Monitoring Program

Document Title: Groundwater Follow-up Monitoring Program	**Document Number:** MOZ-NFLD-001-MOZ-0000-000000-80-EMP-0008
Owner: Environment	**Review Frequency:** Annual

Review Coding

☐ Code 1 – Reviewed with No Comments

☐ Code 2 – Reviewed with Minor Comments

☐ Code 3 – Reviewed with Major Comments

☐ Code 4 – Not Accepted

☐ Code 5 – Information Only

Rev	Rev Date	Issued For	Prepared By	Reviewed By	Approved By
A	Nov. 8, 2022	Use	Stantec	Tara Oak	Tara Oak
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Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

Abbreviations

CWQG-FAL	Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life
EA	Environmental Assessment
EIS	Environmental Impact Statement
GCDWQ	Guidelines for Canadian Drinking Water Quality
GWFMP	Groundwater Follow-up Monitoring Program
IAAC	Impact Assessment Agency of Canada
IR	Independent Review
LAA	Local Assessment Area
L/m	Litres per metre
L/min	Litres per minute
m/s	Metres per second
Marathon	Marathon Gold Corporation
mbgs	Metres below ground surface
MDMER	*Metal and Diamond Mining Effluent Regulations*
NLDECC	Newfoundland and Labrador Department of Environment and Climate Change
PoPC	Parameter of Potential Concern
RAA	Regional Assessment Area
TMF	Tailings Management Facility
tpd	Tonnes per day

1.0 INTRODUCTION

Marathon Gold Corporation (Marathon) submitted an Environmental Impact Statement (EIS) for the Valentine Gold Project (the Project) to the Impact Assessment Agency of Canada (IAAC) on September 29, 2020, and to the Environmental Assessment (EA) Division of the Newfoundland and Labrador of Environment and Climate Change (NLDECC) on November 3, 2020. The Project was released from the provincial and federal EA processes, with conditions, on March 17, 2022, and August 24, 2022, respectively.

The purpose of the Groundwater Follow-up Monitoring Program is to verify predictions and address commitments made in the EIS (Marathon 2020) as well as those developed through Information Requirements (IR) received as part of the regulatory review process. This document describes follow-up and monitoring activities for the construction, operation, and decommissioning/closure phases of the Project, based on regulatory compliance requirements and Project approvals and authorizations. As discussed in Chapter 6 of the EIS and in IR PC-78, Marathon has committed to the development of a follow-up and monitoring program to monitor groundwater levels and groundwater quality at key Project locations. Monitoring data from these locations will be used to validate the predicted effects of the Project on groundwater and to meet regulatory requirements related to specific permits and conditions of approval. This is a living document that will be reviewed, updated and improved upon based on policy and technology changes as the Project progresses through permitting, construction, operation and decommissioning of the Project.

The construction and operation of the Project are governed by an Environmental and Social Management System, which includes tools such as the corporate environmental and social policies, construction and operational environmental protection plans (EPPs), environmental management plans, and follow-up and monitoring programs, which will be updated as applicable throughout the life of the Project. An EPP for the construction phase of the Project has been approved by the NL Minister of Environment and Climate Change. The Construction EPP outlines protection and response measures associated with potential environmental effects related to Project construction activities, providing general environmental protection procedures related to Project construction activities and infrastructure such as air and greenhouse gas emissions, erosion and sedimentation control, rock and soils management, and traffic management, as well as specific protection procedures for caribou, avifauna, and other wildlife including bats and American marten; fish and fish habitat; historic resources; and the Victoria Dam.

The EPP is closely linked to the follow-up monitoring programs as it describes practical procedures to reduce or eliminate potential adverse environmental effects, as well as instructions for addressing planned and unplanned activities/events associated with Project construction. A process for the communication to Indigenous groups of potential adverse effects of planned Project activities upon the use of land and resources by Indigenous persons (including hunting, trapping, fishing and gathering, and access to lands and resources) is provided in the Current Use of Lands and Resources for Traditional Purposes Indigenous Communications Plan. Response measures in the event of an accidental event are described in Section 4 of the Accidents and Malfunctions Prevention and Response Plan (AMPRP). Additionally, communications and reporting requirements are provided in the Section 5 of the AMPRP as well as Appendix A with respect to communication specific to Indigenous groups.

Marathon has developed a grievance mechanism to afford a process for addressing grievances on the part of non-Indigenous and Indigenous groups or Indigenous persons resulting from the effects of the Project to these users, such as effects to land and resource use, health, socio-economic conditions and heritage resources. If grievances are received, these will be logged and investigated.

The follow-up monitoring program presented herein will be implemented throughout Project construction and operation and has been developed to meet the associated requirements identified during the environmental assessment process. The monitoring program is subject to refinements based on consultation with regulators, Indigenous groups, and conditions of authorization.

1.1 PROJECT OVERVIEW

Marathon Gold Corporation (Marathon) is proposing to develop an open pit gold mine near Valentine Lake in central Newfoundland (Figure 1.1). The proposed Valentine Gold Project (the Project) will consist primarily of two open pits, waste rock piles, crushing and stockpiling areas, conventional milling and processing facilities (the mill), a tailings management facility (TMF), personnel accommodations, and supporting infrastructure including roads, on-site power lines, buildings, and water and effluent management facilities.

The Project is located in a rural region, with a history of mining exploration and development activities and other land and resource uses, including commercial forestry, hydroelectric developments, outfitting, and recreational land use. The mine site is accessed by an existing public access road that extends south from Millertown approximately 88 kilometres (km) to Marathon's existing exploration camp (Figure 1.1). Marathon will upgrade and maintain the access road from a turnoff approximately 8 km southwest of Millertown to the mine site, a distance of approximately 76 km.

The Project is comprised of two mining areas, the Leprechaun and Marathon deposits. Standard surface mining techniques will be used to mine gold ore from two open pits. Ore material will initially be mined and processed at a nominal rate of 6,850 tonnes per day (tpd), increasing to 10,960 tpd in Year 4. Ore will be processed through the mill, where it will be crushed, milled and put through floatation and cyanidation processes to recover the gold. High-grade and low-grade ore materials will be stockpiled for mixing and for processing later in the mine life. Tailings will be treated in the process plant area to remove the cyanide and subsequently deposited in an engineered TMF, where effluent will be monitored for compliance with the *Metal and Diamond Mining Effluent Regulations* (MDMER). Gold will be formed into doré bars, which will be shipped from site to market in secured trucks.

The construction of the Project is expected to take place over a period of approximately 20 months, followed by an estimated mine operation life of 13 years. The Project will operate 24 hours a day, seven days a week on a 12-hour shift basis. Upon cessation of mining, the operation will be closed, and the site components will be rehabilitated and monitored in accordance with applicable regulations at the time of closure.

Other Project components and activities that are associated with the primary mining, milling and processing activities include; site and haul road construction and maintenance; waste rock management; electrical power supply and distribution; process and potable water supply and distribution; site wide stormwater and effluent management including: monitoring, treatment, and discharge; fuel storage and fueling stations; mine and plant workshops and services; administrative office; personnel accommodations and lunchrooms; and security. A power line connected from nearby Newfoundland and Labrador (NL) Hydro’s Star Lake Generating Station to the mine site will be required to supply power to the Project and will be constructed and operated by NL Hydro.

The following spatial boundaries are associated with the Project:

- Project Area: The Project Area encompasses the immediate area in which Project activities and components occur and is comprised of two distinct areas: the mine site and the access road. The mine site includes the area within which Project infrastructure will be located, and the access road is the existing road to the site, plus a 20-metre (m) wide buffer on either side. The Project Area is the anticipated area of direct physical disturbance associated with the construction, operation and decommissioning, rehabilitation and closure of the Project.
- Local Assessment Area (LAA) / Regional Assessment Area (RAA): The LAA was delineated for the site, as shown on Figure 1.1. The LAA for groundwater is based on the likely extent of drawdown from open pit dewatering, and changes to flow or groundwater quality due to recharge from the TMF and waste rock piles. The LAA boundaries (Figure 1.1) are based on the study areas described in the baseline hydrogeology reports presented in Baseline Study Appendix 3: Water Resources (BSA.3) and results of groundwater flow modelling presented in Appendix 6A. The RAA is the same as the LAA because the aquifers that interact with the Project are limited in extent due to groundwater divides coinciding with surface water sub-watershed boundaries.

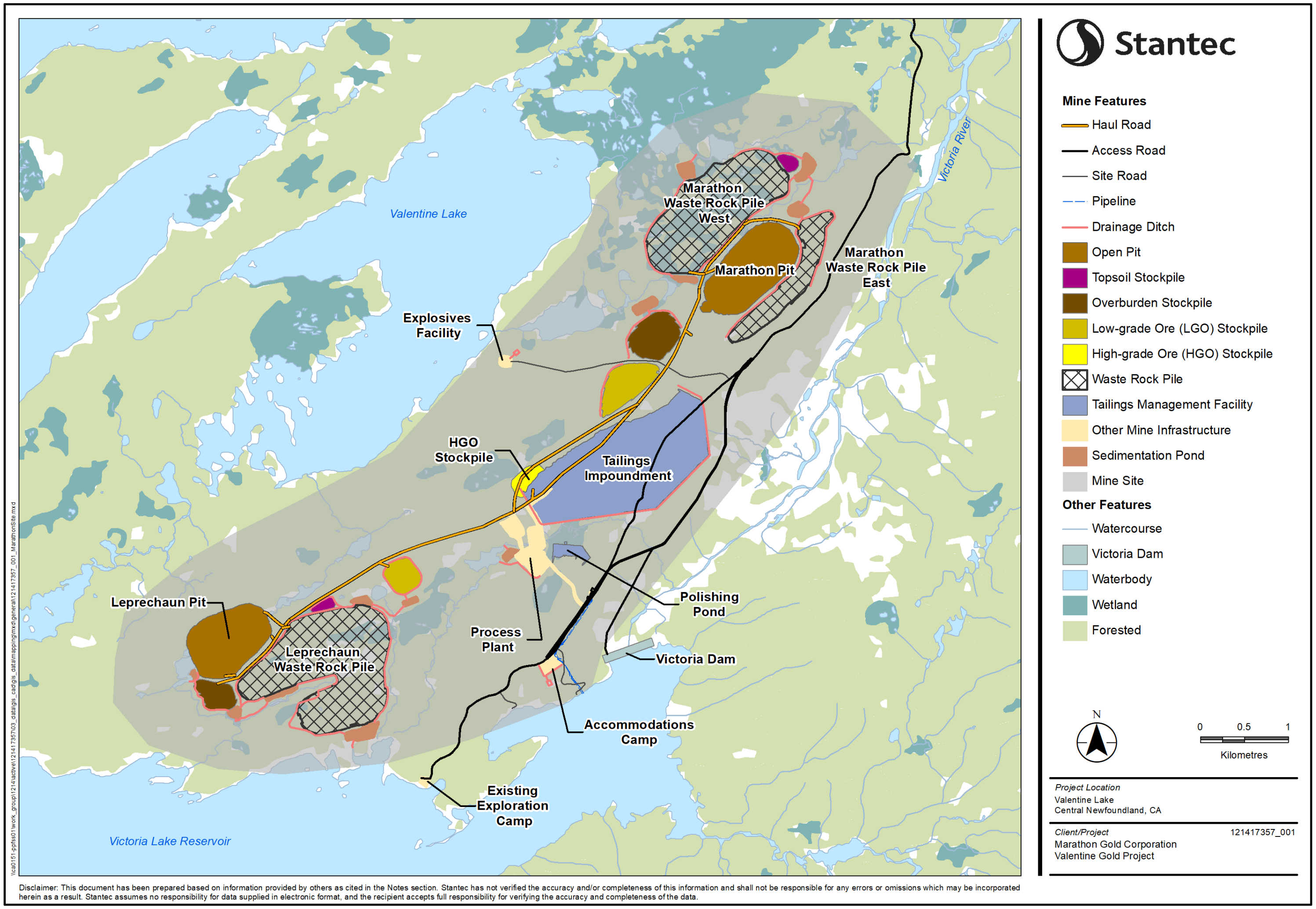

Figure 1.1 Project Location and Spatial Boundaries for the Assessment of Groundwater

1.2 GOALS AND OBJECTIVES

This document has been developed and prepared using currently available information. This monitoring program will require updates when further details regarding Project design, sequencing, and methods become available. It is anticipated that this document will be updated during the permitting stage of Project planning (i.e., following regulatory review) and will be completed prior to the start of the monitoring program.

1.2.1 Purpose

The purpose of the Groundwater Follow-up Monitoring Program (GWFMP) is to:

- Identify the regulatory requirements and standards relevant to groundwater
- Identify and describe the existing conditions for groundwater
- Describe the management and mitigation measures that will be used to reduce the potential effects on groundwater from Project construction and operation
- Describe the monitoring of groundwater that will be conducted during Project construction and operation to meet regulatory requirements

1.2.2 Objectives

The main effect of mine operation on groundwater quantity and flow is a potential lowering of the water table resulting from dewatering the open pits during construction and operation and, to a lesser extent, during closure when the open pits refill. The main effect of mine operation on groundwater quality is the potential increase in concentrations of chemical parameters (and decrease in pH) in seepage from the waste rock piles and TMF to groundwater (Marathon 2020b). Effects on the receiving surface water bodies are likely limited given the long advective groundwater travel time (decades to centuries) to discharge points, and potential for natural attenuation of the parameters along the groundwater flow paths.

The purpose of the GWFMP is to provide a framework for monitoring potential changes in groundwater quantity and quality in relation to the Project. The specific objectives of the program are:

- Establish and/or maintain background monitoring locations to differentiate between natural seasonal or climatic variability in groundwater quality and quantity as the Project progresses.
- Monitoring of groundwater levels in monitoring wells to document changes in water levels and groundwater flow in response to dewatering of the open pits and changes in recharge due to Project components (e.g., waste rock piles, ore stockpile, overburden storage areas, TMF).
- Monitoring of groundwater quality to document the effects of changes in groundwater chemistry associated with Project components (e.g., waste rock piles, ore stockpile, overburden storage areas, TMF).
- Validate the prediction of environmental effects of the Project on groundwater quality and quantity as presented in the EIS for the Project (Marathon 2020b).

- Validate predicted concentrations of analytes in groundwater seepage from the waste rock piles and TMF.
- Maintain a groundwater monitoring well network sufficient to assess effects to water quantity and quality if a threshold, as defined in Section 4.2.1, is exceeded and to assess effectiveness of subsequent adaptive mitigation measures, as defined in Section 6.2.
- Validate the initial three-dimensional numerical groundwater flow model used in the EIS (Marathon 2020b).
- Maintain compliance with applicable permits (e.g., Certificate of Approval).

1.3 REGULATORY SETTING

In addition to the *Canadian Environmental Assessment Act, 2012* and the NL *Environmental Protection Act*, the Project is subject to other federal and provincial legislation, policies, and guidance. This section identifies the primary regulatory requirements and policies of the federal and provincial authorities that influence the scope of the monitoring program on groundwater resources.

1.3.1 Federal Regulatory Requirements

1.3.1.1 Guidelines for Canadian Drinking Water Quality (2022)

Guidelines for potable water are established by Health Canada in collaboration with the Federal-Provincial-Territorial Committee on Drinking Water. *Guidelines for Canadian Drinking Water Quality* (GCDWQ) are applicable as aesthetic and health-based guidelines for a variety of chemical parameters for potable water sources at the site (e.g., accommodations camp).

1.3.1.2 Federal *Fisheries Act* (2019)

MDMER, pursuant to the federal *Fisheries Act*, sets allowable limits for specific metals as sampled by a prescribed schedule. The MDMER set out the maximum allowable limits for concentrations of specific metals and compounds in discharge resulting from the Project. The MDMER also sets forth the extensive Environmental Effects Monitoring criteria to be implemented during the operational phase of the Project.

1.3.1.3 Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life (CWQG-FAL), 1999

The Canadian Council of Ministers of the Environment (CCME) CWQG-FAL provide limits for contaminants in water and are intended to maintain, improve, and/or protect environmental quality, and human and ecological health for a variety of chemical parameters. The CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life* are applicable for freshwater at the site. Though not directly applicable to groundwater, these are important for the surface water monitoring program.

1.3.2 Provincial Regulatory Requirements

1.3.2.1 *Water Resources Act* (2002)

The *Water Resources Act* gives the Water Resource Management Division of the NLDECC the responsibility and legislative power for the management of water resources in the province.

The *Environmental Control Water and Sewer Regulations*, under the *Water Resources Act*, which incorporate the limits imposed by the MDMER, will also apply to discharge of water and effluent from the Project.

Water supply well construction for various Project components (e.g., accommodations camp) is regulated under the *Well Drilling Regulations* (2003), NLR 63/03 under the *Water Resources Act*.

Water well abandonment is regulated under section 18 (3) of the *Well Drilling Regulations*.

1.3.2.2 *The Environmental Protection Act* (2002)

The *Environmental Protection Act* gives the NLDECC the authority to manage contaminated or impacted sites in the province. The NLDECC's *Guidance Document for the Management of Impacted Sites* (2014) outlines the specific process to be followed for all contaminants of concern that have been released into the environment that may require assessment, remediation and/or risk management to ensure protection of human health and the environment. Effective August 30, 2021, the NLDECC requires assessment, remediation and closure reports to utilize Atlantic RBCA Version 4.0 and/or 2021 Atlantic RBCA (Atlantic RBCA, 2021) environmental quality standards (EQS) or pathway-specific standards (PSS). The relevant Atlantic RBCA PSS for groundwater in the Project Area are:

- Human Health-Based Tier II PSS for Groundwater – Potable Groundwater Drinking Water: these guidelines are applicable as aesthetic and health-based guidelines for a variety of chemical parameters for potable water sources at the site (e.g., accommodations camp) and, except for certain petroleum hydrocarbons, are the same as the federal GCDWQ

- Ecological Tier II PSS for Groundwater (>10 metres from Surface Water), Fresh Water: these guidelines are protective of freshwater aquatic life, under the assumption that there is groundwater discharge from an impacted site to a receiving water body

2.0 BASELINE INFORMATION

Baseline conditions of groundwater at the site are detailed in Baseline Study Appendix 3: Water Resources (BSA.3) of the EIS (Marathon 2020a) and are summarized below.

- Water levels collected at the site ranged from approximately -0.8 meters below ground surface (mbgs) (flowing artesian well) to 28.2 mbgs. Continuous water level monitoring by data loggers in five exploration boreholes at the Leprechaun and Marathon pit areas do not indicate a seasonal trend or a strong correlation between precipitation and groundwater levels. Annual fluctuations of water levels in the five measured boreholes were less than 0.8 m.

- In general, it was found that groundwater comprised a slightly hard to very hard, calcium-sodium-bicarbonate-chloride-sulphate type water. Groundwater samples were predominantly slightly alkaline with moderate acid buffering potential and low conductivity, indicating fresh conditions.
- Rising and falling head hydraulic tests in unconfined overburden and shallow bedrock resulted in hydraulic conductivity measurements ranging from 8×10^{-7} meters per second (m/s) to 9×10^{-5} m/s with a geometric mean of 5×10^{-6} m/s.
- Hydraulic tests using packers across a variety of depths in bedrock resulted in hydraulic conductivity measurements ranging from 4×10^{-10} m/s to 6×10^{-6} m/s, with a geometric mean of approximately 5×10^{-8} m/s. Hydraulic conductivity values of shallow wells were generally higher than those observed in deep wells, consistent with a decreasing degree of fracturing and bulk hydraulic conductivity with depth.
- A groundwater divide is inferred to exist along the northeast-trending ridge from the Leprechaun pit to the Marathon pit. Groundwater to the north and west of the divide is generally expected to flow into Valentine Lake which is located to the northwest of the divide. Groundwater to the east and south of the divide is generally expected to either flow into Victoria River located to the east of the divide or into Victoria Lake Reservoir located to the south of the divide. These bordering drainage features are primary areas of discharge for groundwater in the Project Area.
- The only known active groundwater user in the Project Area is the existing exploration camp owned and operated by Marathon. The exploration camp well was completed as a 150 mm diameter open bedrock borehole from 5.5 m to 61.0 mbgs. Aquifer testing results indicate that the current 100-day continuous safe yield of the exploration camp well is approximately 60 L/min (Stantec 2011). Based on a Drilled Well Location Request submitted to NLDECC, the nearest known residences with domestic wells are located in the vicinity of Buchans and Millertown, located approximately 49 km and 60 km from the mine site, respectively (NLDECC 2020).

3.0 PROPOSED MITIGATIONS AND MANAGEMENT MEASURES

Mitigation measures that will be employed to avoid or reduce adverse environmental effects on groundwater resources are presented in EIS Chapter 2, Appendix 2A, Water Management Plan and Chapter 6 (Marathon 2020b) and the EPP (Stantec 2021a). The proposed measures address the following key mitigation categories:

- Site clearing, site preparation, and erosion and sediment control
- Soil management
- Site water management
- Tailings management
- Rehabilitation and closure

A list of general mitigation measures to be applied during each project phase to meet the above categories of the Project is provided in Appendix B.

4.0 MONITORING PROGRAM

4.1 MEASUREABLE PARAMETERS AND THRESHOLDS

4.1.1 Water Quantity

Measurable parameters related to water quantity include the following:

- groundwater levels in monitoring wells at the site
- reduction in baseflow in surface water features supporting ecological habitat
- well yields for existing well users in the Project Area
- rates / volumes pumped from open pits as part of dewatering activities.

4.1.2 Water Quality

To monitor potential chemical interactions between groundwater and surface water, groundwater quality indicator parameters were chosen based on their relevance to the Project and surface water discharge regulatory criteria, specifically the MDMER and Atlantic PIRI. Although MDMER criteria are specifically discharge guidelines, an exceedance of MDMER limits of parameters of potential concern (PoPCs) in groundwater is indicative of potential impacts to receiving surface waters. Table 4.1 provides a list of the selected indicator parameters of PoPCs for the Project and relevant screening levels. With the exception of sulphate and pH, the parameters listed above are defined as deleterious substances under MDMER. pH is included in the analysis as MDMER contains upper and lower limits for discharge. Sulphate is not defined in MDMER but is included as a common indicator of potentially acid generating conditions.

Table 4.1 Parameters of Potential Concern and Relevant Groundwater Guidelines

Parameter of Potential Concern (POPC)	Potable Water Sources	Monitoring Wells	
	GCDWQ[1] (µg/L)	MDMER[2] (µg/L)	Tier II PSS[3] (µg/L)
Arsenic	10	100	50
Copper	2000	100	20
Cyanide	200	500	50
Lead	5	80	10
Nickel	-	250	250
Zinc	5000	400	70
Radium 226	0.5 Bq/L	0.37 Bq/L	-
Un-ionized ammonia	-	500	[4]
pH	70.-10.5	-	-
Sulphate	500000	-	1280000

Table 4.1 Parameters of Potential Concern and Relevant Groundwater Guidelines

Parameter of Potential Concern (POPC)	Potable Water Sources	Monitoring Wells	
	GCDWQ[1] (µg/L)	MDMER[2] (µg/L)	Tier II PSS[3] (µg/L)

Notes:
"-" No guideline reported
1. Guidelines for Canadian Drinking Water Quality (GCDWQ)
2. Maximum authorized monthly mean concentration, Metal and Diamond Mine Effluent Regulations (MDMER)
3. NS Ecological Tier II Pathway-Specific Standards for Groundwater (>10 metres from Surface Water), Fresh Water
4. pH and temperature dependent

4.1.3 Thresholds

Significance criteria (or thresholds) have been established to define significant adverse residual environmental effects on quantity and quality of groundwater. These thresholds consider the federal and provincial regulations, residual effects characterization criteria discussed in the EIS, and measurable parameters discussed in Section 4.1.1 and 4.1.2.

A significant adverse residual effect on the Groundwater Resources VC is defined as a measurable Project-related environmental effect that results in one of more of the following:

- Decrease in the yield from an existing and otherwise adequate groundwater supply well to the point where it is inadequate for its intended use.
- Change in groundwater quality, such that the quality of groundwater from an otherwise adequate water supply well that meets applicable guidelines deteriorates to the point where it becomes non-potable or cannot meet the GCDWQ (Health Canada 2012) for a consecutive period exceeding 30 days.
- Physical or chemical alteration to an aquifer to the extent that interaction with local surface water results in streamflow or surface water chemistry changes that adversely affect aquatic life or a down-stream surface water supply.

4.1.3.1 Water Quantity

The threshold for groundwater quantity relates to a reduction in the groundwater level of an existing water supply well located within the LAA/RAA, yet beyond the Project Area such that, following the application of mitigation, the water supply well no longer meets the needs of the current user(s) or physical alteration to an aquifer to the extent that interaction with local surface water results in streamflow changes that adversely affect aquatic life or a down-stream surface water supply.

There are no known third-party groundwater users located within the LAA/RAA, and no new groundwater users will be permitted within the Project Area or within lands leased by Marathon within the LAA/RAA. Groundwater discharge to surface water features (i.e., baseflow) will be affected by the dewatering of the open pits and the mounding of the water table in and around the TMF and waste rock piles. Groundwater levels in monitoring wells can be compared to baseline conditions and those predicted in the EIS (Marathon 2020b) to assess whether there is potential for a change in associated baseflow to nearby surface water features that is greater than that predicted in the EIS (Marathon 2020b). Potential effects to surface water features as a result of a reduction in groundwater discharge and/or levels are discussed in the Surface Water Follow-up Monitoring Program.

Response to Changes in Water Quantity

Adaptive management with respect to groundwater quantity would be initiated in the event of the following trigger threshold:

1. The groundwater level in a monitoring well declines below the predicted minimum groundwater level elevation (based on observed minimum groundwater elevation from baseline data and maximum predicted drawdown over the life of the Project).

If the trigger threshold criterion is identified, then the following actions will be completed:

1. **Confirm the result** – remeasure the water level to confirm the indicator parameter value. Confirm the equipment used to make the measurement is operating as intended by the manufacture.
   a. If remeasuring indicates a value that meets the defined groundwater quantity trigger threshold, then no action is required and continue with the monitoring program.
   b. If the original measurement is validated, then complete an evaluation of the data.
2. **Evaluate the dataset** - Compare the groundwater level to meteorological data and groundwater and surface water quantity data for the Project to determine if the exceedance is related to a single anomalous event such as a meteorological event, seasonal variation, or the potential for a project related effect.
   a. If the trigger threshold exceedance is not Project related, then continue with ongoing monitoring. Otherwise complete an investigation.
3. **Complete an investigation** - determine if an adverse effect is occurring in the receiving environment. Based on the information derived from the investigation, the potential relevance of the exceedance event to surface water features, aquatics, and wetlands will be evaluated through a qualitative risk evaluation. More rigorous monitoring may be recommended for the nearby surface water features, aquatics, and/or wetlands. Notify relevant authorities if new mitigation is required. Document the results of the assessment in the annual report (refer to Section 5.1).

Tables of monitoring locations with corresponding minimum water levels compared to thresholds will be generated as part of annual reporting described in Section 5.1.

4.1.3.2 Water Quality

The threshold for groundwater quality is:

- a change such that the quality of groundwater from an otherwise adequate water supply well that meets applicable guidelines deteriorates to the point where it becomes non-potable; or,
- water supply well cannot meet the GCDWQ (Health Canada 2022) for a consecutive period exceeding 30 days; or,
- chemical alteration to an aquifer to the extent that interaction with local surface water results in surface water chemistry changes that adversely affect aquatic life or a down-stream surface water supply.

Typical for the Island of Newfoundland, groundwater naturally exceeds several parameters defined in the GCDWG. For parameters with baseline concentrations that are naturally elevated with respect to the health-based standards specified in the GCDWQ as shown in Baseline Study Appendix 3: Water Resources (BSA.3) in the EIS (Marathon 2020a), the determination of a significant adverse residual effect for groundwater quality reflects that the Project will not further impair the quality of these parameters for any existing water supply wells. No groundwater users are known within the area of influence of Project components, with the groundwater recharge from the waste rock piles and TMF discharging to surface water. Therefore, the adverse residual environmental effects of the Project on a change in groundwater quality related to groundwater supplies during each Project phase are not expected to be significant based on the determination of significance presented in the EIS (Marathon 2020b). Monitoring of adverse residual environmental effects of the Project on changes in groundwater quality related to surface water discharge is described below.

Trigger thresholds have been defined as concentrations for key indicator parameters that would initiate specific adaptive management actions depending on the severity of the action level triggered. Two trigger thresholds for groundwater quality have been defined each with a varying level of sensitivity and associated level of response. The purpose of establishing multiple action levels is to identify potential groundwater issues as soon as practical through routine screening, and to identify the appropriate action level to address potential impacts to groundwater resources as a result of the Project. The following section describes the two trigger thresholds and the rationale for their selection.

Trigger Threshold 1 - Statistically Significant Upward Trend

The early identification of increasing trends in the concentration of indicator parameters, prior to guideline exceedance, is a primary component of the groundwater adaptive management plan. Trigger Threshold 1 is meant to identify potential issues associated with the Project before they have the potential to result in a significant adverse effect on the environment. The goal of Trigger Threshold 1 is to obtain more information about potential seepage, identify the source of the trend, if possible, and generally provide increase attention, information, and awareness of potential seepage before it reaches a trigger threshold concentration. Trigger Threshold 1 is defined as a statistically significant upward trend for a given indicator parameter or, for stations that have a statistically significant upward trend in the baseline data, an increase in the magnitude of the trend compared to baseline.

Ongoing trend analysis will be completed using the Mann-Kendall test (Mann 1945; Kendall 1970, Walker and Harrison 2013). The Mann-Kendall test has been found to be a simple effective way to measure whether an indicator parameter is rising or falling. The test can be applied to as few as four points. For this application, the Mann-Kendall test will be applied to the entire dataset for a given monitoring location. Using the method cited by Walker and Harrison (2013), the Mann-Kendall test statistic (S) and the coefficient of variation will be calculated and applied using the 90% confidence level chart.

If Trigger Threshold 1 is identified the following actions will be undertaken:

1. Quality Review of the data – Complete a QA/QC review of the sampling methods, laboratory reports, and Chain of Custody (COC). Assess the validity of outliers that may be biasing the trend analysis. Resample the well and/or re-run the laboratory sample (if the sample is within hold time) to confirm the recent water quality data.
   a. If QA/QC review indicates sampling or laboratory error and the applicable trigger threshold is not identified, then continue with monitoring.
   b. If QA/QC review confirms trigger threshold is identified, then proceed to Action 2.
2. Complete a physical inspection of the identified monitoring well and associated area.
   a. If the monitoring well is compromised, contract a licensed well contractor to repair the well and complete resampling of the well once repaired and re-developed to confirm if applicable trigger threshold is identified.
   b. If the monitoring well is in good condition and there is no obvious reason for the statistically significant upward trend, then proceed to Action 3.
3. Review available data – Review available data to determine if a cause for the statistically significant upward trend can be determined. For example, is the statistically significant upward trend related to a single anomalous event such as a meteorological event, seasonal variation, or the potential for a project-related effect.
   a. If review indicates the occurrence is anomalous or may subside, such as for non-Project related effects, document the assessment in the annual report (refer to Section 5.1) and continue monitoring to confirm reduction.
   b. If review suggests concentrations are increasing or remaining elevated above predictions for extended periods and/or has the potential to be related to the Project, go to Action 4.
4. Refer to Trigger Threshold 2 action plan.

Trigger Threshold 2 – Indicator Parameter Above Guideline

Trigger Threshold 2 is defined as a statistically significant upward trend (Trigger Threshold 1) and an exceedance of MDMER or Tier II PSS concentrations for the indicator parameter (see Table 4.1). Trigger Threshold 2 is defined to alert to the need for additional investigation prior to the potential to significantly affect receiving surface water quality. If an indicator parameter exceeds Trigger Threshold 2, the following actions will be undertaken.

1. Notify the NLDECC of the trigger threshold exceedance and that an investigation will be completed.
2. Complete an investigation – to assess whether the exceedance is Project-related. The investigation will be designed, implemented, and interpreted by a qualified hydrogeologist. The investigation may include the following key aspects:

   a. Lateral and vertical extent of contamination: assess whether the exceedance event is isolated to one well or several wells, and whether the exceedance is limited to one or both of the shallow and deep wells at a given location.
   b. Contaminant Pathway: based on the well interval(s) showing the exceedance and on borehole logs for the well installations, define the geological properties and hydrostratigraphic unit(s) of the seepage pathway.
   c. Parameter(s) of concern: assess whether there are changing trends associated with other parameters at the given monitoring well.
   d. Magnitude of exceedance above the trigger threshold: assess whether the exceedance represents a minor or significant deviation from the trigger threshold. Review the concentration of the source of the exceedance to predicted concentrations from the EIS (Marathon 2020b) to assess the potential for the parameter to further degrade groundwater quality.
   e. If required, augment the monitoring network to delineate source of seepage or increase sample frequency.
3. Based on the information derived from the Trigger Threshold 1 action plan and/or Trigger Threshold 2 investigation, the potential relevance of the exceedance event to surface water quality in the receiving surface water feature will be evaluated through a qualitative risk evaluation. At this time, more rigorous monitoring may be recommended for the downgradient surface water features (e.g., increased sampling frequency, increased number of sample locations, additional parameters).
4. Conclude whether exceedance is related to Project and if so whether it is incidental (accident/malfunction), operational (related to an operational procedure that may be mitigated relatively easily, e.g., pumping configuration), and/or effects of seepage from mine components (e.g., TMF, WRSA).
   a. If exceedance is not related to the Project, continue with the monitoring program with modifications to the program as recommended by the qualified hydrogeologist based on the outcomes of the investigation and document the assessment in the annual report (refer to Section 5.1). Notify relevant regulatory authorities of the outcome of the investigation and that the details of the investigation would be documented in the annual report.
   b. If the exceedance is deemed related to the Project, refer to Action 5
5. **Mitigate effects of the Project:** If mitigation is deemed necessary, options designed to reduce the seepage flow reporting to groundwater are presented in Appendix B.

4.2 MONITORING LOCATIONS

The following sections presents a summary of the existing and proposed monitoring well locations to be included in this GWFMP to monitor groundwater quantity and quality. Groundwater levels and quality within the vicinity of planned site infrastructure (e.g., open pits, tailings management facility, waste rock piles) and near primary areas of discharge for groundwater in the Project Area (i.e., Valentine Lake, Victoria Lake Reservoir, Victoria River) will be monitored to assess potential effects of the Project on groundwater quantity and quality.

Groundwater monitoring locations will be reviewed annually or when a significant change in quantity or quality is observed. Monitoring locations / stations may be added or removed from the monitoring program in accordance with their utility in monitoring the effects of the Project on the environment or to account for modifications during detailed design (i.e., existing monitoring wells that may be overprinted by future Project components may require replacement monitoring wells).

Monitoring locations will be maintained until the location is no longer required. If a monitoring location / station requires removal (e.g., construction), but is identified as part of a regulatory approval, it will only be removed from the monitoring program once the required amendments are approved (e.g., replacement well is installed).

4.2.1.1 Existing Monitoring Wells

Seven monitoring wells were installed at the site in the Fall of 2019 as part of the Hydrogeology Baseline Report (GEMTEC 2020). An additional 43 monitoring wells were installed in 2020 as part of a geotechnical and hydrogeological investigation conducted in support of a feasibility study for the Project (GEMTEC 2021). Based on email correspondence with Marathon, GEMTEC installed an additional 23 monitoring wells in 2021, but have not completed reporting at the time of preparation of the current GWFMP.

Existing monitoring wells were placed in areas of proposed site infrastructure as shown in Figure A-1 to A-4 in Appendix A. Of the 73 monitoring wells, 14 are part of shallow/deep well pairs at seven locations across the site. It should be noted that most existing monitoring wells were installed within the footprint of proposed site infrastructure as part of the feasibility study and were not necessarily intended for use in long-term monitoring. Existing monitoring wells along and outside the boundaries of proposed site infrastructure are included in the monitoring network proposed herein.

4.2.2 Installation of Additional Monitoring Wells

A total of 30 additional monitoring wells are proposed to be installed near boundaries of planned site infrastructure (e.g., open pits, tailings management facility, waste rock piles) and near primary areas of discharge for groundwater in the Project Area (i.e., Valentine Lake, Victoria Lake Reservoir, Victoria River). Locations of proposed wells are shown alongside existing wells in Figure A-2 to A-4 in Appendix A. Actual locations will be established in the field based on topography and access. Monitoring wells will be scheduled for installation following the approval of the monitoring plans. Methodology for installation of additional monitoring wells is summarized in Section 4.2.3.2 and Section 4.2.3.3.

4.2.3 Monitoring Network

A total of 51 monitoring locations are recommended for water level measurement and water quality sampling as part of the GWFMP. The proposed GWFMP consists of 21 existing monitoring wells and 30 additional monitoring wells. Of the existing monitoring wells recommended for monitoring, 11 are within the boundary of planned site infrastructure and may require decommissioning as site development progresses.

In general, monitoring well locations are proposed in the vicinity of open pits, waste rock piles, ore stockpiles, overburden storages areas, and the TMF where drawdown, mounding, and seepage may be expected as a result of dewatering or depositional site activities. Based on the expected extent of drawdown and the long travel times expected, the GWFMP is currently focused on locations immediately adjacent to site infrastructure. The need for further monitoring well installations downstream of site infrastructure will be reviewed as part of the reporting requirements discussed in Section 5.0.

Existing and proposed monitoring wells making up the monitoring network are shown in Table 4.2 and in Figure A-2 to A-4 in Appendix A. Wells that are within the footprint of planned site infrastructure are labelled as “interim” in Table 4.1; the requirement for replacement monitoring wells for each decommissioned monitoring well will be evaluated as part of the reporting requirements discussed in Section 5.0.

In addition to monitoring wells proposed for water level measurement and water quality sampling as part of the GWFMP, NLDECC has requested real time groundwater monitoring stations be established as a condition of EA release. Four real-time groundwater monitoring stations are proposed at two locations as shallow/deep paired wells and are shown in Appendix A.

Table 4.2 Proposed Monitoring Network

Site Location	Monitoring Well ID	Interim Groundwater Monitoring Locations	Long Term Groundwater Monitoring Locations	Water Level Measurement	Water Quality Sampling
Marathon Area	19-MW7		✓	✓	✓
	19-MW8		✓	✓	✓
	20BH-15A	✓		✓	✓
	20BH-15B	✓		✓	✓
	20BH-16	✓		✓	✓
	20BH-20	✓		✓	✓
	Proposed Well		✓	✓	✓
	Proposed Well		✓	✓	✓
	Proposed Well		✓	✓	✓
	Proposed Well		✓	✓	✓
	Proposed Well		✓	✓	✓
	Proposed Well		✓	✓	✓
	Proposed Well		✓	✓	✓
	Proposed Well		✓	✓	✓
	Proposed Well		✓	✓	✓
	Proposed Well		✓	✓	✓
	Proposed Well		✓	✓	✓
	Proposed Well		✓	✓	✓
	Proposed Well		✓	✓	✓

Table 4.2 Proposed Monitoring Network

Site Location	Monitoring Well ID	Interim Groundwater Monitoring Locations	Long Term Groundwater Monitoring Locations	Water Level Measurement	Water Quality Sampling
TMF Area and Plant Site	19-MW2			✓	✓
	19-MW4			✓	✓
	20BH-24	✓		✓	✓
	20BH-25	✓		✓	✓
	20BH-29		✓	✓	✓
	20BH-30		✓	✓	✓
	20BH-31	✓		✓	✓
	21BH-MW-02		✓	✓	✓
	20BH-09	✓		✓	✓
	21BH-GLDR-14	✓		✓	✓
	Proposed Well		✓	✓	✓
	Proposed Well		✓	✓	✓
	Proposed Well		✓	✓	✓
	Proposed Well		✓	✓	✓
	Proposed Well		✓	✓	✓
	Proposed Paired Well (Shallow) Real-time monitoring station		✓	✓	✓
	Proposed Paired Well (Deep) Real-time monitoring station		✓	✓	✓
Leprechaun Area	19-MW3		✓	✓	✓
	19-MW6		✓	✓	✓
	20BH-35A	✓		✓	✓
	20BH-35B	✓		✓	✓
	20BH-37		✓	✓	✓
	Proposed Well		✓	✓	✓
	Proposed Well		✓	✓	✓
	Proposed Well		✓	✓	✓
	Proposed Well		✓	✓	✓
	Proposed Well		✓	✓	✓
	Proposed Well		✓	✓	✓
	Proposed Well		✓	✓	✓
	Proposed Well		✓	✓	✓
	Proposed Paired Well (Shallow) Real-time monitoring station		✓	✓	✓
	Proposed Paired Well (Deep) Real-time monitoring station		✓	✓	✓

Table 4.2 Proposed Monitoring Network

Site Location	Monitoring Well ID	Interim Groundwater Monitoring Locations	Long Term Groundwater Monitoring Locations	Water Level Measurement	Water Quality Sampling
Note: Proposed interim groundwater monitoring locations are located within the footprint of planned site infrastructure may be decommissioned during site development					

4.3 METHODS

4.3.1 Frequency

The proposed initial monitoring program will consist of three-monthly events per year for manual water level measurement and water quality sample collection.

Based on the typical climate conditions, sampling is proposed for April/May, July/August and October/November annually through the construction and operational phases. Closure plans will be further developed based on results. Snowpack depth and air temperature could inhibit site access and sampling between November and March. Some flexibility may be warranted based on actual conditions.

Sampling frequency will be revisited after the first six sampling events to determine if it is appropriate. Modifications to the GWFMP may be warranted depending on the development of site infrastructure and if any significant impacts are detected that warrant further investigation.

The first sampling event should be carried out in existing monitoring wells upon initiation of Project construction. Proposed monitoring wells will be installed a minimum of one year (i.e., three sampling events) prior to the beginning of pit dewatering with sampling incorporated into the well development effort following drilling and installation.

4.3.2 Drilling Methods

It is recommended that the monitoring wells be installed by standard drilling methods which allow for installation of 50-mm-diameter monitoring wells, which are common for environmental investigations. The core should be logged in the field by a technician with geological/geotechnical experience.

The designations of “shallow” and “deep” monitoring wells are relative. For the purpose of this exercise, a shallow monitoring well is one that is screened close to the water table, as observed during drilling. The deep monitoring well would be screened at 15 m below the bottom of the co-located shallow monitoring well. Typically, the deep interval is drilled first to evaluate the subsurface conditions and locate the position of the water table. This information is then used to establish the target depth for that borehole with consideration for the design of the shallow interval to be drilled adjacent to it. The final depths of the boreholes should be determined based on field conditions by the field technician in consultation with the drillers and the project hydrogeologist. Shallow well depth and screen length should consider the expected water table fluctuation range, both from natural factors and site activities.

4.3.3 Monitoring Well Construction

The final construction of the monitoring wells will depend on site conditions and should be specified by the field technician to the driller in consultation with the project hydrogeologist.

4.3.3.1 Well Screen

The shallow monitoring wells should be constructed with a 50-mm-diameter, 3-m-long, 10-slot (or similar) PVC screen placed at the bottom of the borehole with solid PVC riser pipe extending to a minimum of 0.6 m above ground surface.

Sand Pack

A sand pack should be placed around the screen and should extend a minimum of 0.3 m above the top of the screen. The sand must be clean silica suitable for environmental applications with a grain size that is compatible with the screen slot and material to be screened. The sand should be poured slowly to avoid bridging, and a weighted tape should be used to routinely locate the top of the sand and confirm that the minimum height above the top of the screen has been achieved.

4.3.3.2 Annular Seal

The annular space above the top of the sand pack must be sealed to hydraulically isolate the screened interval. The minimum annular seal thickness is 0.3 m, as measured immediately after placement without allowance for swelling. The annular seal will be composed of commercially available bentonite pellets or chips approved for environmental use. Coated pellets should be used if there is a long distance between the water table and the desired depth in the borehole. The coating delays hydration and allows the pellets to settle before they swell and become sticky. About 4 litres of water (of known chemistry) per 0.3 m of pellets or chips will be added as needed to initiate hydration of the bentonite if no water is present in the well at time of installation.

4.3.3.3 Grout

The annular space above the annular seal must be grouted to within 0.4 m of the surface. Ideally, this would be done using a grout mixture of high-yield bentonite and placed using a tremie pipe from the bottom up. Alternatively, the placement of bentonite chips or pellets by hand may be more cost effective and still protective of groundwater from surface contamination. Chips and pellets must be hydrated during placement using the method described above.

4.3.3.4 Surface Seal and Completion

A surface seal should then be installed by filling the annual space from 0.4 m below grade to surface. A protective steel casing with a lockable steel cap should be installed over the monitoring well casing and set 0.6 m into the ground through overburden soil, leaving about 0.6 m above the ground. The top of the

PVC riser pipe should be a maximum of 0.1 m below the top of the protective steel casing to allow for water level measurements.

Each PVC riser pipe should be fitted with a J-plug and a mark should be made on the PVC to indicate the reference point for water level measurements and the elevation survey. The protective casing should be fitted with keyed-alike padlocks.

4.3.3.5 Survey

The spatial coordinates and ground surface and top of PVC casing elevations should be surveyed after well construction. A vertical accuracy of <1 cm is recommended to provide more confidence in water level measurements and the interpretation of flow direction.

4.3.4 Well Development, Testing, and Monitoring Equipment Deployment

4.3.4.1 Well Development

Following the completion of drilling, each monitoring well should be developed using a submersible pump capable of high flow rates and handling turbid water. The volume of the water in the casing should then be calculated based on the depth of the well, the depth to the static water level, and the pipe diameter. For a 50-mm-diameter well, one casing volume is equivalent to the height of the water in the well multiplied by a factor of 2 L/m.

Development should take place across the entire screened interval by raising the pump slowly up the well during the process (i.e., place the pump at the bottom initially and bring to the top of the water column by the time two well volumes have been removed). Development should continue until 10 well volumes has been removed and the water is clear of sediment as is practical and three consecutive readings with 10% of pH/electrical conductivity is achieved. If water is added during drilling, effort should be made to purge the same volume of water that was added, as practical. If the monitoring well does not provide sufficient yield to remove 10 well volumes, it should be pumped dry and allowed to recover three times.

4.3.4.2 Monitoring Equipment Deployment

Dedicated polyethylene sampling tubing with foot valve (e.g., Waterra™) is recommended for all monitoring wells. New and clean tubing and foot valve should be inserted into the well until it reaches the bottom. The tubing should then be cut long enough to allow for 1.5 m extra. The tubing should then be folded so that the extra portion can be inserted into the well while allowing it to be easily retrieved during sampling.

The use of dedicated water level loggers is recommended in select monitoring wells along with one barometric pressure logger. This will allow for a better understanding of the temporal variability of aquifer water levels between the manual water level monitoring events. The water level loggers should be hung using braided steel cable, Kevlar cord, or other suitable cable (made from material that doesn't stretch when wet) from the molded plastic loop on the j-plug. The logger should be placed a minimum of 5 m below the static water level, or deeper in areas immediately adjacent to open pit dewatering. The barometric pressure logger should be deployed inside of any one of the well protectors where it is free to the atmosphere. The use of water level loggers should prioritize monitoring wells with the largest expected increases and decreases of water levels (i.e., boundaries of the open pits, waste rock piles, and TMF). Water level loggers are required to be installed in several wells as well as the deployment of a barometric pressure logger to be incorporated into the dataset of the GWFMP.

4.3.5 Monitoring Well Sampling

Water levels should be measured during every monitoring event using a water level tape. The measurement should be taken relative to the measurement reference point indicated on the PVC casing. The field technician should record the value of the depth to the static water level and note the time of the measurement. This information is required for compensating the logger data, where available. The datalogger should then be pulled, downloaded, and redeployed.

Each monitoring well should be purged prior to the collection of a sample. The purpose of purging is to remove the water in the well and induce the flow of aquifer water into the well to collect a representative sample of aquifer water. Purging should be conducted until three to five well volumes have been removed and three successive measurements of field parameters are within ±0.1 pH units, ±3% for specific conductance, ±10 mV for oxidation-reduction potential, and ±10% for turbidity and dissolved oxygen, as measured using a multi-parameter sonde in a flow-through cell. At a minimum, pH and specific conductance should be tracked during purging. Ideally, the water level will not be drawn down below the top of the screen during purging. If the well pumps dry and the water level recovers to within about 80% of the static condition in less than 8 hours, the well should be evacuated again at least once before sampling is performed.

Both purging and sampling can be performed using the dedicated tubing (i.e., inertial lift pump). Alternatively, a variety of other pump types (e.g., bladder, peristaltic, submersible) could be used, if deemed suitable for the analytes. It is not critical to sample using low flow methods for general chemistry and dissolved metals, though care should be exercised to induce the least amount of agitation. The pump intake should be kept at least one metre off the bottom of the well to avoid the disturbance of any fines that may have accumulated.

Upon the completion of purging a well, a sample should then be collected. Samples should be collected directly in clean bottles supplied by the laboratory. The dissolved metals sample must be filtered using a 0.45 µm filter. Syringe filters can be supplied for this purpose by the laboratory, or a high-volume inline filter may be preferred when the turbidity is elevated. The sample bottles should be filled to the top so that there is no headspace and capped tightly. Analytes that require specific preservation have their own bottle preloaded with the appropriate acid for preservation. All samples should be kept on ice in a cooler and/or refrigerated (<4 °C) and submitted to the laboratory within 28 days of collection (unless otherwise specified by the commercial laboratory).

Water level and sampling at all monitoring wells should be conducted in one event to provide a "snapshot" of aquifer conditions.

4.4 EQUIPMENT AND CALIBRATION RECORDS

Marathon will keep records for the groundwater quality and quantity monitoring equipment that contains, at a minimum:

- Description of equipment, including year and model number
- Manufacturer's specifications
- Calibration test results

Calibration testing will be conducted following equipment manufacturer manual methods, using appropriate standards (if applicable) and at the manufacturer recommended calibration frequency. The date, methods and results of each calibration test will be recorded.

5.0 REPORTING

5.1 ANNUAL REPORTING

Monitoring data will be compiled after every field event. A formal review of the monitoring data will be conducted after the first three events to establish the ambient conditions prior to significant pit development. It is likely that many parameters will show variable concentrations / values with time in the initial data that reflect natural / ambient conditions, not the influence of anthropogenic activity that can be attributed directly to development of the Project Area. Over time, the dataset will grow as will the confidence in defining what may be considered background concentration ranges and expected fluctuations in the water table or hydraulic gradient. The initial data review will be conducted by a qualified hydrogeologist and will be made readily available to regulatory authorities upon their request.

The results of future on-going groundwater monitoring activities will be reviewed, analyzed, and presented in an annual report containing, at a minimum, the following:

- Well hydrographs.
- A map presenting updated groundwater elevation contours from a representative monitoring event.
- Quantification of horizontal and vertical hydraulic gradients.
- Groundwater chemistry presented in table format and screened against a reference regulatory guideline(s).

- A discussion of groundwater chemical conditions and the identification of additional indicator parameters that may be used to identify site-related impacts on groundwater quality.
- Recommendations for on-going monitoring (e.g., changes in parameters, locations, frequency).

In addition to annual provincial and federal reporting, reporting of analytical results to the NLDECC electronic data management system is typically required as part of a Certificate of Approval. The necessity and frequency of formal reporting should be set in consultation with provincial and federal regulatory agencies.

5.2 TERMINATION OF MONITORING

As discussed in Section 5.1, annual reporting will include recommendations for changes related to analyzed parameters, monitoring locations, and monitoring frequency.

Termination of groundwater monitoring will be carried out in consultation with provincial and federal regulatory authorities and will, at a minimum, depend on Mann-Kendall trends identifying the following conditions:

- Project-related water levels in monitoring wells are stable or recovering (increasing) for five consecutive years
- Project-related concentrations of indicator parameters defined in Section 4.2.2 are stable or decreasing for five consecutive years

The separation of project-related effects from other effects (e.g., meteorological event, seasonality) will be evaluated by a qualified hydrogeologist as part of annual reporting described in Section 5.1.

6.0 RELATED DOCUMENTS

Other environmental management plans and monitoring programs related to this follow-up monitoring program are described in Table 6.1.

Table 6.1 Related Management Plans and Monitoring Programs

Plan/Program	Details
Construction EPP	The Construction EPP provides general environmental protection procedures related to Project construction activities and infrastructure such as air and greenhouse gas emissions management; erosion and sedimentation control; rock and soils management; and traffic management. Also included are protection procedures specific to caribou, avifauna, and other wildlife (including bats and American marten); fish and fish habitat; historic resources; and the Victoria Dam. The Construction EPP also includes contingency plans for fuel and hazardous materials spills, failure of erosion and sediment control measures and/or dams, and forest fires.
Accidents and Malfunctions Prevention and Response Plan	The Accidents and Malfunctions Prevention and Response Plan outlines the mitigation measures and response measures for potential accidents and malfunctions. The Plan provides direction for communication and reporting requirements following an accident or malfunction. Potential accidents or malfunctions addressed include tailings management facility malfunction, stockpile slope failure, fuel and hazardous materials spill, unplanned release of contact water, fire/explosion, and vehicle accident.
MDMER Emergency Response Plan	The MDMER Emergency Response Plan describes the measures to be taken to prevent any unauthorized deposit of a deleterious substance or to mitigate the effects of such a deposit. The MDMER Emergency Response Plan identifies potential unauthorized deposits that can reasonably be expected to occur at the mine that may result in damage or danger to fish habitat or fish or the use by man of fish. It provides a description of the measures to be used to prevent, prepare for, respond to, and recover from an unauthorized deposit. In addition, it provides the alerting and notification procedures including the measures to be taken to notify members of the public who may be adversely affected by an unauthorized deposit.
Fish and Fish Habitat Follow-up Monitoring Program	The Fish and Fish Habitat Follow-up Monitoring Program describes the monitoring of fish and fish habitat that will be conducted during Project construction and operation to meet regulatory requirements and verify predicted Project effects made in the EIS. There are several sections and subsections of the *Fisheries Act* that pertain to groundwater, including MDMER which sets allowable limits for specific metals as sampled by a prescribed schedule. The MDMER also sets forth the extensive Environmental Effects Monitoring criteria to be implemented during the operational phase of the Project.

7.0 REFERENCES

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APPENDIX A FIGURES

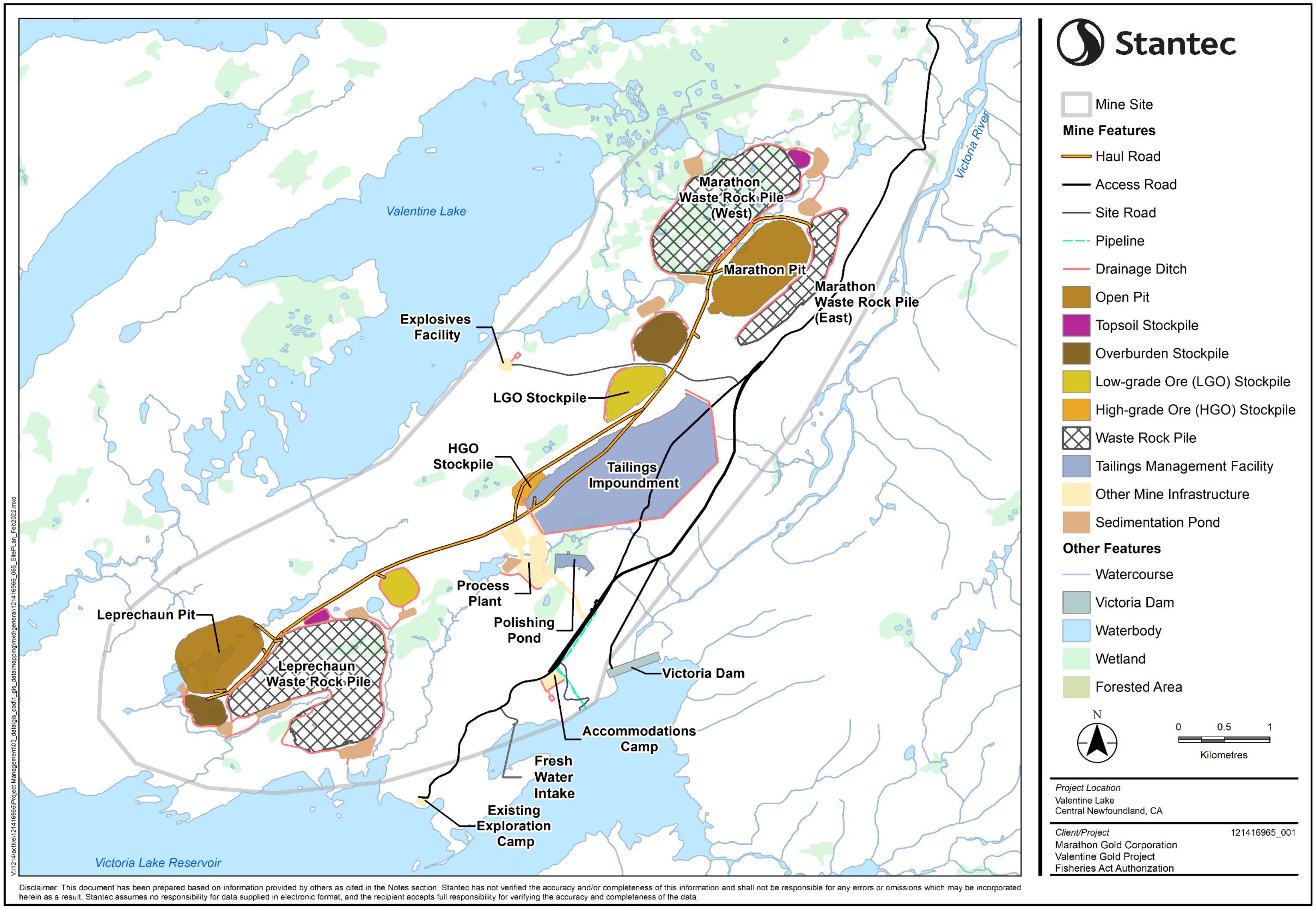

Figure A-1 Site Layout

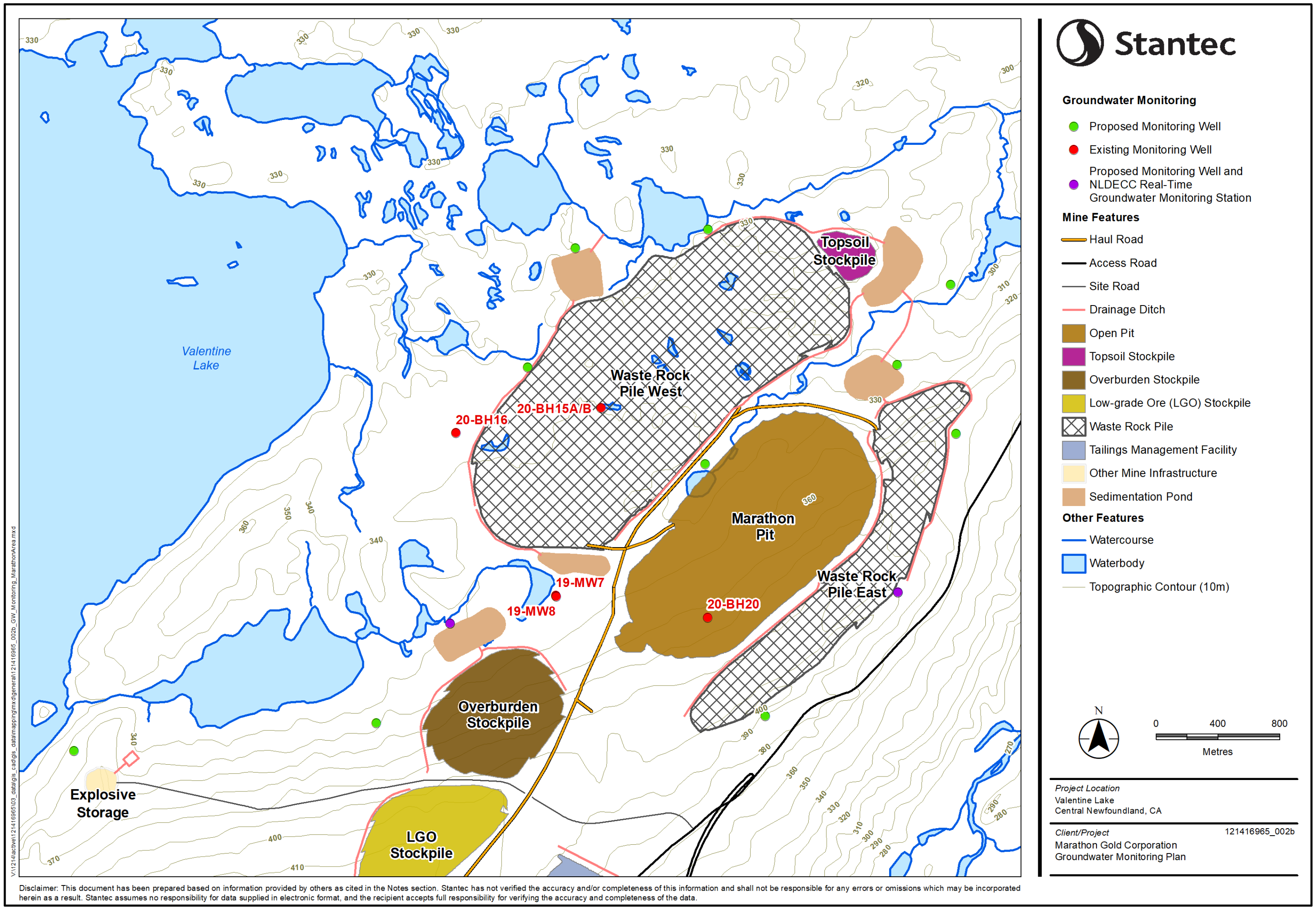

Figure A-2 Marathon Pit Complex Groundwater Monitoring Sites

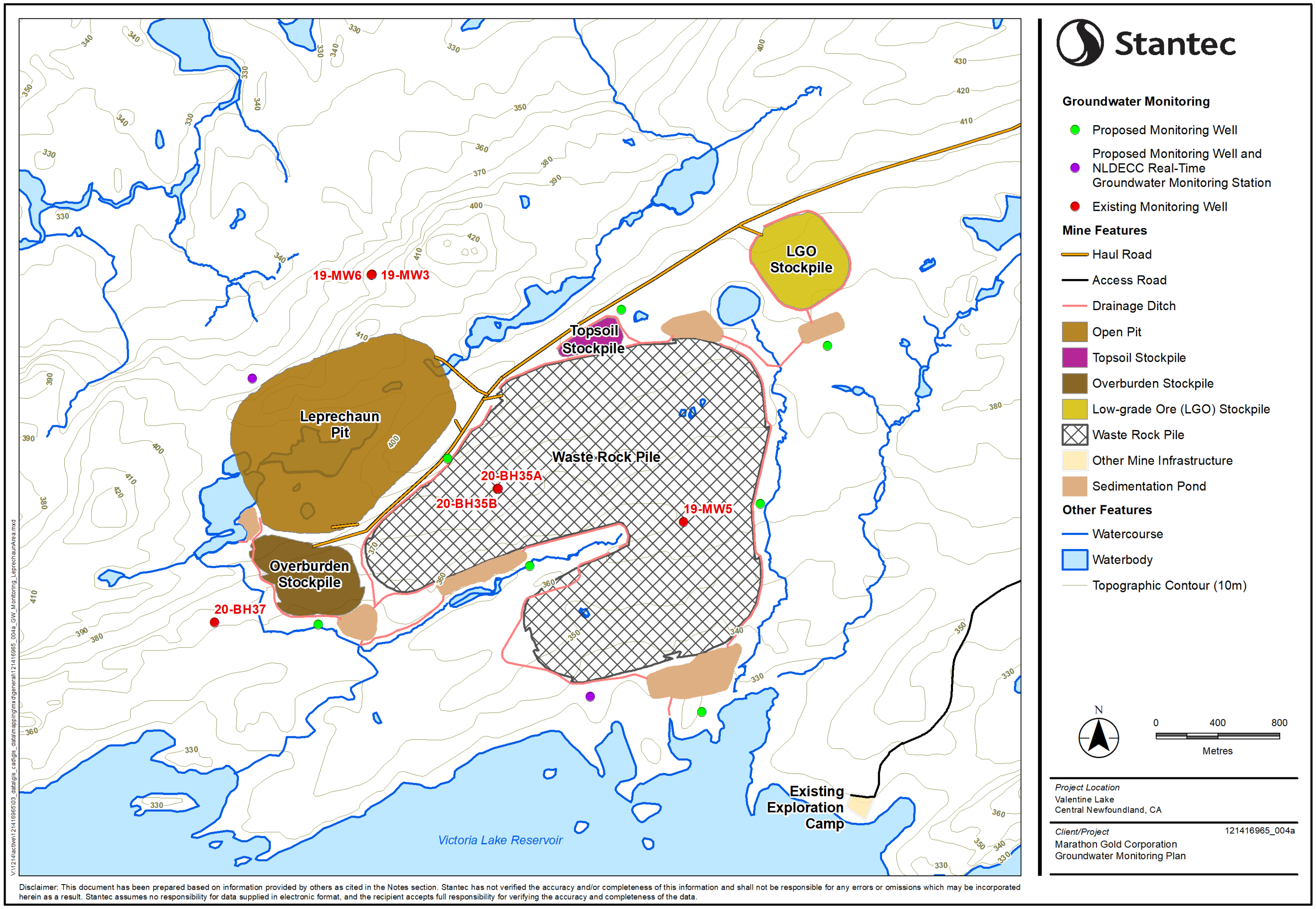

Figure A-3 Leprechaun Pit Complex Groundwater Monitoring Sites

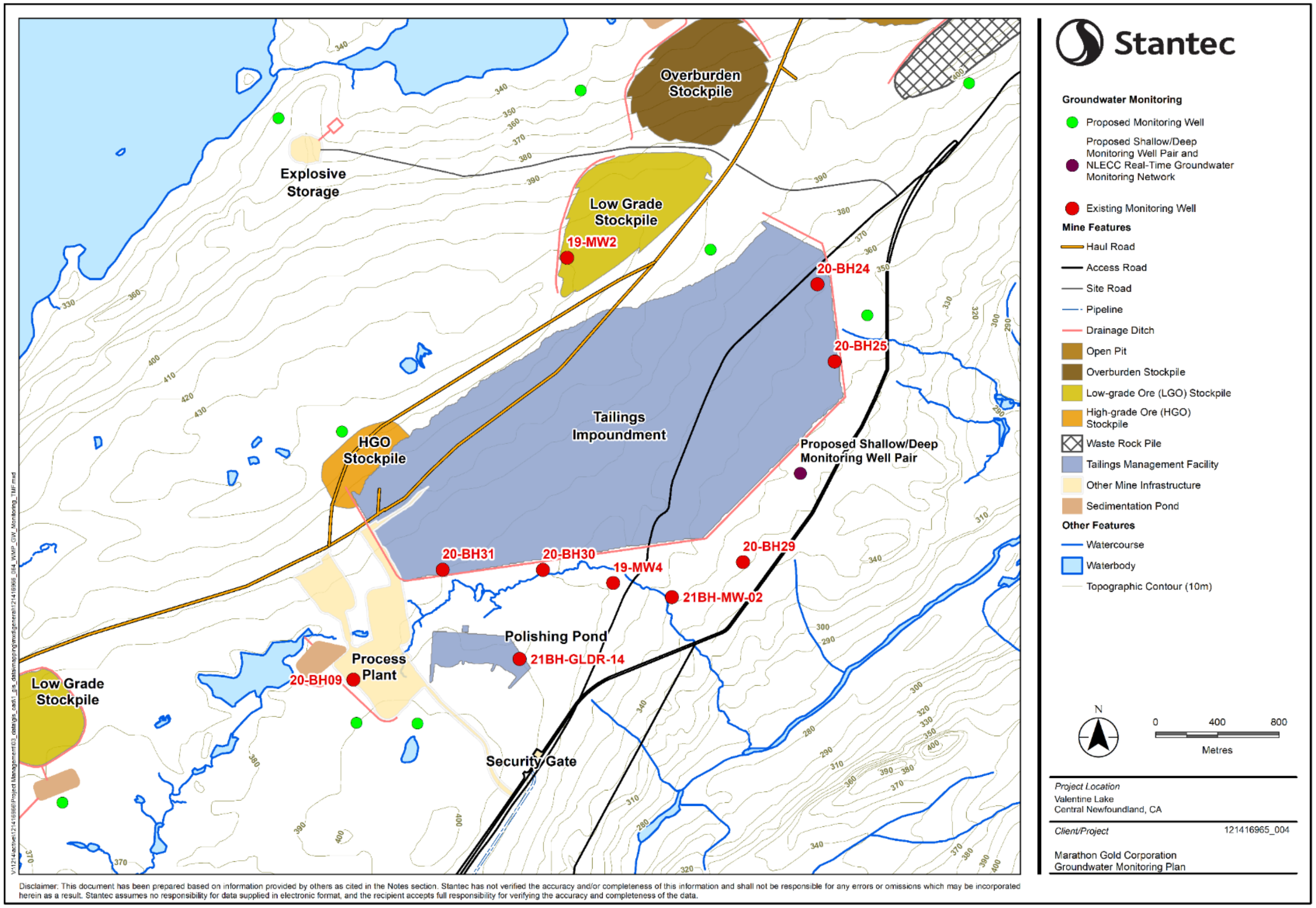

Figure A-4 TMF Area and Plant Site Groundwater Monitoring Sites

APPENDIX B MITIGATION MEASURES

The following are general mitigation measures adapted from the EIS, Chapter 6 (Marathon 2020b). A full list of mitigation measures to be applied throughout Project construction, operation, and decommissioning, rehabilitation and closure is provided in Section 2.7.4. of the EIS (Marathon 2020b).

Project planning, design, and the application of proven mitigation measures will be used to reduce or avoid adverse effects of the Project on groundwater resources, as outlined in Table B.1.

Table B.1 Mitigation Measures: Groundwater Resources

Category	Mitigation	C	O	D
Site Clearing, Site Preparation, and Erosion and Sediment Control	• Project footprint and disturbed areas will be limited to the extent practicable.	✓	-	-
Soil Management	• Sediment control fences will be installed in areas where topsoil is exposed to erosion and siltation, such as slopes and embankments and approaches to stream crossings or water bodies. Sediment control fences will be inspected and maintained over the course of the construction phase until the disturbed area has stabilized and natural revegetation has occurred. Non-biodegradable materials used for Sediment control fences will be removed following revegetation.	✓	✓	✓
Site Water Management	• Marathon will implement a Water Management Plan (Appendix 2A of the EIS (Marathon 2020b)) for the site which will incorporate standard management practices, including drainage control, excavation and open pit dewatering which collectively comprise the water management infrastructure currently designed as part of the Project scope. The Water Management Plan provides detail on runoff and seepage collection strategies and systems (e.g., local seepage collection ponds, berms, drainage ditches, pumps) to collect and contain surface water runoff and groundwater discharge from major Project components (open pit, waste rock piles, TMF, ore stockpile and overburden storage areas, process plant) during climate normal and extreme weather conditions.	✓	✓	✓
	• Standard construction methods, such as seepage cutoff collars, will be used where trenches extend below the water table to mitigate preferential flow paths.	✓	-	-
	• Contact water collection ditches will be installed around the overburden stockpiles, ore stockpiles and waste rock piles to collect toe seepage. Contact water collection ditches will be designed to convey the 1:100-year storm event, and with positive gradients to limit standing water and maintain positive flow.	✓	✓	✓
	• Groundwater quality and quantity will be monitored and adaptively managed, if required, using a network of groundwater monitoring wells to document Project effects on groundwater flow and quality (this report).	✓	✓	✓

Table B.1 Mitigation Measures: Groundwater Resources

Category	Mitigation	C	O	D
Tailings Management	• Shallow groundwater seepage from the TMF will be intercepted by seepage collection ditches and pumped back to the TMF via sump pumps.	✓	✓	✓
	• Cyanide detoxification within the mill using the sulphur dioxide / air oxidation process will result in the degradation of cyanide and precipitation of metals prior to discharge to the TMF.	-	✓	-
Rehabilitation and Closure	• Progressive rehabilitation (e.g., placement of soil cover and vegetation over waste rock piles, erosion stabilization and temporary vegetation of completed organics, topsoil, and overburden stockpiles) will be implemented.	-	✓	✓
	• Open pit filling will be accelerated at closure, which will return groundwater levels to stabilized conditions (Marathon 2020b) in a shorter timeframe.	-	-	✓
Notes: C – Construction Activities; O – Operation Activities; D – Decommissioning, Rehabilitation and Closure Activities				

In the event of threshold exceedances as defined in Section 6.2, the following additional mitigation measures may take place:

- Persistent seepage flows detected in the seepage collection ditches that cannot be adequately captured by existing sump stations will be addressed by the installation of larger seepage collection pumps, where necessary, to direct seepage to the appropriate facility (e.g., pumped back to TMF or effluent treatment plant).
- Modifications to the existing ditch system to increase seepage collection efficiency (e.g., modification of ditch geometry, alignment, or construction materials).
- Installation of one or multiple groundwater pump-back wells that could serve as a hydraulic barrier (i.e., collection of plume waters and pump back to TMF).
- Installation of a barrier wall that could include sheet pile, grout curtain or localized grouting of bedrock.
- For some parameters and flow paths, passive treatment options may offer a viable alternative to other contingency measures. These could include permeable reactive barriers or other forms of seepage interception systems designed to passively treat groundwater plumes *in situ*.
- Based on consideration to the primary investigation described as part of Trigger Threshold 1, secondary evaluation measures may be proposed to better define the source, extent and/or pathway of the contaminant plume. This may include: installation of additional monitoring wells to better constrain the seepage pathway (nature of conductive unit and vertical/lateral extent of the plume); hydraulic testing and discrete interval sampling to better determine whether the seepage plume is isolated to discrete units or fracture zones or distributed over a wider area.
- Numerical modelling to better quantify the contaminant flux to local watercourses.