8.0 SURFACE WATER RESOURCES

Surface water resources are an integral part of the hydrological cycle, and were assessed as a valued component (VC) because they can influence and be influenced by activities of the Berry Pit Expansion (Project Expansion).

Specifically, surface water resources were selected as a VC for the following reasons:

- Importance as an ecosystem (recreation and aquatic life habitat)
- Potential for Project Expansion-related effects on both surface water quality and quantity, including or resulting from:
  - Potential changes to surface water quality associated with effluent releases, surface water runoff, process water management, as well as acid rock drainage and metal leaching (ARD/ML) associated with material storage and stockpiling.
  - Potential changes to hydrological or hydrometric conditions, and effects of lowering the water table on aquatic ecosystems
  - Management of pit water quality during operation and post-closure

Surface water is closely linked to other VCs including Groundwater Resources (Chapter 7) and Fish and Fish Habitat (Chapter 9); and the Other Terrestrial Components discussed in Chapter 11, including vegetation, wetlands, terrain and soils. The potential environmental effects of changes to surface water resources on these VCs are discussed in their respective sections of the Environmental Registration / Environmental Assessment (EA) Update.

8.1 EXISTING ENVIRONMENT

A characterization of the existing surface water conditions within the spatial boundaries defined in Section 5.1.3 is provided in the following sections. Note that the assessment of surface water resources for the Project Expansion uses the same Project Area, Local Assessment Area (LAA) and Regional Assessment Area (RAA) as used for the assessment of the Valentine Gold Project (Approved Project).

8.1.1 Summary of Existing Environment

The following information has been summarized from Chapter 7, Section 7.2 from the Valentine Gold Environmental Impact Statement (EIS), and subsequent information requirements (IRs) for the Approved Project.

8.1.1.1 Climate and Physiographic Setting

Local climate affects runoff characteristics and stream flows that define surface water conditions in the Project Area. The Approved Project lies within the Western Mountains and Central Uplands climate zone of Newfoundland and Labrador (NL) and is generally characterized by cloudy conditions, strong winds and heavy snowfall in winter (Heritage NL 2014). Climate normal, wet- and dry-year precipitation, and temperature data from the Buchans Environment and Climate Change Canada (ECCC) Climate Station (ID 8400698) were used to understand the range of conditions that may be expected in the Project Area (ECCC 2019). The climate normal precipitation for the Buchans ECCC Climate Station was found to be 1,236 mm and the mean annual snowfall was found to be 359.6 cm. Intensity-Duration-Frequency (IDF) curves from the Stephenville ECCC Climate Station (ID 8403800) were assessed to understand the rainfall intensity that may be expected during various return period events (2-, 5-,10-, 20-, 50-, and 100-year). Both IDF and climate data were considered under RCP 4.5 climate change scenarios. Mean annual potential evapotranspiration (PET) for the island of Newfoundland has been mapped. The PET for the Project Area ranges from 450 to 474 mm (NLDOEC 1992).

The topography of the site is hilly with elevations ranging from 267 metres of sea level (masl) to 437 masl across the Project Area. A topographic ridge runs through the mine site in a northeast to southwest direction. Surface water runoff flows through streams and ponds southeast to Victoria Lake Reservoir, northeast to the Victoria River, or northwest to Valentine Lake. Based on a review of soils, surficial geological maps and aerial photographs, the overburden material in the Project Area generally consists of a discontinuous layer of till of variable thickness over exposed bedrock. The soils are described as imperfectly drained, commonly very shallow and associated with large areas of rock outcrops. Coarse textured soils are considered to correspond with sands and loamy sands.

Based on the ecological land classification (ELC) prepared for the Approved Project, twelve vegetation communities (i.e., land cover classes) are present in the LAA. Of these, nine are vegetated, and three are sparsely vegetated, naturally non-vegetated and/or anthropogenic. Ground cover generally consists of forest, wetland bogs, open water, shoreline, and anthropogenic (exploration camp).

8.1.1.2 Surface Water Quantity

Regional flow relationships between watershed area and hydrologic statistics (mean annual flow [MAF], mean monthly flow [MMF], and environmental flows) were used to predict flows in watersheds within the Project Area. These relationships were based on twelve Water Survey of Canada (WSC) hydrometric stations located in the northeast (NE) hydrologic region – the same region as the Project Area (AMEC 2014). The MAF and MMF for 12 WSC stations located in the NE hydrologic region were plotted against watershed areas to establish regression relationships (Figure 8-1). Similarly developed relationships were developed between peak flows and watershed areas for various return periods (2, 5, 10, 20, 50, 100, and 200-year). Low flow relationships were derived using the regional frequency analysis developed by Zadeh (2012) and put forward in the province’s low flow calculation spreadsheet for various return periods. Environmental flows for the province of NL are calculated as 50% MAF for summer months (Summer Environmental Flows), and 30% MAF for winter months (Winter Environmental Flows) (Zadeh 2012).

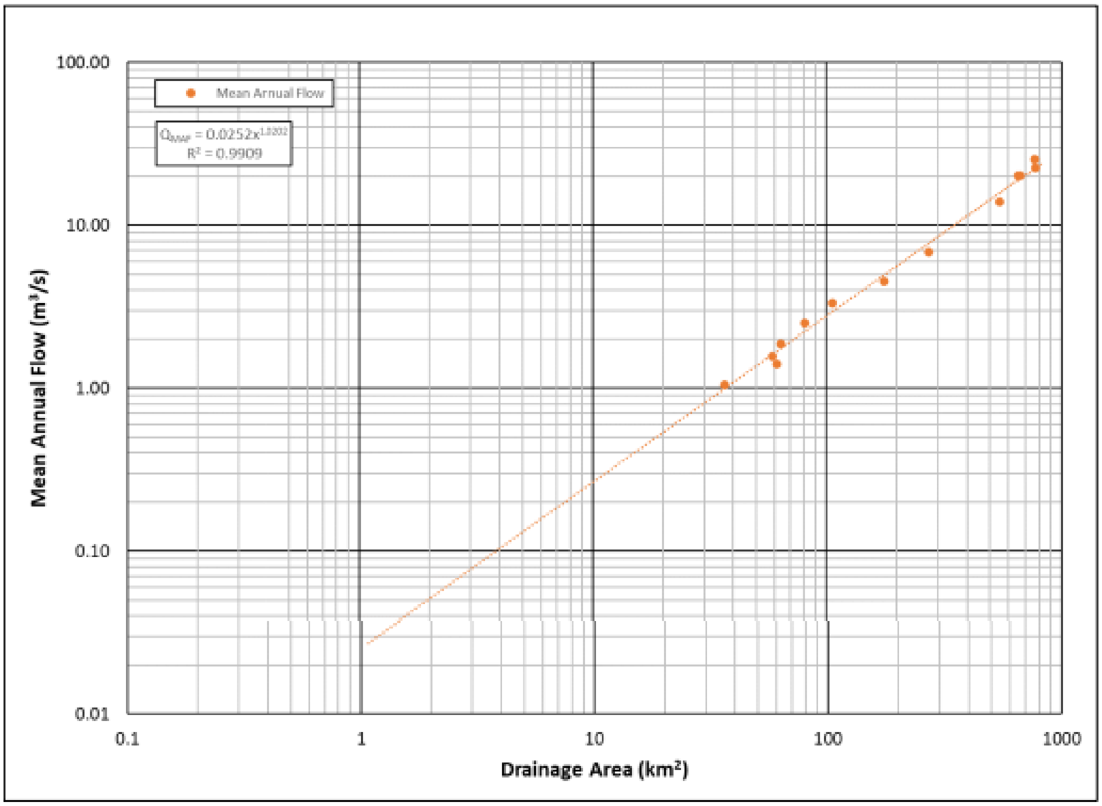
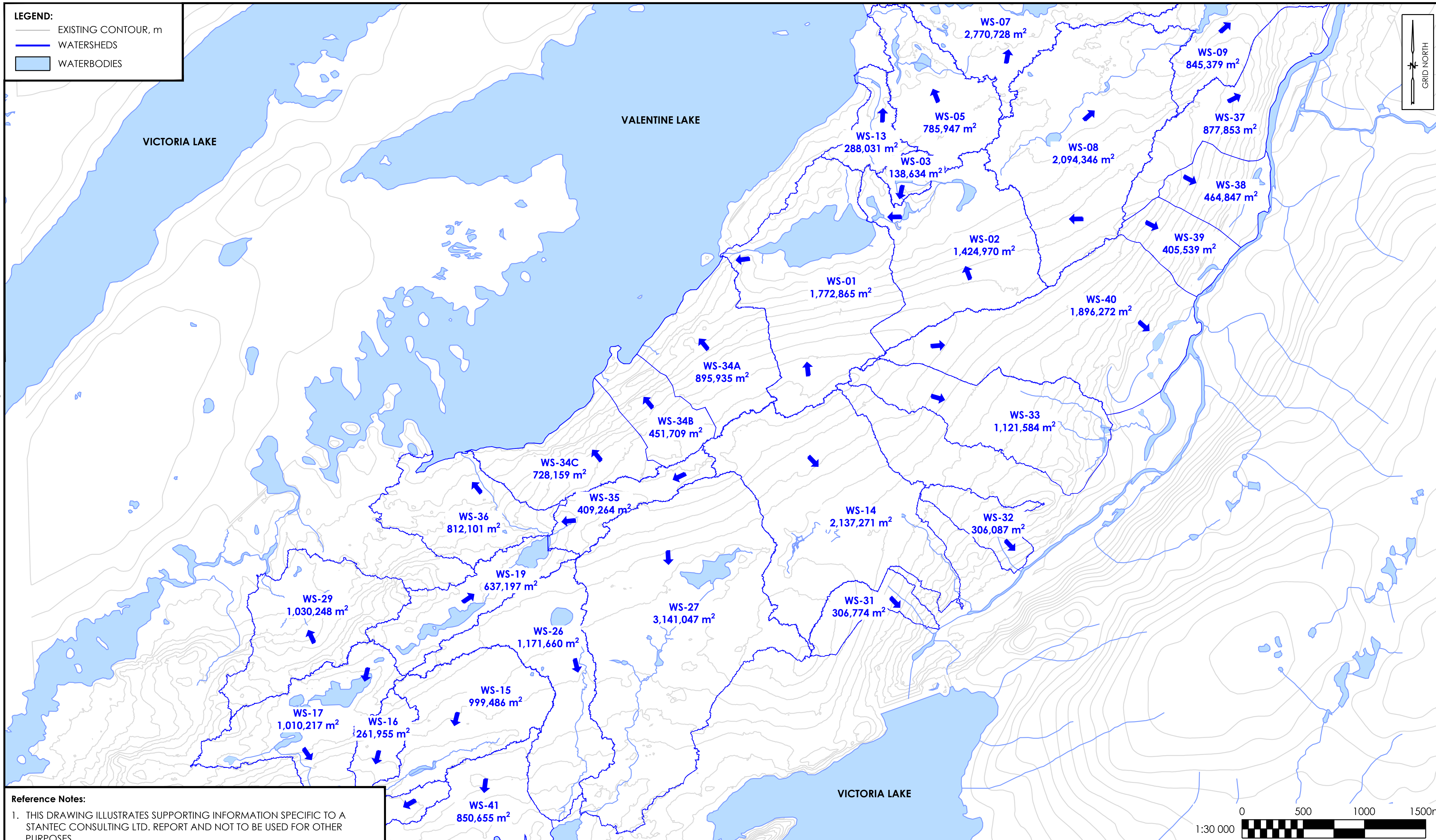


Figure 8-1 Watershed Area and Mean Annual Flow Relationship for Regionally Selected WSC Stations

Watersheds within the Project Area were delineated to capture the watershed areas for the natural/baseline condition that overlap the Approved Project and Project Expansion infrastructure. These watersheds are referred to as pre-development watershed areas. Thirty watersheds were delineated (Figure 8-2), and each contain the entire area that will have runoff directed to a Final Discharge Point (FDP) as part of the Approved Project water management infrastructure. These pre-development watersheds capture the areas needed to quantify the changes to surface water quantity related to the Approved Project.



Z:\1216\active\121620514\5_CAD\sheet_files\FINAL EA REPORT FIGURES\BERRY-FIGURES\121417802_SW_FIG_8.2_PRE-DEV_WS-11x17.dwg

Reference Notes:

1. THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC CONSULTING LTD. REPORT AND NOT TO BE USED FOR OTHER PURPOSES.
2. LIDAR DERIVED CONTOURS JUNE 6-7, 2019 (AETHON AERIAL SOLUTIONS); VERTICAL DATUM: CGVD28.
3. WATERCOURSES AND WATERBODIES: SURVEYED FISH BEARING OR HAS CONNECTIVITY TO FISH BEARING WATER (STANTEC 2012, 2019 & 2020, 2022), SUPPLEMENTED WITH CANVEC 2011 WATERCOURSES AND WATERBODIES.
4. ALL NON-WATER MANAGEMENT INFRASTRUCTURE DESIGN BY: AUSENCO, GOLDER & MOOSE MOUNTAIN TECHNICAL SERVICES DESIGN.

PRE-DEVELOPMENT WATERSHEDS

SURFACE WATER MANAGEMENT

Client: MARATHON GOLD CORPORATION

Job No.:	121417802	**Fig. No.:** 8.2	**Rev. No.:** 00
Scale:	1 : 30 000		
Date:	2023-08-10	Stantec	
Dwn. By:	CP		
App'd By:	SS		

Lake bathymetric data was used to determine assimilative capacity and expected mixing zones at the locations where Approved Project runoff and effluent enter Victoria Lake Reservoir and Valentine Lake. This bathymetric data was also used to determine assimilative capacity and expected mixing zones at the locations where the Project Expansion runoff and effluent enter Valentine Lake.

Finally, twelve hydrometric stations (HS) were established for the Approved Project. Of the twelve stations, three are located within the area of the Project Expansion (HS2, HS9, HS10). Continuous water level data was collected at HS2 and HS9 stream stations using pressure transducers as well as spot flow measurements, while the lake level station (HS10) collected continuous water level data and had no corresponding spot flow measurements. The locations of the hydrometric stations are shown in Figure 8-3. A stage-discharge relationship (rating curve) was developed for the two stream stations, based on measured water level and discharge measurements (Cassie 2018). A minimum of eight discharge measurements were completed at each station for which a rating curve was developed.

Watersheds upstream of each of the HSs were delineated using ArcGIS software. Delineated watersheds corresponding to each HS are shown in Figure 8-3 and a summary of watershed areas and elevation range is provided in Table 8.1.

Table 8.1 Watershed Areas for Hydrometric Stations

Station ID	Watershed Area (km^2)	Elevation at Headwaters (masl)	Elevation at Outlet (masl)
HS2	1.047	382	437
HS9	3.031	333	435
HS10*	3.031	333	435

Note:
* Watershed area for HS10 (Lake monitoring station) was assumed to be the same as HS9 (Lake outlet monitoring station)

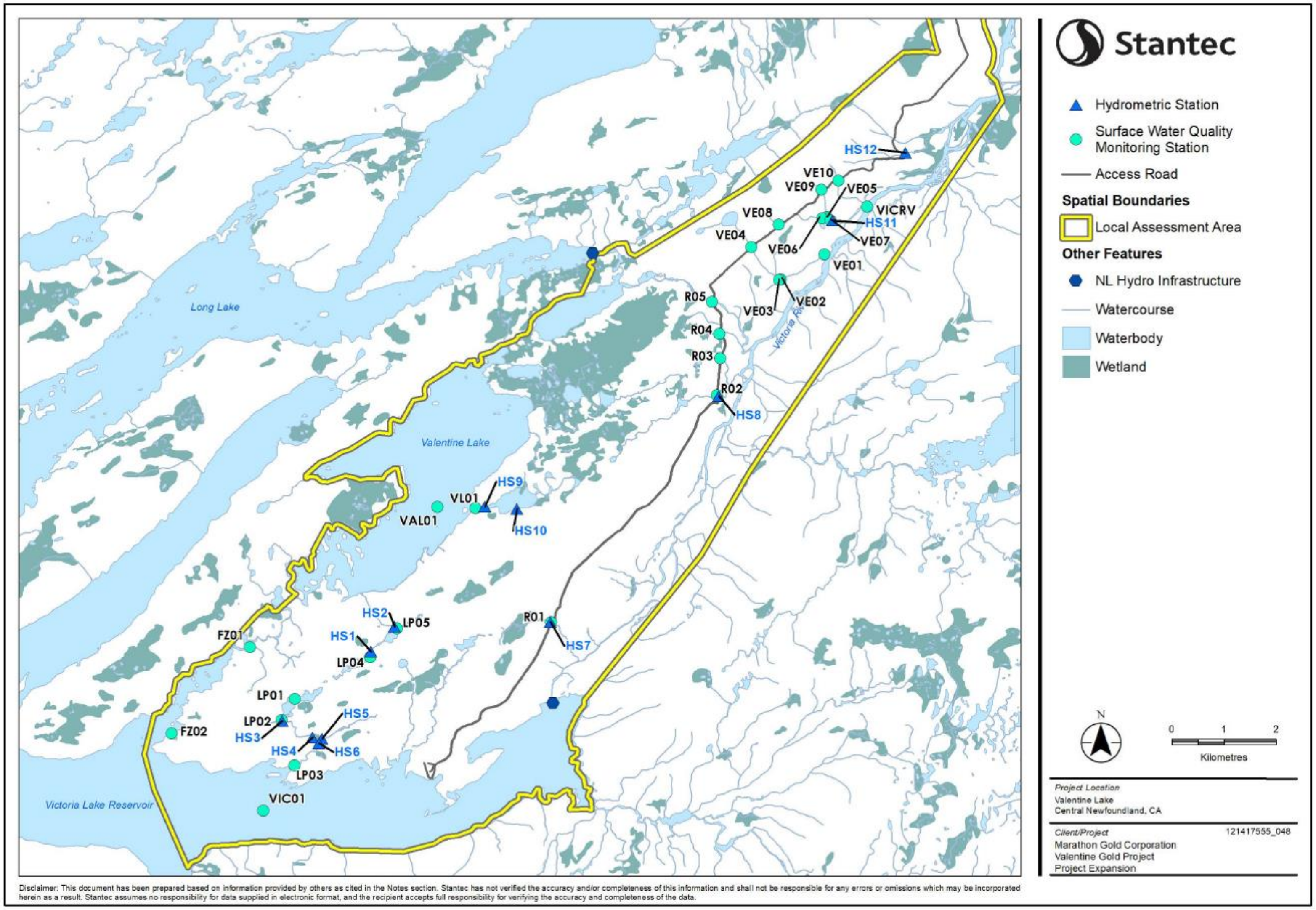


Figure 8-3 Hydrometric Station Locations and Water Quality Monitoring Stations

8.1.1.3 Surface Water Quality

Local water quality data provides a robust baseline dataset, with over 600 samples collected for many parameters at various locations throughout the Project Area over the last nine years. Regional water quality data provides a greater areal coverage with less monitoring frequency over the same period. By considering both the regional and local surface water quality data, existing water quality conditions in the Project Area were established (Figure 8-3).

A comparison between the regional and local water quality shows consistencies including low pH and alkalinity, with several metal concentrations above Canadian Water Quality Guidelines for the Protection of Fish and Aquatic Life (CWQG-FAL). The parameters identified as naturally occurring above CWQG-FAL are of potential concern as these are already at levels that may be harmful to aquatic life. The two primary parameters of concern are aluminum and iron, while five other metals also reported several exceedances and are considered parameters of potential concern including arsenic, cadmium, copper, lead, and zinc. A summary of the baseline water quality results for the Project Area can be found in Baseline Study Appendix 3: Water Resources (BSA.3), Attachment 3-C of the Valentine Gold EIS (Marathon 2020). Information on where to access this document online is contained in Table 1.8.

The baseline study assessed water quality results based on mean, minimum, maximum and 75th percentile concentrations. Concentrations that are below the reportable detection limits (RDLs) are estimated to be equal to half the value of the reportable detection limit for calculating mean, minimum and 75th percentile values. Some of the parameters (e.g., cadmium) had a large number of the results that were at or below the laboratory reportable detection limit. With a large number of sample results at or below the detection limit, the 75th percentile concentration values are estimated to be equal to or lower than the mean value.

Aluminum concentrations ranged from below the RDL to a maximum of 1,640 µg/L, with a mean of 106 µg/L and a 75th percentile of 106 µg/L. The applicable CWQG-FAL for aluminum is 100 µg/L as pH values are greater than 6.5. The aluminum concentrations were found to exceed the CWQG-FAL at many of the water quality monitoring stations at least once, aside from locations R01, VIC01 and VAL01 where concentrations were not exceeded.

Arsenic concentrations ranged from below the RDL of 1.0 µg/L to a maximum of 22.0 µg/L, with a mean of 1.2 µg/L and a 75th percentile of 1.3 µg/L. Arsenic concentrations were below the CWQG-FAL of 5 µg/L for most monitoring locations, with the exception of R01, R02, R03, R05, VL01, FZ01, and FZ02.

Cadmium concentrations ranged from below the RDL to a maximum of 2.25 µg/L, with a mean of 0.017 µg/L and a 75th percentile of 0.0085 µg/L. The hardness adjusted CWQG-FAL for cadmium ranged from 0.04 to 0.37 µg/L (long term). The total cadmium values exceeded the lower limit long term CWQG-FAL at stations VE02, VE05, VE06, VE07, VE09 VE10, RO3, RO5, VL01, and FZ01 at least once during the sampling period.

Copper concentration ranged from below the RDL to a maximum of 220 µg/L, with a mean of 1.4 µg/L and a 75th percentile of 1.0 µg/L. The CWQG-FAL for copper is based on hardness and is 2.0 µg/L when hardness is between 0 and 82 mg/L. Mean water hardness for the water quality monitoring stations was 16.7 mg/L. Reported copper concentrations were below the CWQG-FAL at most locations, except LP03, VE02, VE03, VE04, VE08, VE10, R02, R03, R04, VL01, VICRV, VIC01, and VAL01.

Lead concentrations ranged from below the RDL to a maximum of 2.72 µg/L, with a mean of 0.27 µg/L and a 75th percentile of 0.25 µg/L. The CWQG-FAL for lead is based on hardness and is 1 µg/L when hardness is less than 60 mg/L. Reported lead concentrations were below the CWQG-FAL for most locations except LP01, VE05, VE07, FZ01, and VIC01.

Iron concentrations ranged from below the RDL to a maximum of 8,900 µg/L, with a mean of 286 µg/L and a 75th percentile of 231 µg/L. Most locations reported at least a single exceedance of the CWQG-FAL of 300 µg/L, except stations VIC01 and VAL01.

Zinc concentrations ranged from below the RDL to a maximum of 91.3 µg/L, with a mean of 4.4 µg/L and a 75th percentile of 6.6 µg/L. Zinc concentrations were below the CWQG-FAL limit of 30 µg/L for most locations, except LP01, VE04, VE05, and R04.

Water quality within the Project Area was also noted to vary relative to three site-specific elements. The first is geographic spread, with differences noted between northern and southwestern clusters of monitoring locations. The second is waterbody type, with large lakes exhibiting water quality distinct from other waterbody types monitored in the Project Area (streams, pond outlets and bogs). The third is seasonality, with decreased levels of some constituents noted during periods of increased flow (i.e., TDS levels decreasing during spring melt) and increased levels of others noted during periods of low flow (i.e., elevated iron in the northern cluster from increased groundwater input during summer low flows).

8.1.2 Existing Environment Update

The following section presents a summary of updates to the existing conditions since the submission of the Valentine Gold EIS in 2020. The data for water quality was not updated because baseline conditions for water quality were established for the Project Area in the Valentine Gold EIS and remain valid for the assessment of the Project Expansion.

8.1.2.1 Surface Water Quantity

Watersheds were delineated to capture the pre-expansion areas that will overlap the Project Expansion infrastructure. These watersheds contain the entire area that will have runoff directed to an existing FDP as part of the water management infrastructure. These pre-expansion watersheds (referred to as watershed areas) capture the areas needed to quantify changes to surface water quantity related to the Project Expansion and are shown in Figure 8-2. The watershed numbers have been updated since the submission of the Valentine Gold EIS to reflect the stream names within each watershed. The watershed names are a continuation from the watershed names as submitted in the Fish and Fish Habitat Offsetting Plan written for Fisheries and Oceans Canada (DFO) for the Approved Project. A summary of watershed areas and elevation ranges are provided in Table 8.2.

Table 8.2 Pre-Development Watershed Areas

Watershed (WS) ID	Watershed Area (km^2)	Elevation at Headwaters (masl)	Elevation at Outlet (masl)
WS-01	1.773	434	327
WS-02	1.425	417	338
WS-03	0.139	348	338
WS-05	0.786	350	326
WS-07	2.771	342	300
WS-08	2.094	402	299
WS-09	0.845	355	276
WS-13	0.288	346	326
WS-14	2.137	432	279
WS-15	0.999	412	342
WS-16	0.262	410	342
WS-17	1.010	411	342
WS-19	0.637	410	387
WS-26	1.172	410	326
WS-27	3.141	414	325
WS-29	1.030	430	329
WS-31	0.307	405	275
WS-32	0.306	367	275
WS-33	1.122	434	288
WS-34A	0.896	433	326
WS-34B	0.452	433	326
WS-34C	0.728	431	326
WS-35	0.409	431	388
WS-36	0.812	409	326
WS-37	0.878	394	267
WS-38	0.465	378	267
WS-39	0.406	394	278
WS-40	1.896	428	272
WS-41	0.851	364	325
WS-42	2.603	410	325

Flow statistics for MAF, MMF, and Return Period Flows for these watershed areas have been calculated by applying the relationships developed in the Regional Hydrology Assessment, included in BSA.3, Attachment 3-C of the Valentine Gold EIS (Marathon 2020). Information on where to access this document online is contained in Table 1.8. Table 8.3 presents the calculated flow statistics for each watershed area.

Low and environmental flow statistics (7Q10, 50% MAF, and 30% MAF) have also been calculated for each watershed area by applying the relationships developed in the Regional Hydrology Assessment for the Baseline Study (BSA.3, Attachment 3-C of the Valentine Gold EIS; Table 1.8). Low flow indices for the RAA were derived using a regional frequency analysis for NL (Zadeh 2012). The 7-day duration low flow was calculated for a return period of 2, 10-, 20-, 50-, and 100-years using relationships based on watershed area developed by Zadeh (2012). The 7-day 10-year return period flow (7Q10) is presented in Table 8.4 as the calculated low flow statistic for each watershed area.

Environmental flows were established, as outlined by Zadeh (2012), using relationships between MAF and in-stream flow needs for the winter and summer periods. Recommended minimum flows for the summer and winter periods are 50% MAF and 30% MAF for winter and summer, respectively based on ‘excellent’ river conditions (Zadeh 2012). Table 8.4 presents the calculated environmental flow statistics for each watershed area.

8.2 PROJECT EXPANSION INTERACTIONS AND PATHWAYS

Table 8.5 lists the potential Project Expansion effects on surface water resources and provides a summary of the Project Expansion effect pathways, measurable parameters and units of measurement to assess potential effects. Potential environmental effects and measurable parameters were selected based on review of recent environmental assessments for mining projects in NL and other parts of Canada, comments provided during engagement, and professional judgment.

Table 8.3 Calculated Flow Statistics for Pre-Development Watershed Areas

ID	Area (km^2)	MAF (m^3/s)	Q100	Mean Monthly Flows (m^3/s)											
				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
WS-01	1.773	0.045	2.428	0.022	0.023	0.040	0.129	0.122	0.049	0.025	0.020	0.032	0.048	0.052	0.035
WS-02	1.425	0.036	2.033	0.017	0.018	0.031	0.104	0.100	0.040	0.020	0.016	0.026	0.039	0.041	0.028
WS-03	0.139	0.003	0.305	0.001	0.001	0.003	0.010	0.012	0.005	0.002	0.002	0.003	0.004	0.004	0.002
WS-05	0.786	0.020	1.252	0.009	0.009	0.017	0.058	0.058	0.023	0.011	0.009	0.014	0.021	0.022	0.015
WS-07	2.771	0.071	3.493	0.036	0.037	0.063	0.200	0.184	0.075	0.039	0.031	0.050	0.075	0.082	0.057
WS-08	2.094	0.054	2.781	0.026	0.027	0.047	0.152	0.142	0.058	0.030	0.023	0.038	0.057	0.061	0.042
WS-09	0.845	0.021	1.329	0.010	0.010	0.018	0.062	0.062	0.025	0.012	0.009	0.015	0.023	0.024	0.016
WS-13	0.288	0.007	0.553	0.003	0.003	0.006	0.021	0.023	0.009	0.004	0.003	0.005	0.008	0.008	0.005
WS-14	2.137	0.055	2.828	0.027	0.028	0.048	0.155	0.145	0.059	0.030	0.024	0.039	0.058	0.063	0.043
WS-15	0.999	0.025	1.523	0.012	0.012	0.022	0.073	0.072	0.029	0.014	0.011	0.018	0.027	0.029	0.019
WS-16	0.262	0.006	0.512	0.003	0.003	0.005	0.020	0.021	0.008	0.004	0.003	0.005	0.007	0.007	0.004
WS-17	1.010	0.025	1.536	0.012	0.012	0.022	0.074	0.073	0.029	0.015	0.011	0.018	0.027	0.029	0.019
WS-19	0.637	0.016	1.055	0.007	0.007	0.013	0.047	0.048	0.019	0.009	0.007	0.012	0.017	0.018	0.012
WS-26	1.172	0.030	1.733	0.014	0.014	0.026	0.086	0.083	0.034	0.017	0.013	0.021	0.032	0.034	0.023
WS-27	3.141	0.081	3.869	0.042	0.043	0.072	0.226	0.206	0.084	0.044	0.035	0.057	0.085	0.093	0.066
WS-29	1.030	0.026	1.561	0.012	0.012	0.022	0.075	0.074	0.030	0.015	0.011	0.019	0.028	0.029	0.020
WS-31	0.307	0.008	0.582	0.003	0.003	0.006	0.023	0.024	0.010	0.005	0.003	0.006	0.008	0.008	0.005
WS-32	0.306	0.008	0.581	0.003	0.003	0.006	0.023	0.024	0.010	0.005	0.003	0.006	0.008	0.008	0.005
WS-33	1.122	0.028	1.673	0.013	0.014	0.024	0.082	0.080	0.032	0.016	0.012	0.021	0.030	0.032	0.022
WS-34A	0.896	0.023	1.393	0.010	0.011	0.019	0.066	0.065	0.026	0.013	0.010	0.016	0.024	0.026	0.017
WS-34B	0.452	0.011	0.797	0.005	0.005	0.009	0.033	0.035	0.014	0.007	0.005	0.008	0.012	0.013	0.008
WS-34C	0.728	0.018	1.176	0.008	0.008	0.015	0.054	0.054	0.022	0.011	0.008	0.013	0.020	0.021	0.013
WS-35	0.409	0.010	0.736	0.004	0.004	0.008	0.030	0.032	0.013	0.006	0.005	0.008	0.011	0.011	0.007

Table 8.3 Calculated Flow Statistics for Pre-Development Watershed Areas

ID	Area (km^2)	MAF (m^3/s)	Q100	Mean Monthly Flows (m^3/s)											
				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
WS-36	0.812	0.020	1.286	0.009	0.009	0.017	0.060	0.060	0.024	0.012	0.009	0.015	0.022	0.023	0.015
WS-37	0.878	0.022	1.370	0.010	0.010	0.019	0.064	0.064	0.026	0.013	0.010	0.016	0.024	0.025	0.017
WS-38	0.465	0.012	0.816	0.005	0.005	0.010	0.034	0.036	0.014	0.007	0.005	0.009	0.013	0.013	0.008
WS-39	0.406	0.010	0.730	0.004	0.004	0.008	0.030	0.031	0.013	0.006	0.005	0.007	0.011	0.011	0.007
WS-40	1.896	0.048	2.565	0.024	0.024	0.042	0.137	0.130	0.053	0.027	0.021	0.035	0.051	0.055	0.038
WS-41	0.851	0.021	1.335	0.010	0.010	0.018	0.062	0.062	0.025	0.012	0.009	0.016	0.023	0.024	0.016
WS-42	2.603	0.067	3.320	0.034	0.035	0.059	0.188	0.174	0.071	0.037	0.029	0.047	0.070	0.077	0.053

Table 8.4 Calculated Low Flow Statistics for Pre-Development Watershed Areas

ID	Area (km^2)	7Q10	Winter Env. Flow (50% MAF)	Summer Env. Flow (30% MAF)
WS-01	1.773	0.0022	0.0226	0.0136
WS-02	1.425	0.0018	0.0181	0.0109
WS-03	0.139	0.0001	0.0017	0.0010
WS-05	0.786	0.0009	0.0099	0.0059
WS-07	2.771	0.0036	0.0356	0.0214
WS-08	2.094	0.0027	0.0268	0.0161
WS-09	0.845	0.0010	0.0106	0.0064
WS-13	0.288	0.0003	0.0035	0.0021
WS-14	2.137	0.0027	0.0273	0.0164
WS-15	0.999	0.0012	0.0126	0.0076

Table 8.4 Calculated Low Flow Statistics for Pre-Development Watershed Areas

ID	Area (km^2)	7Q10	Winter Env. Flow (50% MAF)	Summer Env. Flow (30% MAF)
WS-16	0.262	0.0003	0.0032	0.0019
WS-17	1.010	0.0012	0.0127	0.0076
WS-19	0.637	0.0007	0.0080	0.0048
WS-26	1.172	0.0014	0.0148	0.0089
WS-27	3.141	0.0041	0.0405	0.0243
WS-29	1.030	0.0012	0.0130	0.0078
WS-31	0.307	0.0003	0.0038	0.0023
WS-32	0.306	0.0003	0.0038	0.0023
WS-33	1.122	0.0014	0.0142	0.0085
WS-34A	0.896	0.0011	0.0113	0.0068
WS-34B	0.452	0.0005	0.0056	0.0034
WS-34C	0.728	0.0009	0.0091	0.0055
WS-35	0.409	0.0005	0.0051	0.0030
WS-36	0.812	0.0010	0.0102	0.0061
WS-37	0.878	0.0010	0.0110	0.0066
WS-38	0.465	0.0005	0.0058	0.0035
WS-39	0.406	0.0005	0.0050	0.0030
WS-40	1.896	0.0024	0.0242	0.0145
WS-41	0.851	0.0010	0.0107	0.0064
WS-42	2.603	0.0034	0.0334	0.0201

Table 8.5 Potential Effects, Effect Pathways and Measurable Parameters for Surface Water Resources

Potential Environmental Effect	Effect Pathway	Measurable Parameters and Units of Measurement
Change in surface water quantity	• Project activities may have an effect or alter the natural flow regime through changes to surface vegetation cover, imperviousness, topography and drainage divides, slopes, open pit dewatering, seepage from stockpiles, and management of surface water runoff.	• Stream discharge (variety of flow statistics including mean annual, monthly, and event-based discharges) • Lake water levels (mean and range of expected levels) • River morphology
Change in surface water quality	• Project activities may have an effect or alter water quality through changes to the natural flow regime, contact water seepage and runoff, sedimentation and erosion rates, process water discharges, and spills of hazardous materials.	• Water quality parameter concentrations (local and regional means concentrations and expected ranges) • Sedimentation and erosion potential and TSS loads

Table 8.6 identifies the physical activities that might interact with the VC and result in the identified environmental effect. These interactions are indicated by checkmark and are discussed in detail in Section 8.5, in the context of effects pathways, standard and project-specific mitigation / enhancement, and residual effects. Following the table, justification is provided for where no interaction (and therefore no resulting effect) is predicted.

Table 8.6 Project-Environment Interactions with Surface Water Resources

Physical Activities	Environmental Effects to Be Assessed	
	Change in Surface Water Quantity	Change in Surface Water Quality
CONSTRUCTION		
Mine Site Preparation and Earthworks: Clearing and cutting of vegetation and removal of organic materials, development of roads, and excavation and preparation of stockpile areas within the Expansion footprint. For the open pit, earthworks include stripping, stockpiling of organic and overburden materials, and development of in-pit quarries to supply site development rock for infrastructure such as structural fill and road gravels. Also includes temporary surface water and groundwater management, and the presence of people and equipment on site.	✓	✓
Construction / Installation of Infrastructure and Equipment: Construction of infrastructure as required for the Project Expansion. Also includes: • Installation of water control structures (including earthworks) • Presence of people and equipment on-site	✓	✓

Table 8.6 Project-Environment Interactions with Surface Water Resources

Physical Activities	Environmental Effects to Be Assessed	
	Change in Surface Water Quantity	Change in Surface Water Quality
Emissions, Discharges and Wastes[A]: Noise, air emissions / GHGs, light, water discharge, and hazardous and non-hazardous wastes.	✓	✓
OPERATION		
Open Pit Mining: Blasting, excavation and haulage of rock from the open pits using conventional mining equipment.	✓	✓
Topsoil, Overburden and Rock Management: Four types of piles: • Topsoil • Overburden • Waste rock • Low-grade ore Rock excavated from the open pit that will not be processed for gold will be used as engineered fill for site development, maintenance and rehabilitation, assuming it is non-acid generating, deposited in mined out basins of Berry pit, or will be deposited in a waste rock pile.	✓	✓
Tailings Management: Following treating tailings via cyanide destruction, tailings will be thickened and pumped to an engineered tailings impoundment in years 1 to 9, then pumped to the exhausted Berry open pit in year 10 to the end of operation. Marathon plans to upgrade the water treatment process by replacing the proposed polishing pond with a smaller SAGR unit that provides improved treatment of nitrogen species.	✓	✓
Water Management (Collection, treatment and release)**:** Site contact water and process effluent will be managed on site and treated prior to discharge to the environment. Where possible, non-contact water will be diverted away from mine features and infrastructure, and site contact and process water will be recycled to the extent possible for use on site.	✓	✓
Utilities, Infrastructure and Other Facilities: Most utilities, infrastructure and facilities remain unchanged, and are as described in the Valentine Gold EIS (Marathon 2020) and assessed as part of the Approved Project. Relocation of the explosives facility, maintenance of Berry haul road and site snow clearing will be required for the Project Expansion. • Note that while the location of the explosives facility has changed, the design and activities associated with the facility have not.	✓	✓
Emissions, Discharges and Wastes[A]: Noise, air emissions / GHGs, light, water discharge, and hazardous and non-hazardous wastes.	✓	✓
Employment and Expenditures: Operation of the combined Approved Project and Project Expansion is estimated to require a peak workforce of approximately 524 fulltime equivalents (FTEs) (44 FTEs above the Valentine Gold EIS estimate) and an average of 366 FTEs.	-	-

Table 8.6 Project-Environment Interactions with Surface Water Resources

Physical Activities	Environmental Effects to Be Assessed	
	Change in Surface Water Quantity	**Change in Surface Water Quality**
DECOMMISSIONING, REHABILITATION AND CLOSURE		
Decommissioning of Mine Features and Infrastructure	✓	✓
Progressive Rehabilitation: Erosion stabilization and re-vegetation of completed overburden and/or waste rock piles; infilling or flooding of exhausted mining areas; and completing revegetation studies and trials.	✓	✓
Closure Rehabilitation: Active rehabilitation based on successes of progressive rehabilitation activities. Includes: grading and revegetating cleared areas, where practicable; breaching and regrading ponds to reestablish drainage patterns; erosion stabilization and revegetation of completed overburden and/or waste rock piles; and infilling or flooding of open pit.	✓	✓
Post-Closure: Long-term monitoring	–	–
Emissions, Discharges and Waste[A]	✓	✓

Notes:
✓ = Potential interaction
– = No interaction
[A] Emissions, Discharges, and Wastes (e.g., air, waste, noise, light, liquid and solid effluents) are generated by many Project Expansion activities. Rather than acknowledging this by placing a checkmark against each of these activities, "Wastes and Emissions" is an additional component under each Project Expansion phase.

In the absence of mitigation, the Project Expansion may interact with surface water resources in the following ways:

- Mine site preparation and earthworks including clearing of vegetation, stripping of soils, and creation of stockpiles will alter water quantity and quality related to runoff.
- Mine water management, contact water runoff and seepage will affect water quantity and water quality
- Open pit mining will alter the surface water quantity and quality entering local watersheds. Open pits will be dewatered during operation and allowed to fill during closure
- Progressive and closure rehabilitation will alter water quantity and quality by changing runoff patterns and by reducing the amount of exposed bedrock.

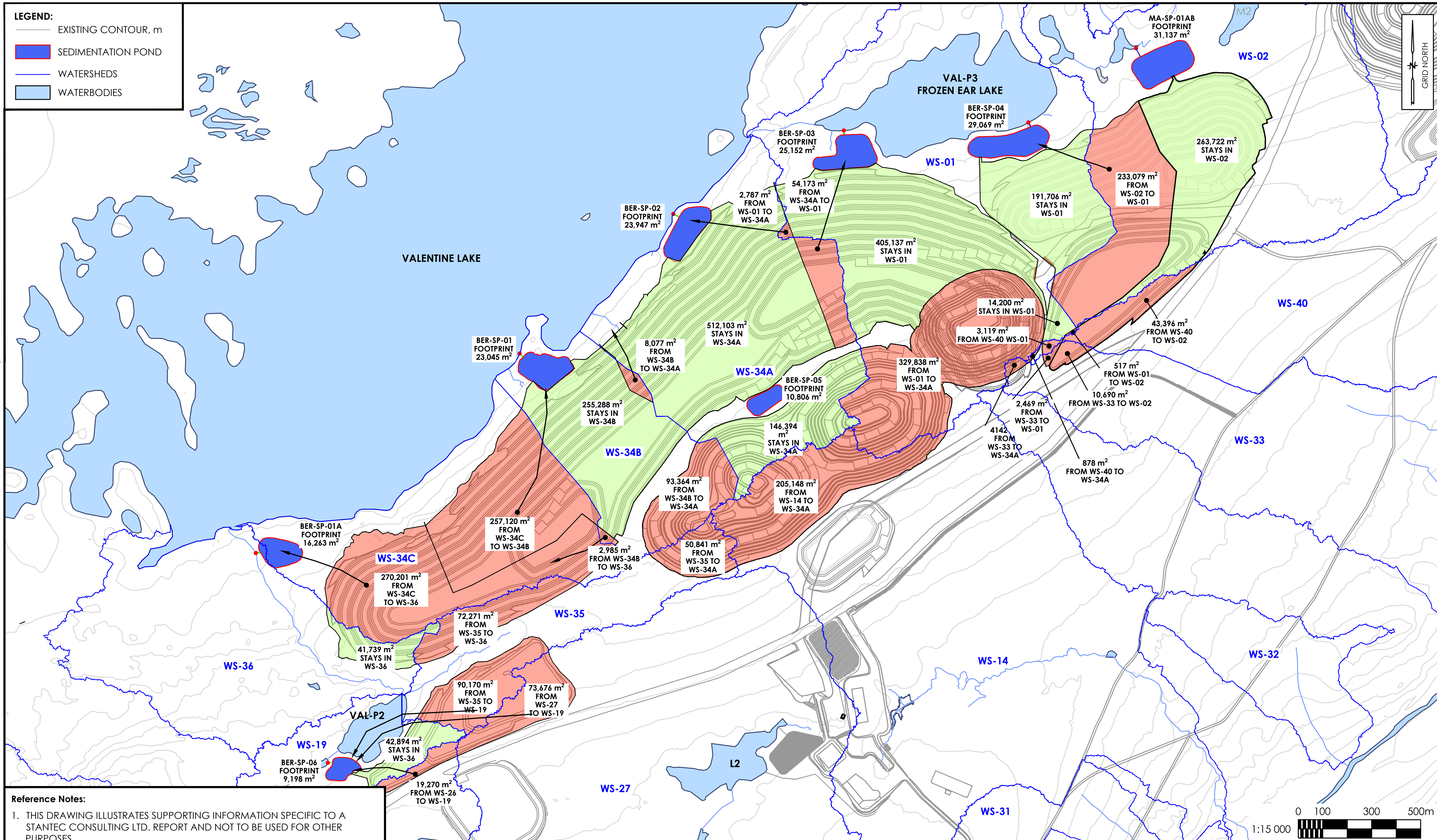
The primary Project Expansion-related effects on surface water resources will include changes to local watershed areas due to construction of stockpiles and the open pit, dewatering during operation, and flooding during closure of the open pit.

8.2.1 Analytical Assessment Techniques

The environmental effects analyses for changes in surface water quantity and surface water quality were carried out using a number of analytical methods and tools including site-wide water quantity and quality GoldSim^{TM} model, site-wide hydrogeological model, and a 3-Dimensional steady state near-field Cornell Mixing Zone Expert System (CORMIX) model. Development of the models, inputs, and results are described in detail in the Water Quantity and Water Quality Model Update Report (Appendix 8A), and the Assimilative Capacity Assessment Study Update Report (Appendix 8B). The following sub-sections provide an overview of the methods used to complete the surface water resources effects assessment. Note that the Project Expansion consists of one open pit, comprised of three basins (northern, central and southern) as described in the Project Description (Chapter 2). For the purposes of the Water Quantity and Water Quality Model Update Report, the southern basin of the Berry open pit is referred to as the Southwest (SW) pit; the central basin is referred to as the Central pit; and the northern basin of the Berry pit is referred to as the Northeast (NE) pit.

8.2.1.1 Analytical Assessment Techniques for Change in Surface Water Quantity

Flows and water levels under pre-development (natural) conditions were used as the baseline against which Project Expansion-related changes during construction, operation, and rehabilitation and closure phases were assessed. Pre-development (baseline) watershed areas are presented in Figure 8-2 and expected changes to these watersheds were delineated for subsequent phases of the mine life, as shown in Figures 8-4 to 8-6 for the Berry Complex. The changes in watershed areas are primarily a result of the construction of mine infrastructure and the implementation of the updated Water Management Plan (Appendix 2A).



Z:\1216\active\121620514\5_CAD\sheet_files\FINAL EA REPORT FIGURES\BERRY-FIGURES\121417802_SW_FIG_8.4_BER_CTCHMENT_OPR-11x17.dwg

Reference Notes:

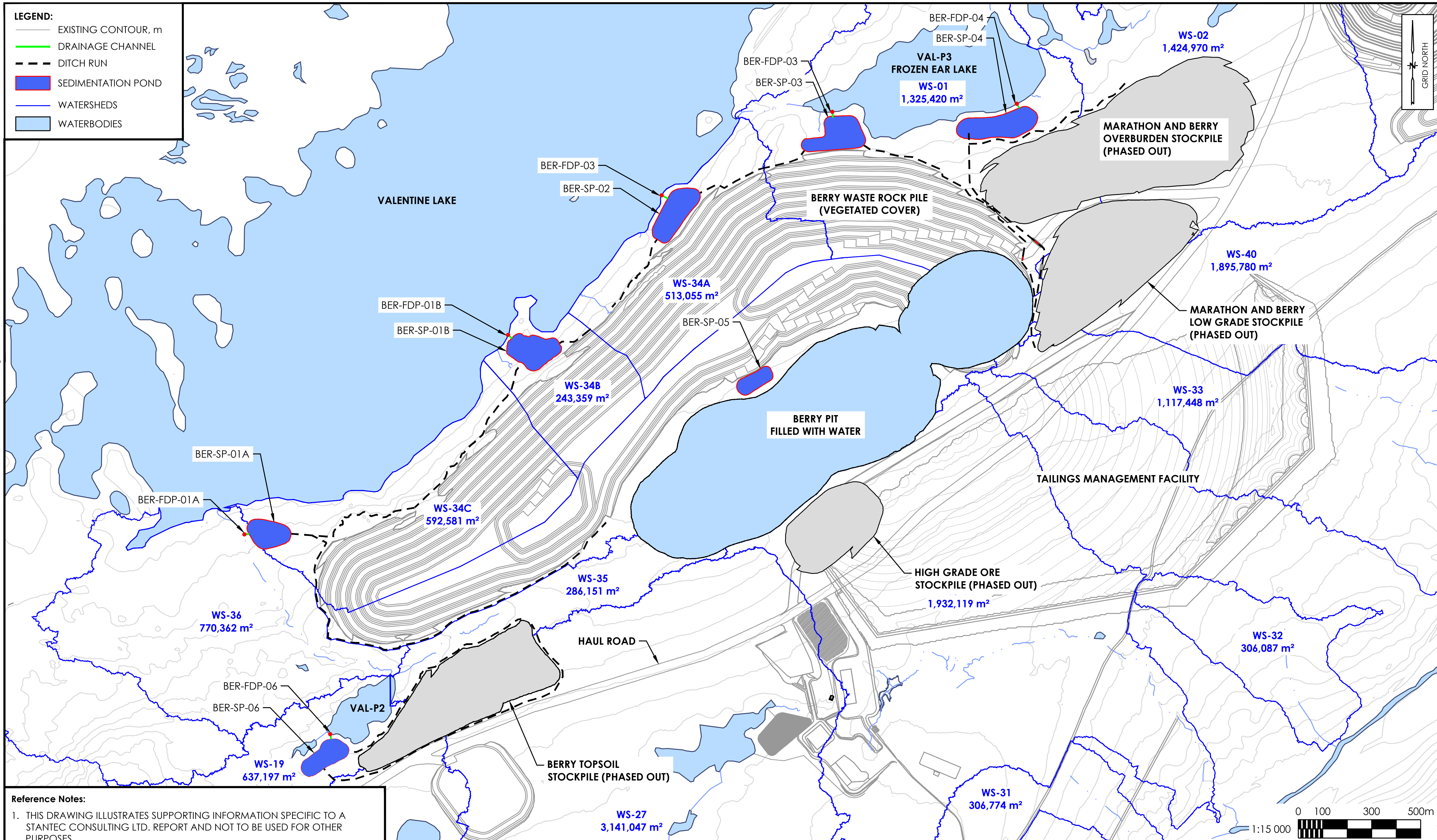
1. THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC CONSULTING LTD. REPORT AND NOT TO BE USED FOR OTHER PURPOSES.
2. LIDAR DERIVED CONTOURS JUNE 6-7, 2019 (AETHON AERIAL SOLUTIONS); VERTICAL DATUM: CGVD28.
3. WATERCOURSES AND WATERBODIES: SURVEYED FISH BEARING OR HAS CONNECTIVITY TO FISH BEARING WATER (STANTEC 2012, 2019 & 2020, 2022), SUPPLEMENTED WITH CANVEC 2011 WATERCOURSES AND WATERBODIES.
4. ALL NON-WATER MANAGEMENT INFRASTRUCTURE DESIGN BY: AUSENCO, GOLDER & MOOSE MOUNTAIN TECHNICAL SERVICES DESIGN.

BERRY CATCHMENT AREA - OPERATIONS

SURFACE WATER MANAGEMENT

Client: MARATHON GOLD CORPORATION

Job No.:	121417802	Fig. No.: 8.4	Rev. No.: 00
Scale:	1 : 15 000		
Date:	2023-08-10		
Dwn. By:	CP	Stantec	
App'd By:	SS		



Z:\1216\active\121620514\5_CAD\sheet_files\FINAL EA REPORT FIGURES\BERRY-FIGURES\121417802_SW_FIG_8.5_BER_CTCHMENT_CLO-11x17.dwg

Reference Notes:

1. THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC CONSULTING LTD. REPORT AND NOT TO BE USED FOR OTHER PURPOSES.
2. LIDAR DERIVED CONTOURS JUNE 6-7, 2019 (AETHON AERIAL SOLUTIONS); VERTICAL DATUM: CGVD28.
3. WATERCOURSES AND WATERBODIES: SURVEYED FISH BEARING OR HAS CONNECTIVITY TO FISH BEARING WATER (STANTEC 2012, 2019 & 2020, 2022), SUPPLEMENTED WITH CANVEC 2011 WATERCOURSES AND WATERBODIES.
4. ALL NON-WATER MANAGEMENT INFRASTRUCTURE DESIGN BY: AUSENCO, GOLDER & MOOSE MOUNTAIN TECHNICAL SERVICES DESIGN.

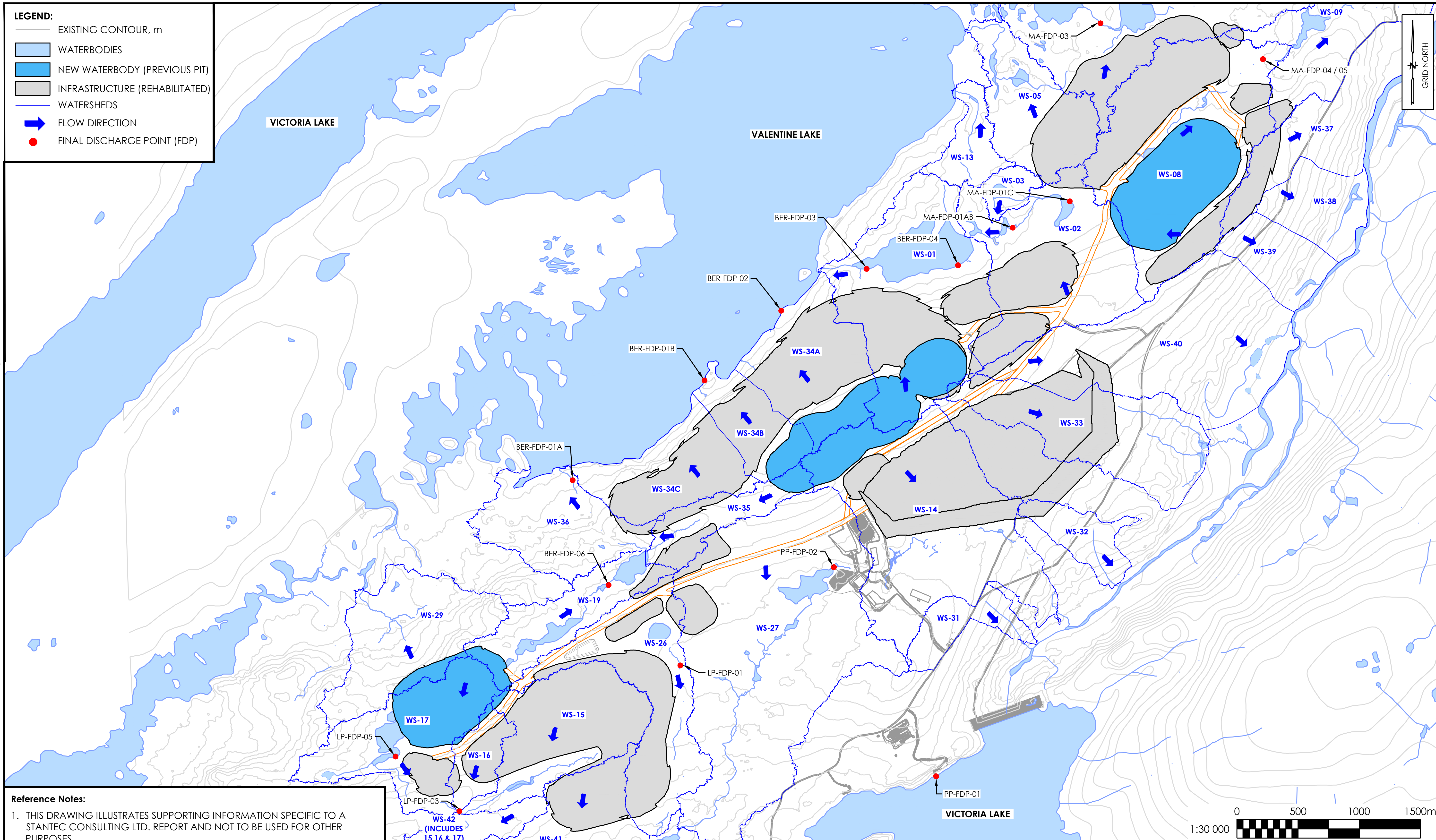
BERRY CATCHMENT AREA - CLOSURE

SURFACE WATER MANAGEMENT

Client: MARATHON GOLD CORPORATION

Job No.:	121417802
Scale:	1 : 15 000
Date:	2023-08-10
Dwn. By:	CP
App'd By:	SS
Fig. No.:	8.5
Rev. No.:	00

Stantec



Reference Notes:

1. THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC CONSULTING LTD. REPORT AND NOT TO BE USED FOR OTHER PURPOSES.
2. LIDAR DERIVED CONTOURS JUNE 6-7, 2019 (AETHON AERIAL SOLUTIONS); VERTICAL DATUM: CGVD28.
3. WATERCOURSES AND WATERBODIES: SURVEYED FISH BEARING OR HAS CONNECTIVITY TO FISH BEARING WATER (STANTEC 2012, 2019 & 2020, 2022), SUPPLEMENTED WITH CANVEC 2011 WATERCOURSES AND WATERBODIES.
4. ALL NON-WATER MANAGEMENT INFRASTRUCTURE DESIGN BY: AUSENCO, GOLDER & MOOSE MOUNTAIN TECHNICAL SERVICES DESIGN.

MINE POST - CLOSURE WATERSHEDS

SURFACE WATER MANAGEMENT

Client: MARATHON GOLD CORPORATION

Job No.:	121417802	Fig. No.: 8.6	Rev. No.: 00
Scale:	1 : 30 000		
Date:	2023-08-09		
Dwn. By:	CP		
App'd By:	SS		

Stantec

Z:\1216\active\121620514\5_CAD\sheet_files\FINAL EA REPORT FIGURES\BERRY-FIGURES\121417802_SW_FIG_8.6_MINE_POST_CLO_WS-11x17.dwg

Project Expansion-related changes in surface water quantity were assessed at the watershed scale using the following tiered approach:

- A site-wide water quantity model was developed in the GoldSim™ model to predict the water quantity changes through the Approved Project and Project Expansion phases. The water quantity model includes the open pits, overburden stockpiles, waste rock piles, low grade ore stockpiles and topsoil piles. With the addition of the Berry pit, the TMF water quantity model was also updated to verify there is adequate storage capacity for the Berry pit tailings.
- Changes in MAF and MMF from pre-development conditions were used as a screening threshold to determine whether further assessment of changes in flow were required. Changes in MAF and MMF were calculated for watersheds during each phase of mine development. MAF and MMF were developed using regional relationships used in the Valentine Gold EIS. Watersheds with an expected change in MMF or MAF of greater than 10% were carried forward to subsequent assessment steps.
- For watersheds with an expected decrease of over 10%, the MMFs were compared with baseline environmental flows. The residual effect was considered to not be significant if the predicted MMF was greater than the baseline environmental flows. If the expected MMF was lower than the baseline environmental flows, a locally significant surface water quantity residual effect is expected within the LAA.
- For watersheds with an expected increase in MMF or MAF of over 10%, expected flood flows (Q100) were compared with baseline conditions to assess the potential for flooding and erosion.
- Changes in MMF and MAF were also assessed at the boundary of the LAA for Valentine Lake. Pre-development watersheds at the extent of the LAA are shown in Figure 8-7. Figures 8-8 to 8-10 show the LAA watersheds for construction and operation, closure, and post-closure mine phases. Expected MMF and MAF for these phases were compared with pre-development conditions to establish expected changes in surface water quantity at the boundary of the LAA. If a residual effect for surface water is spread to the boundary of the LAA and beyond, it is considered a significant residual effect.

8.2.1.2 Analytical Assessment Techniques for Change in Surface Water Quality

Baseline surface water quality was used as the baseline against which changes to surface water quality during Project-Expansion phases were assessed. As outlined in the updated Water Management Plan (Appendix 2A and Section 8.3.1), a design objective for water management infrastructure is to keep non-contact water and contact water separated. Contact water is directed to sedimentation ponds prior to discharge to the environment at FDP locations shown in Figure 8-11. Non-contact water directed to the environment has been assumed to be represented by baseline water quality. Contact water quality was predicted by integrating geochemical contact water predictions into the GoldSim™ water quantity model in a water quality module and is further discussed below.

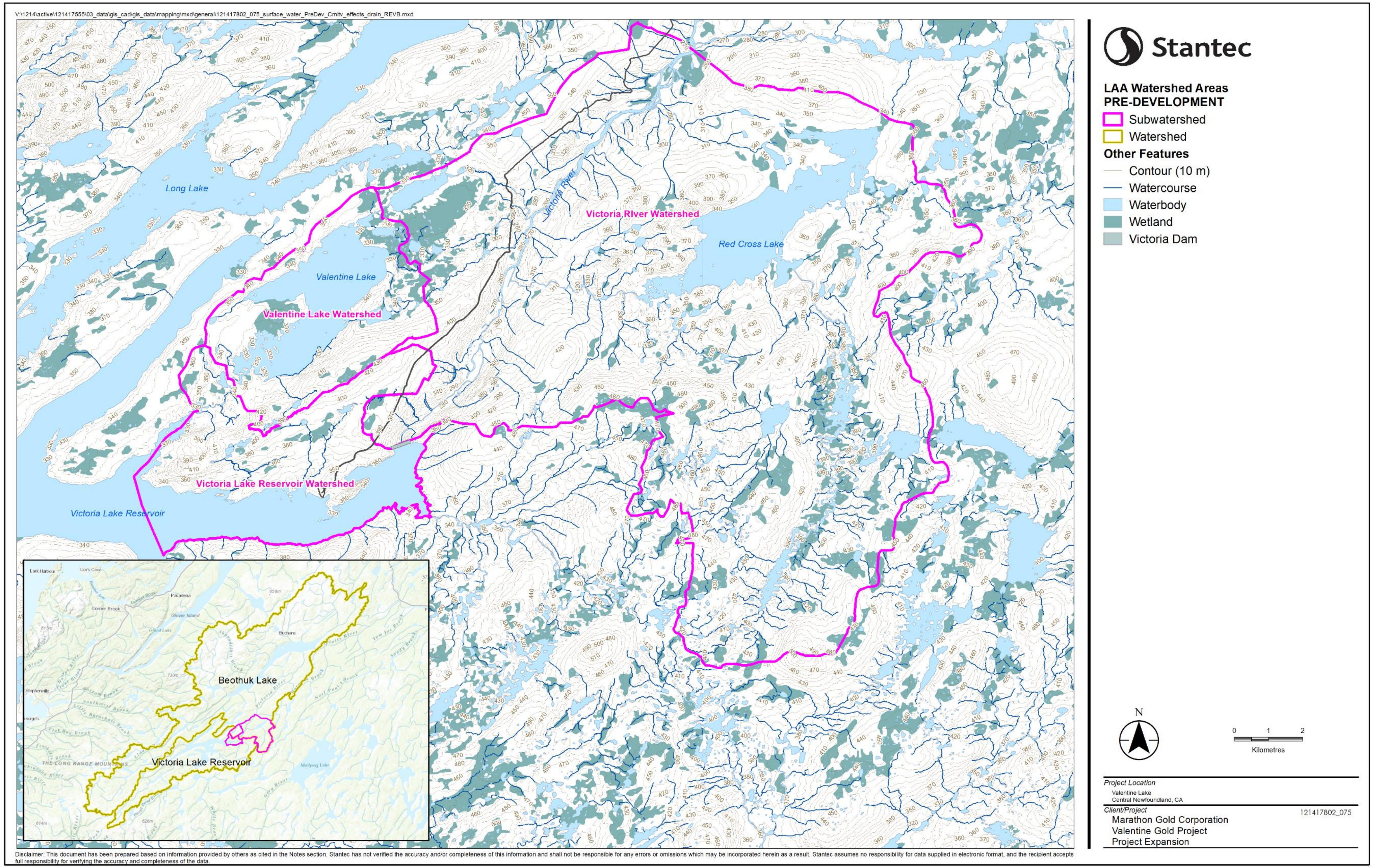


Figure 8-7 LAA Pre-Development Watershed Areas

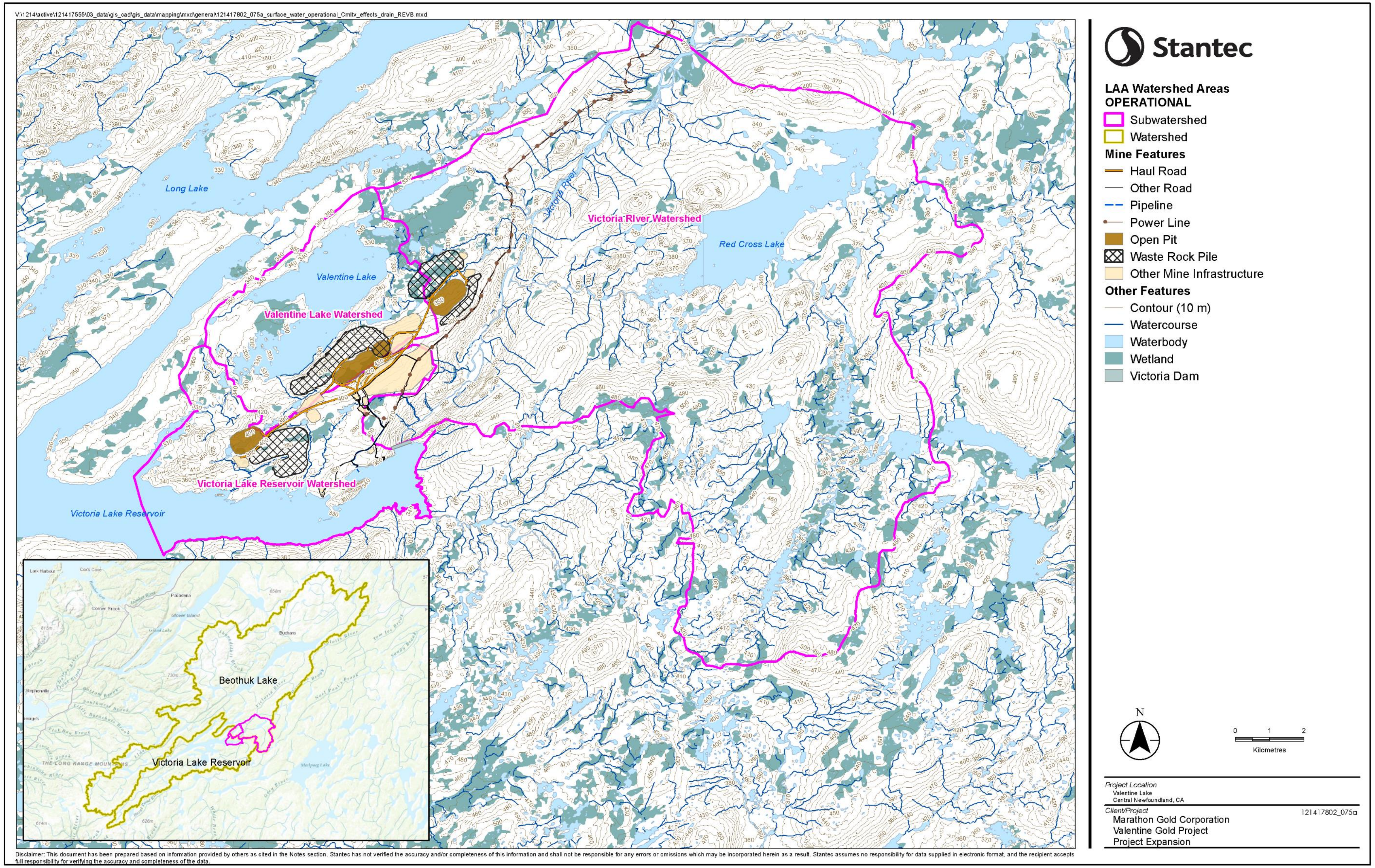


Figure 8-8 LAA Watershed Areas during Construction and Operation

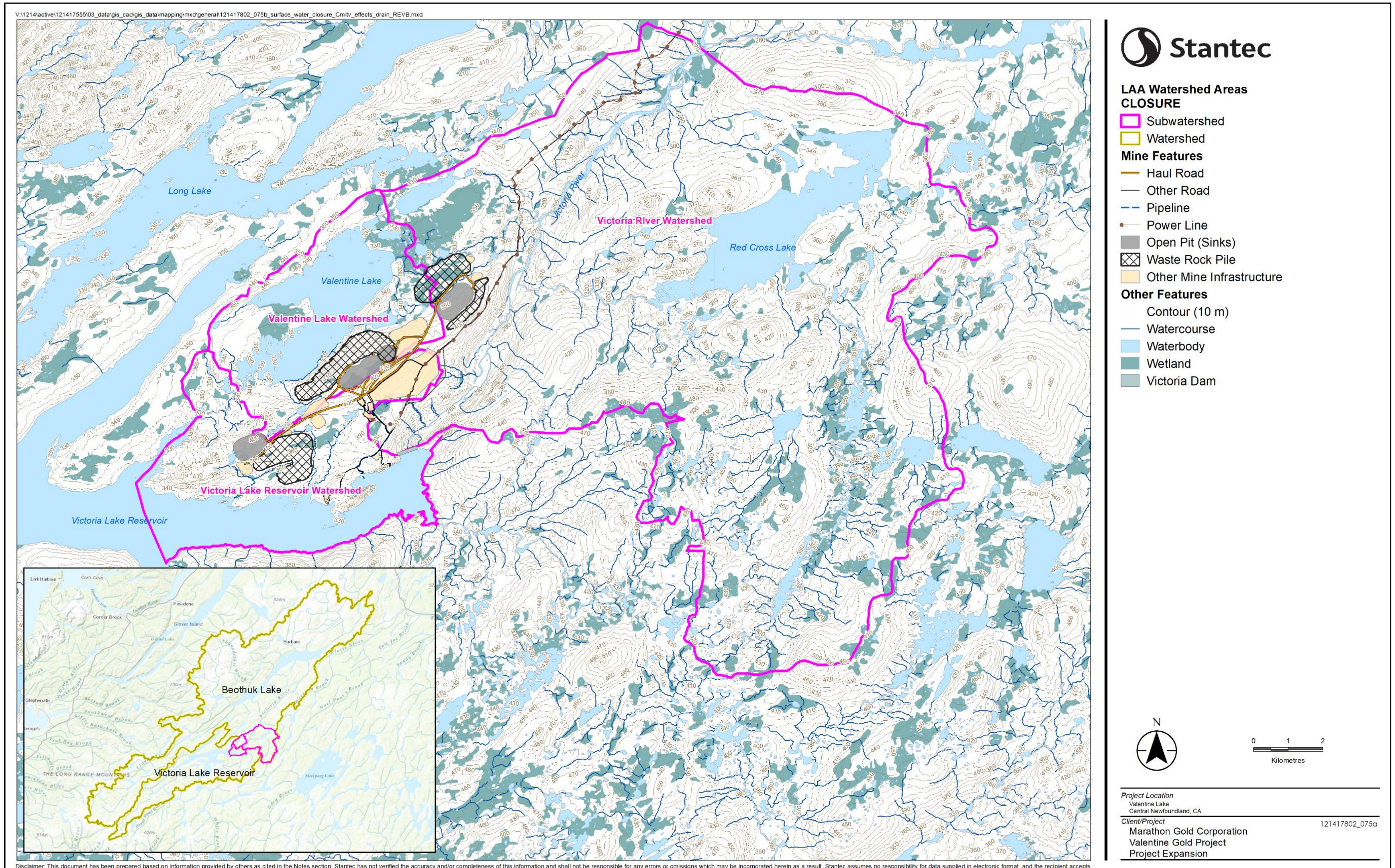


Figure 8-9 LAA Watershed Areas during Closure

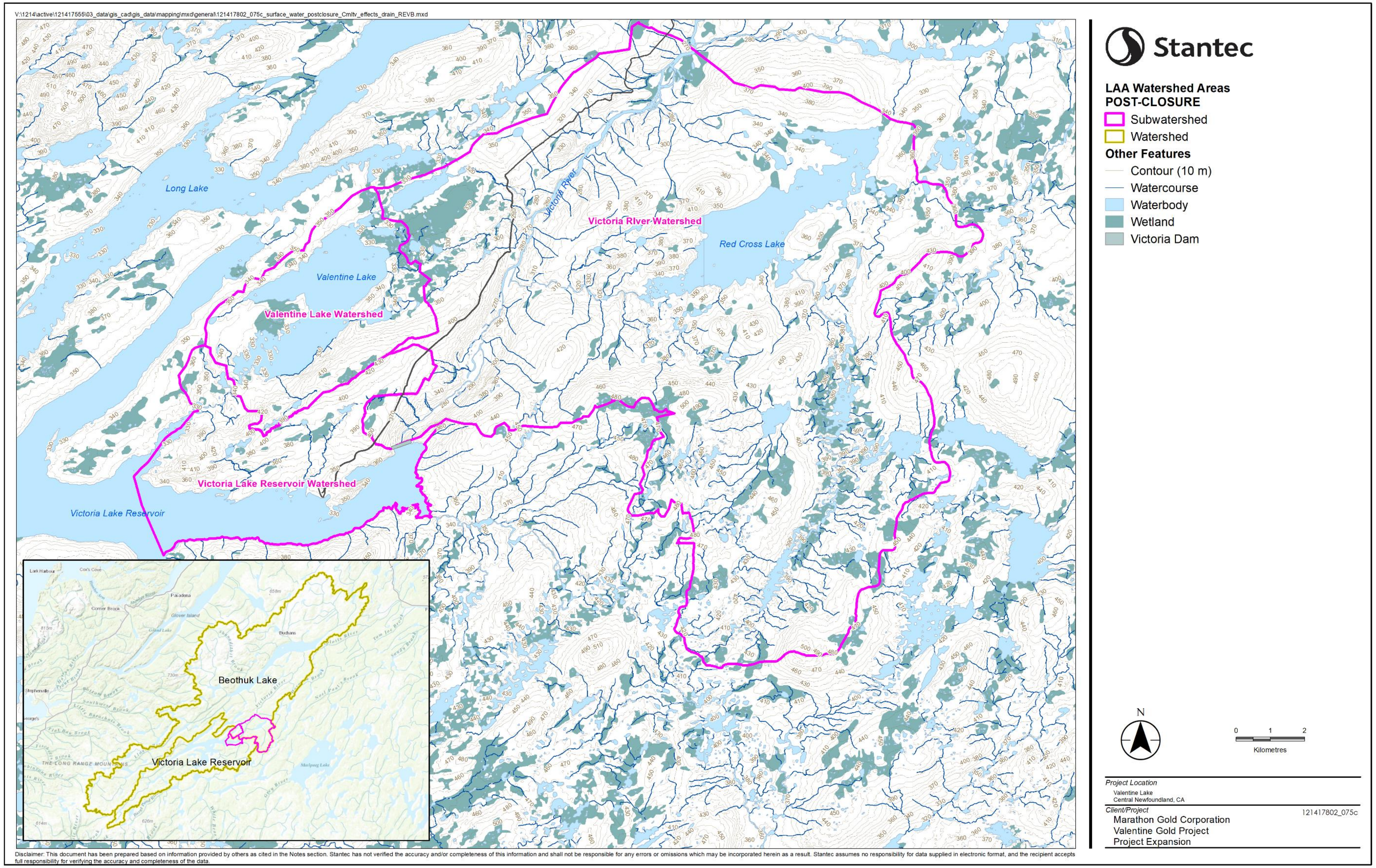


Figure 8-10 LAA Watershed Areas during Post-Closure

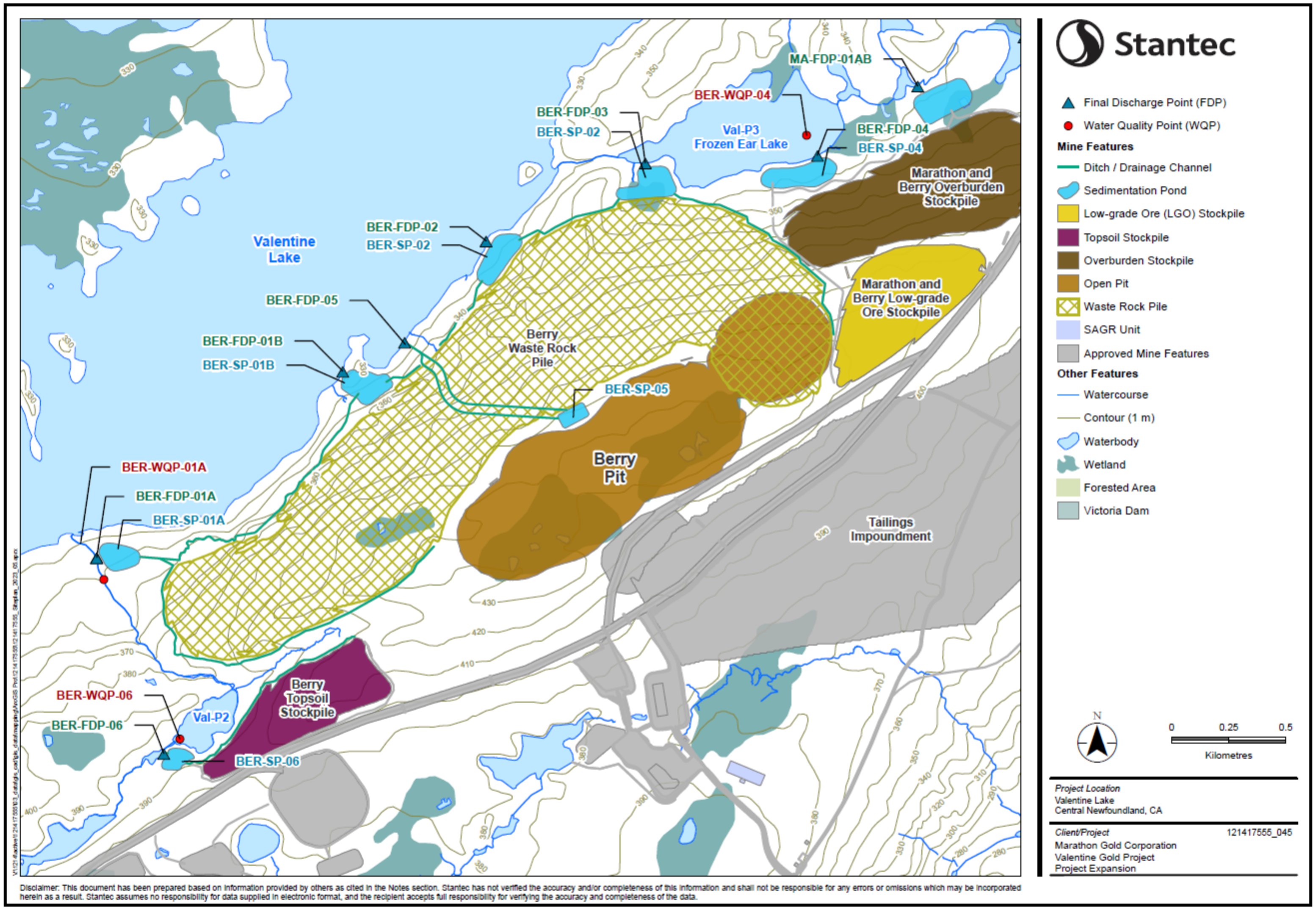


Figure 8-11 Final Discharge Point Locations for the Project Expansion

A list of parameters of potential concern (POPC) was established and changes in these parameters were assessed to determine Project Expansion effects on surface water quality. Selection of the POPCs is discussed in detail in the Water Quantity and Water Quality Model Update Report (Appendix 8A) and the selection criteria are listed below:

- Parameters found to exceed CCME-FAL in baseline monitoring (aluminum, cadmium, iron, arsenic, copper, lead, zinc, and nitrite)
- Parameters listed in the *Metal and Diamond Mining Effluent Regulations* (MDMER) considered to be at risk of being elevated (copper, unionized ammonia, and total cyanide)
- Parameters considered potentially present in mine effluent as a result of mining activities (l, As, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Mo, P, Se, Ag, U, Zn, N-NO_2, N-NO_3, N-$NH_{3\,T}$, N-$NH_{3\,UN}$, and F)

Expected surface water quality for these POPC were assessed at each FDP location, 100 m and 200 m downstream of each FDP, and up to 300 m at the ultimate surface water receiver (Valentine Lake). Assessing the water quality at Valentine Lake was undertaken through the Water Quality Model (Appendix 8A) and Assimilative Capacity Assessment (Appendix 8B) and is further discussed below. The assessment of TMF seepage quality was also updated as the addition of tailings from the Berry pit will alter the geochemistry of the TMF, and there is potential for hydrogeological effects on the TMF with the addition of the Berry pit (Chapter 7).

8.2.1.3 Water Quantity and Quality Model

Water quantity and quality modelling was conducted to simulate proposed water management for the Project Expansion and support site design and operation. The model was developed using the GoldSim™ software package with the contaminant transport module to predict water quality associated with the site-wide water quantity model (water balance). GoldSim™ is commonly used in the mining industry to develop water balance models and predict water quality at user-defined modelling nodes by combining system dynamics with discrete event simulations. As described in further detail in the Water Quantity and Quality Modelling Report (Appendix 8A), the model was run dynamically on a daily time step for the construction phase (Mine Years -2.25 to -1), operation phase (Years 1-15), closure sub-phase (Years 16 until Pit is Full), and post-closure sub-phase (Pit is full).

The water quantity (water balance) model accounted for the precipitation and groundwater gains, and evaporation, transpiration and infiltration losses of the Berry Complex and other mine facilities. These inflows and outflows are based on precipitation rates, catchment and facility areas and volumes, groundwater inflow rates, operational water management strategies, and the movement of materials within the site. The Climate Normal (average condition) and probabilistic scenarios were considered to evaluate the potential effects of the Project Expansion on surface water resources.

For conservatism in the model, it is assumed that the catchment area for stockpile features are at their ultimate stage at the start of construction. However, the build out of the stockpile within the drainage footprint is estimated as a percentage of the stockpile surface area for each year of operation. The open pits are set as a gradual expanding area over the mine operation phase.

The water quality predictions are calculated at the model nodes by integrating source term development (loading sources) into the water balance. Results from this analysis and modelling are presented in the Water Quantity and Quality Model Update Report (Appendix 8A).

Sources of Potential Contaminants

The potential for development of acid rock drainage (ARD) and metal leaching (ML) in mined materials and the identification of POPC was completed to support planning and assessment of potential environmental effects of the Project Expansion. This work is presented in the Acid Rock Drainage / Metal Leaching Management Plan (Proposed Revisions to Address the Addition of the Berry Pit Expansion) report (Appendix 2F).

The methods for ARD/ML assessment generally followed the Mine Environment Neutral Drainage (MEND) publication, Prediction Manual for Characterizing Drainage Chemistry from Sulphidic Geologic Materials (Price 2009). The geochemistry baseline program, followed the approach taken for the EIS for the Approved Project, and included:

- Static testing of samples of waste rock, ore, overburden, and tailings for Acid-Base Accounting, Shake Flask Extraction (SFE) and total metals
- Characterization of composite samples using the static tests and mineralogical methods
- Kinetic testing of composite samples including humidity cell tests (HCTs), ageing tests, and sub-aqueous columns tests

Acid Potential (AP) was calculated from sulphide sulphur hosted in pyrite and marcasite. Neutralization Potential (NP) was calculated from Total Inorganic Carbon considering that calcite and dolomite are dominant acid neutralization minerals in the deposits. ARD classification is based on a Neutralization Potential Ration (NPR = NP/AP) of samples compared to generic thresholds proposed by Price (2009). A sample is conservatively classified as Potentially Acid Generating (PAG) if NPR is below 2; otherwise, the sample is classified as Non-PAG.

ML potentials were evaluated by comparing the concentrations of trace elements in the leachates from SFE and kinetic tests to the concentration limits prescribed in MDMER and to the CWQG-FAL. Concentrations exceeding MDMER and/or 10x CWQG-FAL in kinetic tests indicate parameters with high leaching potential, while concentrations between the CWQG-FAL and 10x CWQG-FAL value were arbitrarily assigned to moderate leaching potential.

Assimilative Capacity Study

An assimilative capacity study was conducted to estimate the water quality of watercourses and waterbodies receiving discharges directly from the eight Project Expansion FDPs, and extending to the ultimate receiver, Valentine Lake. The near-field mixing model CORMIX (Version 12.0) was used to predict water quality under both regulatory and normal discharge scenarios for Valentine Lake, as the ultimate receiver. The regulatory operating conditions are considered worst case and conservative, while normal operating conditions are considered representative of the expected average discharge conditions. Input parameters for these two conditions were:

- Regulatory Operating Conditions:
  - MDMER limits for POPC listed parameters for effluent
  - 95th percentile for effluent POPC not listed in MDMER, generated from geochemical water quality modelling
  - 75th percentile baseline water quality in the receiving watercourses
  - 7Q10 flow receiver conditions (7-day low flow, 10-year return period) in the receiving watercourses based on regression analysis
  - Seepage (toe and basal) flow out of the ponds to represent effluent discharge during dry conditions
- Normal Operating Conditions
  - Maximum mean monthly water quality concentrations for POPCs predicted in modelling
  - Mean concentrations for baseline water quality in the receiving watercourses
  - MAF conditions in the receiving watercourses based on a regression analysis
  - Predicted effluent flow modelled using regional equations and contact areas

The results of the CORMIX models provide an estimate of the POPC concentrations within the effluent mixing zones under conservative conditions in Valentine Lake. The mixing zones were determined in terms of assimilation or dilution ratios for the maximum effluent flow rate expected to enter each receiving waterbody. Results of this model are presented in the Assimilative Capacity Study Update Report (Appendix 8B) and summarized in the Change in Surface Water Quality section (Section 8.4.2).

8.3 MITIGATION AND MANAGEMENT MEASURES

A series of environmental management plans have been developed by Marathon to mitigate the effects of project development on the environment. Mitigation and management commitments for the Approved Project can be found in Appendix 2E. These measures will be applied to the Project Expansion, as applicable. Additional mitigation and management measures that will be required to support the Project Expansion include updates to the Water Management Plan (Appendix 2A), which has been updated to address both the Approved Project and the Project Expansion.

8.3.1 Updated Water Management Plan

The Water Management Plan Update for the Berry Pit Expansion (Appendix 2A) provides proposed updated details on the key site-specific mitigation measures to reduce the potential for Project Expansion effects on surface water quantity and quality. The Water Management Plan will be implemented during construction, operation and closure, and provides details on runoff and seepage collection strategies and systems (e.g., local seepage sedimentation ponds, berms, drainage ditches, pumps) to collect and contain surface water runoff, and groundwater discharge from major mine components (open pit, waste rock piles, TMF and processing plant, ore stockpile, and overburden stockpiles) during climate normal and extreme weather conditions.

The primary objectives of the Water Management Plan are to mitigate operational risks and environmental effects of the project. These objectives include:

- Reduce water inventory through perimeter berms and promote overland flow of non-contact runoff
- Reduce the number of FDPs through grading of ditches and construction of diversion channels
- Maintain flow to fish bearing streams and wetlands by maintaining pre-development catchments and/or flows
- Reduce water management costs during operation through grading and gravitational drainage, thus reducing pumping requirements.

8.3.1.1 Water Management Design

Design criteria used in the Water Management Plan were developed to mitigate potential effects of the Approved Project and Project Expansion on surface water resources and are based on the Project-specific guidance, industry best practices, and Marathon corporate direction. Design criteria related to surface water quality are summarized below and include:

- Use accepted industry best practice geochemistry methods to predict mine contact runoff and seepage quality
- Manage water quality through collection ditches and collection (sedimentation) ponds, collecting water from Approved Project and Project Expansion components and draining locally
- Mean monthly and daily effluent water quality at FDPs to be below MDMER
- Assess water quality in the mixing zone downstream of an FDP using assimilative capacity of receiving waters, and define the mixing zone boundary as the point downstream in the receiving waters where ambient water quality meets the CCME CWQG-FAL, or returns to baseline concentrations
- If Approved Project or Project Expansion component effluent quality does not meet MDMER limits through sedimentation ponds, implement further effluent treatment

Water quality control criteria applied in the design of sedimentation ponds include:

- Runoff from the project component areas for storm events up to 1:10 AEP to allow settlement of sediments to meet MDMER

- Sedimentation ponds were designed to treat a silt sized particle of 5.0 x 10^{-3} mm in diameter (British Columbia Ministry of Environment and Climate Change Strategy 1996), which is a typical particle size used in design of a mine sedimentation pond
- Ponds were designed primarily to meet the minimum residence time required for sediment to settle 1 m, reaching a trapping efficiency of 80%
- Runoff from the water quality design storm event will be detained in the sedimentation pond for a minimum of 24 hours
- A submerged type, reverse slope, low-level outlet will act as a hydrocarbon and Light Non-Aqueous Phase Liquids containment feature, as well as to reduce thermal discharge effects

Construction

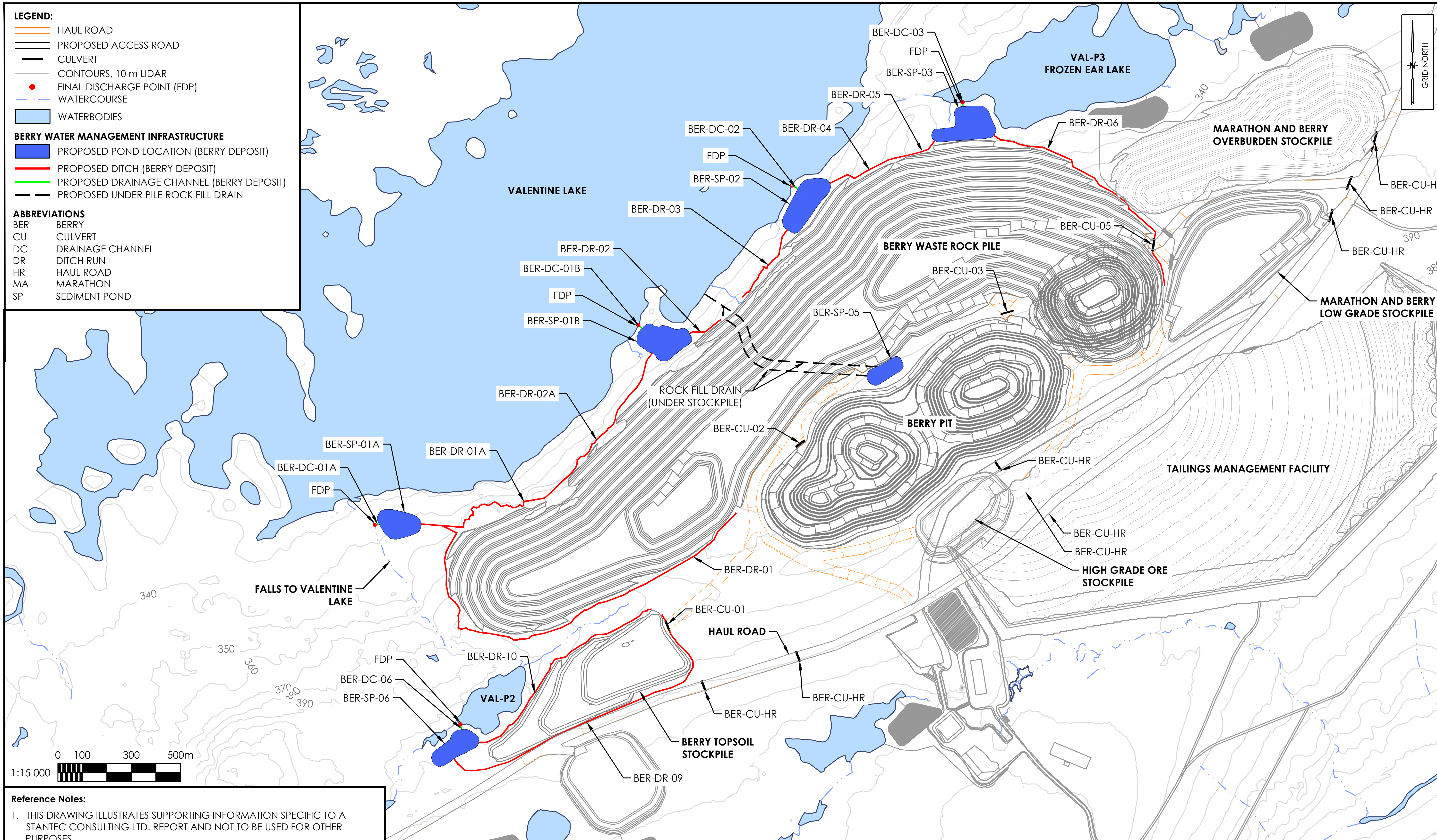
The primary water management activity during the Project Expansion construction phase will be erosion and sediment control measures, and mine dewatering. Erosion and sediment control measures will be required for various construction phase activities including clearing, stripping and grubbing of vegetation, excavation and storage of topsoil and overburden, blasting and removal of mine rock and ore, and dewatering of the starter pits. Other construction activities include ditch construction, haul road construction, and preparation of surfaces for Project Expansion facilities.

Erosion and sediment control measures will be implemented to reduce environmental effects involving earthwork activities during the development of the Project Expansion. The four basic principles to be adopted in implementation of these measures are:

- Direct runoff away from active work areas before construction commences, reducing the volume of sediment-laden water to be managed
- Limit the amount and timing of exposed soil left open at any one time to reduce the potential for erosion
- Control sediment-laden runoff leaving the site by following erosion and sediment control measures put in place for the construction of the Project Expansion
- Protect sensitive receptors from sediment-laden runoff by directing untreated runoff away from these areas

Operation

Water management functions will be carried out independently with decentralized treatment and control at each of the mine complexes for the Approved Project (Leprechaun Complex, Marathon Complex, and TMF and Processing Plant Complex) and the Project Expansion (Berry Complex). The water management design for the Leprechaun, Marathon, and TMF and Processing Plant Complexes during operation can be found in the Valentine Gold EIS for the Approved Project and the Water Management Plan as the water management design has not changed. The water management design for the Berry Complex is presented in Figure 8-12. To reduce the mine water inventory, non-contact water is proposed to be diverted using perimeter berms to allow runoff to naturally flow around/away from disturbed areas. Catchment areas for mine site components were delineated in AutoCAD based on the available project LiDAR (Aethon 2021).



Z:\1216\active\121620514\5_CAD\sheet_files\BERRY-FIGURES\121417802_WMI_FIG_8.12_BER-OPR-11x17.dwg

Reference Notes:

1. THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC CONSULTING LTD. REPORT AND NOT TO BE USED FOR OTHER PURPOSES.
2. LIDAR DERIVED CONTOURS JUNE 6-7, 2019 (AETHON AERIAL SOLUTIONS); VERTICAL DATUM: CGVD28.
3. WATERCOURSES AND WATERBODIES: SURVEYED FISH BEARING OR HAS CONNECTIVITY TO FISH BEARING WATER (STANTEC 2012, 2019 & 2020, 2022), SUPPLEMENTED WITH CANVEC 2011 WATERCOURSES AND WATERBODIES.
4. ALL NON-WATER MANAGEMENT INFRASTRUCTURE DESIGN BY: AUSENCO, GOLDER & MOOSE MOUNTAIN TECHNICAL SERVICES DESIGN.

BERRY COMPLEX - OPERATIONS

WATER MANAGEMENT INFRASTRUCTURE

Client: MARATHON GOLD CORPORATION

Job No.:	121417802	**Fig. No.:** 8.12	**Rev. No.:** 00
Scale:	1 : 15 000		
Date:	2023-08-09	Stantec	
Dwn. By:	CP		
App'd By:	SS		

The Project Expansion components were sited to avoid fish habitat to the extent practicable and maintain appropriate buffers between components and fish habitat. In particular, the site plan was developed to avoid the deposition of mine waste in fish-bearing waters. Site surveys were completed in 2022 to identify fish bearing streams, and final siting of components was adjusted to avoid these streams.

The water management design diverts non-contact water from the mine facilities natural water drainage areas, where possible. Diversion of surface flows using channels and berms constructed around the crest of open pits or up-gradient of waste rock disposal piles and other developed areas will reduce the contact water inventory. Where possible, water collected in pits or in the sedimentation ponds will be used for other purposes on site (e.g., dust suppression) rather than discharged to the environment.

The Project Expansion has a total of eight FDPs located in the Berry Complex, that ultimately drain to Valentine Lake, including a pond serving shared Berry and Marathon stockpiles (i.e., low grade ore and overburden). The eight FDPs associated with the Berry Complex are in addition to the 11 FDPs associated with the other three complex for a total of 19 FDPs across the Project Area. MDMER limits will be met at FDPs prior to release.

A total of seven sedimentation ponds are designed to provide on-site storage of runoff for the Berry Complex, as summarized in Table 8.7. One sedimentation pond from the Marathon Complex, MA-SP-01AB, has been modified to receive runoff collected from low grade ore and overburden stockpiles shared between the Marathon and Berry pits. The ponds will provide controlled releases of discharge and are designed to provide adequate residence time for settling. Permanent pools in ponds will be excavated below grade, thus reducing the total dam height and improving dam safety. Effluent will be released slowly to enhance baseflow augmentation and reduce the potential for downstream scour and erosion. MDMER limits will be met at FDPs prior to release to the receiver. Contact water from the Berry Pit will be pumped to BER-SP-05 sedimentation pond and will drain through rock fill drains under the waste rock pile (BER-DR-10 and BER-DR-11) into Valentine Lake.

Table 8.7 Sediment Pond and Ditch Design Management Infrastructure

Mine Facility	Ditch Run	Water Management Pond	FDP	Discharge Location
Berry Waste Rock Pile [257.5 ha]	BER-DR-01	BER-SP-01A	BER-FDP-01A	Valentine Lake
	BER-DR-01A			
	BER-DR-02A	BER-SP-01B	BER-SP-01B	
	BER-DR-02			
	BER-DR-03	BER-SP-02	BER-FDP-02	
	BER-DR-04			
	BER-DR-05	BER-SP-03	BER-FDP-03	
	BER-DR-06			

Table 8.7 Sediment Pond and Ditch Design Management Infrastructure

Mine Facility	Ditch Run	Water Management Pond	FDP	Discharge Location
Berry / Marathon Overburden Stockpile [40.1 ha]	MA-DR-01	MA-SP-01AB	MA-FDP-01AB	ValP3 to Valentine Lake
	MA-DR-02			
Berry / Marathon Low Grade Ore Pile [23.9]	BER-DR-07	BER-SP-04	BER-FDP-04	
	BER-DR-08			
Berry Pit [83.0ha]	Rock Fill Drain under Waste Rock Pile (BER-DR-11)	BE-SP-05	BER-FDP-05	Valentine Lake
	Rock Fill Drain under Waste Rock Pile (BER-DR-12)			
Berry Topsoil Pile [19.2 ha]	BER-DR-09	BER-SP-06	BER-FDP-06	Unnamed Tributary to Valentine Lake
	BER-DR-10			

Sedimentation ponds were designed based on particle settling characteristics. The minimum target particle size was 5 microns and the assumed settling velocity of the particles was 2 x 10^{-5} m/s (conservatively assuming the temperature of the water in the pond is close to freezing). Given a minimum vertical settling zone of 1 m, it will take 14 hours for a particle to reach the trapped sediment zone below the pond outlet invert. Ditches will be constructed along the perimeter of piles to convey the 1:100 AEP surface runoff and toe drainage to sedimentation ponds for water quality and quantity control. Trapezoidal geometry ditch runs were designed to convey flow through gravity and provide a minimum of 20 cm freeboard under design flows. Ditch excavation materials will be sidecast and berms constructed of the sidecast glacial till material. Ditches will be lined with rip-rap for erosion protection. In areas with ditch gradients steeper than 8%, sediment traps (i.e., check dams) will be installed at a spacing of 200 m per ditch grade % to provide energy dissipation and reduce erosional flow velocities in the ditch. For the same purpose, energy dissipation pools will be installed at the change in ditch gradient from slopes of 10% higher to shallower slopes.

Pond storage, geometry and outlet configuration are summarized in Table 8.8. The inactive and 1:100 year active pond storage volumes below the spillway are summarized for each sediment pond. Pond geometry includes the designed pond bottom elevation and berm crest elevation, in addition to the pond width and length. Outlet configuration of the bottom draw pipes and associated orifice diameter needed to provide residence time and extended discharge attenuation, and spillway width were also provided as these dimensions change for each sediment pond. Pumps will be required to dewater the Berry pit. A pit dewatering pond was designed at a low-lying location adjacent to the Berry pit. It was assumed that a pond volume of 37,500 m^3 for the Berry pit will be adequate to contain the pit dewatering rates based pump test results reported by GEMTEC (2022a) and updated groundwater modeling (Appendix 7A). Pit dewatering discharge directed to the BER-SP-05 pond at the surface will be subsequently drained to Valentine Lake.

Table 8.8 Pond Storage, Geometry, and Outlet Configuration

Sediment Pond Name	Inactive Pond Storage (m^3)	Active Pond Storage (m^3)	Total Pond Storage (m^3)	Pond Bottom Elev. (m)	Pond Berm Crest Elev. (m)	10-year Return Period Orifice Diameter (mm)	Spillway Base Width (m)	Spillway Elev. (m)
BER-SP-01A	12,300	34,600	46,900	335.0	339.9	150	3	340.2
BER-SP-01B	18,400	51,500	69,900	325.9	331.9	250	3	331.1
BER-SP-02	16,400	45,400	61,800	324.8	333.0	200	3	332.2
BER-SP-03	22,700	63,500	86,200	333.0	339.0	250	3	338.2
BER-SP-04	15,200	42,600	57,800	338.9	343.0	200	3	340.2
BER-SP-05	25,600	76,500	102,100	418.0	424.0	250	7	423.2
BER-SP-06	17,600	26,700	44,300	388.0	394.0	200	3	393.2
MA-SP-01AB	14,191	44,596	58,788	338.3	342.8	200	3	341.7

With the addition of the Berry pit, the water quantity model was updated to simulate the placement of Berry pit associated tailings in the TMF, assess mill reclaim water needs and sources, particularly during the Mine Years 10 to 15 period when tailings are deposited in the Berry pit and the TMF is the primary source, and ensure there is adequate capacity for tailings in the Berry pit southern basin. The tailings pond will collect direct precipitation, runoff from the tailings surface, effluent discharged from the mill with the tailings (Mine Years 1 to 9), and water pumped back from the seepage collection sumps around the facility. During the operation phase, water will be pumped from the tailings pond via a reclaim pump system for the operation of the processing plant. Since the assessment of the Approved Project, further design has been completed with respect to the TMF treatment processes. Excess runoff from the TMF (not re-used for processing) will be routed through a water treatment plant and a submerged attached growth reactor (SAGR®) unit prior to discharge via a pipeline to Victoria Lake Reservoir. The pipeline extends into Victoria Lake Reservoir at the final discharge point PP-FDP-01. Freshwater make-up required in the process plant will be supplied from Victoria Lake Reservoir. In Year 10, when tailings deposition is switched from the TMF to the Berry pit southern basin, process water will continue to be sourced from the TMF as reclaim, in addition to the minimum of 8% freshwater make-up from Victoria Lake Reservoir. Additionally at this time, in-pit dewatering would cease in the Berry pit and the pit will be allowed to fill via natural in-flows and water delivered to the pit via the tailings effluent. If the TMF is not able to supply sufficient reclaim during Mine Years 10 to 15, water will be pumped from the Berry southern basin when water levels are less than 100 m below the pit overflow elevation.

Decommissioning, Rehabilitation, and Closure

Water management during progressive rehabilitation, and rehabilitation and closure, will be consistent with that during operation. However, due to the ground disturbance associated with the rehabilitation activities, standard erosion and sediment control measures for construction will also be implemented to supplement the existing water quality treatment infrastructure.

The duration of rehabilitation and closure activities provides adequate time for earthworks activities to be completed, vegetation to establish, and water quality to improve and the open pit to fill and eventually discharge to the environment. When vegetation has established on rehabilitated the waste rock pile, water management ponds will be breached to allow drainage to the natural ground and local receivers, and water management features will be removed and restored to natural, pre-development drainage conditions. The Berry / Marathon overburden stockpile and Berry waste rock pile perimeter ditches will be covered with side case material and regraded to allow non-contact water to drain down the over the perimeter ditch footprints and overland to local receivers following natural drainage patterns. Contact seepage will be substantially reduced from the uncovered condition for the waste rock pile due to the increase in runoff and evapotranspiration potential of the vegetated soil covers; the reduced volume of contact seepage will migrate across the perimeter ditches retrofitted with passive treatment systems and assimilate (attenuate naturally) with local groundwater to discharge into local receiving waters.

Based on the results of the water quantity and water quality model update (Appendix 8A), passive treatment systems may be required to be implemented during closure / post-closure at the Project Expansion waste rock piles and TMF. The potential need for passive treatment for the TMF during closure / post-closure was previously identified as a component of the Approved Project. Based on the updated water quality model and addition of tailings from the Berry pit to the TMF, seepage quality in the TMF toe seepage collection system is predicted to exceed CWQG-FAL for aluminum, arsenic, cadmium, chromium, copper, manganese, phosphorus, zinc, total ammonia, and unionized ammonia. The model report recommends future monitoring to confirm these exceedances and the implementation of passive treatment technologies to treat the seepage during closure.

To treat TMF seepage in closure to background or the CWQG-FAL thresholds, further passive treatment is expected. The primary passive treatment technologies for mine related waters include aerobic and anaerobic wetlands, sulfate reducing bioreactors, anoxic limestone drains (ALD), and successive alkalinity producing systems (SAPS). Selection and design of a passive system is based on water chemistry, flow rate, local topography, and site characteristics.

Metal removal via anaerobic passive systems occurs via electrochemical reducing conditions to convert mobile metals (e.g., iron, lead, zinc, copper, cadmium) to more stable, nontoxic forms. The key component of contaminant reduction in an anaerobic filter is a continuous source of organic matter, typically in the form of compost, peat, saw dust, or wood chips. When the organic rich media is flooded, microbial respiration consumes available oxygen and produces alkalinity, driving the redox state towards sulfate reducing conditions. Under these anaerobic conditions, sulfate-reducing bacteria convert sulfate to sulfide by catalyzing the oxidation of organic carbon producing hydrogen sulfide. Metals in solution will precipitate in the presence of hydrogen sulfide to form insoluble metal sulfide precipitates. These precipitates are removed from the water and sequestered within the organic rich treatment media.

The Rehabilitation and Closure Plan by GEMTEC (2022b) identified feasible passive treatment options to manage site water post closure for the Approved Project:

- Convert waste rock pile and TMF seepage collection ditches into anerobic Permeable Reactive Barriers (PRBs).
- Convert waste rock pile and TMF seepage collection ditches into French drains with an anaerobic PRB to passively intercept and convey site water to anaerobic vertical flow engineered wetlands.

These options will be evaluated and applied for post closure water management for the Berry waste rock pile. Options will be selected based upon anticipated water quality and results of a pilot study. It is anticipated that a subsurface flow PRB will be sufficient to reduce metal concentration to below the CWQG-FAL.

Post Closure and Monitoring

During the post-closure period, site monitoring will be carried out to demonstrate that closure strategies of Approved Project and Project Expansion facilities are performing as intended. Monitoring will be conducted at residual FDPs of the water management facilities and at receiving locations (e.g., Victoria River, Valentine Lake, and Victoria Lake Reservoir) simulated in the groundwater model to intercept seepage from the pits, waste rock piles, and TMF. Post-closure monitoring and maintenance will be carried out at a reduced frequency from the operation phase or closure period.

The post-closure monitoring program will continue after final closure activities are completed. Post-closure monitoring will cease once the effects related to the Approved Project and Project Expansion are deemed to be physically and chemically stable and accepted by regulatory agencies. The site can then be closed out or released by the NLDIET and NLDECC and an application made to relinquish the property back to the Crown.

In addition to the application to relinquish the property back to the Crown, Marathon would also submit a Notice of Intent to the federal Minister of Environment and Climate Change Canada under Part 4 of the MDMER to be granted recognized closed mine (RCM) status. RCM status can only be granted if the following conditions are met:

- The mine's rate of production was less than 10% of its design-rated capacity for a continuous period of three years starting on the day on which the written notice is received by the federal Minister of Environment and Climate Change Canada.
- Marathon has conducted a biological monitoring study during the above referenced three-year period in accordance with the MDMER Division 3 of Part 2 of Schedule 5.

If Marathon has complied with the requirements set out above from Part 4 under the MDMER, the mine becomes a RCM after the expiry of the three-year period referred to above. Once RCM status is achieved, the MDMER no longer apply to the mine.

8.4 SUMMARY OF APPROVED PROJECT RESIDUAL EFFECTS

8.4.1 Surface Water Quantity

The Valentine Gold EIS calculated expected MAFs for 23 local watersheds overlapped by Approved Project infrastructure during the construction, operation, and decommissioning, rehabilitation and closure phases of the Approved Project. Generally, where changes in MAF are projected to be less than 10%, no residual effect is anticipated. This is based on the assumption that a high level of ecological protection is provided when flow alterations are within 10% of the natural flow (Richter et al. 2011; DFO 2013). Where an increase of over 10% in MAF is predicted, increased flows during high flow events are considered a potential residual effect. Where a decrease of over 10% in MAF is predicted, decreased flows during low flow events (environmental flows) are considered a potential residual effect. Surface water quantity residual effects were considered significant if a change in MAF of over 10% was predicted at the boundary of the LAA for the Victoria River, Valentine Lake and Victoria Lake Reservoir. Changes in MAF of over 10% within local watersheds were considered to cause a potential localized residual effect, although not considered significant.

During the construction and operation phases, it was expected that 15 watersheds would maintain a MAF within 10% of, or above, pre-development conditions. Of the seven watersheds that experienced a decrease in MAF of over 10%, environmental flows were expected to be maintained in all except four watersheds.

During the closure phase, it was expected that 13 watersheds would maintain a MAF within 10% of, or above, pre-development conditions. Of the nine watersheds that experienced a decrease in MAF of over 10%, environmental flows were expected to be maintained in all except five.

During the post-closure phase, it was expected that 17 watersheds would maintain a MAF within 10% of, or above, pre-development conditions. Of the five watersheds that experienced a decrease in MAF of over 10%, environmental flows were expected to be maintained in all except one for which the reduction in flow would be permanent.

At the LAA boundaries for the Victoria River, Valentine Lake and Victoria Lake Reservoir, with offsetting and environmental measures applied, changes in MAF were less than 10%, and residual water quantity changes were predicted to be not significant.

8.4.2 Surface Water Quality

The Valentine Gold EIS predicted the residual environmental effects on surface water quality to be not significant, as effluent water quality would be below the MDMER limits at the final discharge points and no watershed management targets would be contravened. Local water quality immediately downstream of some final discharge points and points where seepage enters surface water would experience increases of POPC above baseline levels and the CWQG-FAL. However, these changes were expected to be contained within the boundaries of the LAA and to be dissipated within 300 m of entering one of the three ultimate receiving waterbodies.

8.4.3 Significance Determination

With mitigation and management measures, residual environmental effects on surface water resources were predicted to be not significant, given the Approved Project was not predicted to result in:

- A change in surface water quantity of over 10% MAF at the boundaries of the LAA
- A change in surface water quality above baseline and the CWQG-FAL beyond an identified mixing zone within each of the ultimate surface water receiving environments of the Approved Project (Valentine Lake, Victoria River and Victoria Lake Reservoir)

8.5 ASSESSMENT OF RESIDUAL EFFECTS OF PROJECT EXPANSION

8.5.1 Assessment Criteria Methods

This section describes the criteria and methods used to assess environmental effects on surface water resources. Residual environmental effects (Section 8.5.2) are assessed and characterized using criteria defined in Section 8.5.1.1, including direction, magnitude, geographic extent, timing, frequency, duration, reversibility, and ecological or socio-economic context. These are consistent with the criteria used for the Valentine Gold EIS. The assessment also evaluates the significance of residual effects using threshold criteria or standards beyond which a residual environmental effect is considered significant. The definition of a significant effect for the Surface Water Resources VC is provided in Section 8.5.1.2 and is consistent with that used for the Approved Project.

8.5.1.1 Residual Effects Characterization

Table 8.9 presents definitions for the characterization of residual environmental effects on surface water resources. The criteria describe the potential residual effects that remain after mitigation measures have been implemented. Quantitative measures were developed, where possible, to characterize residual effects. Qualitative considerations were used where quantitative measurement was not possible.

Table 8.9 Characterization of Residual Effects on Surface Water Resources

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Direction	The long-term trend of the residual effect	**Neutral –** no net change in measurable parameters for surface water relative to baseline **Positive –** a residual effect that moves measurable parameters in a direction beneficial to surface water relative to baseline **Adverse –** a residual effect that moves measurable parameters in a direction detrimental to surface water relative to baseline

Table 8.9 Characterization of Residual Effects on Surface Water Resources

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Magnitude	The amount of change in measurable parameters or the VC relative to existing conditions	**Negligible –** no measurable change to surface water relative to baseline **Low –** a measurable change is detectable and within the normal variability that would be expected (baseline) **Moderate –** a measurable change occurs that is considered elevated above baseline and within acceptable limits **High –** a measurable change occurs that is considered elevated above acceptable limits or regulatory objectives
Geographic Extent	The geographic area in which a residual effect occurs	**Project Area –** residual effects are restricted to the Project Area **LAA –** residual effects are restricted to the LAA **RAA –** residual effects extend into the RAA
Frequency	Identifies how often the residual effect occurs and how often during the Project or in a specific phase	**Single event –** occurs only once **Multiple irregular event –** occurs at no set schedule **Multiple regular event –** occurs at regular intervals **Continuous –** occurs continuously
Duration	The period required until the measurable parameter or the VC returns to its existing (baseline) condition, or the residual effect can no longer be measured or otherwise perceived	**Short term –** residual effect restricted to construction or decommissioning, rehabilitation and closure phases **Medium term –** residual effect extends through Project operation and is expected to subside when operations cease **Long term –** residual effect extends beyond the life of the Project **Permanent** – recovery to baseline conditions unlikely
Reversibility	Describes whether a measurable parameter or the VC can return to its existing condition after the project activity ceases	**Reversible –** the residual effect is likely to be reversed after activity completion and rehabilitation **Irreversible –** the residual effect is unlikely to be reversed
Ecological and Socio-economic Context	Existing condition and trends in the area where residual effects occur	**Undisturbed –** area is relatively undisturbed or not adversely affected by human activity **Disturbed –** area has been substantially previously disturbed by human development or human development is still present

8.5.1.2 Significance Definition

Significant adverse residual environmental effects on surface water resources have been defined considering the federal and provincial regulations, policies and guidelines identified in Section 5.1.4, and the residual effects characterization criteria presented in Section 8.4.1.1.

A significant adverse residual effect on surface water quantity is defined as a measurable change in hydrological and/or sediment transport regime that:

- Does not meet established instream flow needs (environmental flow thresholds) assessed at a monthly scale,
- Contravenes a watershed management target including:
  - an uncompensated loss of fish habitat
  - changes to flow that increase sedimentation and erosion above regulatory guidance in waterbodies receiving surface water runoff
  - changes to flows that cause flooding downstream of the Project Area beyond existing conditions
  - changes to pond and lake levels outside the Project Area to a point that it affects their ability to support existing ecological functions

A significant adverse residual effect on surface water quality is defined as a measurable change in water quality that:

- Exceeds an implemented water quality requirement such as MDMER limits or a site-specific water quality guideline for the protection of aquatic life, or
- Contravenes a watershed management target including:
  - degrading water quality that causes acute or chronic toxicity to aquatic life
  - changes the trophic status of a lake or stream, or
  - exceeds the generally accepted TSS monitoring guideline (the CCME CWQG-FAL) applied for Project Expansion activities

8.5.2 Assessment of Residual Effects

8.5.2.1 Change in Surface Water Quantity

Water Quantity Model Results

Outflows from the sedimentation ponds are forecast in the water quantity and water quality model, which account for seepage (toe and basal) and surface runoff collected in the perimeter ditching of each Project Expansion facility and dewatering of the three basins of the Berry pit (southern, central and northern). The conceptual water management setup in the water quantity and water quality model for the construction phase (Mine Year -2.25 to -1) and operational phase (Mine Years 1 to 15) is presented in Figures 8-13 to 8-16. As indicated in Section 8.2.1, the Water Quantity and Water Quality Model Update Report referred to the southern basin of the Berry pit as the Southwest pit; the central basin is referred to as the Central pit; and the northern basin of the Berry pit is referred to as the Northeast pit.

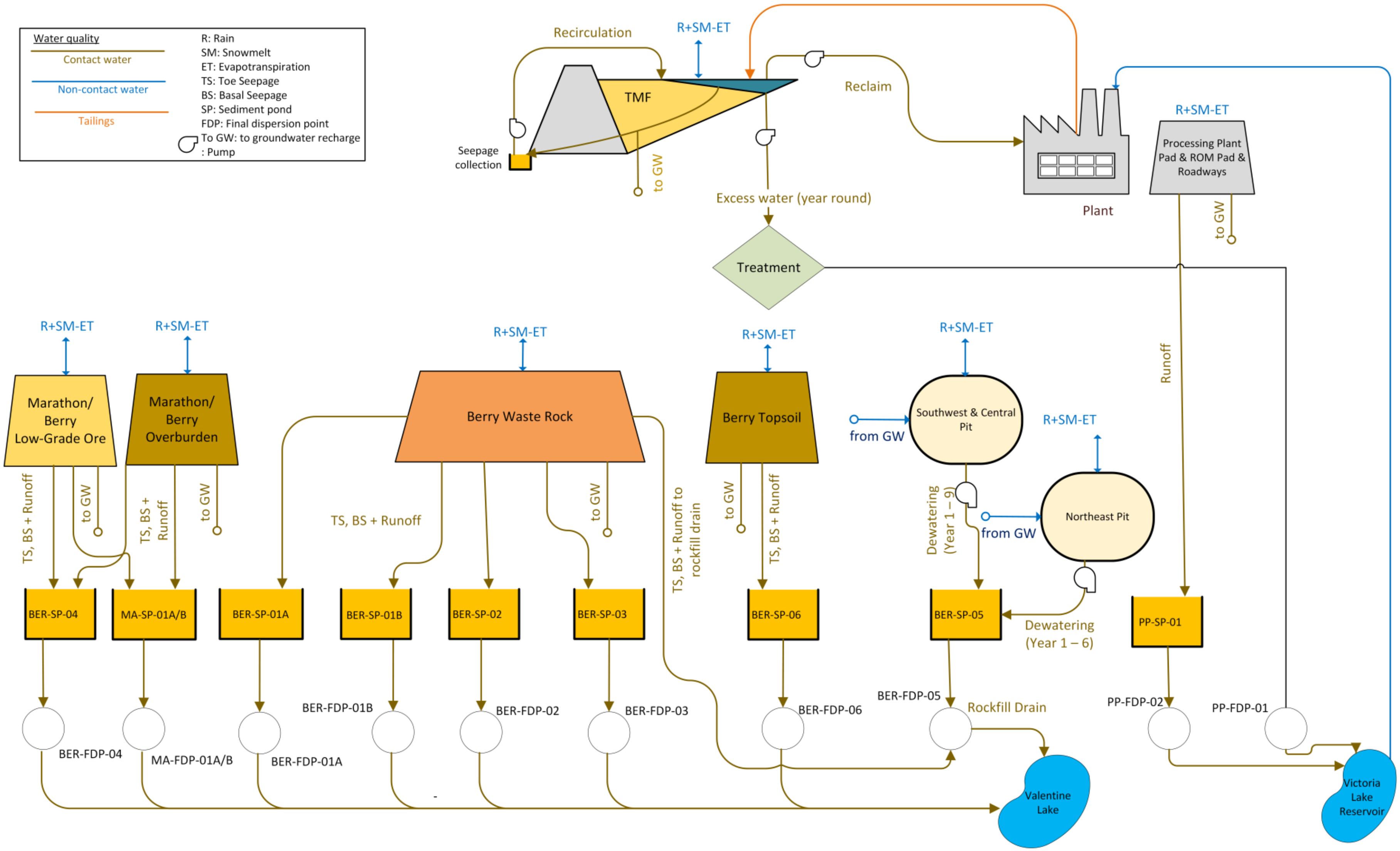


Figure 8-13 Mine Water Management Conceptual Model – Construction and Operations Mine Years -2.25 to 6

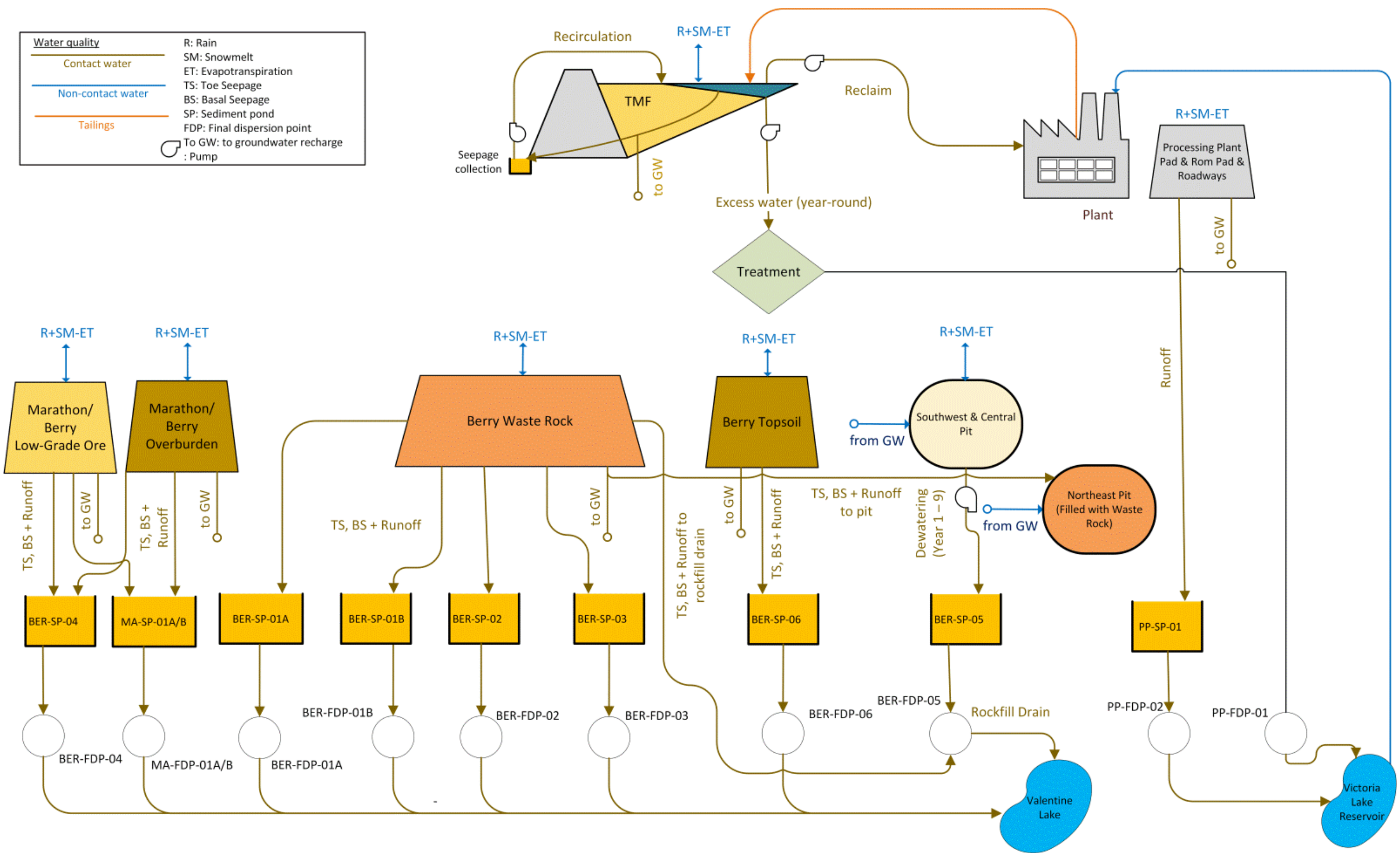


Figure 8-14 Mine Water Management Conceptual Model – Operations Mine Years 7-9

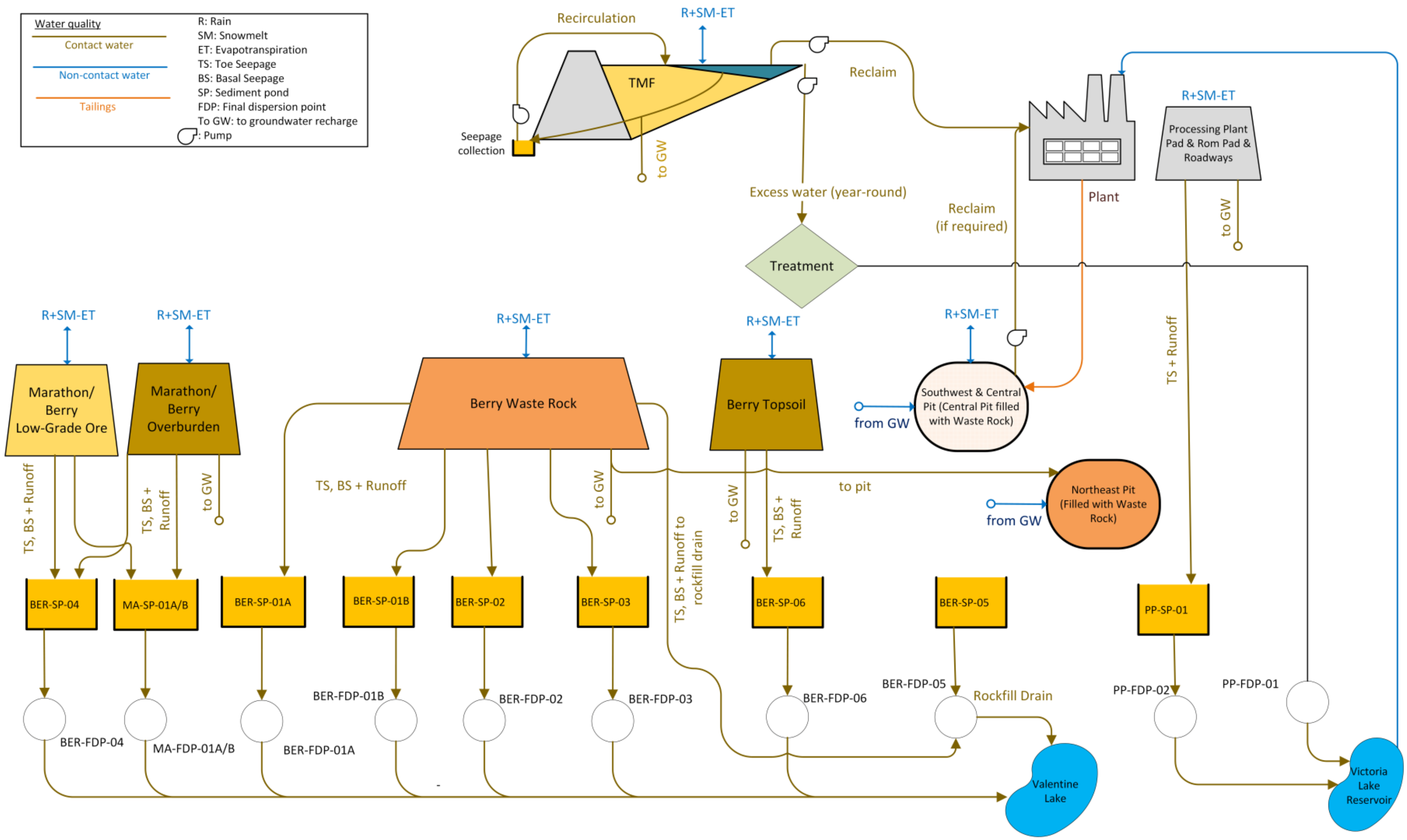


Figure 8-15 Mine Water Management Conceptual Model – Operations Mine Years 10-12

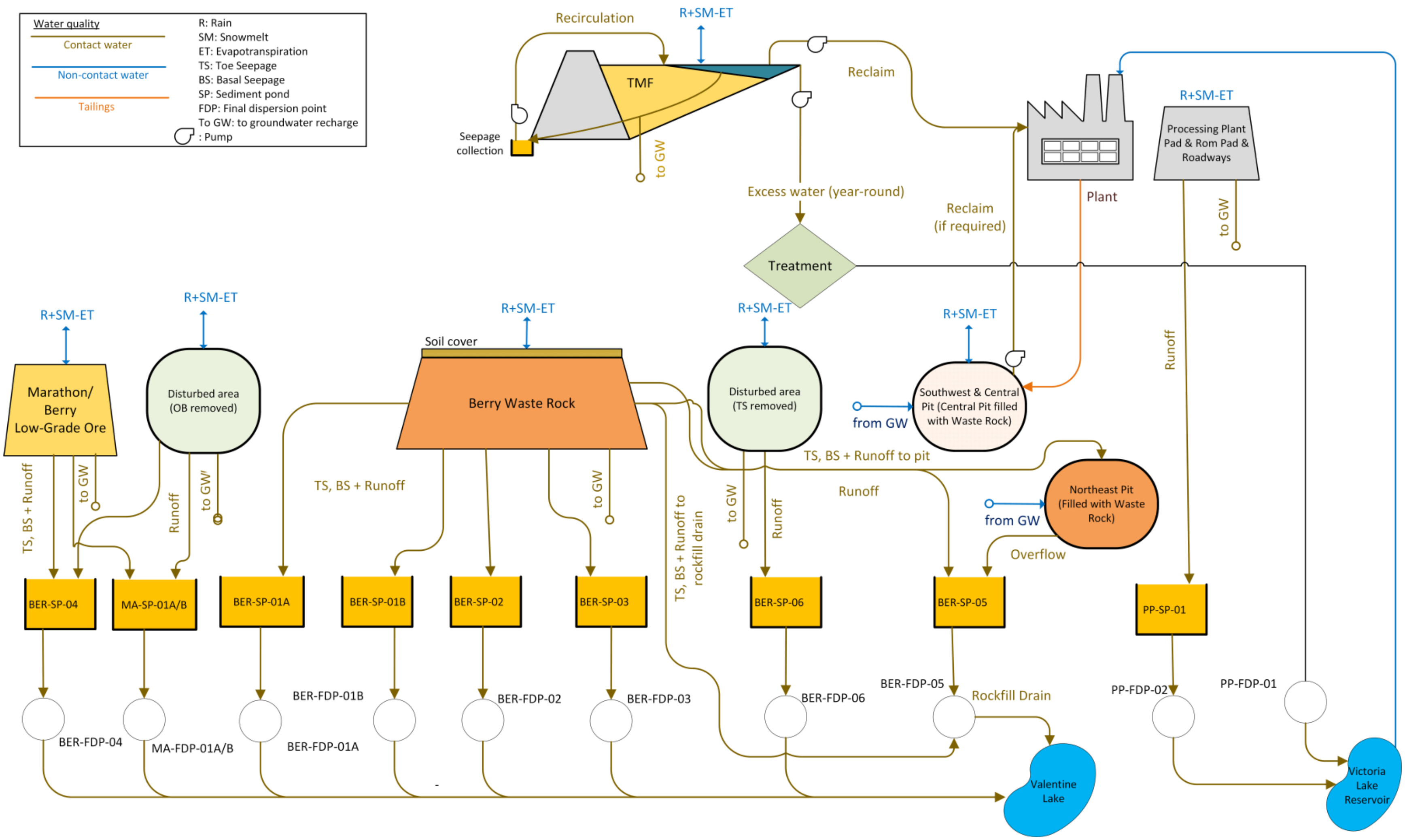


Figure 8-16 Mine Water Management Conceptual Model – Operations Mine Years 13-15

During all Project Expansion phases, the magnitude of the flow from the water management ponds is dictated by outlet configuration, pond volume, level, surface water flow and groundwater infiltration to the ponds.

The water quantity model shows that the ponds become full during freshet of the first year, and overflow to the FDPs thereafter. Table 8.10 presents the water management pond predicted climate normal average outflows from the phases of development for the Berry Complex. As examples, Figures 8-17 and 8-18 present initialization monthly flow rates and storage volume of BER-SP-03 and BER-SP-05, respectively. The BER-SP-03 pond collects runoff from the Berry waste rock pile with toe seepage and surface runoff as the dominant contributors to inflow to the pond. The BER-SP-05 water management pond receives dewatering from the open pits during the operation phase, and pit lake overflow during the closure and post-closure sub-phases. The water quantity model simulates the filling up of the ponds following their initial construction with runoff contributions from the stockpiles and disturbed areas until the pond is full and overflows to the environment.

With the addition of the Berry pit, the water quantity model was updated to simulate the placement of Berry pit associated tailings in the TMF, assess mill reclaim water needs and sources, particularly during the Mine Years 10 to 15 period when tailings are deposited in the Berry pit and the TMF is the primary source, and ensure there is adequate capacity for tailings in the Berry pit southern basin. As the Berry pit will receive tailings beginning in Year 10 (where previously, the Leprechaun Pit was to receive tailings), the water quantity model for the TMF was also updated to reflect these changes. The water quantity model estimated TMF inflows and outflows, and variations in the storage volume. Figure 8-19 presents tailings storage volume for the average condition and shows that the TMF has adequate storage capacity during the operation phase and closure sub-phase. The average condition storage volumes are predicted to be below the maximum storage volume at the spillway. Excess water from the TMF is sent to the treatment plant, which is estimated to be required during the period when tailings are placed in the TMF until the end of Mine Year 9 (Model Year 11.25) and restarted during the last year of operations (Mine Year 15; Model Year 16.25) when reclaim demands by the mill are reduced and then end. During the TMF operation period (Mine Years 1 to 9), the average condition daily flow rate to the treatment plant is 1,250 m^3/day, and for the winter months (December to March), the average daily flow is 400 m^3/day. The average winter treatment plant flow rate is approximately 30% of the average annual treatment flow rate. The winter months treated water volume will be potentially used by the mill in place of freshwater from the Victoria Lake Reservoir or discharged to the Victoria Lake Reservoir. In Mine Year 17 (Model Year 18.25) the tailings pond will be drawn down by pumping to the treatment plant, and the TMF tailings area rehabilitated with a soil overburden cover and the emergency spillway breached to not allow ponding in the TMF.

Table 8.10 Characterization of Residual Effects on Surface Water Resources

Pond/ FDP	Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
		Average Flow (m^3/day)												
BER-SP-01A	Construction (Year -2.25 to -1)	0	0	0	0	0	0	0	0	0	0	0	0	0
	Operation (Year 1 to 9)	426	284	629	1,514	339	169	138	276	288	331	360	435	427
	Operation (Year 10-13)	356	284	578	1,340	258	124	116	196	205	237	267	375	361
	Closure (Year 14 to 18)	470	399	615	1,456	371	164	88	335	380	486	515	564	487
	Post Closure (From Year 19)	-	-	-	-	-	-	-	-	-	-	-	-	-
BER-SP-01B	Construction (Year -2.25 to -1)	0	0	0	0	0	0	0	0	0	0	0	0	0
	Operation (Year 1 to 9)	666	479	949	2,263	548	285	223	480	517	585	646	727	691
	Operation (Year 10-13)	494	394	788	1,827	366	183	171	289	302	344	385	522	505
	Closure (Year 14 to 18)	572	474	726	1,717	441	193	104	398	452	581	615	671	579
	Post Closure (From Year 19)	-	-	-	-	-	-	-	-	-	-	-	-	-
BER-SP-02	Construction (Year -2.25 to -1)	0	0	0	0	0	0	0	0	0	0	0	0	0
	Operation (Year 1 to 9)	481	350	761	1,811	397	196	164	318	339	382	432	521	508
	Operation (Year 10-13)	436	348	692	1,605	322	158	147	252	265	305	342	461	445
	Closure (Year 14 to 18)	464	377	575	1,360	350	150	81	314	357	464	491	535	460
	Post Closure (From Year 19)	-	-	-	-	-	-	-	-	-	-	-	-	-
BER-SP-03	Construction (Year -2.25 to -1)	0	0	0	0	0	0	0	0	0	0	0	0	0
	Operation (Year 1 to 9)	590	429	770	2,050	467	219	163	384	425	497	558	635	594
	Operation (Year 10-13)	475	378	778	1,805	337	152	142	245	259	310	352	502	478
	Closure (Year 14 to 18)	565	466	717	1,694	432	187	100	387	440	570	604	660	568
	Post Closure (From Year 19)	-	-	-	-	-	-	-	-	-	-	-	-	-
BER-SP-04	Construction (Year -2.25 to -1)	472	367	269	888	372	211	144	381	428	481	321	315	379
	Operation (Year 1 to 9)	656	537	835	1959	532	279	200	504	568	646	705	712	678
	Operation (Year 10-13)	612	509	805	1890	506	266	194	481	518	623	652	709	647
	Closure (Year 14 to 18)	707	576	845	1995	583	311	212	578	667	748	788	778	732
	Post Closure (From Year 19)	-	-	-	-	-	-	-	-	-	-	-	-	-
BER-SP-05	Construction (Year -2.25 to -1)	0	0	0	0	0	0	0	0	0	0	0	0	0
	Operation (Year 1 to 9)	2790	2560	3331	5443	3301	3170	3244	3709	3636	3569	3621	3403	3481
	Operation (Year 10-13)	100	136	235	551	125	55	37	105	108	151	157	210	164
	Closure (Year 14 to 18)	1703	1449	2112	4726	1490	577	447	1320	1523	1990	2099	2224	1805
	Post Closure (From Year 19)	2438	2235	3084	6754	2035	702	565	1728	2044	2642	2953	2794	2497
BER-SP-06	Construction (Year -2.25 to -1)	0	0	0	0	0	0	0	0	0	0	0	0	0
	Operation (Year 1 to 9)	501	366	577	1421	417	225	153	415	474	539	583	561	515
	Operation (Year 10-13)	501	412	604	1427	418	225	153	416	469	540	572	566	525
	Closure (Year 14 to 18)	457	390	572	1350	395	213	145	393	433	513	538	558	496
	Post Closure (From Year 19)	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 8.10 Characterization of Residual Effects on Surface Water Resources

Pond/ FDP	Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
		Average Flow (m^3/day)												
MA-SP-01AB	Construction (Year -2.25 to -1)	453	352	518	1219	199	122	92	278	358	448	454	452	443
	Operation (Year 1 to 9)	535	435	671	1573	427	215	152	399	454	529	577	580	545
	Operation (Year 10-13)	494	404	632	1484	397	198	142	370	417	494	529	551	509
	Closure (Year 14 to 18)	483	391	598	1406	386	194	136	365	427	490	545	528	496
	Post Closure (From Year 19)	-	-	-	-	-	-	-	-	-	-	-	-	-

Note:
Southern and Central basins are full and overflow in Mine Year 19

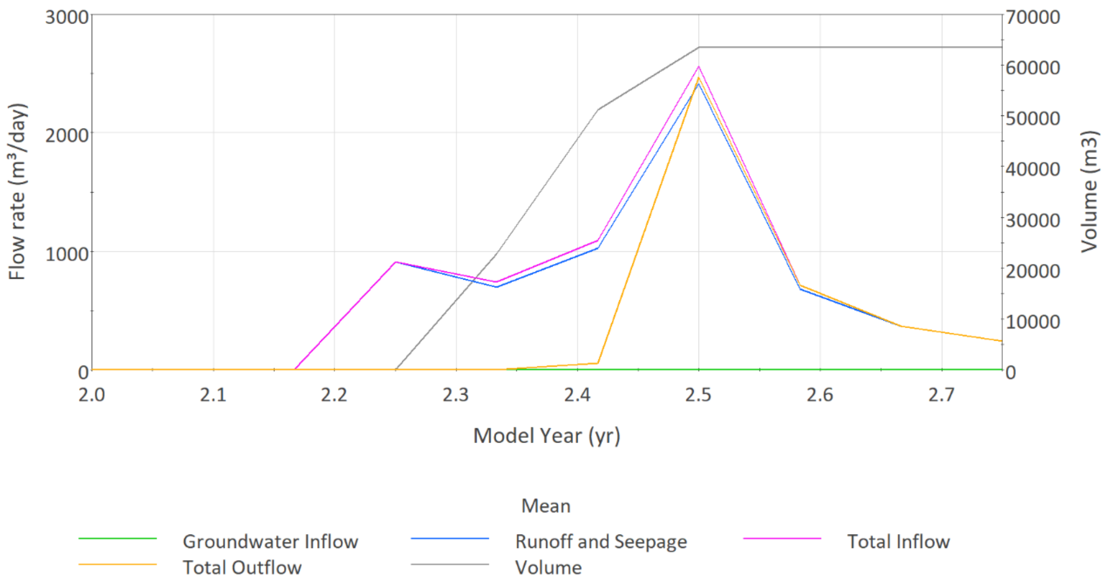


Figure 8-17 Average Condition Volume, Inflows and Outflow of Water Management Pond BER-SP-03

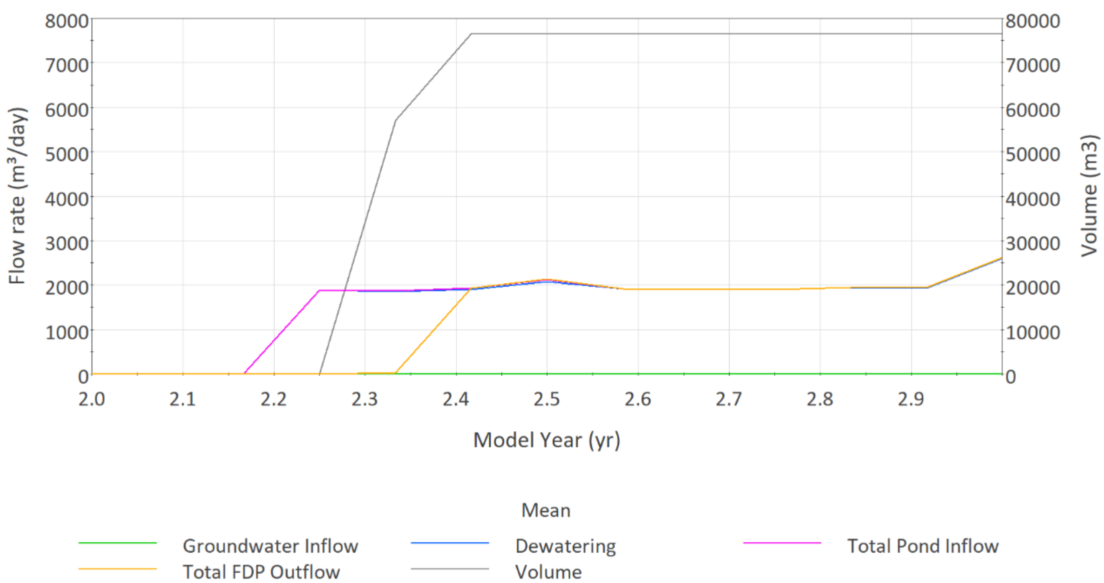


Figure 8-18 Average Condition Volume, Inflows, and Outflow of Water Management Pond BER-SP-05

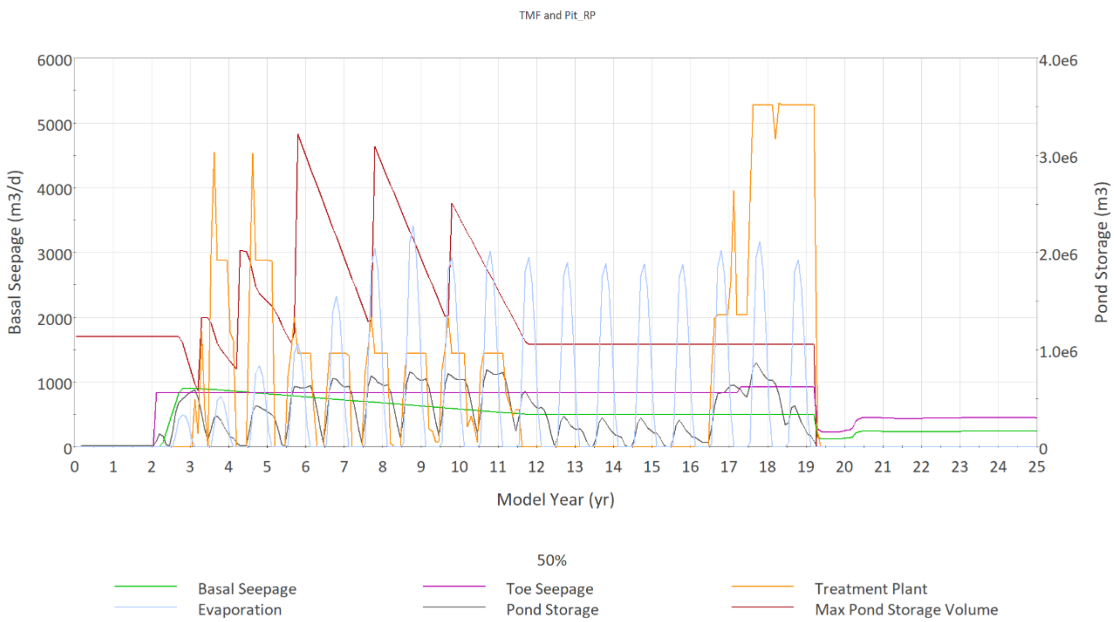


Figure 8-19 Average Climate Condition Tailings Pond Storage and Outflows

The northern basin of Berry pit begins operation in Mine Year 1 and stops operation at the end of Mine Year 6. In these years, flow components into the open pit include groundwater seepage, precipitation, surface runoff from natural areas, evaporation, and dewatering. The model predicts that the northern basin filled with waste rock will take between 7.75 and 9.8 years to fill to the spillway elevation after dewatering stops (Figure 8-20).

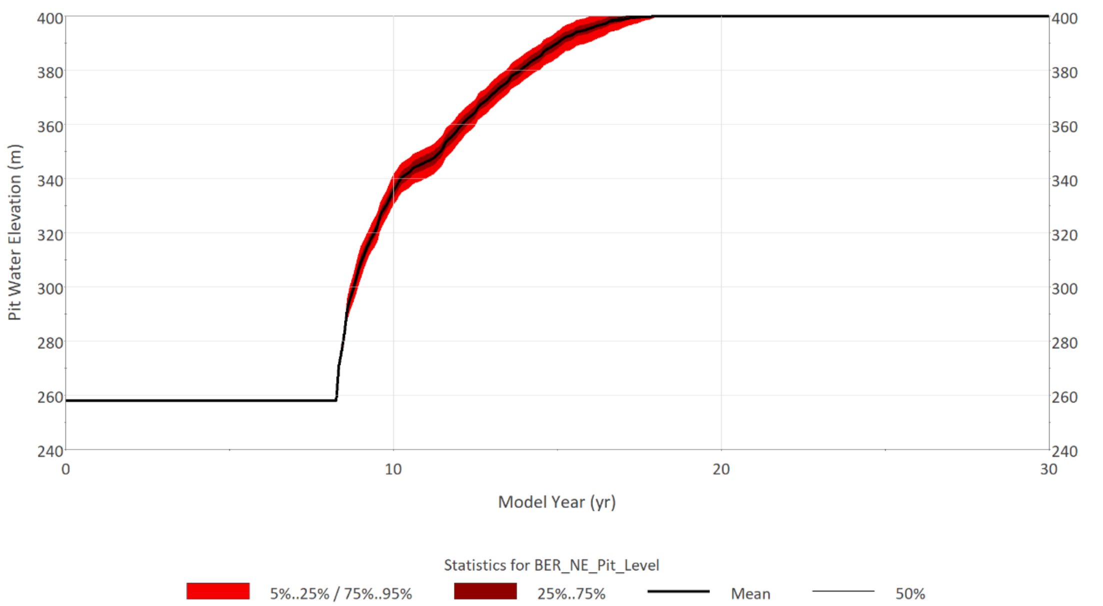


Figure 8-20 Probabilistic Analysis of Natural Filling of Northern Basin of Berry Pit

The southern and central basins of the Berry pit operate from Mine Year 1 to the end of Mine Year 9. Tailings are deposited in the southern basin from Mine Year 10 to the end of Mine Year 15. The model predicts that the southern and central basins will reach the full pit lake elevation between 6.3 and 9.75 years from the stop of operation, including the placement of mine tailings in the southern basin and backfilling of waste rock in the central basin (Figure 8-21). The placement of tailings stops at the end of Mine Year 15, which is six years after dewatering stops in the pit complex. The pit lake will overflow to the environment as early as several months after the stop of tailings placement within the open pit for the 25-year return period wet-scenario (95th percentile).

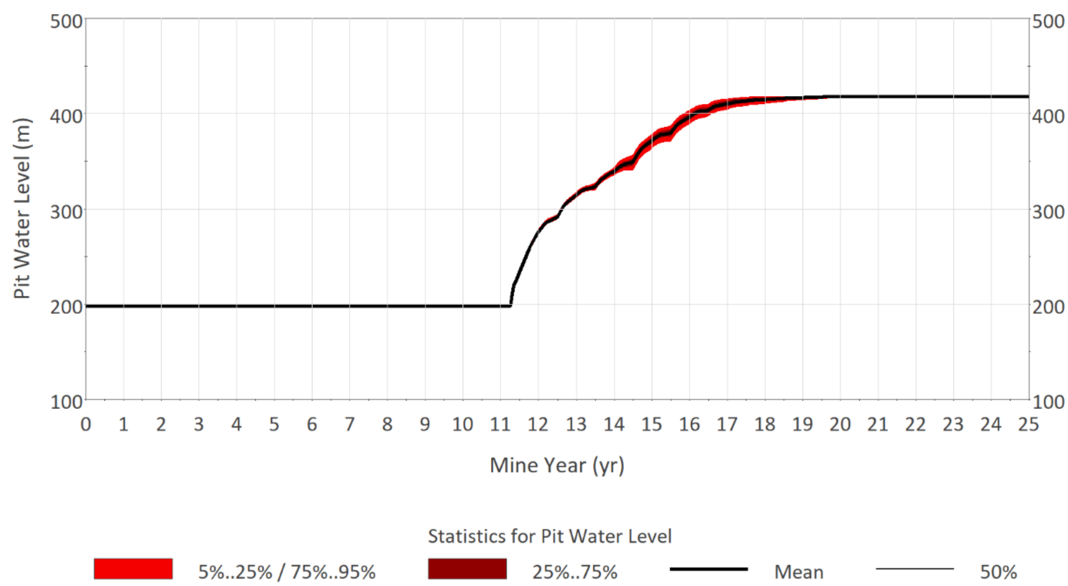


Figure 8-21 Probabilistic Analysis of Tailings Deposition and Natural Filling of Southern and Central Basins of the Berry Complex

As part of the Project Expansion, the Leprechaun pit will not receive tailings from the mill. The updated water quantity model assessed the length of time to fill the open pit to the spillway elevation of 380 m asl from when the Leprechaun pit stops operation at the end of Mine Year 12 using the Approved Project freshwater taking rate from Victoria Lake Reservoir of 4 Mm^3 /year to accelerate pit filling (Marathon 2020). The Approved Project model estimated for the average climate condition the Leprechaun pit would fill within eight years after the end of pit operation with the placement of tailings in the pit. The Leprechaun pit with no tailings placed in the pit is predicted to fill within 11 years for the average condition and 5th percentile (5-year return period annual dry year) and 10.6 years for the 95th percentile (25-year return period annual wet year) (Figure 8-22). This estimate will extend the water taking from Victoria Lake Reservoir by up to three years.

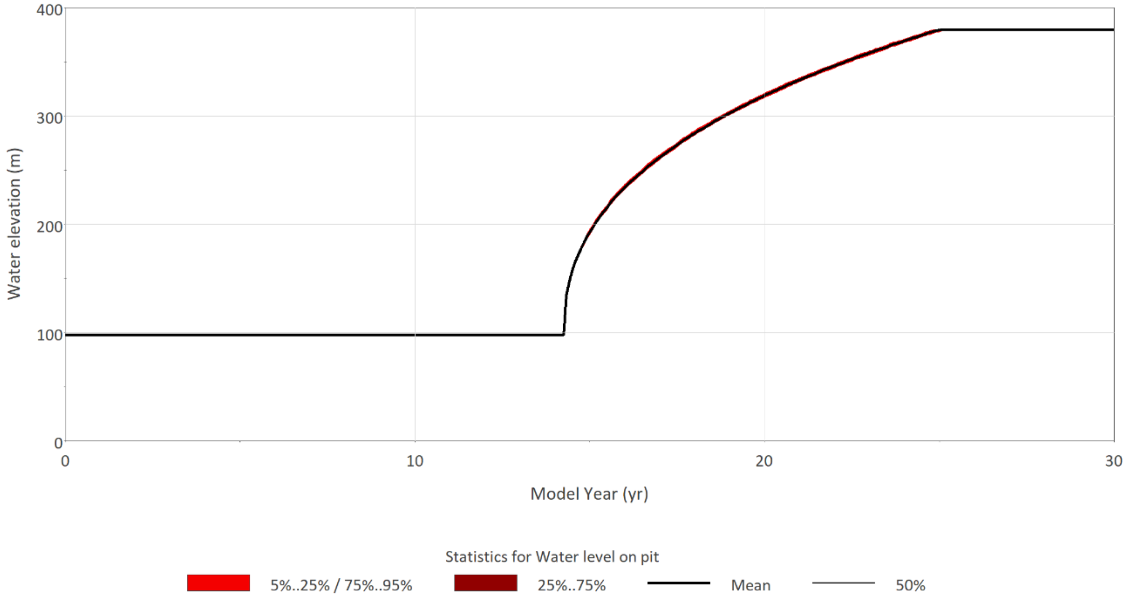


Figure 8-22 Probabilistic Analysis of Accelerated Filling of the Leprechaun Pit Adding Water from Victoria Lake Reservoir

The updated water quantity model for the Project Expansion assessed the length of time to fill the Marathon pit to the spillover elevation of 330 m asl. The model assessed the Approved Project accelerated filling rate of 6.2 Mm^3/year from Valentine Lake, beginning at the end of in-pit mining at the end of Mine Year 13. Figure 8-23 presents the probabilistic analysis results for when the Marathon pit reaches its spillway elevation due to accelerated filling. The Marathon pit is predicted to fill to the spillway elevation for the climate normal condition and 5th percentile condition in 9.3 years, and for the 95th percentile condition in 8.8 years, which is a little over a year longer than estimated by the Approved Project model (Marathon 2020).

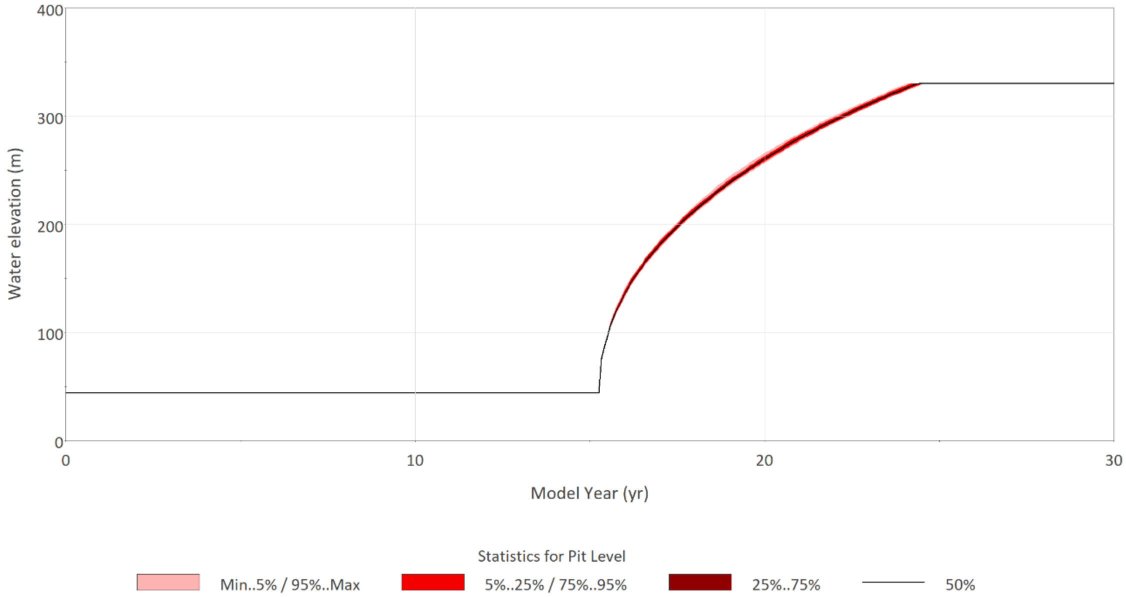


Figure 8-23 Probabilistic Analysis of Accelerated Filling of the Marathon Pit Adding Water from Valentine Lake

Change in Surface Water Quantity Residual Effects

Residual effects, following the incorporation of mitigation measures described in Section 8.3, are described below. Changes in watershed area and estimated changes in MAFs through the mine life phases are shown in Table 8.11. Estimated changes in MMFs are shown in Tables 8.12 to 8.15 for each project phase. Where changes in MAF were projected to be less than 10%, no residual effect is anticipated. Where an increase of over 10% in MAF is predicted, increased flows during high flow events were considered a potential residual effect. Where a decrease of over 10% in MAF is predicted, decreased flows during low flow events (environmental flows) were considered a potential residual effect.

Table 8.11 Summary of Watershed Area, MAF, and Environmental Flow Changes through Project Expansion Phases

Watershed ID	Watershed Area (km^2)					MAF (m^3/s)					Largest change in MAF (%)	MAF % of Pre-Development Summer Environmental Flow				MAF % of Winter Environmental Flow			
	Baseline	Construction/ Operation Years 1-9	Operation Years 10-15	Closure	Post-Closure	Baseline	Construction/ Operation Years 1-9	Operation Years 10-15	Closure	Post-Closure		Construction/ Operation Years 1-9	Operation Years 10-15	Closure	Post-Closure	Construction/ Operation Years 1-9	Operation Years 10-15	Closure	Post-Closure
1	1.773	0.775	0.775	0.775	0.775	0.043	0.0424	0.0406	0.0426	0.0406	-10% (Op, PCl)	88%	180%	188%	180%	213%	300%	314%	300%
2	1.425	0.803	0.803	0.803	0.803	0.028	0.0284	0.0284	0.0282	0.0279	-23% (PCl)	57%	157%	156%	154%	162%	261%	260%	257%
8	2.094	0.352	0.352	0.352	0.352	0.069	0.0688	0.0759	0.0215	0.0702	-60% (Cl)	157%	283%	80%	262%	328%	472%	134%	437%
14	2.137	0.765	0.765	0.765	0.765	0.019	0.0192	0.0192	0.0192	0.0192	-65% (All)	-30%	70%	70%	70%	17%	117%	117%	117%
19	0.683	0.623	0.623	0.623	0.623	0.022	0.0215	0.0216	0.0213	0.0199	+27% (Op)	170%	272%	268%	250%	350%	453%	446%	416%
27	3.141	2.152	2.152	2.152	2.152	0.055	0.0551	0.0551	0.0551	0.0551	-32 % (All)	36%	136%	136%	136%	127%	227%	227%	227%
34a	0.896	0.149	0.149	0.149	0.149	0.05	0.0498	0.0107	0.0298	0.0378	+68 (CO)	342%	95%	265%	336%	637%	158%	441%	560%
34b	0.452	0.073	0.073	0.073	0.073	0.01	0.0097	0.0076	0.0084	0.0084	-25% (Cl, PCl)	74%	136%	151%	151%	190%	226%	251%	251%
34c	0.728	0.186	0.186	0.186	0.186	0.005	0.0045	0.0045	0.0045	0.0045	-75% (All)	-50%	50%	50%	50%	-17%	83%	83%	83%
35	0.409	0.196	0.196	0.196	0.196	0.005	0.0048	0.0048	0.0048	0.0048	-53% (All)	-6%	94%	94%	94%	57%	157%	157%	157%
36	0.812	0.77	0.77	0.77	0.77	0.024	0.0243	0.0235	0.0249	0.025	+22% (Cl, PCl)	138%	231%	245%	245%	297%	384%	408%	408%

Notes:

1. Largest changes in mean annual flows (MAF) compared to the baseline conditions and the Project Expansion phase that this change will be experienced in
2. Changes in % of the MAF refer to the conservative scenarios (refers to the Project Expansion phase which could result in the greatest change in MAF)
3. CO = Construction & Operations (Year 1-9), Op = Operations (Year 10-15), Cl = Closure, PCl = Post Closure, All = All phases
4. Summer Environmental Flow (50% MAF) and Winter Environmental Flow (30% MAF) were used in this assessment

Table 8.12 MMF for Construction and Operation (Years 1 to 9) (m^3/s)

Watershed ID	Phase	MMF (m^3/s)											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Baseline	0.022	0.023	0.040	0.129	0.122	0.049	0.025	0.020	0.032	0.048	0.052	0.035
	CO	0.031	0.027	0.046	0.128	0.075	0.032	0.018	0.025	0.032	0.042	0.045	0.039
	%Change	43%	19%	16%	0%	-38%	-36%	-29%	26%	0%	-12%	-13%	10%
2	Baseline	0.017	0.018	0.031	0.104	0.100	0.040	0.020	0.016	0.026	0.039	0.041	0.028
	CO	0.017	0.016	0.028	0.084	0.066	0.027	0.014	0.015	0.021	0.030	0.031	0.024
	%Change	1%	-9%	-11%	-19%	-34%	-33%	-31%	-6%	-18%	-23%	-24%	-14%
8	Baseline	0.026	0.027	0.047	0.152	0.142	0.058	0.030	0.023	0.038	0.057	0.061	0.042
	CO	0.056	0.050	0.071	0.146	0.082	0.058	0.052	0.062	0.065	0.067	0.069	0.063
	%Change	110%	86%	51%	-4%	-42%	1%	75%	169%	70%	18%	12%	50%
14	Baseline	0.027	0.028	0.048	0.155	0.145	0.059	0.030	0.024	0.039	0.058	0.063	0.043
	CO	0.009	0.009	0.016	0.056	0.056	0.023	0.011	0.008	0.014	0.021	0.022	0.014
	%Change	-68%	-68%	-66%	-64%	-61%	-62%	-63%	-64%	-64%	-64%	-65%	-67%
19	Baseline	0.007	0.007	0.013	0.047	0.048	0.019	0.009	0.007	0.012	0.017	0.018	0.012
	CO	0.013	0.011	0.020	0.062	0.051	0.021	0.011	0.012	0.017	0.023	0.024	0.018
	%Change	80%	56%	47%	33%	8%	12%	17%	66%	45%	34%	35%	53%
27	Baseline	0.042	0.043	0.072	0.226	0.206	0.084	0.044	0.035	0.057	0.085	0.093	0.066
	CO	0.027	0.028	0.048	0.156	0.146	0.059	0.031	0.024	0.039	0.058	0.063	0.044
	%Change	-34%	-34%	-33%	-31%	-29%	-30%	-31%	-31%	-31%	-31%	-32%	-34%
34a	Baseline	0.010	0.011	0.019	0.066	0.065	0.026	0.013	0.010	0.016	0.024	0.026	0.017
	CO	0.039	0.035	0.050	0.095	0.055	0.044	0.042	0.048	0.049	0.050	0.051	0.048
	%Change	282%	234%	161%	45%	-15%	68%	220%	385%	197%	104%	99%	184%
34b	Baseline	0.005	0.005	0.009	0.033	0.035	0.014	0.007	0.005	0.008	0.012	0.013	0.008
	CO	0.008	0.006	0.012	0.032	0.013	0.006	0.004	0.006	0.007	0.009	0.009	0.010
	%Change	74%	26%	32%	-5%	-63%	-58%	-44%	27%	-12%	-29%	-25%	19%
34c	Baseline	0.008	0.008	0.015	0.054	0.054	0.022	0.011	0.008	0.013	0.020	0.021	0.013
	CO	0.002	0.002	0.004	0.014	0.015	0.006	0.003	0.002	0.003	0.005	0.005	0.003
	%Change	-78%	-78%	-76%	-74%	-72%	-72%	-74%	-74%	-74%	-74%	-76%	-77%
35	Baseline	0.004	0.004	0.008	0.030	0.032	0.013	0.006	0.005	0.008	0.011	0.011	0.007
	CO	0.002	0.002	0.004	0.015	0.016	0.006	0.003	0.002	0.004	0.005	0.005	0.003
	%Change	-56%	-56%	-54%	-52%	-49%	-50%	-51%	-52%	-52%	-52%	-53%	-55%
36	Baseline	0.009	0.009	0.017	0.060	0.060	0.024	0.012	0.009	0.015	0.022	0.023	0.015
	CO	0.014	0.012	0.024	0.074	0.061	0.025	0.013	0.012	0.017	0.025	0.026	0.019
	%Change	48%	29%	37%	24%	2%	3%	8%	30%	17%	12%	13%	28%

Note: CO = construction and operation (Year 1 to 9)

Table 8.13 MMF for Operation (Years 10 to 15) (m^3/s)

Watershed ID	Project Phase	MMF (m^3/s)											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Baseline	0.023	0.040	0.129	0.122	0.049	0.025	0.020	0.032	0.048	0.052	0.035	0.023
	Op	0.026	0.045	0.124	0.073	0.031	0.017	0.023	0.030	0.040	0.042	0.038	0.026
	%Change	15%	14%	-4%	-40%	-38%	-32%	16%	-8%	-17%	-19%	6%	15%
2	Baseline	0.017	0.018	0.031	0.104	0.100	0.040	0.020	0.016	0.026	0.039	0.041	0.028
	Op	0.017	0.016	0.027	0.083	0.065	0.027	0.014	0.015	0.021	0.030	0.031	0.024
	%Change	0%	-10%	-13%	-20%	-35%	-34%	-33%	-7%	-19%	-22%	-24%	-13%
8	Baseline	0.026	0.027	0.047	0.152	0.142	0.058	0.030	0.023	0.038	0.057	0.061	0.042
	Op	0.064	0.057	0.077	0.160	0.088	0.061	0.054	0.070	0.073	0.075	0.076	0.072
	%Change	141%	110%	63%	6%	-38%	6%	81%	200%	91%	33%	24%	70%
14	Baseline	0.027	0.028	0.048	0.155	0.145	0.059	0.030	0.024	0.039	0.058	0.063	0.043
	Op	0.009	0.009	0.016	0.056	0.056	0.023	0.011	0.008	0.014	0.021	0.022	0.014
	%Change	-68%	-68%	-66%	-64%	-61%	-62%	-63%	-64%	-64%	-64%	-65%	-67%
19	Baseline	0.007	0.007	0.013	0.047	0.048	0.019	0.009	0.007	0.012	0.017	0.018	0.012
	Op	0.013	0.012	0.020	0.062	0.052	0.021	0.011	0.012	0.017	0.023	0.024	0.018
	%Change	80%	64%	50%	33%	8%	12%	17%	66%	44%	34%	35%	54%
27	Baseline	0.042	0.043	0.072	0.226	0.206	0.084	0.044	0.035	0.057	0.085	0.093	0.066
	Op	0.027	0.028	0.048	0.156	0.146	0.059	0.031	0.024	0.039	0.058	0.063	0.044
	%Change	-34%	-34%	-33%	-31%	-29%	-30%	-31%	-31%	-31%	-31%	-32%	-34%
34a	Baseline	0.010	0.011	0.019	0.066	0.065	0.026	0.013	0.010	0.016	0.024	0.026	0.017
	Op	0.008	0.007	0.014	0.036	0.018	0.007	0.004	0.006	0.007	0.009	0.010	0.010
	%Change	-26%	-33%	-29%	-45%	-73%	-72%	-66%	-42%	-57%	-62%	-62%	-40%
34b	Baseline	0.005	0.005	0.009	0.033	0.035	0.014	0.007	0.005	0.008	0.012	0.013	0.008
	Op	0.006	0.005	0.010	0.027	0.011	0.005	0.003	0.004	0.005	0.006	0.006	0.007
	%Change	33%	6%	12%	-20%	-69%	-66%	-53%	-17%	-42%	-51%	-49%	-11%
34c	Baseline	0.008	0.008	0.015	0.054	0.054	0.022	0.011	0.008	0.013	0.020	0.021	0.013
	Op	0.002	0.002	0.004	0.014	0.015	0.006	0.003	0.002	0.003	0.005	0.005	0.003
	%Change	-78%	-78%	-76%	-74%	-72%	-72%	-74%	-74%	-74%	-74%	-76%	-77%
35	Baseline	0.004	0.004	0.008	0.030	0.032	0.013	0.006	0.005	0.008	0.011	0.011	0.007
	Op	0.002	0.002	0.004	0.015	0.016	0.006	0.003	0.002	0.004	0.005	0.005	0.003
	%Change	-56%	-56%	-54%	-52%	-49%	-50%	-51%	-52%	-52%	-52%	-53%	-55%
36	Baseline	0.009	0.009	0.017	0.060	0.060	0.024	0.012	0.009	0.015	0.022	0.023	0.015
	Op	0.013	0.012	0.023	0.072	0.060	0.024	0.013	0.011	0.016	0.024	0.025	0.019
	%Change	39%	29%	33%	21%	0%	1%	6%	20%	11%	7%	8%	23%

Note: Op = Operation (Years 10 to 15)

Table 8.14 MMF for Closure (m^3/s)

Watershed ID	Project Phase	MMF (m^3/s)											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Baseline	0.022	0.023	0.040	0.129	0.122	0.049	0.025	0.020	0.032	0.048	0.052	0.035
	Cl	0.031	0.028	0.044	0.123	0.075	0.031	0.017	0.025	0.034	0.044	0.047	0.040
	%Change	43%	22%	13%	-4%	-39%	-36%	-34%	29%	4%	-7%	-9%	13%
2	Baseline	0.017	0.018	0.031	0.104	0.100	0.040	0.020	0.016	0.026	0.039	0.041	0.028
	Cl	0.017	0.016	0.027	0.082	0.065	0.027	0.014	0.015	0.021	0.030	0.032	0.024
	%Change	-1%	-11%	-14%	-21%	-35%	-34%	-33%	-8%	-17%	-23%	-23%	-15%
8	Baseline	0.026	0.027	0.047	0.152	0.142	0.058	0.030	0.023	0.038	0.057	0.061	0.042
	Cl	0.016	0.014	0.023	0.063	0.037	0.015	0.008	0.013	0.017	0.023	0.024	0.020
	%Change	-38%	-48%	-51%	-58%	-74%	-74%	-74%	-45%	-55%	-60%	-61%	-52%
14	Baseline	0.027	0.028	0.048	0.155	0.145	0.059	0.030	0.024	0.039	0.058	0.063	0.043
	Cl	0.009	0.009	0.016	0.056	0.056	0.023	0.011	0.008	0.014	0.021	0.022	0.014
	%Change	-68%	-68%	-66%	-64%	-61%	-62%	-63%	-64%	-64%	-64%	-65%	-67%
19	Baseline	0.007	0.007	0.013	0.047	0.048	0.019	0.009	0.007	0.012	0.017	0.018	0.012
	Cl	0.012	0.012	0.020	0.062	0.051	0.021	0.011	0.011	0.016	0.023	0.024	0.018
	%Change	73%	60%	47%	31%	8%	11%	16%	62%	41%	32%	32%	53%
27	Baseline	0.042	0.043	0.072	0.226	0.206	0.084	0.044	0.035	0.057	0.085	0.093	0.066
	Cl	0.027	0.028	0.048	0.156	0.146	0.059	0.031	0.024	0.039	0.058	0.063	0.044
	%Change	-34%	-34%	-33%	-31%	-29%	-30%	-31%	-31%	-31%	-31%	-32%	-34%
34a	Baseline	0.010	0.011	0.019	0.066	0.065	0.026	0.013	0.010	0.016	0.024	0.026	0.017
	Cl	0.026	0.023	0.034	0.082	0.034	0.013	0.008	0.021	0.025	0.033	0.034	0.034
	%Change	158%	114%	77%	24%	-48%	-49%	-36%	107%	49%	33%	33%	104%
34b	Baseline	0.005	0.005	0.009	0.033	0.035	0.014	0.007	0.005	0.008	0.012	0.013	0.008
	Cl	0.007	0.006	0.010	0.025	0.012	0.005	0.002	0.005	0.007	0.009	0.009	0.009
	%Change	51%	25%	5%	-24%	-67%	-65%	-65%	8%	-21%	-29%	-28%	11%
34c	Baseline	0.008	0.008	0.015	0.054	0.054	0.022	0.011	0.008	0.013	0.020	0.021	0.013
	Cl	0.002	0.002	0.004	0.014	0.015	0.006	0.003	0.002	0.003	0.005	0.005	0.003
	%Change	-78%	-78%	-76%	-74%	-72%	-72%	-74%	-74%	-74%	-74%	-76%	-77%
35	Baseline	0.004	0.004	0.008	0.030	0.032	0.013	0.006	0.005	0.008	0.011	0.011	0.007
	Cl	0.002	0.002	0.004	0.015	0.016	0.006	0.003	0.002	0.004	0.005	0.005	0.003
	%Change	-56%	-56%	-54%	-52%	-49%	-50%	-51%	-52%	-52%	-52%	-53%	-55%
36	Baseline	0.009	0.009	0.017	0.060	0.060	0.024	0.012	0.009	0.015	0.022	0.023	0.015
	Cl	0.014	0.014	0.024	0.073	0.061	0.025	0.012	0.012	0.019	0.027	0.028	0.021
	%Change	53%	43%	36%	23%	2%	3%	4%	38%	24%	20%	21%	38%

Note: Cl = Closure

Table 8.15 MMF for Post-Closure (m^3/s)

Watershed ID	Project Phase	MMF (m^3/s)											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Baseline	0.022	0.023	0.040	0.129	0.122	0.049	0.025	0.020	0.032	0.048	0.052	0.035
	PCl	0.028	0.027	0.055	0.117	0.073	0.031	0.016	0.024	0.033	0.043	0.046	0.037
	%Change	30%	19%	38%	-9%	-40%	-38%	-36%	22%	1%	-11%	-11%	6%
2	Baseline	0.017	0.018	0.031	0.104	0.100	0.040	0.020	0.016	0.026	0.039	0.041	0.028
	PCl	0.016	0.016	0.023	0.081	0.065	0.026	0.014	0.015	0.021	0.030	0.032	0.023
	%Change	-5%	-10%	-26%	-22%	-35%	-34%	-34%	-8%	-18%	-23%	-23%	-16%
8	Baseline	0.026	0.027	0.047	0.152	0.142	0.058	0.030	0.023	0.038	0.057	0.061	0.042
	PCl	0.061	0.057	0.056	0.176	0.080	0.039	0.031	0.053	0.061	0.073	0.079	0.071
	%Change	129%	109%	19%	16%	-44%	-32%	3%	128%	60%	28%	28%	68%
14	Baseline	0.027	0.028	0.048	0.155	0.145	0.059	0.030	0.024	0.039	0.058	0.063	0.043
	PCl	0.009	0.009	0.009	0.056	0.056	0.023	0.011	0.008	0.014	0.021	0.022	0.014
	%Change	-68%	-68%	-82%	-64%	-61%	-62%	-63%	-64%	-64%	-64%	-65%	-67%
19	Baseline	0.007	0.007	0.013	0.047	0.048	0.019	0.009	0.007	0.012	0.017	0.018	0.012
	PCl	0.011	0.011	0.010	0.058	0.050	0.020	0.010	0.010	0.015	0.021	0.022	0.016
	%Change	54%	47%	-22%	23%	5%	7%	11%	46%	32%	23%	25%	37%
27	Baseline	0.042	0.043	0.072	0.226	0.206	0.084	0.044	0.035	0.057	0.085	0.093	0.066
	PCl	0.027	0.028	0.028	0.156	0.146	0.059	0.031	0.024	0.039	0.058	0.063	0.044
	%Change	-34%	-34%	-61%	-31%	-29%	-30%	-31%	-31%	-31%	-31%	-32%	-34%
34a	Baseline	0.010	0.011	0.019	0.066	0.065	0.026	0.013	0.010	0.016	0.024	0.026	0.017
	PCl	0.035	0.032	0.029	0.105	0.040	0.015	0.010	0.025	0.031	0.040	0.044	0.041
	%Change	238%	203%	51%	60%	-38%	-44%	-25%	154%	88%	64%	73%	141%
34b	Baseline	0.005	0.005	0.009	0.033	0.035	0.014	0.007	0.005	0.008	0.012	0.013	0.008
	PCl	0.007	0.006	0.006	0.025	0.012	0.005	0.002	0.005	0.007	0.009	0.009	0.008
	%Change	46%	30%	-39%	-24%	-67%	-66%	-65%	7%	-16%	-30%	-25%	5%
34c	Baseline	0.008	0.008	0.015	0.054	0.054	0.022	0.011	0.008	0.013	0.020	0.021	0.013
	PCl	0.002	0.002	0.002	0.014	0.015	0.006	0.003	0.002	0.003	0.005	0.005	0.003
	%Change	-78%	-78%	-88%	-74%	-72%	-72%	-74%	-74%	-74%	-74%	-76%	-77%
35	Baseline	0.004	0.004	0.008	0.030	0.032	0.013	0.006	0.005	0.008	0.011	0.011	0.007
	PCl	0.002	0.002	0.002	0.015	0.016	0.006	0.003	0.002	0.004	0.005	0.005	0.003
	%Change	-56%	-56%	-77%	-52%	-49%	-50%	-51%	-52%	-52%	-52%	-53%	-55%
36	Baseline	0.009	0.009	0.017	0.060	0.060	0.024	0.012	0.009	0.015	0.022	0.023	0.015
	PCl	0.014	0.014	0.013	0.073	0.061	0.025	0.012	0.012	0.019	0.027	0.028	0.021
	%Change	53%	46%	-24%	23%	2%	3%	4%	38%	26%	20%	22%	35%

Note: PCl = Post-Closure

Construction and Operation

Construction and Operation Years 1-9

Details of predicted surface water quantity changes anticipated during the construction and operation Years 1 to 9 from pre-development conditions are presented in Table 8.11 and Table 8.12, and discussed below. Residual effects for construction and operation were considered together as changes to water quantity are anticipated to be minimal through construction activities and the largest changes captured during the operation phase.

- WS-01 is expected to experience MAF within 10% of the pre-development MAF/MMF. No residual effect for surface water quantity is expected as a result of the Project Expansion.
- WS-14 is expected to receive a decrease in MAF of greater than 10%, however changes to MMF and MAF were addressed in the Approved Project. No further residual effects are anticipated for this watershed as a result of the Project Expansion.
- WS-8, WS-19, WS-34A, and WS-36 will experience an increase in MAF of greater than 10%. Water management infrastructure, further detailed in the updated Water Management Plan (Appendix 2A), will attenuate flows using berms, ditching and sedimentation ponds. Berms will be used to divert non-contact water from entering the water management infrastructure and to keep it in its pre-development watershed. Ditches will collect and convey contact water to sedimentation ponds. These ponds will attenuate peak runoff rates and allow water to be released over time to extend the period of baseflow augmentation released to the downstream watersheds. Flows were compared to the Q100 flood flows and flows during construction and operation were between 1.88% and 3.5% of the Q100 flow. Therefore, attenuation and management of discharge will keep peak flows at or below baseline peak flows.
- WS-2, WS-27, WS-34B, WS-34C, and WS-35 are expected to experience a decrease in MAF of greater than 10%. The following is a detailed assessment of predicted flow reductions in respective watersheds:
  - WS-34B and 34C are headwater watersheds draining north towards Valentine Lake. Due to the conservative approach taken in this assessment of selecting the most upstream point on a watershed required to capture the upstream mine footprint, the pre-disturbance watersheds are relatively small (0.073 and 0.186 km^2 respectively) and taking even a small area out of these watersheds results in a substantial change in expected flows. Reductions in MAF of 17% and 75%, respectively is projected. The revised MAF for WS-34B is projected to be 166% and 276% greater than the pre-development summer and winter environmental flows, respectively. The revised MAF for WS-34C is projected to be 50% and 83% greater than the pre-development summer and winter environmental flows, respectively.

  - WS-35 has much of its pre-disturbance watershed overlaid by the footprint of the waste rock pile and topsoil stockpile. Water draining from the piles and perimeter ditches is directed to a sedimentation pond located in an adjacent watershed (WS-19); therefore WS-35 will lose a large portion of its flow and a reduction of 53% in MAF is projected. The revised MAF is projected to be 94% and 157% less than the baseline summer and winter environmental flows, respectively. The flow lost from WS-35 joins a larger watershed approximately 150 m downstream at the confluence of the WS-35 and WS-19 watersheds (Tributary id 35 and 19). However, baseline environmental flows will not be maintained for the 150 m reach between WS-35 and WS-19.
  - WS-2 and WS-27 are located within infrastructure assessed in the Valentine Gold EIS. Design changes to the waste rock piles and topsoil stockpiles have changed the area affected by the Approved Project in these watersheds. Reductions in MAF of 23% and 32%, respectively are projected. The revised MAF for WS-2 is projected to be 154% and 257% greater than the pre-development summer and winter environmental flows, respectively. The revised MAF for WS-27 is projected to be 136% and 227% greater than the pre-development summer and winter environmental flows, respectively.
- Expected MAFs for the construction and operation (Year 1-9) phases were calculated for the LAA watershed of Valentine Lake. Valentine Lake is expected to experience an increase in MAF of 0.4%, primarily due to dewatering the Berry pit, which results in increased flows to Valentine Lake. Thus, at the LAA boundary, no substantial residual surface water quantity effects are anticipated.

Operations Years 10-15

Details of predicted surface water quantity changes anticipated during the construction and operation Years 10 to 15 from pre-development conditions are presented in Tables 8.11 and 8.13 and discussed below. Commencing in Year 10 tailings will be deposited in the southern basin of the Berry pit which will be a change from the Approved Project in which in Year 10 tailings were to be deposited in the Leprechaun pit. Residual effects for construction and operation were considered together as changes to water quantity are anticipated to be minimal through construction activities and the largest changes captured during the operation phase. There is no change in predicted flows within+/-10% for WS-01, WS-02, WS-08, WS-14, WS-19, WS-27, WS-34B, WS-34C, WS-35, and WS-36 from the Construction and Operations (Years 1-9) phase. Increases in flow of greater or less than 10% will be offset as part of the offsetting plan for the *Fisheries Act* (FA) Authorization (Section 9.5.2.1).

- WS-34A will experience an increase in MAF of greater than 10%. Water management infrastructure, further detailed in the updated Water Management Plan (Appendix 2A), will attenuate flows using berms, ditching and sedimentation ponds. Berms will be used to divert non-contact water from entering the water management infrastructure and to keep it in its pre-development watershed. Ditches will collect and convey contact water to sedimentation ponds. These ponds will attenuate peak runoff rates and allow water to be released over time to extend the period of baseflow augmentation released to the downstream watersheds. To the extent possible, water management infrastructure will keep surface water within the pre-development watershed. The mitigation measures applied through the Water Management Plan are anticipated to result in no residual effects downstream.

- Expected MAFs for the Year 10-15 operation phase were calculated for the LAA watershed of Valentine Lake. Valentine Lake is expected to experience a reduction in MAF of -6% due to the attenuation of water in the southern basin of the Berry pit. As the change in MAF is less than 10% at the LAA boundary, no substantial residual surface water quantity effects are anticipated.

Decommissioning, Rehabilitation and Closure

At the end of the operation phase, the main features requiring rehabilitation will include the Berry open pit, Berry waste rock pile, associated infrastructure and water management infrastructure. Details of surface water quantity changes anticipated during closure from pre-development conditions are presented in Table 8.11 and 8.14 and are discussed below. During closure and post-closure, watersheds WS-01, WS-02, WS-08, WS-14, WS-19, WS-27, WS-34A, WS-34B, WS-34C, WS-35, and WS-36 experience changes in surface water quantity of the same magnitude as in the construction and operation (Years 1-9) phase (e.g., WS-01 experiences MAF within 10% of baseline conditions in the construction and operation Phase, and in the closure and post-closure sub-phases). Anticipated changes in closure and post-closure at the Valentine Lake Watershed (LAA) are discussed in the following sub-sections:

Closure

Active mining from the Berry, Leprechaun and Marathon pits will cease in Years 9, 13 and 14 respectively. As a change from the Approved Project, the Leprechaun pit will no longer receive tailings and slurry water as it will be redirected to the Berry pit. Waste rock will be deposited in the northern and central basins of the Berry pit and the southern basin of the Berry pit will be operated as a tailings storage facility from Year 9 to the end of operation. Due to filling of the Berry pit with waste rock, tailings and tailings slurry water, it is not anticipated that water will be withdrawn from Valentine Lake to fill the Berry pit. It is estimated that it will take between 6.3 and 9.75 years after the end of operations for Berry pit to reach the full pit lake elevation under normal climate conditions.

As a change from the Approved project, the Leprechaun pit will no longer receive tailings and slurry water as it will be redirected to the Berry pit and will be allowed to fill with water at the end of operations. To expedite the time required to fill the Approved Project open pits, water is proposed to be withdrawn from Valentine Lake to accelerate filling of the Marathon pit and from Victoria Lake to accelerate filling of the Leprechaun pit. A flow rate of 5.5 million cubic metres per year (Mm3/year) or 0.178 m3 per second (m3/s) from Valentine Lake is required to fill the Marathon pit over a period between 8.8 and 9.3 years. A flow rate of 4.0 Mm^3/year from Victoria Lake Reservoir will be used to fill the Leprechaun pit for a period of 10.6 to 11 years from the cessation of mining at the end of Mine Year 13 to fill to the 380 m asl spillway elevation for the wet and dry scenarios, respectively. Accelerated pit filling will mitigate potential residual effects in that it will act to improve the water quality of the pit lake, reduce long-term liability related to an extended period of natural pit filling, and expedites the submergence of potentially reactive materials exposed on the pit walls. For Valentine Lake, the proposed pumping rate corresponds to 28% of the pre-development MAF. As the reduction in MAF was greater than 10%, it was also compared with pre-development environmental flows. The closure MAF is projected to be 41.8% and 69.6% greater than the pre-development summer and winter environmental flows, respectively.

Post-Closure

The start of the post-closure phase will be marked by the completion of rehabilitation activities as the project moves from closure to post-closure. Details of surface water quantity changes anticipated during the post-closure phase relative to pre-development conditions are presented in Table 8.11 and 8.15 and are discussed below:

Expected MAFs for the post-closure phase were calculated for the LAA watersheds of Valentine Lake. Valentine Lake is expected to experience a loss in MAF of -2%; this may be due to the attenuation of water in the pit lakes during post-closure. As the change in MAF is less than 10% at the LAA boundary, no substantial residual surface water quantity effects are anticipated.

8.5.2.2 Change in Surface Water Quality

Water Quality Model Results

Sources of Potential Contaminants

An assessment of ARD/ML to determine the absence/presence of PAG has been completed and is presented in Appendix 2F. Mine water from the open pit areas may contain suspended solids, explosive residuals (mainly ammonia, nitrite, and nitrate), and elevated levels of metals. Most of the pit walls and rubble on pit benches will be represented by waste rock, which has low ARD/ML potential in the Berry deposit. Minimum ARD onset time is about six years after exposure of a small amount of PAG materials based on kinetic testing. These materials will be submerged during pit filling and therefore acidification of pit lakes water is not currently expected. Mine water discharged during operation and post-mining pit lake discharges are expected to meet the MDMER limits.

Findings presented in the Acid Rock Drainage / Metal Leaching Management Plan (Proposed Revision to Address the Berry Pit Expansion) (Appendix 2F) are summarized below:

- The overall estimated percentage of PAG (1<NPR) and uncertain waste rock (1<NPR<2) is 11% for the Berry Complex. All waste rock units have some PAG samples and waste rock shows moderate ML potential for Al, Cd, Cu, Fe, Mo, Se, U, and Zn based on currently available (early) data from kinetic tests. There are no exceedances of the MDMER limits observed in leachates from the waste rock humidity cells. Where waste rock will be used for site earthworks and grading during construction and operational development, necessary test work will be conducted to prevent PAG materials from being used in construction.
- For Low Grade Ore (LGO), 41% of the samples are classified as PAG material. In the kinetic testing to date, there are exceedances of the CWQG-FAL in Al, Cd, Cu, Fe, U and Zn. The MDMER limit was exceeded for Cu in Week 8 of the Berry LGO-PAG-CO3DP humidity cell test (HCT).
- Approximately 58% of high-grade ore is classified as PAG. Concentrations of Al, Cd, Cu, Fe, and Zn have exceedances of the respective CWQG-FAL thresholds in the kinetic testing results available to date. No exceedances of MDMER are observed in results.

- Approximately 51 Mt of tailings will be produced from both high-grade ore and low-grade ore with about 30% of the material originating from the Leprechaun pit, 19% originating from the Berry pit, and the remainder from the Marathon pit. It is critical that high grade ore destined for processing be processed within the onset period for acid rock drainage potential, of which the shortest onset period is approximately 11 years.
- Composite samples of tailings from both deposits are classified as non-PAG and are not expected to generate ARD. During operation, tailings pond and pore water will likely exceed the MDMER limits for total cyanide (CN_T), un-ionized ammonia ($N\text{-}NH_3$ UN), and copper (Cu) sourced from process water. Seepage from the TMF is conservatively predicted to exceed MDMER limits for CN_T, un-ionized ammonia, and Cu in post-closure. Requirement for treatment is further predicted by the water quality model and assimilative capacity assessment (Appendix 8A and Appendix 8B, respectively).

Water Quality Management

Water quality management for the Project Expansion follows the water quality management practices from the Approved Project and involves water quality treatment of surface runoff in contact with Project Expansion facilities and groundwater seepage. The water quality treatment process for excess TMF water includes the process plant cyanide destruction circuit, tailings pond, water treatment plant, and SAGR® unit. The treatment process is designed to provide a final effluent that complies with MDMER and is summarized below:

- Cyanide (CN) destruction circuit in the mill circuit reduces the cyanide levels in the effluent discharge.
- Sedimentation of suspended solids and supplemental natural cyanide degradation in the TMF tailings pond, with seasonal discharge to a process water treatment plant.
- Copper and ammonia removal and pH adjustment in the water treatment plant.
- Peak effluent flow equalization and ammonia treatment occurs in the SAGR® unit to further reduce concentrations of ammonia and cyanide. Treated effluent complies with MDMER criteria limits.

Water Quality Predictions

The mean and 95th percentile surface water quality statistics at the FDPs were predicted during the project construction, operation, and decommissioning, rehabilitation and closure phases, and are summarized as follows:

- Water quality parameters (both monthly mean and 95th percentiles) are expected to comply with the MDMER discharge limits at all discharge points during all mine phases.
- CWQG-FAL is predicted to be exceeded for parameters such as aluminum, arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, molybdenum, phosphorus, selenium, silver, uranium, zinc, nitrite, nitrogen ammonia, nitrogen unionized ammonia, fluoride and nitrate at some sediment ponds which are associated with seepage from waste rock. These parameters are predicted to decline during closure (Appendix 8A).

- TMF discharge will be treated in a water treatment plant and discharged to the SAGR® unit prior to discharge to the environment. The tailings pond is predicted to have concentrations of unionized ammonia, total cyanide, and copper above the MDMER limits, but will be processed in the water treatment plant to comply with the MDMER limits prior to discharge to the SAGR® unit. Ammonia treatment and cyanide degradation will occur in the SAGR® unit, further reducing their concentrations.
- The pit lakes are predicted to meet the MDMER limits prior to discharging to the environment. Predicted effluent / discharge water quality are further described in the Water Quantity and Water Quality Model Update Report (Appendix 8A).

Change in Surface Water Quality Residual Effects

Residual effects, following the incorporation of mitigation measures described in Section 8.3, are described below.

Construction and Operation

Residual Project Expansion effects on surface water quality during construction and operation, and after mitigation measures are applied, are described below. Residual effects for construction and operation activities were considered together as changes to water quality are anticipated to be minimal through construction activities and the largest changes captured during the operation phase.

Erosion and Sedimentation

- Erosion and sedimentation have the potential to alter surface water quality from the initiation of earthworks related to site preparation during construction through to the end of operation. The Water Management Plan (Appendix 2A) provides details on the planned use of sedimentation ponds to receive and treat contact water prior to discharging to FDPs. Details of the sediment treatment capacity of these ponds are provided in Table 8.8.
- Project Expansion infrastructure and ground disturbance activities will take place upstream of sedimentation ponds which will allow treatment before discharge to the receiving environment.
- Sedimentation ponds will be constructed early and progressively as upstream mine infrastructure is constructed and will be initiated so they are functioning during construction activities to the extent possible.
- Ponds are designed with adequate residence time to treat the expected TSS load resulting from a 1:10 AEP, attenuate flows from a 1:100 year storm event, and to safely pass flows resulting from a 1:200 year storm event. Details regarding proposed pond sizes and expected TSS treatment potential are provided in the Water Management Plan (Appendix 2A).
- As construction activities are completed and mine infrastructure moves into operation, the amount of sediment accumulation in sedimentation ponds will be monitored. Ponds with significant accumulation will be cleaned out prior to operation. Ponds will also be inspected throughout operation for sediment accumulation and cleaned out, as necessary.
- Non-contact water will be diverted from mine infrastructure to reduce the flows entering sedimentation ponds.

- In addition to the large-scale erosion and sedimentation reduction measures outlined in the Water Management Plan (Appendix 2A), it is expected that localized control measures will be implemented when earth works and progressive rehabilitation occur (i.e., silt fences, reducing amount of time disturbed soil is exposed, grading controls, and advanced seeding of disturbed soils to enhance soil stabilization).

Mine Contact Water

Assessment of contact water utilized the following assessment sequence:

- Geochemical testing and modelling to determine water quality source terms and aging predictions.
- Water Quantity and Water Quality Modelling (Appendix 8A) in GoldSim™ refined water movement throughout the Project Expansion at a monthly time scale and used contact water runoff and seepage estimates, water management infrastructure storage/sedimentation characteristics, and geochemical results to predict contact water quality at the FDPs.
- A mass balance model was developed to estimate water quality in the receiving water at the FDP, 100 m and 200 m downstream from the FDP.
- Where local, small receiving watersheds discharged to the ultimate receiver (Victoria Lake Reservoir, Valentine Lake and the Victoria River), a CORMIX model was run to determine the effluent mixing zone in the larger ultimate receiver (within the LAA).

As described in Section 8.3.1 and the Water Management Plan (Appendix 2A), contact water will be directed to sedimentation ponds for treatment prior to being discharged at a FDP. The water quality in the receiving environment is dependent on both the water quality and quantity of the effluent, and the background water quality and quantity expected to be in the receiver (baseline). The receiving water assessment was run for a conservative regulatory scenario (high effluent concentrations [95th percentile or the MDMER limits] and low flow [7Q10]) and poor water quality (75th percentile) conditions in the receiving water. A normal operating condition scenario (mean effluent and receiver concentrations and MAF and discharge rates) was also run. Excess water from the TMF will be routed to the water treatment plant and SAGR® unit prior to being discharged via a pipeline to a FDP in Victoria Lake Reservoir.

As the FDPs for the Project Expansion all drain to Valentine Lake, a mixing zone assessment of these receivers was completed using CORMIX. The Assimilative Capacity Study Update Report (Appendix 8B) provides further details on the mass balance and CORMIX modelling results. Mixing zone watershed areas, referred to as Area 1 and Area 2 on Figure 8-24 were established to capture the FDPs entering Valentine Lake from the Project Expansion.

Tables 8.16 to 8.18 presents a summary of the expected water quality for each FDP, and 100 m, and up to 300 m into the ultimate receiver (Valentine Lake). Generally, for both the regulatory and normal operating scenarios, limited assimilative capacity is seen downstream of the FDP until reaching Valentine Lake. Mixing rapidly improves once discharge reaches Valentine Lake due to the large volume of water available for mixing. The FDPs and these downstream assessment points are shown in Figure 8-24.

Table 8.16 Predicted FDP Effluent Water Quality – Operation (Year 1-9)

Parameter	Units	MDMER, Max Monthly Mean	MA-SP-01AB		BER-SP-01A		BER-SP-01B		BER-SP-02		BER-SP-03		BER-SP-04		BER-FDP-05		BER-SP-06	
			Mean	95%	Mean	95%	Mean	95%	Mean	95%	Mean	95%	Mean	95%	Mean	95%	Mean	95%
Aluminum (Total)	µg/L	-	426.1	535.4	600	600.0	600.0	600.0	600.0	600.0	600.0	600.0	279.8	322.0	592.1	597.3	173.8	232.9
Arsenic (Total)	µg/L	100	15.7	20.3	33.6	39.8	34.0	40.3	33.4	39.6	17.1	20.2	11.8	18.1	3.1	3.6	14.3	25.1
Cadmium (Total)	µg/L	-	0.06	0.08	0.25	0.29	0.25	0.29	0.25	0.29	0.13	0.15	0.05	0.07	0.05	0.05	0.04	0.08
Chromium (Total)	µg/L	-	4.6	6.2	4.3	5.3	4.3	5.4	4.3	5.3	3.8	5.0	2.4	5.0	2.3	4.9	2.6	5.0
Copper (Total)	µg/L	100	9.64	11.34	39.29	49.45	40.00	50.45	39.21	49.45	32.71	41.20	9.24	11.17	2.39	3.00	5.75	9.76
Iron (Total)	µg/L	-	793	900	329	520	324	520	324	520	325	520	312	520	270	515	349	520
Lead (Total)	µg/L	80	1.00	1.29	1.27	1.44	1.28	1.46	1.27	1.44	0.78	0.99	0.42	0.60	0.29	0.36	0.44	0.75
Manganese (Total)	µg/L	-	443.60	586.90	562.40	643.30	570.20	651.60	562.90	642.80	414.50	501.70	215.20	442.60	260.00	428.80	214.70	442.60
Mercury (Total)	µg/L	-	0.0290	0.0378	0.222	0.278	0.226	0.283	0.221	0.278	0.1853	0.2292	0.0240	0.0274	0.0155	0.0178	0.012	0.017
Molybdenum (Total)	µg/L	-	16	19	75	86	76	87	75	86	38	43	15	19	7	7	4	6
Phosphorus (Total)	µg/L	-	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Selenium (Total)	µg/L	-	1.57	2.04	3.08	3.52	3.10	3.55	3.06	3.50	1.75	1.97	1.12	1.39	0.62	0.65	0.65	1.04
Silver (Total)	µg/L	-	0.14	0.17	0.85	1.07	0.87	1.09	0.85	1.07	0.72	0.88	0.11	0.13	0.06	0.07	0.05	0.05
Uranium (Total)	µg/L	-	4.84	6.28	60.56	75.80	61.34	76.67	60.35	75.31	29.98	38.10	4.62	6.29	3.24	4.71	0.73	1.36
Zinc (Total)	µg/L	400	12.24	15.88	35.05	43.70	35.67	44.47	35.03	43.65	29.52	36.01	5.91	7.50	4.72	7.50	4.96	7.50
Nitrite (as N)	µg/L	-	161	235	315	433	315	430	445	574	214	276	99	132	143	243	10	12
Nitrate (as N)	µg/L	-	6,398	9,302	13,541	18,643	13,544	18,531	19,066	24,687	9,052	11,748	4,004	5,438	5,695	9,968	62	100
Ammonia (as N), Total	µg/L	-	906	1,323	1,736	2,381	1,735	2,367	2,452	3,160	1,187	1,517	546	725	790	1,330	70	128
Ammonia (as N), Un-ionized	µg/L	500	34.44	50.27	65.97	90.48	65.93	89.95	93.18	120.08	45.11	57.65	20.74	27.54	30.03	50.54	2.66	4.88
Cyanide (Total)	µg/L	50-0	31	40	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Cyanide (WAD)	µg/L	-	3	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Sulphate	µg/L	-	29,967	34,684	80,923	95,575	81,892	96,573	80,603	94,909	51,839	65,896	28,271	33,264	10,840	12,196	5,491	9,508
Fluoride	µg/L	-	260	327	1,026	1,106	1,038	1,118	1,023	1,097	901	960	234	264	138	167	133	165

Table 8.17 Results of CORMIX Modeling at the End of 100 m Mixing Zone in Valentine Lake

Parameter, Units	CWQG-FAL Long-term	75th Percentile Baseline Valentine Lake	Regulatory Scenario (Dry Conditions)					Average Conditions				
			FDP-06/01A	FDP-01B	FDP-02	FDP-03/04/01AB	FDP-05	FDP-06/01A	FDP-01B	FDP-02	FDP-03/04/01AB	FDP-05
Aluminum (Total), µg/L	100	15.0	16.2	16.8	16.6	16.9	37.8	21.7	21.2	19.2	41.4	107.4
Arsenic (Total), µg/L	5	0.5	0.7	0.8	0.8	0.9	4.4	1.0	0.9	0.8	1.4	0.9
Cadmium (Total), µg/L	0.04	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Chromium (Total), µg/L	1	**1.9**	**1.9**	**1.9**	**1.9**	**1.9**	**2.0**	**1.1**	**1.1**	**1.1**	**1.3**	**1.3**
Copper (Total), µg/L	2	0.75	0.96	1.05	1.02	1.13	**4.64**	0.95	0.99	0.85	1.60	0.82
Iron (Total), µg/L	300	25	26	26	26	27	44	32	29	28	53	65
Lead (Total), µg/L	1	0.25	0.42	0.49	0.46	0.56	**3.38**	0.26	0.26	0.26	0.28	0.26
Manganese (Total), µg/L	210	6.7	8.03	8.65	8.40	8.57	23.25	13.26	12.25	10.29	27.92	46.55
Mercury (Total), µg/L	0.026	0.0065	0.007	0.007	0.007	0.0070	0.0069	0.009	0.009	0.008	0.0111	0.0080
Molybdenum (Total), µg/L	73	1.0	1	1	1	2	1	2	2	2	2	2
Phosphorus (Total), µg/L	4[a]	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**
Selenium (Total), µg/L	1	0.25	0.26	0.26	0.26	0.26	0.27	0.28	0.28	0.27	0.33	0.31
Silver (Total), µg/L	0.25	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.07	0.05
Uranium (Total), µg/L	15	0.05	0.21	0.28	0.25	0.24	0.23	0.64	0.78	0.57	0.89	0.56
Zinc (Total), µg/L	4	2.5	3.33	3.70	3.56	**4.03**	**18.09**	2.84	2.90	2.78	3.34	2.86
Nitrite (as N), µg/L	60	12	13	13	14	13	21	12	13	13	19	31
Nitrate (as N), µg/L	3,000	25	64	81	91	51	415	155	187	189	439	940
Ammonia (as N), Total, µg/L	689	25	30	32	33	28	76	42	45	46	80	148
Ammonia (as N), Un-ionized, µg/L	19	0.95	1.14	1.22	1.27	1.13	2.89	1.59	1.73	1.74	3.03	5.64
Cyanide (Total), µg/L	-	10	11	11	11	12	29	10	10	10	10	10
Cyanide (WAD), µg/L	5	1	1	1	1	1	1	1	1	1	1	1
Sulphate, µg/L	128,000 [b]	1,000	1,197	1,289	1,251	1,259	1,439	1,819	1,968	1,684	3,320	2,587
Fluoride, µg/L	120	60	62	63	63	63	64	70	72	68	86	73

Notes:
[a] 4 µg/L for Valentine Lake (based on hardness, pH and DOC)
[b] Sulphate Guideline is for British Columbia Ministry of Environment and Climate Change Strategy 2017 for the protection of aquatic life
Bold indicates exceedance of CWQG-FAL

Table 8.18 Results of CORMIX Modeling at the End of 200 m Mixing Zone in Valentine Lake

Parameter, Units	CWQG-FAL Long-term	75th Percentile Baseline Valentine Lake	Regulatory Scenario (Dry Conditions)					Average Conditions				
			FDP-06/01A	FDP-01B	FDP-02	FDP-03/04/01AB	FDP-05	FDP-06/01A	FDP-01B	FDP-02	FDP-03/04/01AB	FDP-05
Aluminum (Total), µg/L	100	15.0	15.5	15.7	15.6	15.7	22.8	16.7	16.9	16.1	28.0	35.9
Arsenic (Total), µg/L	5	0.5	0.6	0.6	0.6	0.6	1.8	0.7	0.7	0.6	1.0	0.6
Cadmium (Total), µg/L	0.04	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Chromium (Total), µg/L	1	**1.9**	**1.9**	**1.9**	**1.9**	**1.9**	**1.9**	**1.1**	**1.1**	**1.1**	**1.2**	**1.1**
Copper (Total), µg/L	2	0.75	0.83	0.86	0.85	0.90	**2.08**	0.67	0.70	0.65	1.07	0.59
Iron (Total), µg/L	300	25	25	26	25	26	32	27	26	26	39	34
Lead (Total), µg/L	1	0.25	0.31	0.34	0.33	0.37	1.32	0.25	0.25	0.25	0.27	0.25
Manganese (Total), µg/L	210	6.7	7.20	7.43	7.34	7.41	12.37	8.12	8.08	7.35	16.90	15.07
Mercury (Total), µg/L	0.026	0.0065	0.007	0.007	0.007	0.0067	0.0067	0.007	0.008	0.007	0.0089	0.0068
Molybdenum (Total), µg/L	73	1	1	1	1	1	1	1	1	1	2	1
Phosphorus (Total), µg/L	4[a]	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**
Selenium (Total), µg/L	1	0.25	0.25	0.25	0.25	0.25	0.26	0.26	0.26	0.26	0.29	0.26
Silver (Total), µg/L	0.25	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.05
Uranium (Total), µg/L	15	0.05	0.11	0.14	0.13	0.08	0.11	0.25	0.33	0.25	0.48	0.17
Zinc (Total), µg/L	4	2.5	2.81	2.95	2.90	3.08	**7.84**	2.62	2.65	2.61	2.93	2.58
Nitrite (as N), µg/L	60	12	12	12	13	12	15	10	10	10	14	14
Nitrate (as N), µg/L	3,000	25	40	46	50	39	158	69	87	88	236	238
Ammonia (as N), Total, µg/L	689	25	27	28	28	27	43	31	33	33	53	54
Ammonia (as N), Un-ionized, µg/L	19	0.95	1.02	1.05	1.07	1.02	1.62	1.17	1.25	1.26	2.01	2.04
Cyanide (Total), µg/L	-	10	10	11	10	11	17	10	10	10	10	10
Cyanide (WAD), µg/L	5	1	1	1	1	1	1	1	1	1	1	1
Sulphate, µg/L	128,000[b]	1,000	1,074	1,108	1,094	1,073	1,150	1,277	1,370	1,264	2,180	1,370
Fluoride, µg/L	120	60	61	61	61	61	61	63	64	63	73	63

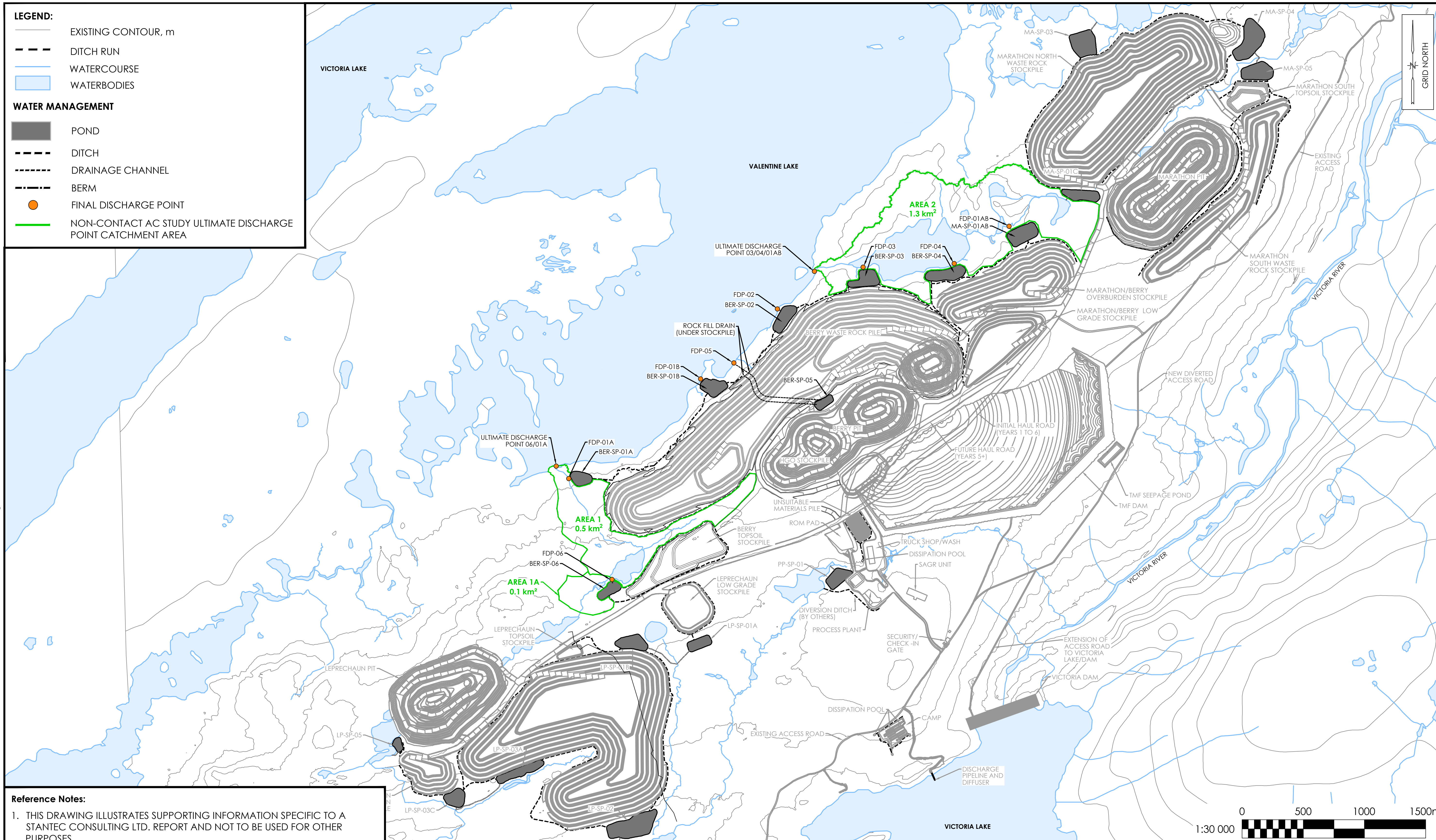
Notes:
[a] 4 µg/L for Valentine Lake (based on hardness, pH and DOC)
[b] Sulphate Guideline is for British Columbia Ministry of Environment and Climate Change Strategy 2017 for the protection of aquatic life
Bold indicates exceedance of CWQG-FA

LEGEND:

- EXISTING CONTOUR, m
- DITCH RUN
- WATERCOURSE
- WATERBODIES

WATER MANAGEMENT

- POND
- DITCH
- DRAINAGE CHANNEL
- BERM
- FINAL DISCHARGE POINT
- NON-CONTACT AC STUDY ULTIMATE DISCHARGE POINT CATCHMENT AREA



Reference Notes:

1. THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC CONSULTING LTD. REPORT AND NOT TO BE USED FOR OTHER PURPOSES.
2. LIDAR DERIVED CONTOURS JUNE 6-7, 2019 (AETHON AERIAL SOLUTIONS); VERTICAL DATUM: CGVD28.
3. WATERCOURSES AND WATERBODIES: SURVEYED FISH BEARING OR HAS CONNECTIVITY TO FISH BEARING WATER (STANTEC 2012, 2019 & 2020, 2022), SUPPLEMENTED WITH CANVEC 2011 WATERCOURSES AND WATERBODIES.
4. ALL NON-WATER MANAGEMENT INFRASTRUCTURE DESIGN BY: AUSENCO, GOLDER & MOOSE MOUNTAIN TECHNICAL SERVICES DESIGN.

BERRY NON-CONTACT ULTIMATE DISCHARGE POINT CATCHMENTS

WATER MANAGEMENT INFRASTRUCTURE

Client: MARATHON GOLD CORPORATION

Job No.:	121417802
Scale:	1 : 30 000
Date:	2023-08-09
Dwn. By:	CP
App'd By:	SS

Fig. No.: 8-24

Rev. No.: 00

Stantec

Z:\1216\active\121620514\5_CAD\sketch_files\4_20230623-FDP-AREAS\121417555_BERRY-AS_01 - 11x17.dwg

The baseline concentration of total phosphorus and total chromium in the receiver is above the CWQG-FAL; therefore, the concentration of these parameters in the mixing zone is also above the CWQG-FAL. This exceedance is related to the laboratory detection limit for these parameters (Section 8.1.1.3). No residual water quality effects associated with phosphorus are expected from the Project as predicted levels return to baseline for each FDP.

BER-FDP-01A

BER-FDP-01A will receive contact water from sedimentation ponds downstream of the Berry waste rock pile. No POPCs were found to be elevated above baseline conditions at the FDP. At the edge of the 100 m mixing zone of Valentine Lake, POPCs were predicted to be below the CWQG-FAL.

BER-FDP-01B

BER-FDP-01B will receive contact water from sedimentation ponds downstream of the Berry waste rock pile. No POPCs were found to be elevated above baseline conditions at the FDP. At the edge of the 100 m mixing zone of Valentine Lake, POPCs were predicted to be below the CWQG-FAL.

BER-FDP-02

BER-FDP-02 will receive contact water from sedimentation ponds downstream of the Berry waste rock pile. No POPCs were found to be elevated above baseline conditions at the FDP. At the edge of the 100 m mixing zone of Valentine Lake, POPCs were predicted to be below the CWQG-FAL.

BER-FDP-03

BER-FDP-03 will receive contact water from sedimentation ponds downstream of the Berry waste rock pile. No POPCs were found to be elevated above baseline conditions at the FDP. At the edge of the 100 m mixing zone of Valentine Lake, POPCs were predicted to be below the CWQG-FAL.

BER-FDP-04

BER-FDP-04 will receive contact water from sedimentation ponds downstream of the Berry / Marathon overburden stockpile. No POPCs were found to be elevated above baseline conditions at the FDP. At the edge of the 100 m mixing zone of Valentine Lake, POPCs were predicted to be below the CWQG-FAL.

BER-FDP-05

BER-FDP-05 will receive dewatering from the open pit during the operation phase, and pit lake overflow during the closure and post-closure sub-phases. In the regulatory scenario, the combined effluent from BER-FDP-05 has potential exceedances at 100 m from the FDP for copper, lead and zinc. The lead concentration meets the CWQG-FAL at 200 m from the FDP. Extrapolated dilution ratios were used to estimate the mixing zone extents at 300 m, where copper and zinc are estimated to meet the guideline. The copper, lead and zinc exceedances are due to elevated concentrations in the effluent, conservative assumptions of effluent flow, and the lower assimilative capacity of the nearshore area. The effluent concentrations for these parameters were conservatively assumed to be at the MDMER monthly limits, which are higher than the predicted concentrations in the effluent discharge during operation.

BER-FDP-06

BER-FDP-06 will receive contact water from sedimentation ponds downstream of the Berry topsoil stockpile. No POPCs were found to be elevated above baseline conditions at the FDP. At the edge of the 100 m mixing zone of Valentine Lake, POPCs were predicted to be below the CWQG-FAL.

MA-FDP-01AB

MA-FDP-01AB will receive contact water from sedimentation ponds downstream of the Berry / Marathon overburden stockpile and the Berry / Marathon low grade ore stockpile. No POPCs were found to be elevated above baseline conditions at the FDP. At the edge of the 100 m mixing zone of Valentine Lake, POPCs are predicted to be below the CWQG-FAL.

None of the ultimate mixing zones in Valentine Lake were predicted to overlap or combine with each other.

Decommissioning, Rehabilitation, and Closure

As discussed in Section 8.2, the closure phase has been sub-divided into closure and post-closure for the purposes of the Surface Water Resources VC. The transition between these two phases will be marked by the completion of rehabilitation activities. Details of surface water quality changes anticipated during the closure and post-closure phases are discussed below:

Erosion and Sedimentation Control

Closure

Erosion and sedimentation can alter surface water quality during the closure phase as rehabilitation activities occur. The water management infrastructure outlined in the Water Management Plan (Appendix 2A) will remain in place until upstream infrastructure has been decommissioned and rehabilitated. Sedimentation ponds will be among the last infrastructure to be rehabilitated. Non-contact water will continue to be diverted from mine surface water infrastructure to reduce the load entering sedimentation ponds and mine surfaces will be rehabilitated with a vegetated soil cover for non-contact runoff. The non-contact water will be diverted until the ditches have been retrofitted as PRBs, and if necessary, the sedimentation ponds are converted into engineered wetlands to further treat seepage water quality (see Section 8.3.1).

Post-Closure

Erosion and sedimentation can alter surface water quality during post-closure through the maintenance of mine monitoring infrastructure. Maintenance of roads to access monitoring locations will continue to mitigate erosion and sedimentation.

Mine Contact Water

Closure

During closure, treatment of mine contact water will change to allow for the flooding of the open pit basins. There will be a substantial reduction in discharge from BER-FDP-05 as the Berry pit southern and central basins are filling as the FDP only receives seepage and runoff from a portion of the waste rock pile and overflow from the northern basin.

Sedimentation ponds and associated ditching for the waste rock pile and reclaimed stockpiles will continue to operate as upstream rehabilitation takes place and will only be removed once upstream rehabilitation works are complete.

Seepage from the Project Expansion waste rock piles and the TMF that is not collected in water management infrastructure will route to natural groundwater flow paths downgradient to local surface water receivers. Seepage quality will be improved during downgradient migration via natural attenuation.

The tailings pond will be drained via pumping and the effluent treated in the water treatment plant beginning in Mine Year 17 (active closure), and the TMF tailings area will be rehabilitated with a soil overburden cover, and the emergency spillway lowered to avoid ponding in the TMF. The TMF seepage collection ditches will be retrofitted with passive treatment systems to treat contact seepage and assimilate (attenuate naturally) with local groundwater to discharge into local receiving waters. It is predicted that water will cease to discharge from one of the TMF FDPs (PP-FDP-01) beginning in Mine Year 18 (post-closure) for the average condition, which is when the overburden cover would be constructed.

During the closure sub-phase, elemental concentrations in the seepage from the Berry waste rock pile decline because elemental leaching (e.g., oxidation) is partially decreased due to soil cover. The elemental concentrations stabilize during post-closure and remain above the CWQG-FAL for Al, As, Cd, Cr, Cu, Fe, Pb, Mn, Ag, and Zn. Concentrations of nitrogen species are flushed from the pile decreasing below the CWQG-FAL, and stabilizing at baseline levels.

As mentioned in Section 8.3.1, during the closure sub-phase, contact seepage from the waste rock pile and the TMF that is not expected to be adequately treated via natural attenuation at local receivers to background or the CWQG-FAL quality, is planned to be treated by passive treatment systems.

Two options were identified as feasible passive treatment options to manage site water post closure (GEMTEC 2022b):

- Convert waste rock pile and TMF seepage collection ditches into anerobic PRBs
- Convert waste rock pile and TMF seepage collection ditches into French drains with an anaerobic PRB to passively intercept and convey site water to a anaerobic vertical flow engineered wetlands

Options will be selected based upon water quality monitoring results during operation and results of a pilot study. If water quality is marginally/moderately above the CWQG-FAL, a subsurface flow PRB will be sufficient to reduce metal concentration to below CWQG-FAL. If anticipated water quality is excessively above CWQG-FAL, additional treatment will likely be required.

Post-Closure

Post-closure, seepage from the waste rock pile and overflow from the Berry pit will migrate towards Valentine Lake. Seepage from the TMF will migrate towards the Victoria River. The GoldSim™ model predicted water quality of the seepage and overflow from the pit and TMF. It is expected that more seepage and pit overflow will occur in post-closure than during closure, as seepage collection ditches and other water management infrastructure are removed.

Overflow from the Berry pit is expected to be below MDMER limits and above CWQG-FAL for Al, Cd, Cr, Cu, Mn, P, Zn, total ammonia, and un-ionized ammonia. Seepage from the waste rock pile is expected to be below MDMER limits and above CWQG-FAL for Al, As, Cd, Cr, Cu, Fe, Mn, Hg, P, Ag, Zn, and F.

Peak concentrations of metals and nitrogen species in basal seepage from the TMF will likely occur about 20 years or sooner after the start of closure (Mine Year 18), due to the dispersion within the tailings sediment column. Seepage from the TMF is expected to exceed MDMER (500 µg/L) for un-ionized ammonia with a predicted a concentration of 558 µg/L. In addition to un-ionized ammonia, toe and basal seepage from the TMF will likely exceed CWQG-FAL for Al, Cd, Cr, Cu, Fe, Mn, Se, Zn, total ammonia, and weak-acid dissociable cyanide (Appendix 8A).

The passive treatment systems discussed to be installed in the closure sub-phase above are expected to treat contact seepage and assimilate naturally with local groundwater to discharge into local receiving waters at or below the CWQG-FAL and baseline condition concentrations.

8.5.2.3 Project Expansion Residual Environmental Effects

Summary of Project Expansion Residual Environmental Effects on Surface Water Quantity

Surface water quantity changes assessed at the boundary of the LAA for Valentine Lake are predicted to be within ± 10% MAF.

During the construction and operation phase (Year 1-9), it is expected that five WSs will maintain a MAF within 10% of, or above, pre-development conditions. Six WSs are predicted to experience a decrease in MAF of over 10%, however environmental flows (30% MAF (Summer) and 50% MAF (Winter)) are expected to be maintained for all WSs.

During the operations phase (Year 10-15), it is expected that four WSs will maintain a MAF within 10% of, or above, pre-development conditions. Seven WSs are predicted to experience a decrease in MAF of greater than 10%; however environmental flows are expected to be maintained for all WSs.

During the closure phase, it is expected that five WSs will maintain a MAF within 10% of, or above, pre-development conditions. Six WSs are predicted to experience a decrease in MAF of greater than 10%; however environmental flows are expected to be maintained for all WSs.

During the post-closure phase, it is expected that five WSs will maintain a MAF within 10% of, or above, pre-development conditions. Six WSs are predicted to experience a decrease in MAF of greater than 10%; however environmental flows are expected to be maintained for all WSs.

With the implementation of mitigation measures, residual effects on surface water quantity are anticipated to be adverse in direction, with the Project Expansion predicted to cause a reduction in surface water quantity in some watersheds within the LAA during all phases of mine life. Other watersheds will receive an increase in flow that may provide a positive change.

The predicted magnitude of residual adverse effects is low. Predicted changes in water quantity at the LAA boundary during construction and operation (Years 1-9), operations (Year 10-15), closure, and post-closure phases are considered to be within the range of natural variability. The change in surface water quantity is predicted to extend to the boundary of the LAA and be continuous and long-term in duration. The natural seasonal variations including precipitation, surface runoff, and groundwater flows could affect the surface water quantity within the LAA; however, these variations would not be considered a Project Expansion-related effect. Changes to some watersheds within the LAA will be realized post-closure and therefore, these are considered long-term effects. Effects on water quantity for most of the watercourses/waterbodies assessed are considered reversible as conditions will return to pre-development flow patterns for the majority of the site post-closure. The ecological context is disturbed, with the ecological function considered typical compared to other lake systems in the region and pre-development conditions.

Summary of Project Expansion Residual Environmental Effects on Surface Water Quality

Mine contact water discharged from the FDPs will comply with the MDMER requirements prior to entering the receiving environment and non-contact water is expected to remain at baseline conditions.

Localized effects are expected in the receiving watercourses and bodies immediately downstream of BER-FDP-05. These local effects will extend into the ultimate receiving waterbody (Valentine Lake) for only several hundred meters before water quality is expected to return to either baseline levels or below the CWQG-FAL. It is noted that these localized effects may be overestimated due to the conservative approach taken in the supporting water quality modelling and assimilative capacity assessment, further discussed in Appendix 8B. Specific POPC that have been identified as having the largest required mixing zones (i.e., up to 300 m) include copper, lead, and zinc.

With the implementation of mitigation measures, the residual effects on surface water quality are anticipated to be adverse in direction. Taking into consideration proposed mitigation and management measures, it is predicted that the Project Expansion is likely to cause increased concentrations of some POPCs in watercourses downstream of BER-FDP-05, and into the ultimate receivers within the LAA. The magnitude or residual adverse effects is considered low, as predicted changes in water quality at the LAA boundary during construction, operation and closure conditions are within the range of natural variability. The changes in surface water quality are predicted to extend to the boundaries of the LAA, with localized effects experienced within the LAA. Effects will be continuous and both short term (large storms, one-off events) and long term (seepage from waste rock piles and TMF) in duration. Effects on water quality for most of the watercourses / waterbodies assessed are considered reversible as conditions will return to baseline conditions once Project discharges cease. Irreversible effects may occur as a result of seepage from mine infrastructure (TMF and waste rock pile). However, with the implementation of vegetated covers, seepage quality is expected to be mitigated to meet regulations prior to reaching the ultimate receiver. The ecological context is considered to be disturbed. The ecological function is typical compared to other lake systems in the region and pre-development conditions.

Summary of Project Expansion Residual Environmental Effects

Residual environmental effects that are likely to occur as a result of the Project Expansion are summarized in Table 8.19.

Table 8.19 Project Expansion Residual Effects on Surface Water Resources

Residual Effect	Residual Effects Characterization							
	Project Phase	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and socio-economic context
Change in Surface Water Quantity	C	A	L	LAA	LT	C	R / I	D
	O	A	L	LAA	LT	C	R / I	D
	D	A	L	LAA	LT	C	R / I	D
Change in Surface Water Quality	C	A	L	LAA	LT	C	R / I	D
	O	A	L	LAA	LT	C	R / I	D
	D	A	L	LAA	LT	C	R / I	D

KEY:
See Table 8.9 for detailed definitions

Project Phase
C: Construction
O: Operation
D: Decommissioning

Direction:
P: Positive
A: Adverse
N: Neutral

Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Geographic Extent:
PA: Project Area
LAA: Local Assessment Area
RAA: Regional Assessment Area

Duration:
ST: Short term
MT: Medium term
LT: Long term
P: Permanent
N/A: Not applicable

Frequency:
S: Single event
IR: Irregular event
R: Regular event
C: Continuous

Reversibility:
R: Reversible
I: Irreversible

Ecological / Socio-Economic Context:
D: Disturbed
U: Undisturbed

8.5.3 Determination of Significance for Project Expansion

Significant adverse residual environmental effects on surface water resources have been defined considering the federal and provincial regulations, policies and guidelines identified in Section 5.1.4 for both surface water quantity and surface water quality. The significance definitions are provided in Section 8.5.1.2.

8.5.3.1 Surface Water Quantity

The residual environmental effects on surface water quantity for the Valentine Lake receiver is not significant as the predicted changes in MAF are within ±10%. As discussed in Section 8.5.2.1, the ±10% threshold is selected based on case studies presented by Richter et. al. (2011) and guidance provided by DFO (2013), which indicate that a high level of ecological protection is provided when flow alterations are within 10% of the natural flow.

Some predicted changes in MAF for the pre-development watersheds associated with Project Expansion infrastructure and activities are greater than 10%, indicating a potential localized residual effect. The effect is defined as significant if a decrease of over 10% in MAF is predicted, and the reduced flows do not meet the environmental flow threshold assigned as summer and winter environmental flows. For the Project Expansion, all WSs are expected to provide sufficient summer and winter environmental flows during the Project Expansion phases, and thus no residual effects are anticipated. Any potential effects on fish habitat from decreased surface water quantity will be mitigated and compensated with the implementation of an offsetting plan, as discussed in Section 9.5.2.1.

If changes of MAF are predicted to increase by more than 10% and contravenes a watershed management target, then the effect is considered significant. This includes where the MAF increase may cause flooding downstream of the Project Expansion beyond existing conditions or causes changes to pond and lake levels outside of the Project Area to a point that it affects their ability to support existing ecological functions. MAF values that were predicted to increase by more than 10% were compared to the Q100 flood flows and no residual effects in the watersheds are anticipated. The increased flows will be mitigated by constructing water management infrastructure that attenuates peak flows using berms, ditching and sedimentation ponds. These sedimentation ponds will attenuate peak runoff rates and allow water to be released over time to extend the period of baseflow augmentation released to the downstream watersheds.

At the LAA boundary, with mitigation measures and environmental measures applied, residual water quantity changes are predicted to be not significant.

8.5.3.2 Surface Water Quality

The predicted residual environmental effects on surface water quality are not predicted to be significant as effluent will comply with the MDMER requirements at the FDPs, and no watershed management targets will be contravened. Local water quality immediately downstream of BER-FDP-05 and points of seepage inflow from Project Expansion infrastructure will experience increases of POPC above baseline levels and the CWQG-FAL, however, these changes are expected to be contained within the boundaries of the LAA and to be assimilated within 300 m of entering the Valentine Lake ultimate receiver.

With mitigation and environmental protection measures applied, the residual environmental effects on the surface water quality are predicted to be not significant.

8.6 COMBINED RESIDUAL EFFECTS OF THE PROJECT EXPANSION AND APPROVED PROJECT

8.6.1 Change in Surface Water Quantity

The residual adverse effects for the combined Project Expansion and the Approved Project with respect to surface water quantity are predicted to be low. A change in MAF less than 10% is predicted for the LAA watershed will result from the addition of Project Expansion infrastructure and changes in watershed areas and water management.

Based on the existing Project Expansion design, the Project Expansion is not anticipated to change the surface water quantity at the LAA boundary compared to the Approved Project as the change in MAF remains within 10% of pre-development conditions.

8.6.2 Change in Surface Water Quality

The residual adverse effects for the combined Project Expansion and the Approved Project with respect to surface water quality are predicted to be low. The change in water quality is primarily related to discharges of effluent to waterbodies, seepage, and stream flows.

Discharges to the ultimate receiver (Valentine Lake) from the FDPs were assessed using a CORMIX model which investigated potential overlapping mixing zones between the Approved Project and Project Expansion. No overlapping mixing zones were identified and any exceedances of CWQG-FAL at the FDPs were dissipated within 300 m of the FDP into Valentine Lake.

8.6.3 Summary of Changes from the Approved Project

The residual effects of the Approved Project in combination with the Project Expansion are summarized below. Table 8.20 presents a comparison between residual effects for the Approved Project and the Approved Project plus Project Expansion. Overall, there are no substantive differences between residual effects for the Approved Project alone compared to the Approved Project plus the Project Expansion. With mitigation and environmental protection measures applied, the residual environmental effects on surface water quantity and quality for the Approved Project in combination with the Project Expansion are predicted to be not significant.

Table 8.20 Residual Effects on Surface Water for Approved Project Plus Project Expansion

Residual Effect	Residual Effects Characterization for Approved Project								Change in Residual Effect Characterization with Addition of Project Expansion (i.e., Combined Effects of Approved Project and Project Expansion)
	Project Phase	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Context	
Change in Surface Water Quantity	C	A	L	LAA	LT	C	R / I	D	No change
	O	A	L	LAA	LT	C	R / I	D	No change
	D	A	L	LAA	LT	C	R / I	D	No change
Change in Surface Water Quality	C	A	L	LAA	LT	C	R / I	D	No change
	O	A	L	LAA	LT	C	R / I	D	No change
	D	A	L	LAA	LT	C	R / I	D	No change

KEY:

See Table 8.9 for detailed definitions

Project Phase
C: Construction
O: Operation
D: Decommissioning

Direction:
P: Positive
A: Adverse
N: Neutral

Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Geographic Extent:
PA: Project Area
LAA: Local Assessment Area
RAA: Regional Assessment Area

Duration:
ST: Short term
MT: Medium term
LT: Long term
P: Permanent
N/A: Not applicable

Frequency:
S: Single event
IR: Irregular event
R: Regular event
C: Continuous

Reversibility:
R: Reversible
I: Irreversible

Ecological / Socio-Economic Context:
D: Disturbed
U: Undisturbed

8.7 ASSESSMENT OF CUMULATIVE EFFECTS

This cumulative effects assessment (CEA) focuses on incremental changes in the residual effects of the Approved Project in combination with the Project Expansion, which are summarized in Section 8.6.3, as well as incremental changes in potential cumulative effects due to differences in on-going and likely future activities since the Approved Project was released from the EA process.

8.7.1 Past and Ongoing Effects

As described in Chapter 7 (Surface Water Resources) of the Valentine Gold EIS, the Project Area is located along a topographic divide that drains surface water to three primary receivers (Victoria Lake Reservoir, Valentine Lake and Victoria River) via small watersheds (maximum size of 2.2 km^2). Victoria Lake Reservoir is the headwaters of the Bay d'Espoir hydroelectric system and was established through the construction of the Victoria Control Structure Dam. This altered the natural drainage of Victoria Lake Reservoir from north towards Beothuk Lake to south towards the Victoria Canal. The dam raised the Victoria Lake Reservoir levels from 290 to 325 masl and water levels can now vary up to four metres every year.

The existing land within the Project Area is generally undisturbed and surface water runoff characteristics are considered consistent with other watersheds located in the same hydrologic zone (Northeast Hydrologic Zone as described by AMEC 2014). Surface water quality in the Project Area was noted to vary substantially and to be dependent on the type of waterbody, location of the waterbody, and the time of year that samples were collected. The most distinct difference in water quality was noted in the large waterbodies of Victoria Lake Reservoir, Valentine Lake and Victoria River, which were seen to be more dilute in comparison with the smaller headwater streams located in the Project Area. Several parameters were noted to occur naturally at levels above CWQG-FAL, including aluminum, iron, arsenic, cadmium, copper, lead, and zinc.

8.7.2 Potential Project-Related Contributions to Cumulative Effects

As described in Section 8.5 and 8.6, Approved Project and Project Expansion activities have the potential to alter surface water quantity in local watersheds through changes in upstream drainage patterns, construction of water management infrastructure, and alteration of ground cover and runoff. Emissions and discharges that enter surface water from areas of mine development (i.e., pits, waste rock piles, TMF, sedimentation ponds) have the potential to alter surface water quality from existing conditions due to the altered geochemistry resulting from rock exposure and mining processes. The combined Projects, therefore, have the potential to result in the following residual effects on surface water:

- A change in surface water quantity
- A change in surface water quality

The combined Project-specific effects assessment for surface water includes a summary of residual environmental effects and a determination of significance in Section 8.6. With the implementation of mitigations (Section 8.3), the residual effects of routine combined Project activities on surface water are predicted to be confined to within the LAA and to be not significant. Residual effects are consistent with those of the Approved Project alone as predicted in the Valentine Gold EIS.

8.7.3 Other Projects and Activities and Their Effects

Table 5.6 summarizes past, present, ongoing and future projects and activities in the RAA that have potential to cause a change in surface water quantity and quality; thereby affecting surface water. A full discussion of other projects and activities and their effects is provided in the Valentine Gold EIS (Section 20.4.3). As indicated above, the focus of this CEA is on incremental changes in potential cumulative effects due to differences in on-going and likely future activities since the Approved Project was released from the EA process.

8.7.4 Potential Cumulative Environmental Effects

Past, present and ongoing activities / projects that are predicted to contribute to cumulative effects on surface water include mining and exploration, forestry, hunting, outfitting, trapping, and/or fishing, aquaculture, off-road vehicles, hydroelectric development, and existing linear features (Table 5.6). However, potential cumulative effects of these projects / activities have been accounted for in the existing conditions and residual environmental effects (Sections 8.1, 8.5 and 8.6) and are not discussed further. As indicated in Figure 5-4, forestry activities since submission of the Valentine Gold EIS are focused on areas to the east of Beothuk Lake and at a distance that would prevent geographic overlap of potential effects on surface water quality and quantity.

Future planned and proposed activities / projects that were not considered in the Valentine Gold EIS and are predicted to potentially contribute to cumulative effects on surface water include the advancement of the Buchans Resources Limited Project and the Victoria River Quarry (Table 5.6). These projects have the potential to overlap with Project activities temporally and spatially and have similar effects pathways as effects arising from the Project, including a change in water quantity and water quality.

It is anticipated that the Buchans Resources Limited Project will employ best management practices, including being subject to MDMER, to reduce or eliminate potential residual effects on surface water quantity and quality. Due to the large assimilative capacity potential of Beothuk Lake and the Exploits River, residual effects experienced under normal operating conditions within the local area of the Buchan's Resources Limited Project are not expected to result in cumulative effects within the cumulative effects RAA for the Approved Project and Project Expansion.

Newcrete Investments Limited was issued Environmental Preview Report (EPR) guidelines in March 2023 for their proposed Victoria River Quarry (located <500 m from the mine site). The Registration document for this proposed project indicates that watercourses will be avoided (the quarry is located at least 30 m from any watercourse), and no installation of water crossing infrastructure is anticipated (Newcrete 2022). In addition, site runoff will be treated through settling on the quarry floor, erosion control ditches with check dams, hay bales, and silt fencing to filter water leaving the quarry site. The Registration document indicates that site runoff will be released into vegetated areas. Significant surface water quality effects from the proposed quarry are not anticipated as the aggregate extraction will occur above the groundwater table and the proposed quarry is located outside the watershed areas for the Project Expansion, thus seepage water and contact water from the Approved Project and Project Expansion are not anticipated to interact with the proposed quarry. Given the level of analysis required for this proposed quarry and the mitigation outlined in the registration document (Newcrete 2022), it is anticipated that appropriate mitigation measures will be in place for this quarry, should it be approved. With mitigation and considering the proposed quarry is located outside of sub-watershed areas for the Approved Project and Project Expansion, cumulative effects to surface water quantity or quality in the Victoria River and adjacent tributaries are not anticipated.

8.7.5 Cumulative Effects Summary and Evaluation

The cumulative effects on surface water of past, present, ongoing, and reasonably foreseeable projects and activities, in combination with the environmental effects of the Project Expansion, are reflected in residual effects predictions in Sections 8.5 and 8.6. Based on the assessment in Section 8.7.4, the potential cumulative effects of the Approved Project and Project Expansion and other reasonably foreseeable project is predicted to be low in magnitude (a measurable change in water quantity and quality within local watersheds but restricted to the LAA). Cumulative effects are predicted to be short to long-term in duration, continuous, and irreversible. The ecological and socio-economic context for the Surface Water Resources VC is considered disturbed in the cumulative effects RAA.

With mitigation, the cumulative effects from the Approved Project, Project Expansion and reasonably foreseeable future activities are expected to be not significant (Table 8.21) (Significance Definition provided in Section 8.5.1.2). This is consistent with the effects prediction for the Approved Project in the Valentine Gold EIS.

Table 8.21 Summary of Potential Cumulative Effects for Surface Water

Residual Cumulative Effect[A]	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Context
	A	L	LAA	ST / LT	C	R/I	D
Contribution from the Approved Project and Project Expansion to the Residual Cumulative Effect[A]	Approved Project and Project Expansion related changes to surface water quantity and quality will be restricted to several local watersheds and not extend beyond the LAA. Based on the existing Project Expansion design, the Project Expansion is not anticipated to change the surface water quantity at the LAA boundary compared to the Approved Project as the change in MAF remains within 10% of pre-development conditions. Surface water quality will experience similar local effects in watersheds immediately downstream of Approved Project and Project Expansion FDPs but will return to baseline, or below CWQG-FAL within the LAA.						
Significance[B]	Although there are limitations in the available information of the effects from other present, past and future physical activities, a conservative approach was taken to estimate the cumulative effects (e.g., effects to surface water quality and quantity of future physical activities). The predicted effects are similar to those that have occurred during other mining and quarry projects / activities, thereby increasing confidence in the assessment. The cumulative effects on surface water are predicted to be not significant with a high prediction confidence.						

Notes:
[A] Descriptors are provided in Table 8.9
[B] Significance definition is provided in Section 8.5.1.2

8.8 FOLLOW-UP AND MONITORING

Follow-up and monitoring are intended to verify the accuracy of predictions made during the EA, to assess the implementation and effectiveness of mitigation and the nature of the residual effects, and to manage adaptively, if required. Compliance monitoring will be conducted to confirm that mitigation measures are implemented. Should an unexpected deterioration of the environment be observed during follow-up and/or monitoring, intervention mechanisms will include initiating the adaptive management process. This may include an investigation of the cause of the deterioration and identification of existing and/or new mitigation measures to be implemented to address it. Follow-up and monitoring will be implemented as part of the updated Water Management Plan and/or existing Surface Water Follow-up Monitoring Program for the Approved Project. Additional monitoring for the Project Expansion related to surface water will include surface water quality monitoring at the new proposed FDPs for the Berry Complex and within the receiving environment, as described in the Surface Water Follow-up Monitoring Program and Water Management Plan.

8.9 REFERENCES

Ausenco. 2021. N.I. 43-101 Technical Report & Feasibility Study in the Valentine Gold Project. Prepared for Marathon Gold Corporation.

Ausenco. 2022. N.I. 43-101 Technical Report & Feasibility Study in the Valentine Gold Project. Prepared for Marathon Gold Corporation. December 20, 2022. Available at: https://marathon-gold.com/site/uploads/2022/12/FINAL-REPORT-Valentine-Gold-43-101-and-FS-Dec-20.pdf

British Columbia Ministry of Environment and Climate Change Strategy. 1996. Guidelines for Assessing the Design, Size, and Operation of Sedimentation Ponds Used in Mining. Available at: http://www.bcrock.com/reports/Design_SedimentPonds.pdf

CCME (Canadian Councils of Ministers of the Environment) 2020. Canadian Water Quality Guidelines for the Protection of Aquatic Life. Available online: https://wcww.ccme.ca/files/ceqg/en/backup/222-080516095450.pdf. Accessed August 2020

DFO (Fisheries and Oceans Canada). 2013. Framework for Assessing Ecological Flow Requirements to Support Fisheries in Canada. Available online at: https://www.conservationgateway.org/ConservationPractices/Freshwater/EnvironmentalFlows/MethodsandTools/ELOHA/Documents/Fisheries-and-Oceans-Canada-SAR-2013.pdf . Accessed July 2020.

DFO (Fisheries and Oceans Canada). 2019. Policy for Applying Measures to Offset Adverse Effects on Fish and Fish Habitat Under the *Fisheries Act*. Available Online: https://waves-vagues.dfo-mpo.gc.ca/Library/40939698.pdf. Accessed October 28, 2021.

ECCC (Environment and Climate Change Canada). (2019). Canadian Climate Normals 1981-2010 Buchans. Retrieved from Climate Normals and Averages: https://climate.weather.gc.ca/climate_normals/results_1981_2010_e.html?stnID=6579&autofwd=1

ECCC (Environment and Climate Change Canada). 2020. National Long-term Water Quality Monitoring Data. Retrieved from Environment and Climate Change Canada: https://open.canada.ca/data/en/fgpv_vpgf/67b44816-9764-4609-ace1-68dc1764e9ea

GEMTEC. 2022a. Valentine Gold Project 2022 Feasibility Study Update: Geotechnical and Hydrogeological Investigation Final Report. Submitted to Marathon Gold Corporation. October 19, 2022.

GEMTEC. 2022b. Rehabilitation and Closure Plan. Valentine Gold Project. Prepared for Marathon Gold Corporation. Submitted to Mineral Development Division. November 4, 2022.

Marathon (Marathon Gold Corporation). 2020. Valentine Gold Project Environmental Impact Statement. September 2020.

Newcrete Investments Ltd. (Newcrete). 2022. Victoria River Quarry Permit, Environmental Assessment Registration Document. Available online at: env_assessment_y2022_2227-Registration-Document.pdf (gov.nl.ca)

NLDOEC (Newfoundland and Labrador Department of Environment and Conservation). 1992. Water Resources Atlas of Newfoundland. Retrieved from Municipal Affairs and Environment: https://www.mae.gov.nl.ca/waterres/cycle/hydrologic/atlas.html

Richter, B., Davis, M., Apse, C., & Konrad, C. 2011. Short Communication A Presumptive Standard for Environmental Flow Protection. River Research and Applications.

Zadeh, S. 2012. Low Flow Frequency Study for Newfoundland and Labrador. Master of Engineering Thesis, Faculty of Engineering and Applied Science, Memorial University of Newfoundland.