators and the critical controls (refer to table 4-2 and 5-2). Instrument monitoring and inspections work together as a comprehensive data set to enable assessment of the water management infrastructure performance and provide a basis for informed decision. 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 3-6 of this OMS manual.

Table 7-5 indicate the type of information collected through instruments monitoring and how it is collected. Table 7-6 summarise the data acquisition program related to instrument monitoring

Table 7-5: 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 • Survey monument to provide information on settlement and deformation • Staff gauge to inform about water level of a pond versus its operating level • Blast monitor to inform on potential impact of blasting vibration on the structure • Flow meters and seepage monitoring station to inform on volume of water movement • Surveys conducted to measure ice cover, water level, 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 • Water quality analysis of water discharged through diffuser to inform on Environmental compliance • Water quality analysis of water stored in the various pond on site to inform on water movement decision
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 7-6: Summaries of data acquisition program related to instrument monitoring of Whale Tail water management infrastructure

Instrument monitoring	Location of monitoring (3)	Parameter measured	Acquisition Methodology	Standard Acquisition frequency	Acquisition Responsible	Documentation methodology	Documentation Responsible
Thermistors	Whale Tail Dike, WRSF Dike, Mammoth Dike	Temperature (C^0) 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	Geotechnical Technician	Data are exported from VDV into instrumentation report emitted at a predetermined frequency (1)(2)	Geotechnical Engineer
Piezometer	Whale Tail Dike, Whale Tail South, Attenuation Pond	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	Geotechnical Technician	Data are exported from VDV into instrumentation report emitted at a predetermined frequency (1)(2)	Geotechnical Engineer
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 exported from VDV into instrumentation report emitted at a predetermined frequency (1)(2)	Geotechnical Engineer
Survey monument (4)	-	Elevation of monument which is then converted into mm of displacement (minimum precision of 3 mm required)	Data are acquired using a total station	Monthly in winter and bi-weekly from May to September	Geotechnical Technician	Data are exported into geoexplorer. Instrumentation report are emitted at predetermined frequency (1)(2)	Geotechnical Technician
Staff Gauge	Attenuation pond, WRSF pond, NE pond	Water level in pond	Take picture of the gauge	During each inspection	Inspection officer	Within inspection report	Inspection officer
Blast Monitor	Whale Tail Dike, WRSF Dike, Mammoth Dike, NE Dike	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 vicinity of the dike	Geotechnical Technician	Update the blast vibration log. Discussion on recorded vibration in instrumentation report	Geotechnical Technician
Flow meter	NE pond, WRSF pond,	Volume of water pump (m^3)	Pumpman operator will inscribe flowmeter value on a pumping sheet	Daily when pump is operating	E&I Pump crew supervisor	Data will be integrated in the water balance	Water & Tailings engineer
Seepage monitoring station (manual reading with a V notch)	Where umpumped seepage is observed	Seepage flow (m^3/s)	Using a bucket and a stopwatch	Weekly during period of flow	Geotechnical Technician	Documented within instrumentation	Geotechnical Engineer
Survey shot	Whale Tail South, Whale Tail North, WRSF Pond, NE Pond	Elevation of the water level (minimum precision of 3 mm required)	Surveyor will take a water/ice level at a predetermined area	Once per week	Surveyor Leader	Integrated in the water movement log	Water & Tailings engineer
Airborne survey	All water management infrastructure	Topographic aerial survey made using drone	Surveyor will take a drone survey	Once per year after freshet	Surveyor Leader	Within survey database	Surveyor Leader
Water quality	Mammoth Lake, WTP discharge, WRSF pond, NE pond, attenuation pond, sumps (5)	Parameter 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 7-5 for more information on reporting methodology and the frequency of reporting
(2) Refer to section 7-6 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) Survey monument are planned to be installed in 2020
(5) Location of water quality sampling point can be found in water management plan

7.4 ADDING INSTRUMENT TO THE MONITORING PROGRAM

Any addition to the monitoring program must be validated by the Engineering Superintendent or by the Environment Superintendent for aspect relating to water quality. 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 coordinate (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

7.5 ANALYSIS OF SURVEILLANCE RESULTS

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

For visual inspection the process of analysing the data and communicating the results is describe in section 7-4 and happen at the same time 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 inform the action to take if performance indicator is not met.

For the instrumentation monitoring to be effective the data must be reviewed, analysed and reported at the proper frequency. Table 7-7 summarise the requirement for review, analyses and reporting of instrumentation data.

The person responsible for instrumentation data review need to update the surveillance log each time an instruments results has been reviewed and analysed. The person responsible for review of reporting and distribution need to update the surveillance log once the report has been reviewed and distributed.

Instrumentation	TARP Level	Expected range of observation	Responsible for review & analyse	Frequency of review	Responsible for reporting	Reporting frequency	Responsible for review and distribution	Distribution List
Piezometer, thermistor, SAA, (**Dewatering**)	Green	Define in TARP for dewatering	Geotechnical Engineer	Daily	Geotechnical Engineer	Bi-weekly instrumentation report	Geotechnical Coordinator	Engineering geotechnical team, designer, EOR
	Yellow	Define in TARP for dewatering	Geotechnical Engineer	Twice a Day	Geotechnical Engineer	Weekly instrumentation report	Geotechnical Coordinator	Engineering geotechnical team, designer, EOR
	Orange	Define in TARP for dewatering	Geotechnical Engineer	Twice a Day	Geotechnical Engineer	Weekly instrumentation report	Geotechnical Coordinator	Engineering Geotechnical Team, EOR, designer, Management
Piezometer, thermistor, SAA, survey monument (**Operation**)	Green	Define in TARP of each structure	Geotechnical Engineer	Bi-Weekly	Geotechnical Technician	Quarterly instrumentation report	Geotechnical Engineer	Engineering geotechnical team, designer, EOR
			Geotechnical technician	Weekly				
	Yellow	Define in TARP of each structure	Geotechnical Engineer	Weekly	Geotechnical Technician	Instrumentation reporting included within monthly inspection report	Geotechnical Engineer	Engineering geotechnical team, designer, EOR
			Geotechnical technician	Every 3 days				
	Orange	Define in TARP of each structure	Geotechnical Engineer	Daily	Geotechnical Engineer	Instrumentation reporting included within weekly update report	Geotechnical Coordinator	Engineering Geotechnical Team, EOR, designer, Management
			Geotechnical technician	Daily				
Staff Gauge / Survey shot (freeboard)	Green	Define in TARP of each structure	Water & Tailings Engineer	Weekly	Water & Tailings Engineer	Within the monthly attenuation pond and pumping infrastructure inspection report	Geotechnical Coordinator	Engineering geotechnical team, designer, EOR
	Yellow	Define in TARP of each structure	Water & Tailings Engineer	Daily	Water & Tailings Engineer	Within the monthly attenuation pond and pumping infrastructure inspection report	Geotechnical Coordinator	Engineering geotechnical team, designer, EOR
	Orange	Define in TARP of each structure	Water & Tailings Engineer	Twice a day	Water & Tailings Engineer	Included within weekly update report	Geotechnical Coordinator	Engineering Geotechnical Team, EOR, designer, Management
Blast Monitor	-	PPV> 50 mm/s	Geotechnical Technician	After retrieving a blast monitor on a water management structure	Geotechnical Technician	In Quarterly instrumentation report	Geotechnical Engineer	Engineering geotechnical team, designer, EOR
Flow meter / Seepage monitoring	Green	Define in TARP of each structure	Water & Tailings Engineer	Weekly	Water & Tailings Engineer	During the monthly update of the water balance	Geotechnical Coordinator	Engineering geotechnical team, designer, EOR
	Yellow	Define in TARP of each structure	Water & Tailings Engineer	Daily	Water & Tailings Engineer	During the monthly update of the water balance	Geotechnical Coordinator	Engineering geotechnical team, designer, EOR
	Orange	Define in TARP of each structure	Water & Tailings Engineer	Twice a day	Water & Tailings Engineer	Included within weekly update report	Geotechnical Coordinator	Engineering Geotechnical Team, EOR, designer, Management
Water quality	Green	Define in TARP of each structure	Environment General Supervisor	As per water management plan	Environment General Supervisor	As per water management plan	Environment Superintendent	Engineering geotechnical team

	Yellow	Define in TARP of each structure	Environment General Supervisor	As per water management plan	Environment General Supervisor	As per water management plan	Environment Superintendent	Engineering geotechnical team
	Orange	Define in TARP of each structure	Environment General Supervisor	As per water management plan	Environment General Supervisor	As per water management plan	Environment Superintendent	Engineering geotechnical team

Table 7-7 :Requirement for review, analyses and reporting of instrument data

7.5.1 Procedure in case of data exceeding expected range of observation

If data exceeding the expected range of observation or anomalous data readings are observed, the following actions need to be taken:

- Re-read to check the reading (if the reading is from VDV, take a manual reading in the field);
- Check readout equipment to verify that it is functioning correctly;
- Verify calibration;
- If instrument has stopped functioning, notify the Engineering Superintendent 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 Engineering Superintendent. Any malfunctioning instrument or frozen piezometer must be documented.
- In the case of valid data that would exceed the TARP level do a special inspection if possible.

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

7.5.1.1 Blast Monitor

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 changing condition.

If more than one occurrence of blast vibration exceeding the limit are observed within a 2 weeks period the Engineering Superintendent needs to be notified of the situation.

7.5.2 Anomalous Instrumentation Data

Anomalous instrumentation data includes the following as presented in Table 7-7. These anomalies could happen without triggering a TARP level change and need to be investigated and recorded:

Table 7-8: Example of anomalous data and some common cause

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 or a sheared cable)
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); • Sharp increase in reading (verify that the instrument is not frozen) • Loss of data (could be a transmission error, faulty hardware or a sheared cable)
SAA
• 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)
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 seem to not reflect the probable water elevation. This could be due to a settlement or displacement of the staff gauge. • Increase or decrease in 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 taken at the good location, wave actions or daily variances in GPS signal

7.6 SURVEILLANCE DOCUMENTATION & REPORTING

One visual inspection report per structure needs to be completed, reviewed and distributed per the frequency in Table 7-4.

An instrumentation report need to prepare at predetermined frequency to present all instrumentation monitoring data as described in Table 7-8.
Table 7-9 describe how instrumentation data should be reported.

Instrumentation reports need to include the following information:

- Table presenting all the instruments installed on each structure, their status and pertinent installation information
- Graph of all instruments for all structure covered by the report. The graph need to present data for a minimum period of 1 year. Higher recurrence should be presented if clarity of the presented information allows it. The graph need to be presented in a way that allow for data interpretation without referring to other document
- Analyses of all instruments data presented highlighting specific trend
- Discussion on anomalous trend

For the structure having a yellow Tarp level the instrumentation data relevant to the cause of the alert need to be included with each visual inspection report.

For the structure having an orange Tarp level the instrumentation data relevant to the alert level need to be included with each inspection report. In addition the weekly update reports need 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
- What is the mitigation plan and what action have been taken since the last update report
- Discussion on the result of the instrumentation data

Table 7-9: How data should be presented in report for instrumentation monitoring

Thermistance
• Temperature vs. depth plots over time. • The plot should indicate the thermistor string reference number and date of each measurements presented • The plot need to indicate relevant stratigraphy and their depth • Plot need to be presented with a cross-section of the installation (if on a structure) as well as a plan view showing the instrument location
Piezometer
• Plots of total head as elevation versus time; and • Plot need 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 need to indicate the instrument number, the dates of each measurement and a mention if the temperature read by the instrument is less than 0 degree
SAA
• Cumulative displacement plots (to view total displacement); • Incremental displacement plots (to present increasing or accelerating movements between readings); • Cumulative displacement at crest versus time; and • Time plots at zones of identified displacement. • The plot need 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 need to be included showing the instrument location
Survey Monument
• Total net movement plots (to present total displacement); • Vertical displacement plots; and • Lateral displacement plots parallel and perpendicular to the dike axis • The plot need to indicate the survey monument number, what is considered positive and negative displacement and the dates of each measurement • A plan view need to be included showing the instrument location

7.7 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. The following will be stored in the hard copy and/or electronic format. Section 7.1 indicates where each of these items can be found electronically:

- Instrumentation report
- Visual inspection report
- Weekly report for structure in orange Tarp level
- Dike safety inspection (annual geotechnical inspection)
- Dam Safety Review report;
- Surveillance log
- Instruments database and map
- Maintenance log of geotechnical instrument
- Maintenance log of water management infrastructure
- Pump maintenance record

Appendix A

Simplified Inspection Form

Detailed Inspection Forms Template

Simplified Surveillance Form

Structure :	Date :
Surveillance done by :	

	Item	Changing condition ? Yes	No	NA	Comments
1	Freeboard and pond level				
2	Tension Cracks				
3	Sinkhole				
4	Settlement				
5	Sloughing				
6	Erosion				
7	Debris & Obstruction (ditches, sump)				
8	Seepage				
9	Turbidity				
10	Instrumentation Condition				
11	Piezometric reading				
12	Thermistor reading				
13	SAA reading				
14	Flowmeter				
15	Condition of pipe and pump				

Recomendation

This simplified form is to be used as per the OMS manual instruction. The surveillance log must be updated after this surveillance report is filed. All condition deviating from normal operating threshold must be described in the comments section. Picture of changing condition should be attached to this document. Any changing condition must be reported to the geotechnical engineer. Any chaning condition trigering a change in threshold level must be communicated to the Engineering Coordinator or Superintendant

DIKE VISUAL INSPECTION REPORT

AGNICO EAGLE
MEADOWBANK

The instrumentation data is treated separately in the instrumentation quarterly report.

Inspecting Officer	Choose an item.
Report No.	Dike-VIR-
Inspection Date	

Dike name	

Last Inspection Date						
Weather during the current inspection		Sunny ☐	Overcast ☐	Rain ☐	Snow ☐	Wind ☐
	Comments:					
Main changes since the last inspection						

Tarp level (Based on OMS manual revision from March 2018)	

General Condition Summary

➢

Inspecting Officer: _____ Review Officer: _____ Date Reviewed: _____
(YY/MM/DD)

DIKE VISUAL INSPECTION REPORT

AGNICO EAGLE
MEADOWBANK

Field observations

Location	Observations	Recommendations
Downstream slope and berm	▪	▪
Upstream slope and berm	▪	▪
Crest	▪	▪

Seepage Report

Location	Observations	Recommendations
	▪	▪

Methodology: For the visual inspection, any anomaly or change since the last inspection must be reported. These anomalies include cracks, erosion, settlements, sink holes, bulging, sloughing, seepage signs, snow/ice, rutting, mud, ponds/puddles, signs of saturated soil and any damage on the liner or objects/water over the liner.

Aerial view of the Dike

Map of the Dike

Downstream slope and berm

DS1: Downstream slope and berm.	Location and orientation of DS1.

DS2: Downstream slope and berm.	Location and orientation of DS2.

Upstream slope and berm

US1: Upstream slope. Lake is frozen.	Location and orientation of US1.

US2: Upstream slope.	Location and orientation of US2.

Crest surface

CR1: Rolling surface.	Location and orientation of **CR1**

Appendix B

Potential Mitigation for Upset Condition

Potential Mitigation Plan for Upset Condition on Water Management Infrastructures

Upset Condition	Area / Cause		Comments/Monitoring	Contingency or Corrective Action
Overtopping and Subsidence	1a	Water level rise / storm event	Lake levels and crest elevations is 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 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 comprises 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 from the mining operations can be placed to raise the dike crest and compensate settlement. Mining operations 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 makes this a low concern	Rip-rap can be added and/or 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 is 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 mining.	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 in to 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. Build additional dike downstream increasing pumping.

Upset 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 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 stabilising 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 and 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 trained inspector is an appropriate monitoring strategy in addition the instrumentation. Survey of crest face and toe is conducted.	Re-assess stability (numerical modelling) and construct a stabilising berm if required Fill inactive tension cracks with bentonite
	4b	Earthquake Induced: Slope Failure	Site is located in a low seismic zone. Dam consisting of massive rock zone has a low sensitivity to seismic motion.	Do 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 self-weight of the dike versus ice loads and water pressure. Large inflows through the breach may occur as a consequence if the cut-off wall breached. Pit would flood requiring suspension of mining activities. Potential for loss of life of workers inside dikes. Inclinometer, settlement prism and monument monitoring is done routinely.	Repair the cutoff wall
Subsidence	6	Foundation Soils	Unexpected foundation soils consolidated during dike construction or dewatering. A significant quantity of clay would be required to generate settlement resulting in a water release event. Prism 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. Soil conditions will be observed during dewatering to accommodate actual conditions.
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

Upset Condition	Area / Cause		Comments/Monitoring	Contingency or Corrective Action
Pump and Pipeline Failure	8	Pumping infrastructures	Freezing protection is provided by heat tracing and insulation. Pipelines monitored pump pressures at plant and frequent site inspection.	Replace defect in pipeline Repair the pump and use another pump in the meantime