Valentine Gold Project: Federal Information Requirements

Round Three Information Requirements:
Response to IR(3)-11

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January 7, 2022

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LIST OF APPENDICES

RESPONSE TO IR(3)-11

IR 3 Reference #:	**IR(3)-11**
IR 2 Reference #:	IR(2)-11 IR(2)-12 IR(2)-14 IR(2)-15
EIS Reference:	Reference to EIS: Appendix 6A, Sections 4.3.3, 4.3.4, 4.4, 5.2.1.3, 5.3.1.2, 5.2.2, and 5.3.2, Tables 4-2, 4-3, 5-1, 5-2, 5-3, 5-4, 5-6, and 5-7, Figures 4.1, 4.2, 4.3, 4.4 5.2 and 5.4
Context and Rationale:	The boundary conditions within the groundwater flow model (that includes the recharge applied to the top surface, and the drain and river boundaries used to represent surface water features) are user specified, and control the degree to which groundwater may interact with surface water, groundwater elevations, and the forecasted effects that mine dewatering and mine waste storage can have on groundwater flow. The model results are affected by these boundary conditions, and it effects the assessment of surface water and fish and fish habit as groundwater is a vector to those valued components. Round two information requests 11, 12, 14, 15 highlighted model results related to model boundary conditions that were inconsistent with either the reported applied boundary condition or the simulated changes in groundwater elevations. To support review of these results, maps showing depth to groundwater (i.e., the water table) were requested for the baseline, end of operations, and post closure conditions. These maps were provided in response to IR(2)-11 as Figures IR(2)-11.1, 11.2 and 11.3. In reviewing the response, Figure IR(2)-11.1 indicates that for the calibrated baseline simulation, many areas of the model domain have a water table that is above ground surface. These results are especially prevalent to the northwest of the Leprechaun Pit and to the south of the Marathon Pit where simulated groundwater elevations are more than 10m above ground surface. IR responses provided to date highlight the ability of this model to produce a reasonable calibration to observed groundwater levels and baseflow values. However, the results of this model are not conceptually feasible given the portions of the domain in which the water table is significantly above ground surface.

IR 3 Reference #:	**IR(3)-11**
	Various incongruent model results highlighted in Round 2 (IRs 11, 12, 14, 15) appear to be related to numerical instability, and the related lack of conceptual feasibility from the calibrated model. Some examples include the fluxes at NT3 under baseline conditions and the increase in groundwater flow to NT1 and NT2 at the end of operations relative to baseline. Due to the highlighted concerns regarding the baseline calibrated model, forecast results for groundwater drawdown, and groundwater-surface water interaction cannot be relied upon for the effects assessment.
Information Requirement:	Provide a calibrated baseline groundwater model that aligns with the conceptual model, such that the groundwater table is at, or below the ground surface in the absence of surface water features or significant confining units. Provide forecast model results based on the updated calibrated model that limits numerical artifacts so that the reported results align with the expected outcomes, and applied boundary condition changes. Based on revised model results, update the effects assessment for surface water, fish and fish habitat as applicable.
Response:	A review of the numerical groundwater flow model has been conducted in relation to NRCan's request to: • Provide a calibrated baseline groundwater model that aligns with the conceptual model, such that the groundwater table is at, or below the ground surface in the absence of surface water features or significant confining units. • Provide forecast model results based on the updated calibrated model that limits numerical artifacts so that the reported results align with the expected outcomes, and applied boundary condition changes. The changes to the modelling inputs and results are provided in a technical memo included as Appendix IR(3)-11.1. The changes to the groundwater modelling results have also been interpreted for their impacts to the effects assessments for the Groundwater Resources, Surface Water Resources, and Fish and Fish Habitat Valued Components as presented in the EIS. As detailed in Appendix IR(3)-11.1, the results from the revised groundwater modelling forecast reduced impacts on groundwater baseflows to surface water features as compared to that presented in the EIS. As a result, the effects assessed in the EIS are more conservative that the effects predicted using the revised modelling, and therefore there is no change to the determination of significance presented in the EIS.
Appendix:	Appendix IR(3)-11.1 Technical Memo on Updated Groundwater Modelling

Appendix IR(3)-11.1
Technical Memo on Updated Groundwater Modelling

Valentine Gold Project: Federal Information Requirements

Appendix IR(3)-11.1 Technical Memo on Updated Groundwater Modelling

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1.0 INTRODUCTION

As part of the technical review of the EIS for the Valentine Gold Project (the Project), Natural Resources Canada (NRCan) has requested additional information on the groundwater flow model that was prepared in support of the environmental assessment of the Project. NRCan has specifically requested that a review of the numerical groundwater flow model be conducted to:

- Provide a calibrated baseline groundwater model that aligns with the conceptual model, such that the groundwater table is at, or below the ground surface in the absence of surface water features or significant confining units.
- Provide forecast model results based on the updated calibrated model that limits numerical artifacts so that the reported results align with the expected outcomes, and applied boundary condition changes.

This technical memo provides the results of the review of the numerical groundwater flow model calibration that has been conducted, evaluating if changes could be made to the model that could reduce the simulated groundwater levels in areas in accordance with NRCan's request, while maintaining a suitable calibration to observed water levels and baseflow estimates to surface water features. The changes to the modelling inputs and results are provided in detail in the sections below.

As requested by NRCan, the changes to the groundwater modelling results have also been interpreted for their impacts to the effects assessments for the Groundwater Resources, Surface Water Resources, and Fish and Fish Habitat Valued Components (VCs) as presented in the EIS. As detailed below (Section 4), the results from the revised groundwater modelling forecast reduced impacts on groundwater baseflows to surface water features than in the EIS. As a result, the effects assessed in the EIS are more conservative that the effects predicted using the revised modelling, and the determination of significance presented in the EIS is not changed.

2.0 CHANGES TO NUMERICAL GROUNDWATER FLOW MODEL INPUTS

The numerical groundwater flow model was revised to reduce the simulated groundwater levels where simulated levels were above the ground surface. The areas of the model where simulated water levels were above ground surface occurred in three primary areas, as shown on Figure 1:

- In the vicinity of wetlands
- Along hill slopes
- At the base of hill slopes

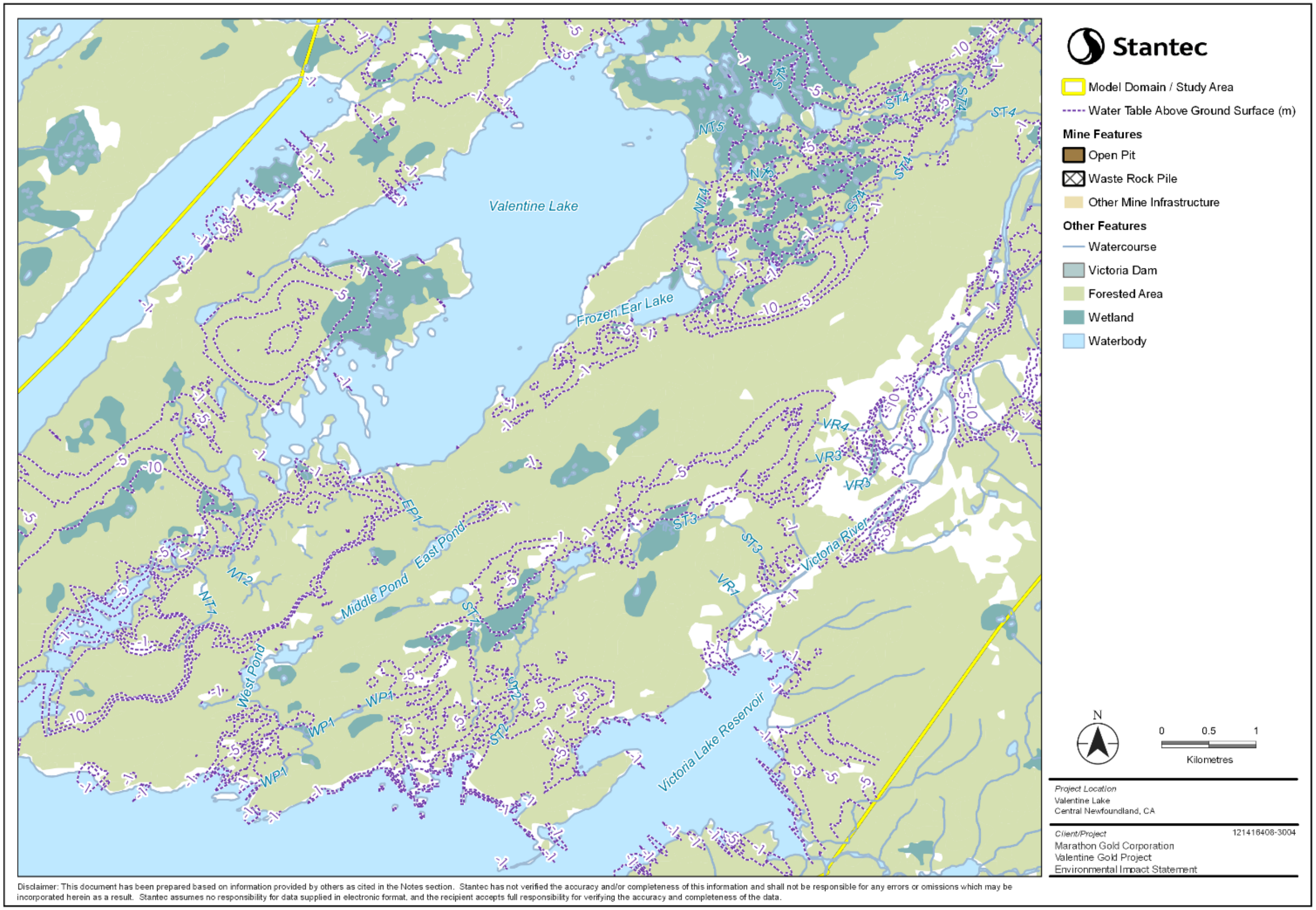

Figure 1 Areas with Water Table Above Ground Surface at Baseline for Original Model in EIS

Several methods were investigated using the numerical groundwater flow model to address the simulated elevated water levels:

- Incorporating additional evapotranspiration (compared to the net recharge method applied in the groundwater modelling) using the MODFLOW Evapotranspiration package.
- Incorporating potential wetland seepage areas using the MODFLOW Drain package for areas defined using the Saturated Soils layer from the Wooded Areas, Saturated Soils and Landscape in Canada – CanVec Series – Land Features (Natural Resources Canada 2019). This was extended to include low lying areas with ponded water as observed in imagery from Google Earth. The drain stage was assigned based on the ground surface elevation, and the conductance was assigned at 1 m^2/d. The location of the new drain cells added to the model based on this criterion are provided in Figure 2.
- Reducing recharge by applying a linearly varying recharge multiplier to the net recharge from the EIS model based on surface slope. A recharge multiplier of 0.05 was assigned to slopes greater than 35°, and a recharge multiplier of 1.00 was assigned to slopes of 0°. The calculated surface slope is illustrated on Figure 3, and the function that calculates the recharge multiplier based on ground surface slope is illustrated on Figure 4.
- Increasing the conductance factor for drain features in lowland areas at the base of hill slopes.

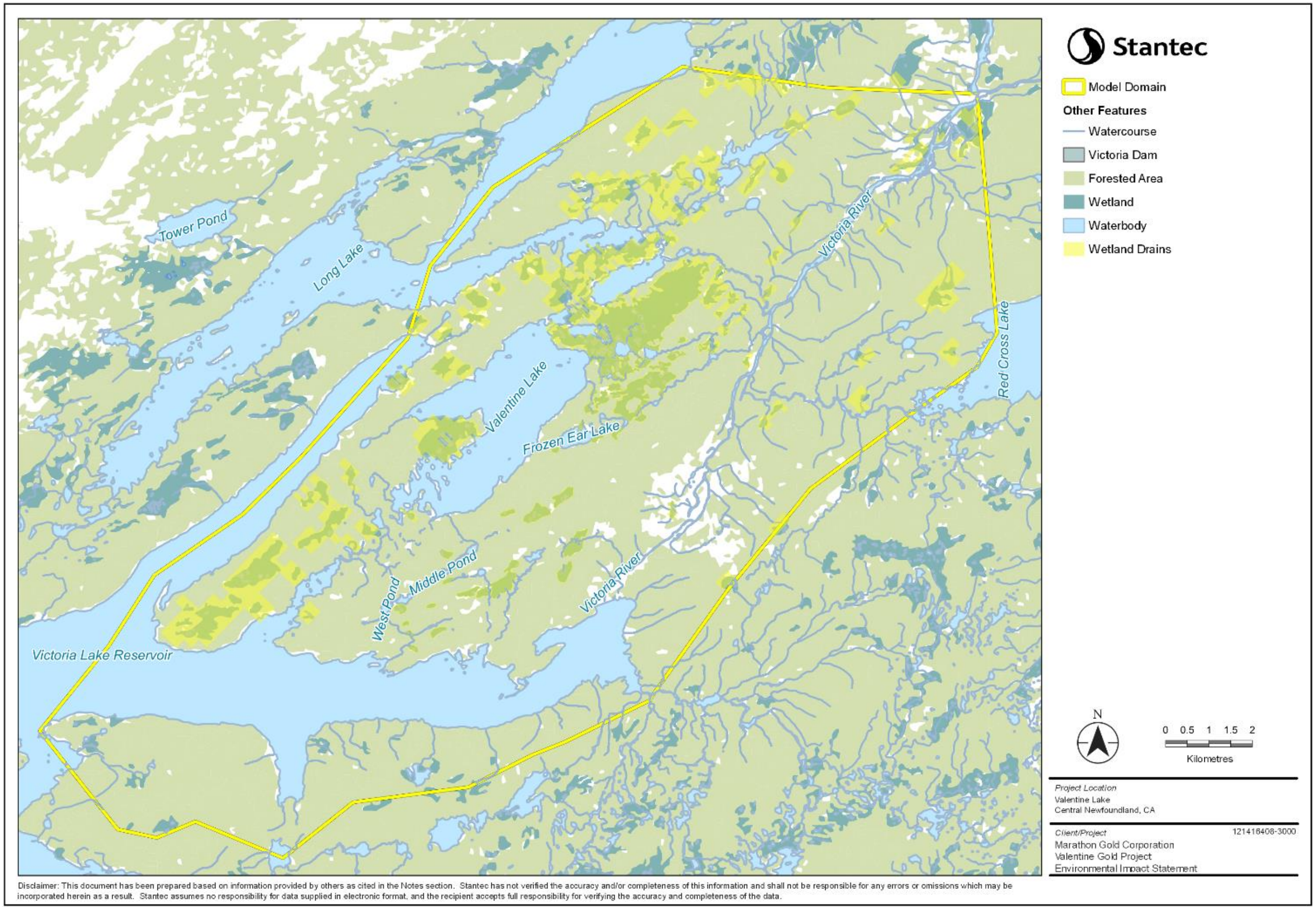

Figure 2 Location of Model Drain Cells Corresponding to Saturated Soils (Wetlands)

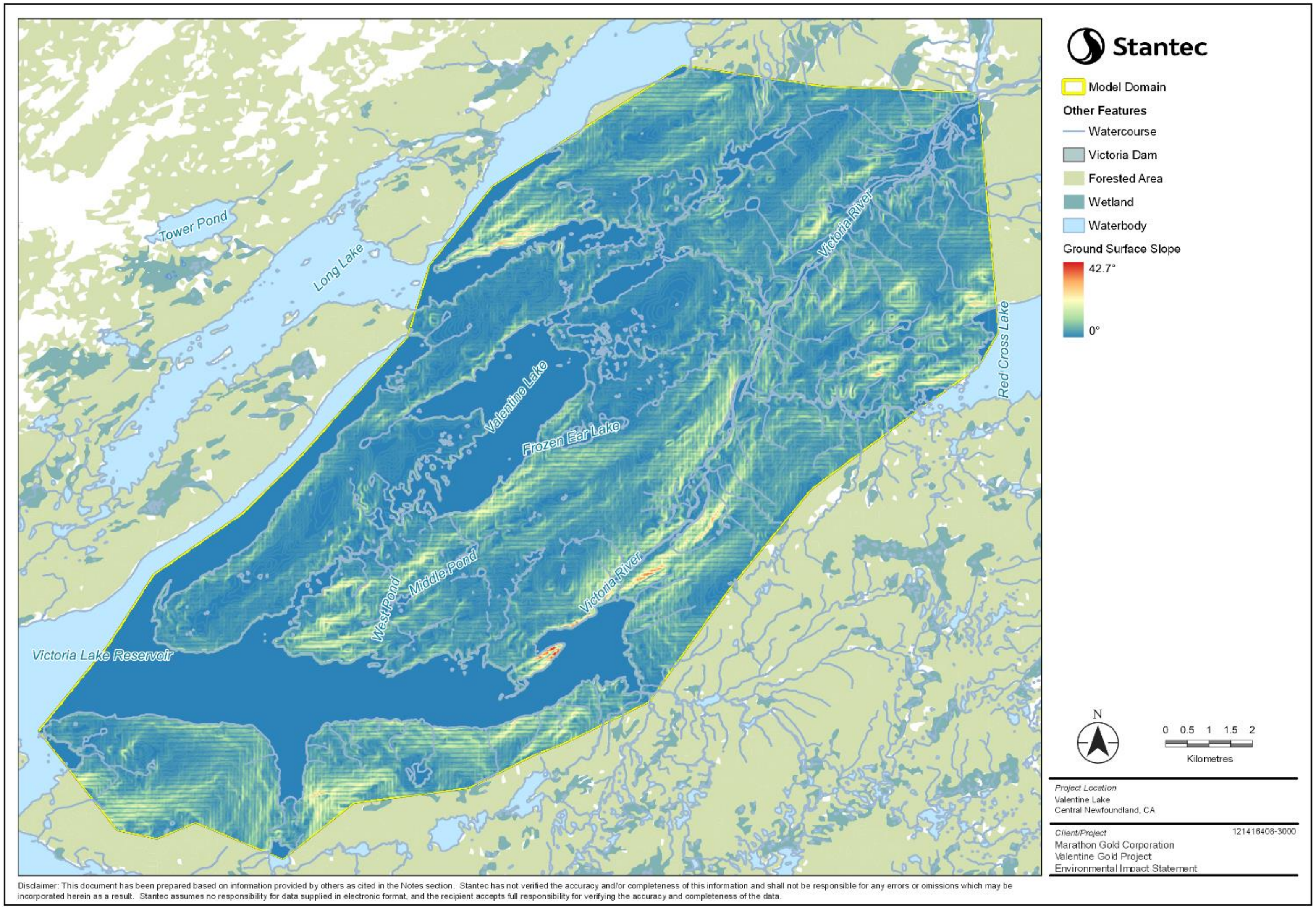

Figure 3 Ground Surface Slope (degrees) Used to Calculate Variable Recharge Rates

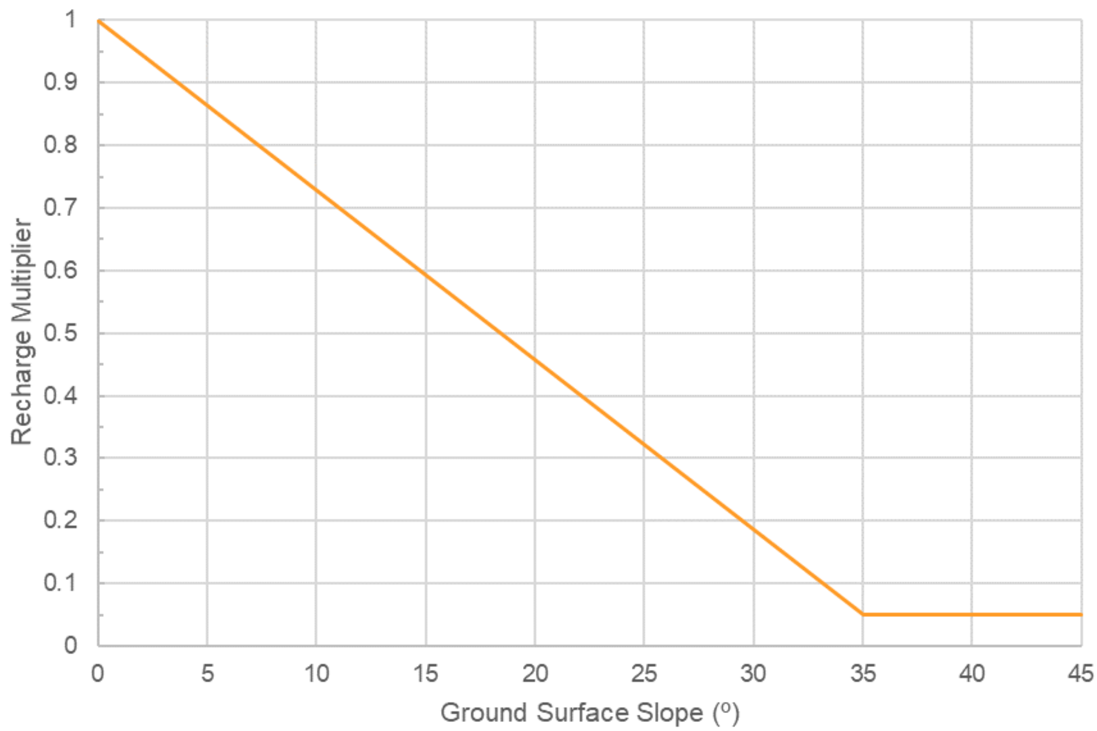

Figure 4 Relationship Between Ground Surface Slope and Recharge Multiplier Used in Revised Groundwater Modelling

The modelling presented in the EIS was conducted using the ModelMuse (Winston 2014) graphical user interface (GUI) for Modflow-NWT (Niswonger et al. 2011). These modelling files were imported to the Groundwater Vistas (Environmental Simulations, Inc. 2017) GUI to facilitate the updates.

The groundwater modelling residual statistics used to evaluate the “goodness of fit” of the calibration in the EIS were used to evaluate the revised calibration. This included the calibration to water levels and the calibration to groundwater baseflow to surface water features. The statistical measures of the calibration to water levels included the standard error of the estimate and the Root Mean Squared (RMS) error. In evaluating the fit between the observed and the simulated water levels, the RMS error is usually regarded as the best measure (Anderson and Woessner 1991). The RMS error is calculated as the average of the squared differences between the measured and the simulated water levels. If the ratio of the RMS error to the total water level differential over the model area (normalized RMS error) is small (i.e., less than 10%; Spitz and Moreno 1996), then the errors are only a small part of the overall hydraulic response of the model. Additionally, the mean error and absolute mean errors are also used, with a goal of achieving mean and absolute mean errors as close to zero as possible. As presented in the EIS, the mean error for the modelling was -0.46 m, the absolute mean error was 1.88 m, and the normalized RMS was 2.6%.

In addition to the calibration to water levels, the EIS model was calibrated to baseflows to surface water features. As discussed in the response to IR-12 (submitted to IAAC on April 14, 2021), the groundwater model was calibrated to baseflow for six surface water monitoring locations (HS1, HS3, HS5, HS7, HS8, and HS9) shown on Figure 5. The baseflow estimates were calculated using the derived relationships between mean annual flow and drainage area presented in the Surface Water VC (Chapter 7 of the EIS), based on a mean annual baseflow index of 35%. These baseflow estimates do not account for the potential baseflow-type responses of lake and wetlands. A good match to baseflow from a groundwater model is generally accepted as 20%. As discussed in the response to IR(2)-12 (submitted to IAAC on September 22, 2021), the match of the baseflows in the EIS model ranged from 0.3 to 28%, with an average match of 1.1%.

The methods investigated in this revised modelling effort are expected to change the calibration obtained during the baseline modeling. For the purposes of this revision, the following criteria were used to assess the calibration of the model:

- Normalized RMS < 10%
- Average baseflow within 50% (based on uncertainty in baseflow estimates)
- As few areas as possible where water table exceeds ground surface

The average fit of the baseflows was increased from a more typical range of 20% to 50% based on a review of the baseflow estimates. The baseflow index used to estimate the baseflows used as calibration targets can be influenced by the storage and release of surface water within large lakes and wetlands. Because the baseflow index method applied did not account for these features, and because large portions of the watershed areas upstream of the calibration flow targets include lakes/ponds and wetlands, the baseflow estimates were considered accurate within 50% for this re-evaluation of the calibration of the model.

It was possible to reduce the water table to below the ground surface throughout the model using the evapotranspiration package. However, because this approach applied to all areas in the model, the net recharge was reduced to about 10% of the recharge rate used in the EIS (i.e., about 3% of the average annual precipitation). Although a good match of water level targets was possible using this approach, the simulated baseflows to surface water features were underpredicted (average of 75.4%, ranging from -28.3% to -102.0%) and were not considered acceptable for the current modelling.

A more reasonable match of water levels and baseflows to surface water features was achieved using a combination of wetland seepage area drains, reduced recharge, and increased conductance factors for drains in lowland areas. The effects of these changes on the calibration to water levels are summarized on Figure 6 and in Table 1, and on the calibration to baseflows in streams in Table 2.

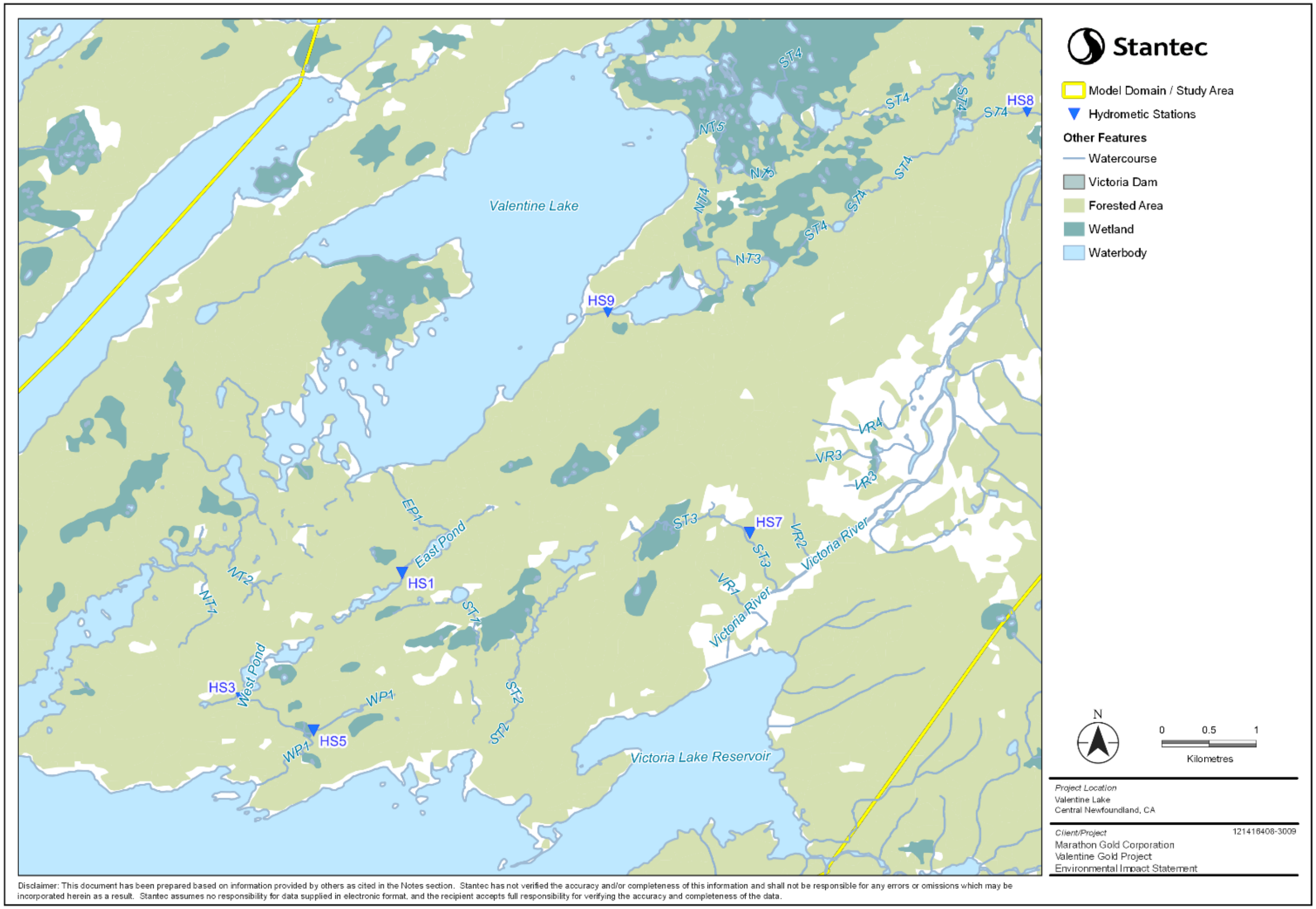

Figure 5 Location of Surface Water Hydrometric Stations used for Baseflow Calibration Targets in Groundwater Modelling

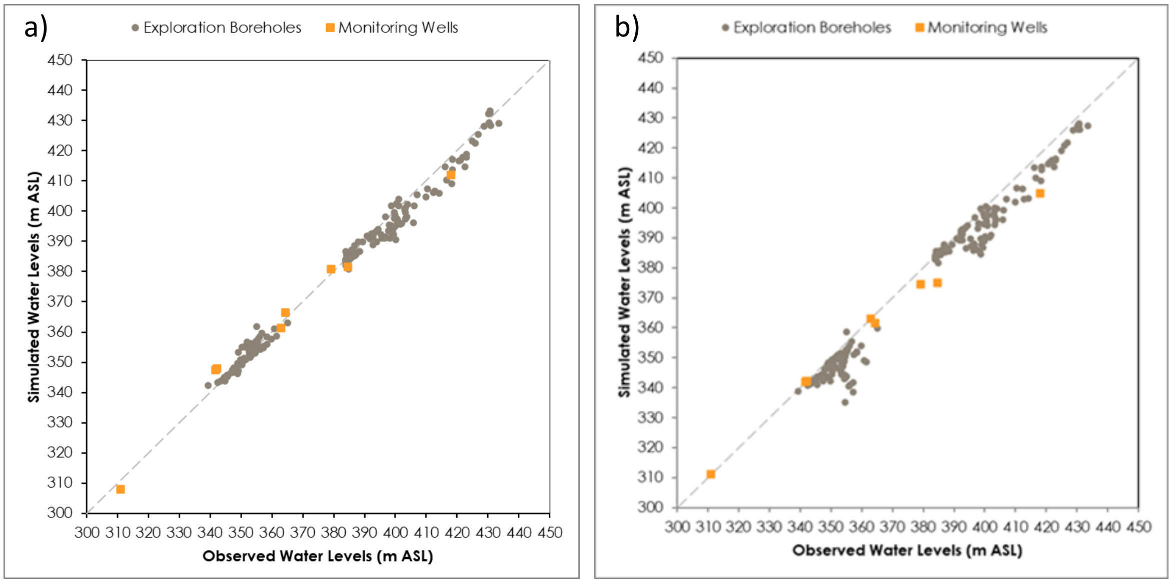

Figure 6 Comparison of calibration fits for a) EIS Model and b) Revised Model

Table 1 Comparison of Water Level Calibration Statistics for EIS Model and Revised Model

Statistic	EIS Model	Revised Model
Mean Error (m)	-0.46	-2.1
Absolute Mean Error (m)	1.88	2.31
Normalized Root Mean Squared Error (%)	2.6	4.9

Table 2 Comparison of Baseflow Calibration for EIS Model and Revised Model

Flow Target Location	Estimated Baseflow (m^3/d)	Simulated Baseflow (m^3/d) [% Difference of Estimated Baseflow]	
		EIS Model	Revised Model
HS1	401	515 [28.4%]	428 [6.8%]
HS3	700	587 [-16.1%]	323 [-53.8%]
HS5	997	782 [-21.6%]	542 [-45.6%]
HS7*	1,737	1,805 [3.9%]	1,600 [-7.9%]
HS8*	5,058	5,040 [-0.4%]	3,294 [-34.8%]
HS9*	2,918	2,894 [-0.8%]	1,348 [-15.0%]
Average % Difference		[-1.1%]	[-23.1%]

Although the water level calibration statistics for the updated model presented in Table 1 show a somewhat higher calibration error than those in the EIS model, the statistics are still within acceptable ranges, with the normalized RMS remaining below 10%. The effects on the calibration to baseflows in Table 2 are larger for the revised model than for the EIS model, with an average baseflow at the targets underpredicted by 23.1%. However, based on the uncertainty in the baseflow estimates described above, the model is considered to provide a reasonable match of flows overall.

The calibrated model continues to exhibit some areas where the water table is approximately 1 m above ground surface in the updated model, as shown on Figure 7. The extent of these areas is reduced (compare Figure 1 and Figure 7), and the areas are generally located away from Project components where interactions would be expected between the Project and groundwater resources. These areas generally correspond to local depressions in the digital elevation model (DEM) used to generate the model ground surface. The DEM used for the topographic surface in the groundwater model is a combination of LiDAR flown for the site (which is rounded to the nearest integer elevation in metres) and the CanVec national ground surface DEM. There are areas where the LiDAR data and the CanVec data differ by more than 2 m, which can affect the interpreted ground surface elevation. However, these errors are considered to be bounded within 2 m, and areas where the water table may locally exceed these ranges were considered negligible in the interpretations of water table surfaces in the model.

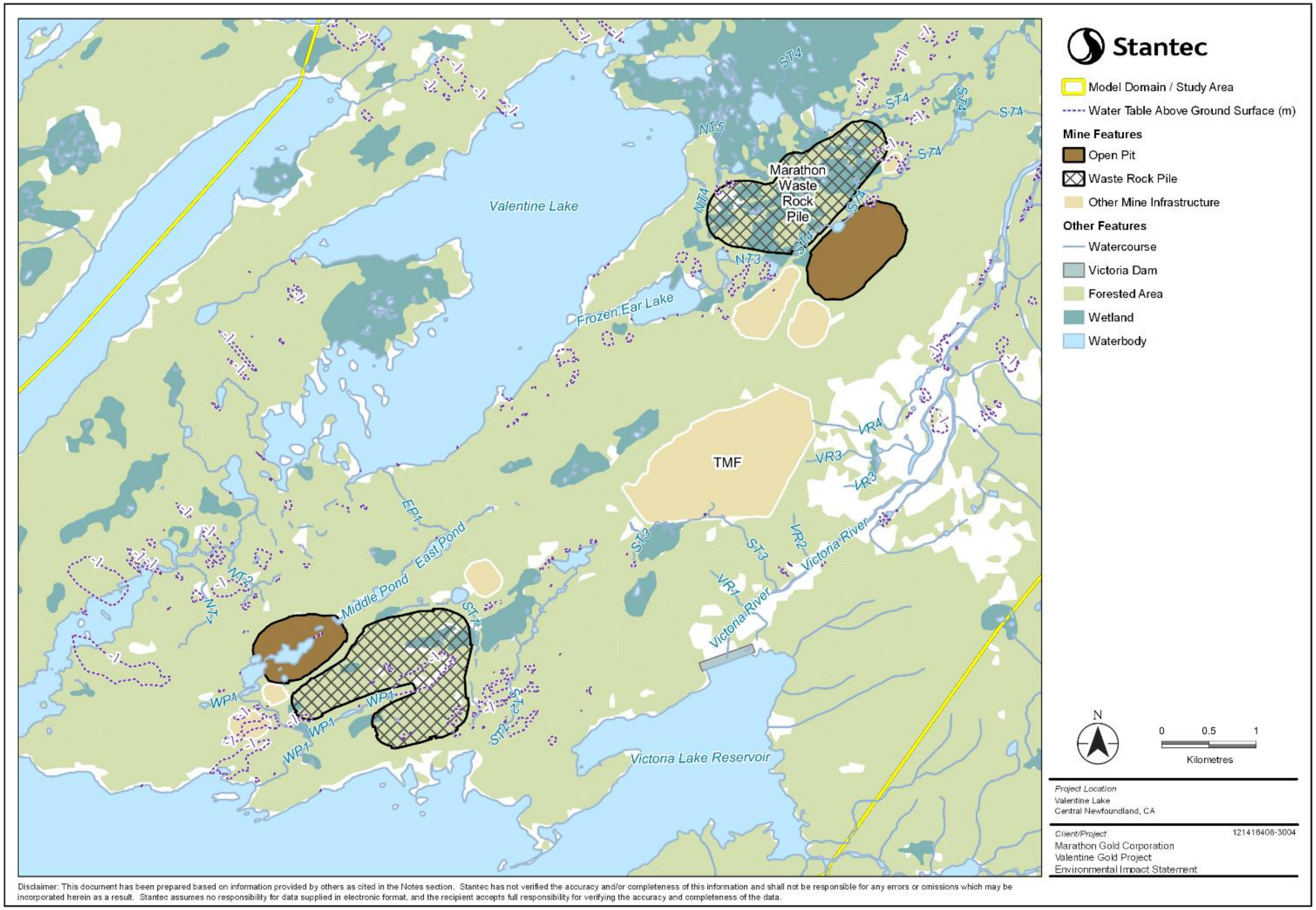

Figure 7 Areas with Water Table Above Ground Surface at Baseline for Revised Model

3.0 CHANGES TO RESULTS

3.1 BASELINE CONDITIONS MODEL RESULTS

The baseline conditions generated by the revised model compared to the results from the EIS are presented in Table 3. Groundwater levels above ground surface in the EIS model likely resulted in an over estimation of baseflows of groundwater to the surface water features in this model. As shown, groundwater fluxes to the receptors are lower for the revised model than those in the EIS model with the exception of NT1, NT2, VR3, and VR4. The conductance at these four receptors was increased in the revised model to remove more water from the model in these areas, which resulted in higher flows, due to an improved simulated hydraulic connection between the surface water feature and the modelled aquifer. The groundwater flows to the remainder of the surface water features were lower in the revised model due to the reduction in recharge rate and the removal of water by some of the wetland features resulting in less baseflow. Water captured in the wetland features can be released to surface water, or could be removed due to evapotranspiration in the summer months.

The water table contours for the revised baseline model are presented on Figure 8.

Table 3 Comparison of Net Baseflow from Groundwater to Surface Water for Baseline Conditions

Water Feature	Net Flow from Groundwater to Surface Water (m^3/d)		Mean Annual Flow (m^3/d)
	EIS Model	Revised Model	
Unnamed Tributary to Victoria Lake Reservoir NT1	332.6	322.6	1,580.7
Unnamed Tributary to Victoria Lake Reservoir NT2	61.2	685.2	2,157.1
Frozen Ear Lake and Tributaries NT3	2,874.2	1,174.4	8,739.5
Unnamed Tributary to Valentine Lake NT4	357.4	248.9	1,077.9
Unnamed Tributary to Valentine Lake NT5	408.4	396.5	1,552.9
Middle and East Pond and Tributaries EP1	919.9	504.6	6,710.2
West Pond and Tributaries WP1	2,167.9	1,027.9	6,633.0
Unnamed Tributary to Victoria Lake Reservoir ST1	782.5	245.6	3,481.0
Unnamed Tributary to Victoria Lake Reservoir ST2	2,872.6	1,298.8	5,787.1
Unnamed Tributary to Victoria River ST3	1,306.4	218.7	3,934.4
Unnamed Tributary to Victoria River ST4	5,201.6	3,008.3	17,021.8
Unnamed Tributary to Victoria River VR1	0.002	-	837.5
Unnamed Tributary to Victoria River VR2	0.2	-	968.4
Unnamed Tributary to Victoria River VR3	153.5	164.0	2,219.5
Unnamed Tributary to Victoria River VR4	12.0	573.1	1,705.2

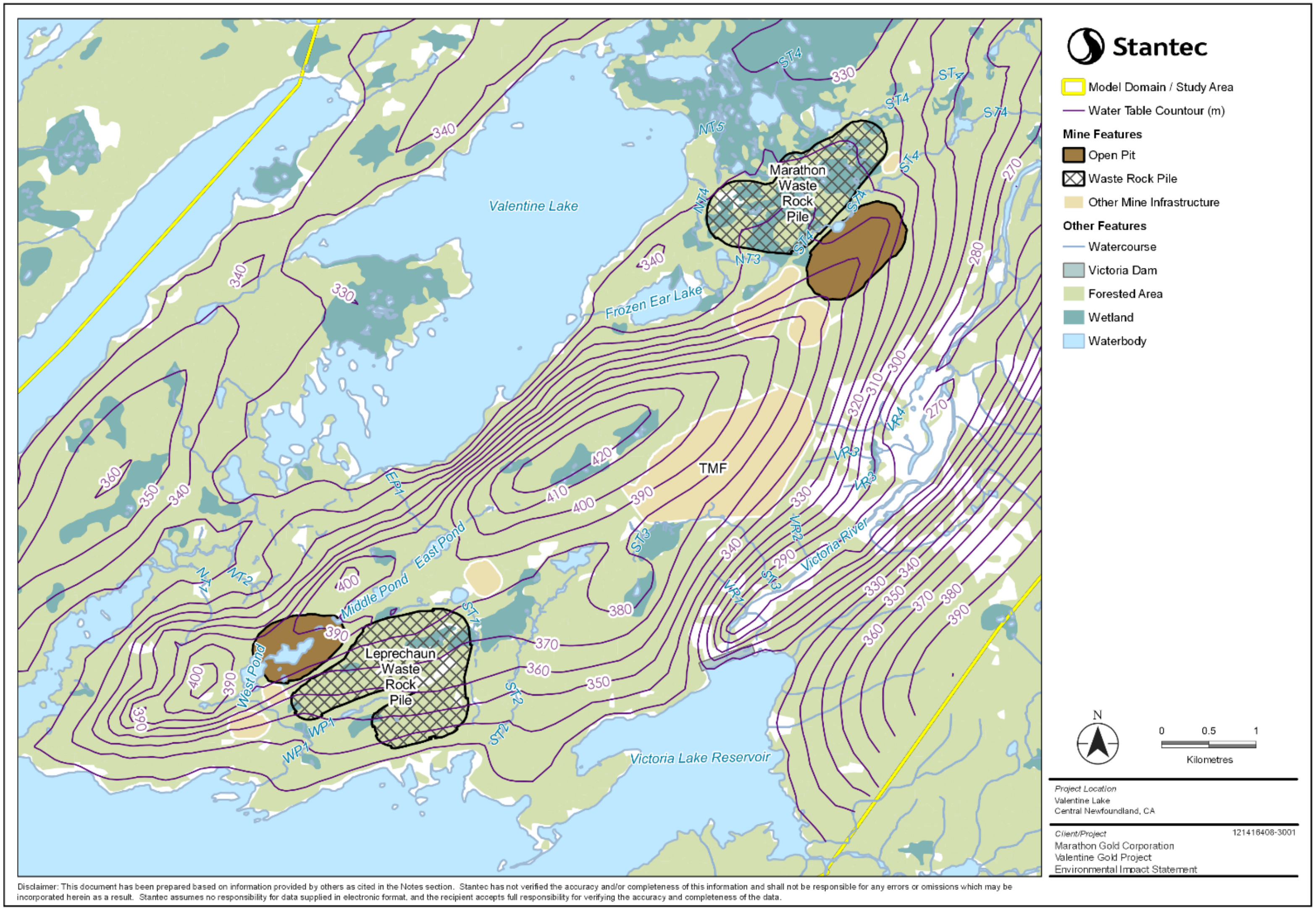

Figure 8 Baseline Water Table Contours for Revised Model

3.2 PROJECT OPERATION PHASE MODEL RESULTS

The conditions at the end of mine operations (i.e., the operation phase of the Project) from the revised model compared to the revised baseline conditions and the mean annual flow in the watercourses are presented on Table 4. The revised water table elevation contours at the end of operation are presented on Figure 9, and the corresponding areas where the water table exceeds the pre-development ground surface are presented on Figure 10. The revised drawdown contours at the end of operation are presented on Figure 11.

The areas where the water table is simulated to be above ground surface shown on Figure 10 are consistent with the baseline areas (see Figure 7), with additional mounding observed under areas with increased recharge (i.e., within the footprint of the tailings management facility (TMF) and waste rock piles). These areas are consistent with the mounding (i.e., negative drawdown) shown on Figure 11 for these features.

Table 4 Comparison of Revised Net Baseflow from Groundwater to Surface Water for Baseline and Operation Conditions

Water Feature	Net Flow from Groundwater to Surface Water (m^3/d)		Mean Annual Flow (m^3/d)
	Baseline	Operation	
Unnamed Tributary to Victoria Lake Reservoir NT1	322.6	315.5	1,580.7
Unnamed Tributary to Victoria Lake Reservoir NT2	685.2	589.0	2,157.1
Frozen Ear Lake and Tributaries NT3	1,174.4	1,187.2	8,739.5
Unnamed Tributary to Valentine Lake NT4	248.9	142.1	1,077.9
Unnamed Tributary to Valentine Lake NT5	396.5	377.5	1,552.9
Middle and East Pond and Tributaries EP1	504.6	307.7	6,710.2
West Pond and Tributaries WP1	1,027.9	1,014.0	6,633.0
Unnamed Tributary to Victoria Lake Reservoir ST1	245.6	148.6	3,481.0
Unnamed Tributary to Victoria Lake Reservoir ST2	1,298.8	1,324.9	5,787.1
Unnamed Tributary to Victoria River ST3	218.7	89.3	3,934.4
Unnamed Tributary to Victoria River ST4	3,008.3	2,156.8	17,021.8
Unnamed Tributary to Victoria River VR1	-	-	837.5
Unnamed Tributary to Victoria River VR2	-	14.2	968.4
Unnamed Tributary to Victoria River VR3	164.0	199.0	2,219.5
Unnamed Tributary to Victoria River VR4	573.1	549.2	1,705.2

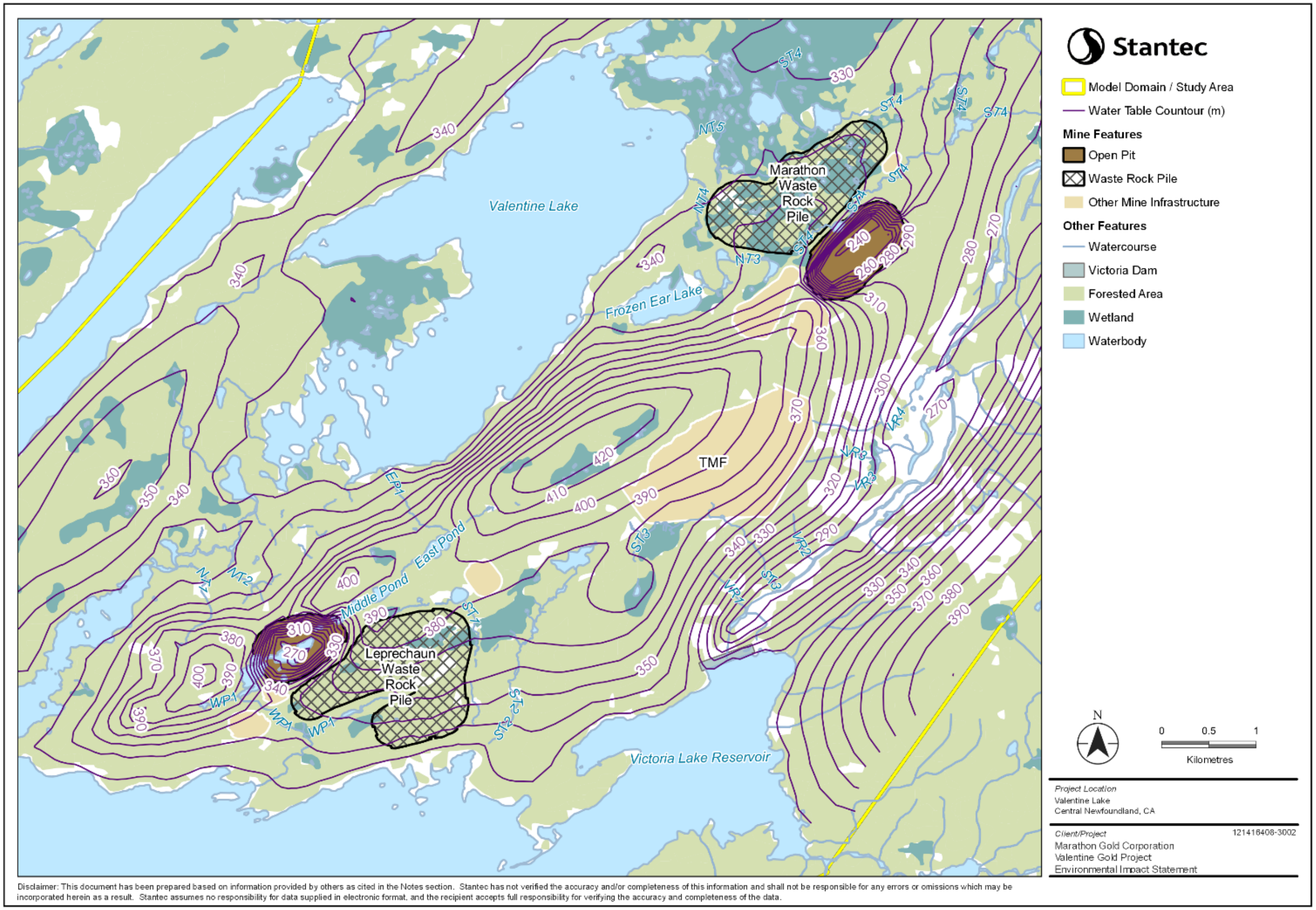

Figure 9 Water Table Elevation Contours at End of Operation for Revised Model

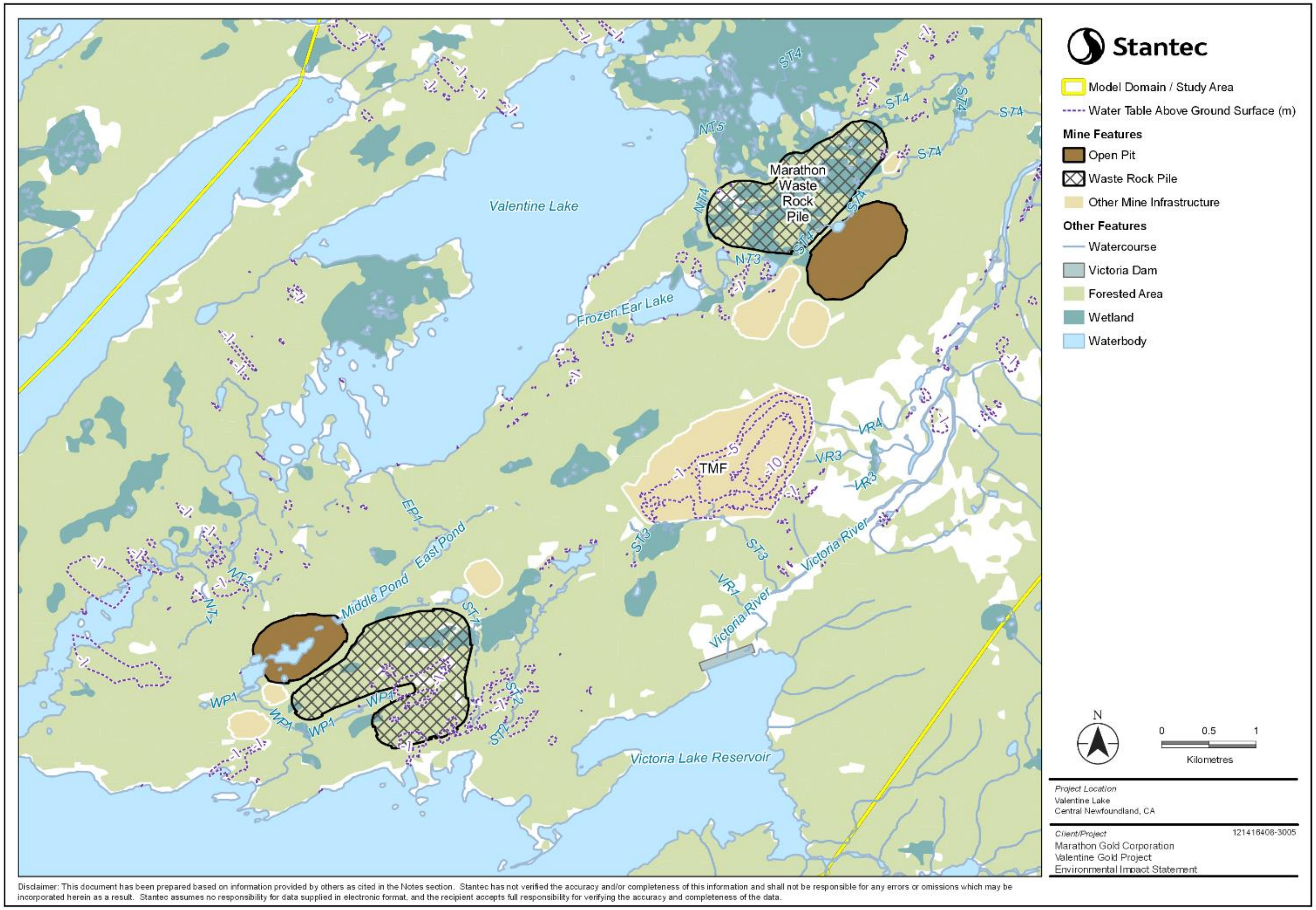

Figure 10 Areas with Water Table Above Ground Surface at End of Operation for Revised Model

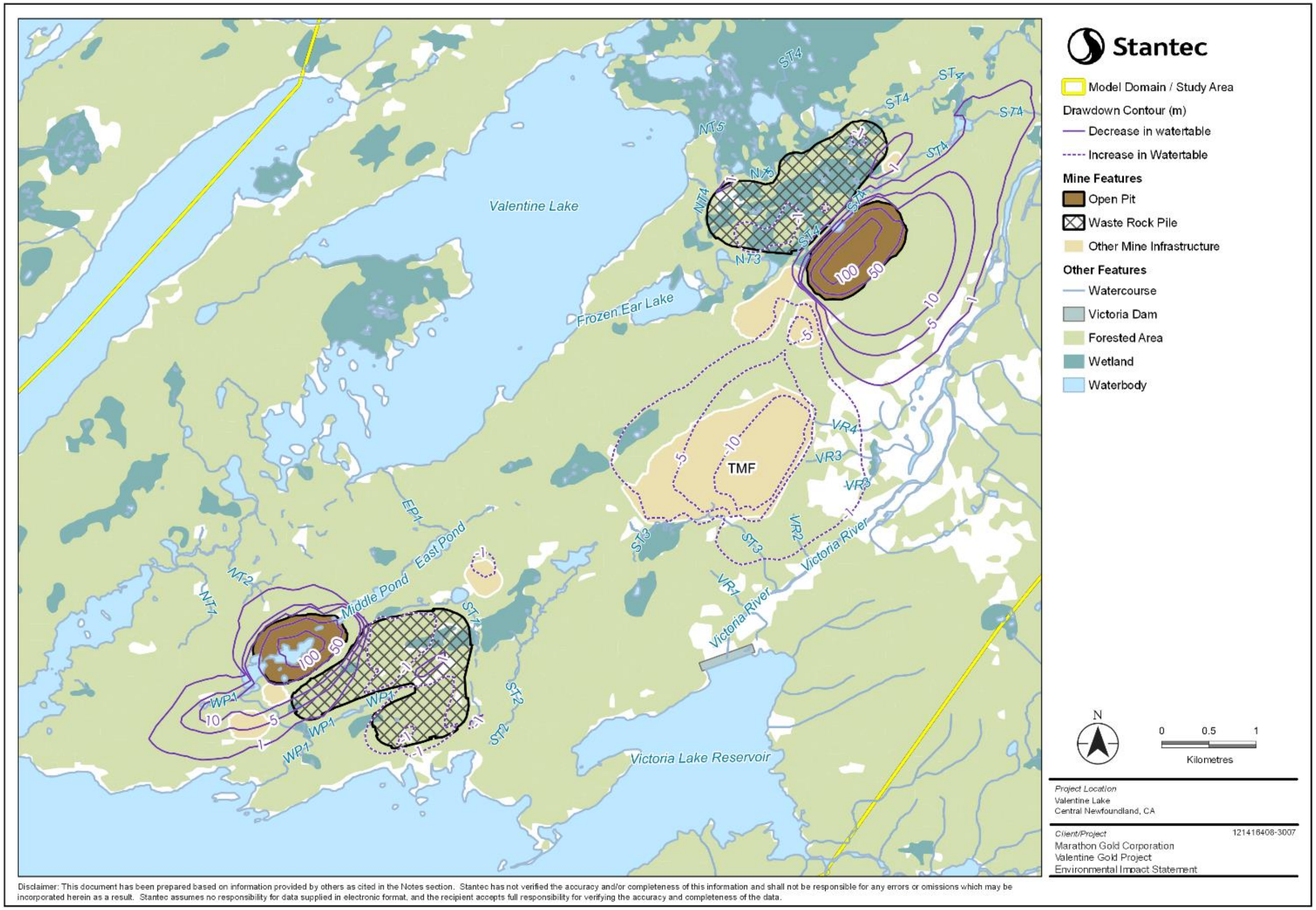

Figure 11 Water Table Drawdown Contours at End of Operation for Revised Model

The drawdowns of the water table associated with the operation of the open pits shown on Figure 11 are different than those presented in the EIS. The areas associated with the 1 m drawdown contour are generally smaller than those presented in the EIS. Drawdowns at the Leprechaun pit in the revised model extend to the southwest rather than to the north. Drawdowns at the Marathon pit in the revised model extend slightly more to the northeast compared to the southwest than those presented in the EIS. The changes to the extent of these drawdown contours do not change the interpretations of groundwater effects presented in the EIS, because there are no groundwater users within these areas. Potential interactions with surface water resources are discussed below.

The results presented in Table 4 show a general decrease in baseflows during operation compared to baseline conditions, with the exception of ST1, VR2, and VR3. Similar to the changes in baseflow observed in the EIS modelling, the revised flows at ST1 have increased due to the increased recharge rate assigned to the waste rock piles compared to baseline conditions, which is observed in the mounding (i.e., negative drawdown) contours presented in Figure 11. Also, consistent with the changes in baseflow observed in the EIS modelling, the revised flows at VR2 and VR3 are influenced by the presence of the TMF, which is also observed in the mounding contours presented in Figure 11. Although the specific flow rates are different than those presented in the EIS, changes in flows due to mining operations simulated using the revised model are consistent with areas that had simulated increases or decreases in flows in the EIS model.

The interpretations of groundwater drawdowns and discharge in the revised modelling have not changed substantively from the EIS; therefore, the original determination of that the Project would not result in significant adverse effects to Groundwater Resources during Project operation remains unchanged based on the revised model results.

3.3 POST-CLOSURE MODEL RESULTS

Post-closure conditions (i.e., the Closure phase of the Project following the filling of the open pits, and removal of Project-related water management features such as seepage collection ditches) from the revised model compared to the revised baseline conditions and the mean annual flow in the watercourses are presented on Table 5. The revised water table elevation contours during post-closure are presented on Figure 12, and the corresponding areas where the water table exceeds the pre-development ground surface are presented on Figure 13. The revised drawdown contours during post-closure are presented on Figure 14.

Table 5 Comparison of Revised Net Baseflow from Groundwater to Surface Water for Baseline and Post-Closure Conditions

Water Feature	Net Flow from Groundwater to Surface Water (m^3/d)		Mean Annual Flow (m^3/d)
	Baseline	Post-Closure	
Unnamed Tributary to Victoria Lake Reservoir NT1	322.6	319.1	1,580.7
Unnamed Tributary to Victoria Lake Reservoir NT2	685.2	632.5	2,157.1
Frozen Ear Lake and Tributaries NT3	1,174.4	1,177.6	8,739.5
Unnamed Tributary to Valentine Lake NT4	248.9	142.1	1,077.9
Unnamed Tributary to Valentine Lake NT5	396.5	377.5	1,552.9
Middle and East Pond and Tributaries EP1	504.6	368.5	6,710.2
West Pond and Tributaries WP1	1,027.9	1,396.6	6,633.0
Unnamed Tributary to Victoria Lake Reservoir ST1	245.6	150.9	3,481.0
Unnamed Tributary to Victoria Lake Reservoir ST2	1,298.8	1,324.7	5,787.1
Unnamed Tributary to Victoria River ST3	218.7	85.9	3,934.4
Unnamed Tributary to Victoria River ST4	3,008.3	2,246.1	17,021.8
Unnamed Tributary to Victoria River VR1	-	-	837.5
Unnamed Tributary to Victoria River VR2	-	-	968.4
Unnamed Tributary to Victoria River VR3	164.0	176.7	2,219.5
Unnamed Tributary to Victoria River VR4	573.1	579.8	1,705.2

The drawdowns of the water table associated with the filled open pits shown on Figure 14 are different than those presented in the EIS. The areas associated with the 1 m drawdown contour are generally smaller than those presented in the EIS. Drawdowns at the Leprechaun pit in the revised model extend to the southwest rather than to the north. Drawdowns at the Marathon pit in the revised model extend slightly more to the northeast compared to the southwest than those presented in the EIS. The changes to the extent of these drawdown contours do not change the interpretations of groundwater effects presented in the EIS, because there are no groundwater users within these areas. Potential interactions with surface water resources are discussed below.

The results show a general decrease in post-closure baseflows compared to baseline conditions, with the exception of ST1 and VR3, which is consistent with the results and interpretations presented in the EIS. As discussed in the operation section above, the flows at ST1 have increased due to the increased recharge rate assigned to the waste rock piles compared to baseline conditions. The flows at VR3 are influenced by the increased recharge associated with the presence of the TMF. These effects are also observed in the mounding contours within these areas presented in Figure 14.

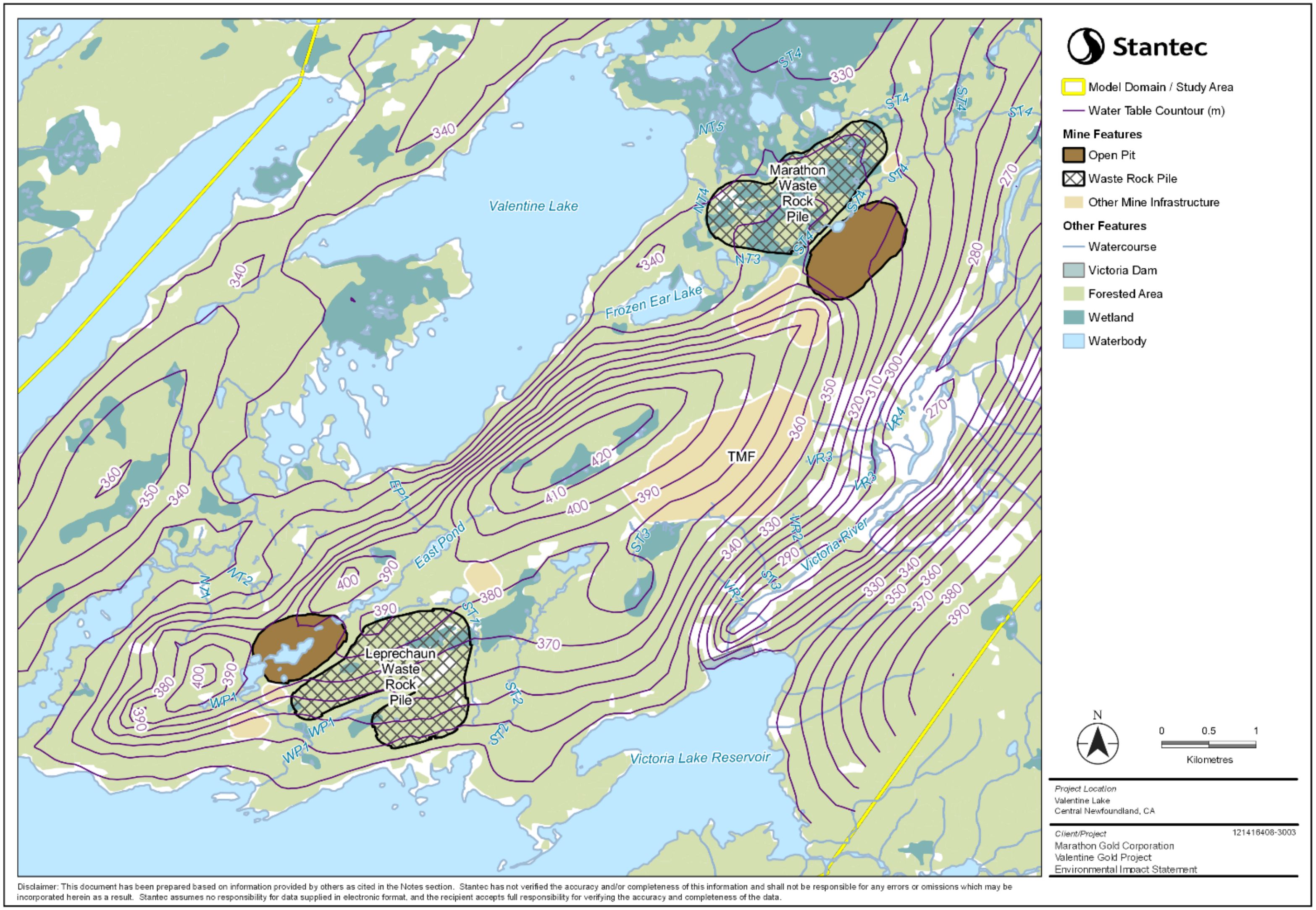

Figure 12 Water Table Elevation Contours during Post-Closure for Revised Model

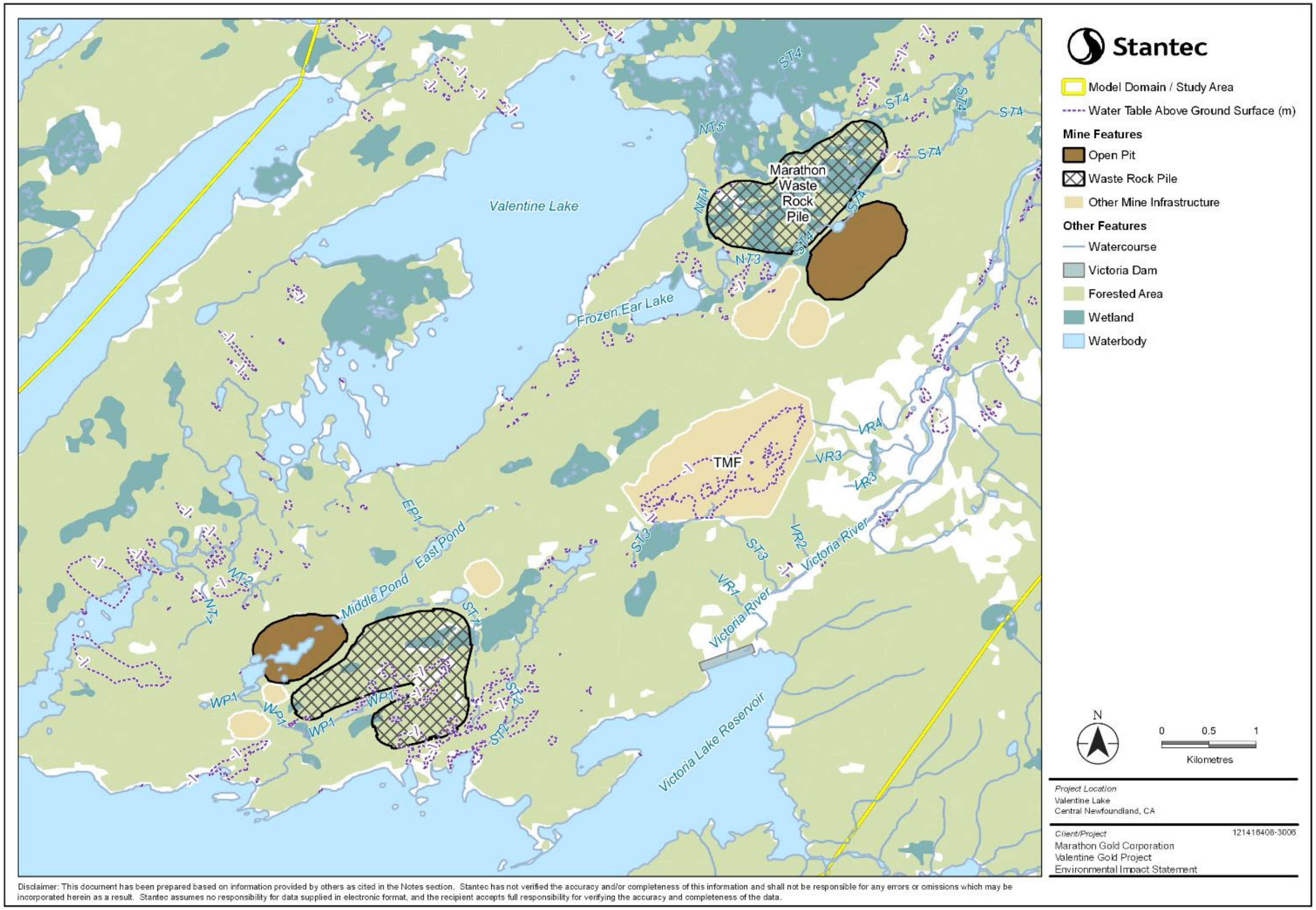

Figure 13 Areas with Water Table Above Ground Surface during Post-Closure for Revised Model

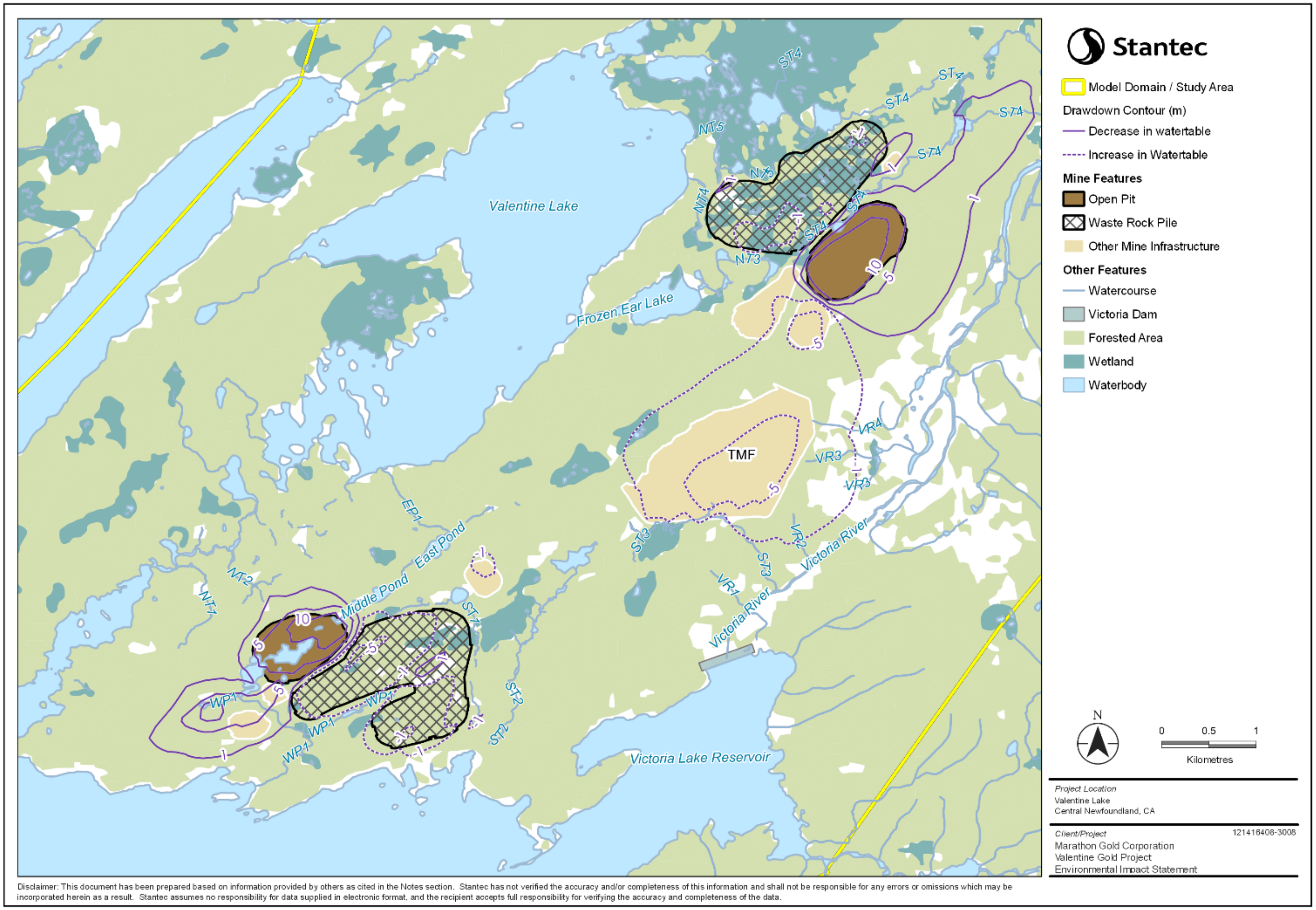

Figure 14 Water Table Drawdown Contours during Post-Closure for Revised Model

Therefore, because the interpretations of groundwater drawdowns and discharge have not changed substantively from the EIS, the original determination that the Project would not result in significant adverse effects to Groundwater Resources during the rehabilitation, decommissioning and closure phase of the Project remains unchanged based on the revised model results.

4.0 INTERPRETATION OF RESULTS

The revised groundwater model results show an overall decrease in estimated baseflows to surface water receptors compared to the model results for the EIS, with the exceptions noted above. However, as also noted above, the changes in baseflows due to mining during Project operation and closure are only slightly changed. Therefore, the subsequent interpretations of the effects of changes in groundwater flows due to the Project do not change the determination in the EIS that the Project would not result in significant adverse effects to “groundwater quantity and groundwater quality for the Groundwater Resources VC.

The results from groundwater modelling are carried into the Surface Water Resources VC through the water balance/water quality modelling and the assimilative capacity modelling. In the water balance/water quality models, groundwater flows are added to the calculated surface water flows in seepage collection ditches and ponds. An overall decrease in groundwater flow as seepage to surface water based on the revised groundwater model compared to the EIS groundwater model would only have a minor effect on calculated surface water flows and surface water quality. In general, a decrease in groundwater seepage rates would reduce the overall seepage in the water balance. However, as the groundwater seepage quality would not be changed based on these results, the overall water quality in the seepage collection ditches would not be affected by the relatively minor reductions to groundwater seepage rates. Therefore, the effects assessment presented in the EIS is considered to be conservative, and does not require additional assessment at this time.

The assimilative capacity model adds deep groundwater seepage from the waste rock piles and TMF to the reduced flows in surface water receivers (reduced by changes in watershed area which accounts for indirect groundwater effects). Reducing the flow rate for the added groundwater seepage effectively reduces the amount of mass of contaminants added to surface water receivers for the assimilative capacity calculations. Therefore, the overall impacts to surface water resources due to the lower groundwater baseflow estimates from the revised modelling do not require additional assessment at this time.

Similarly, for the Fish and Fish Habitat VC, groundwater impacts to surface water flows were considered indirectly (i.e., through reductions in watershed areas) carried from the Surface Water Resources VC, and groundwater impacts to surface water quality from the assimilative capacity modelling results. As discussed above, because the results of the assimilative capacity model presented in the EIS are considered conservative with respect the reductions in groundwater seepage rates from the revised modelling, the effects from groundwater will not require additional assessment of Fish and Fish Habitat at this time.

5.0 REFERENCES

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