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Joseph Mackenzie, Chair
Wek'èezhìi Land and Water Board
PO Box 32
Wekweètì, NT X1A 3S3
Canada

6 November 2018

Dear Mr. Mackenzie:

Subject: DDMI Response to WLWB Information Request re: Water License W2015L2-0001 Amendment Request for the Deposition of Processed Kimberlite to Mine Workings

Diavik Diamond Mines (2012) Inc. (DDMI) submitted an Application to amend Water License W2015L2-0001 to allow for the deposition of Processed Kimberlite (PK) material into mine workings on 1 June 2018. Following review of the Application, the Wek'èezhìi Land and Water Board (WLWB or 'the Board') are to conduct a preliminary screening. On 31 August 2018 the Board determined that there was insufficient information available on the record to inform a preliminary screening determination and issued an Information Request (IR) to DDMI. This letter outlines DDMI's response to the IR issued by the Board and includes a Technical Memorandum by Golder Associates Ltd. (Golder) that summarizes the preliminary modelling analysis conducted to respond to the Board's request and serves as primary evidence demonstrating anticipated meromictic conditions and how water quality and fish habitat will be impacted at closure (Attachment-1: Water Quality Modelling of A418, A154 and A21 Mined Out Pits).

The Board's IR identified three focus areas where more information was required, namely:

1. How water quality in each pit (i.e., A418, A154 and A21) will be impacted at closure/post-closure in relation to the deposition of PK and Processed Kimberlite Containment (PKC) Facility "slimes";
2. Whether the anticipated meromictic conditions within the three pits at closure/post-closure would be altered by the deposition of PK; and,
3. Whether fish and fish habitat are likely to be impacted at closure/post-closure because of deposition of PK and PKC Facility "slimes" into each pit.

Golder subsequently conducted a preliminary modelling analysis of pit lake water quality and expected mixing conditions in each of the three mine areas at closure/post-closure, with and without the deposition of PK in these areas. This preliminary modelling did not differentiate between "PK" and PKC Facility "slimes" from the perspective of an impact on water quality as PK already includes a slimes fraction. The scenarios evaluated in the model are outlined below, followed by a summary response to each WLWB Information Request. Please refer to Attachment-1 for a more comprehensive discussion of the modelling analysis.

Base Case Scenario	No PK deposited in the pits; filled with fresh water
Development Scenario	PK deposited in the pits; 150 m fresh water cap above the PK
Sensitivity Scenario 1	PK deposited in the pits; 50 m freshwater cap above the PK
Sensitivity Scenario 2	PK deposited in the pits; 20 m freshwater cap above the PK
Sensitivity Scenario 3	Increased size of the two breaches in the A418 dike (only assessed with a 20 m freshwater cap above the PK; breaches increased to 60x60m at 2 m deep vs 30x60m at 2 m deep)

IR-1

Demonstrate how the water quality in each pit (i.e., A418, A154, and A21) will be impacted at closure/post-closure because of deposition of PK and PKC Facility “slimes” and demonstrate whether the water quality at closure/post-closure will be impacted such that the pits (i.e., A418, A154, and A21) may not be able to be reconnected to Lac de Gras, once flooded. This may include:

a. The potential effects of tailings on the water quality of the freshwater cap for all potential closure scenarios (i.e., with/without slimes, variable PK fill elevations);

   Potential effects on surface water quality are shown numerically in Table 2 (Attachment-1). The Development Case results for each mine area are shown relative to AEMP Benchmarks as a metric of potential effect. The Development Case results are indicative of both deposition of PK and deposition of PK with PKC Facility “slimes”. The results show that the PK deposition in mine workings does not cause an exceedance of AEMP benchmarks in post-closure surface water in any of the three mine areas. Water quality remains generally within the range of current conditions in Lac de Gras.

   In addition to the Development Case, Sensitivity Scenarios 1 and 2 were also evaluated to determine the impact of different fill levels on surface water quality. The results show limited difference between a 150m and 50m deep water cap, but with a 20m deep water cap the water fully mixes causing elevated sulphate, nitrate and selenium concentrations relative to Lac de Gras and AEMP benchmarks in the A418 area.

b. Predicted water quality in deep waters of the mine pits and how this will change over time because of the deposition of PK;

   Predicted change over time in water quality in deep waters of the mine pits can be observed for Total Dissolved Solids (TDS) in Figures 5, 10 and 15 of Golder (2018) for A418, A154 and A21 respectively. In each, the Base Case shows water quality without deposition of PK and the Development Case shows water quality with PK. Additional results are included for Sensitivity Scenario 1 and Sensitivity Scenario 2.

   Predicted change over time is also shown for a conservative tracer that represents dissolved species from the PK (Figures 6, 11 and 16) and a settleable constituent that represents particulates (Figures 7, 12 and 17) for A418, A154 and A21 respectively.

c. The proposed maximum PK fill elevation within each pit in relation to overlying water quality, including an assessment of the water cover depth;

   Golder (2018) shows that a 50m water cover is sufficient to prevent mixing of bottom water with surface water, where as a 20m water cover was not sufficient. This result was consistent for A418, A154 and A21. From this analysis, the maximum fill elevation for PK would therefore be around 50m below Lac de Gras water level, or approximately 365m RL. DDMI *does not envisage any development scenario that would fill any of the mine areas to this elevation however this is a suitable maximum PK fill elevation.*

d. Identification of contaminants of potential concern within the freshwater cap over the tailings, and mitigation measures for any contaminants of concern;

DDMI directed Golder (2018) to predict water quality concentrations for all parameters that have an AEMP benchmark. Conservatively all of the parameters with an AEMP benchmark are "contaminants of potential concern". Golder (2018) evaluated two potential mitigation measures a) depth of water cap in each mine area, and b) size of dike breaches in A418. As described in c) above, the depth of the water cap is the most effective mitigation against poor surface water quality. Surface water quality in A418 was not sensitive to the size of the dike breaches indicating this is likely not a very effective mitigation measure (Section 4.1.1).

e. The likelihood of PK material being re-suspended;

Golder (2018) evaluated resuspension potential in each of the mine areas and concluded that because this material is not predicted to re-suspend in the 20-m deep pit lake, it would not be anticipated to re-suspend in deeper lakes, so further modelling of fines resuspension is not necessary at this stage (Section 4.1.1, 4.1.2, 4.1.3). This prediction is consistent with findings from existing pit lakes that contain submerged mine waste.

f. A risk assessment of the effects to surface water quality in the pits and Lac de Gras in the event that unanticipated mixing occurs;

The potential risk of an unanticipated mixing event on surface water quality was evaluated in Golder (2018) Section 4.3. In this unlikely event, Golder assessed that the maximum estimated mixed concentrations would generally exceed the benchmark for the following constituents: sodium, sulfate, nitrate and nitrite as nitrogen, cadmium, copper, molybdenum, nickel, selenium, silver and zinc. The exceedances are projected to occur generally on all pits, with the maximum exceedance occurring in pit A21. The described turnover scenario would be unlikely, and the elevated concentrations would be short lived (i.e. in the order of months) and limited to a small area of Lac de Gras.

g. The potential effects to Lac de Gras should modelling predict degradation of the water quality in the pits because of deposition of PK; and

Modelling completed by Golder (2018) does not predict degradation of water quality in any of the pits provided the final water cover is 50 m or greater in depth. As such, potential effects to Lac de Gras were not considered further.

h. A demonstration of how potential mitigation measures may optimize water quality in the freshwater cap.

Golder (2018) evaluated two potential mitigation measures a) depth of water cap, and b) size of dike breaches. As described in c) above, the depth of the water cap is the most effective mitigation against poor surface water quality. Surface water quality was not sensitive to the size of the dike breaches in A418, indicating this is likely not a very effective mitigation measure. These mitigation measures are demonstrated in Golder (2018) using scenario analysis and comparing predicted results to AEMP benchmarks.

IR-2

Demonstrate whether the anticipated meromictic conditions within the pits (i.e., A418, A154, and A21) at closure/post-closure would be altered by the deposition of PK. This may include:

a. Modelling to demonstrate the stability of the anticipated meromictic condition with and without the deposition of PK and PKC Facility "slimes";

   Golder (2018) demonstrated the anticipated mixing conditions for each of the mine areas with and without PK (as noted above, the modelling did not differentiate between PK with and without "slimes" as all PK includes a slimes fraction). Without PK deposition the modelling predicts that the post-closure pit lakes would mix regularly to depth. This is best illustrated in Figures 5, 10 and 15 for the A418, A154 and A21 pits respectively where the Base Case (no PK deposition) predictions show no stratification and the Development Case (with PK deposition) shows a clear stratification. Mixing conditions for Sensitivity Scenarios 1 and 2 were also evaluated for A418, A154 and A21, as well as Sensitivity Scenario 3 for A418.

b. The influence of the final PK fill elevation on the stability of meromixis; and

   Golder (2018) shows that a 50m water cover is sufficient to prevent mixing of bottom water with surface water, whereas a 20m water cover was not sufficient. This result was consistent for A418, A154 and A21. From this analysis the maximum fill elevation for PK would therefore be around 50m below the Lac de Gras water level, or approximately 365m RL. DDMI does not envisage any development scenario that would fill any of the mine areas to this elevation.

c. A demonstration of how potential mitigation measures could improve the stability of the anticipated meromictic condition.

   Golder (2018) evaluated the depth of water cap as a potential mitigation measure to improve the stability of the anticipated meromictic condition. The analysis shows that a 50m water cover is sufficient to prevent mixing of bottom water with surface water, whereas a 20m water cover was not sufficient. This result was consistent for A418, A154, and A21. The depth of the water cap is therefore an effective stability mitigation.

IR-3

Demonstrate whether fish and fish habitat are likely to be impacted at closure/post-closure because of deposition of PK and PKC Facility "slimes" into each pit.

As described in response to IR-1 (above) surface water quality is predicted to remain below AEMP benchmarks with deposition of PK and PK slimes, provided the closure water cap is a minimum of 50m deep. AEMP benchmarks are expected to be protective of fish and fish habitat. As such, fish and fish habitat are unlikely to be impacted at closure / post-closure and no further analysis / demonstration was required.

This may include:

a. Detailed information on any potential change and corresponding mitigation to the level of serious harm to fish resulting from the proposed Amendment;

   Assuming a water cap a minimum of 50m deep, there are no expected changes to the level of serious harm to fish as a result of the proposed Amendment based on the reasons described above and in Golder (2018).

b. The potential risk that water quality may not be suitable for the re-introduction or establishment of fish at closure;

Deposition of PK or PK slimes is not predicted to impact surface water quality such that it would not be suitable for the re-introduction of fish, as noted above and in Golder (2018).

c. The potential change in fish habitat conditions at closure/post-closure because of the proposed Amendment;

Assuming a water cap a minimum of 50m deep, there are no expected changes to fish habitat conditions as a result of the proposed Amendment based on the reasons described above and in Golder (2018).

d. The potential risk to fish in the event that unanticipated mixing occurs at closure/post-closure;

The potential risk to fish of an unanticipated mixing event was evaluated based on expected changes in surface water quality that are described in Section 4.3 of Attachment-1. In this unlikely event, Golder assessed that the maximum estimated mixed concentrations would generally exceed the benchmark for the following constituents: sodium, sulfate, nitrate and nitrite as nitrogen, cadmium, copper, molybdenum, nickel, selenium, silver and zinc. The exceedances are projected to occur generally in all pits, with the maximum exceedance occurring in pit A21. In this unlikely event, elevated surface water concentrations would be short-lived (i.e. in the order of months) due to a high volume of exchange with Lac de Gras and limited to a relatively small area, thereby limiting potential risk to fish.

e. The effect to the fish population in Lac de Gras if reconnection to Lac de Gras was not possible; and

As described in IR-3(b) above, deposition of PK or PK slimes are not predicted to impact surface water quality such that it would not be suitable for the re-introduction of fish; no further analysis was therefore conducted for effects to fish if the pit lakes were not reconnected to Lac de Gras.

f. A demonstration of how potential mitigation measures may limit potential impacts to fish and fish habitat.

Assuming a water cap a minimum of 50m deep, impacts to fish and fish habitat have not been identified; therefore no further evaluation of potential mitigations was conducted.

IR-4

Describe how DDMI’s pre-submission engagement specifically addressed the proposal to deposit PK into all three mines; and

While engagement sessions did primarily focus on conceptual designs for the most probable option of depositing PK to the A418 mine workings, the fact that DDMI would be requesting approval to deposit PK in any mine working was noted during the meetings. Specifically the other mine workings options were highlighted in the discussion when examining the mine plan for all four pipes (slide 7, Appendix I of the Application). DDMI highlighted the potential for another mine working to become available prior to A418 due to unforeseen changes to the mine plan, which may occur for a variety of reasons ranging from geotechnical challenges to financial constraints. During engagement sessions, no party expressed concern with our intention to seek approval for the option to deposit PK in any mine working versus only having A418 as a disposal option. DDMI also discussed the use of multiple mine workings with Diavik’s Traditional Knowledge Panel during the May 2018 Panel meeting and enclose the final report as supporting evidence.

Rio Tinto

IR-5

If DDMI has not engaged specifically on the deposit of PK into all three mines, provide a timeline for completing additional engagement (i.e., not associated with the Board's process) related to PK deposition in the A154 and A21 pits and updating the engagement record.

Not applicable; please refer to DDMI's above response to IR-4.

Should you have any questions regarding this submission, please contact the undersigned.

Yours sincerely,

Sean Sinclair
Superintendent, Environment

cc: Anneli Jokela, WLWB
Anita Ogaa , WLWB
Ryan Fequet, WLWB

Attach: Water Quality Modelling of A418, A154 and A21 Mined Out Pits (Golder 2018)
DDMI Traditional Knowledge Panel Session #11 – Options for Processed Kimberlite

TECHNICAL MEMORANDUM

DATE 2 November 2018

Golder Reference No. 1893614-1698-TM-Rev1-3000

WORK PLAN No. 587 Rev.0

DIAVIK PO No. D04148

TO Gord MacDonald
Diavik Diamond Mines (2012) Inc.

FROM Shadi Dayyani and Jerry Vandenberg

EMAIL Shadi_Dayyani@golder.com; Jerry_Vandenberg@golder.com

DIAVIK MINE – WATER QUALITY MODELLING OF A418, A154 AND A21 MINED OUT PITS

1.0 INTRODUCTION

Diavik Diamond Mines (2012) Inc. (DDMI) is evaluating potential environmental effects related to storage of fine processed kimberlite (PK) in the mined-out A418, A154 and A21 Pits and underground workings (if applicable). At closure, the PK would be capped with freshwater and the overlying pit lake will be reconnected to Lac de Gras, consistent with the Revised Interim Closure and Reclamation Plan (Version 3.1; DDMI 2010). DDMI retained Golder Associates Ltd. (Golder) to develop hydrodynamic models for the A418, A154 and A21 pit lakes to evaluate the post-closure pit lake water quality following placement of freshwater caps over the deposited fine PK in these pits. The model domains included the pits, the diked area and a small connecting portion of Lac de Gras for each pit lake. The sub-level retreat and underground workings are assumed to be back-filled with PK and were not included in the models. The model domain extended from Lac de Gras water surface to the bottom of the open pit, although the simulations that included PK deposition only used the model cells above the PK-water interface. Concentrations of a full suite of water quality parameters in the pit lakes were estimated using the hydrodynamic results to provide an estimate of mixing and consequent mass balance.

The objectives of the hydrodynamic modelling were to determine (a) whether the pit lakes water column will turn over or remain stratified, thereby isolating mine-influenced water from mixing with surface water in the pit lake, (b) the long-term stability of stratification, and (c) the resulting influence of PK consolidation on pit lakes water quality for each scenario. The modelling was intended to answer these questions for preliminary planning purposes, and as such, simplifying assumptions were employed as described in Section 2.2. Based on DDMI's review of the findings and other closure planning, if a scenario is selected as the preferred option, that scenario can be modelled with greater certainty and presented in a format that would be suitable to support a full closure plan update.

To achieve these objectives, model predictions were generated for the following modelling scenarios:

- Base Case Scenario – No PK deposited in the pits
- Development Scenario – PK deposited in the pits with 150 m fresh water cap

Three additional sensitivity scenarios were also evaluated to assess the effects of freshwater cap thickness and sizes of breaches in the dikes on the predicted pit lake water quality. Details of the sensitivity scenarios are provided in Section 2.3. This memorandum describes model development, simulations and results for the A418, A154 and A21 pit lakes.

2.0 METHODS

2.1 Model Platform

2.1.1 Consolidation Model

To account for the influence of PK settling and release of pore water on surface water quality, a conceptual consolidation model was developed to predict the pore water released to the pit lakes as a result of PK consolidation and associated settlement. In the consolidation model, solids component in the pits (i.e., deposited PK) was assumed to be a single layer from 20 m below the pit crest elevation for all the scenarios including PK (i.e., Development Case and Sensitivity scenarios; Section 2.3) to the bottom of the mined-out sub-level retreat. The consolidation curves estimated for the 20-m freshwater cap in each pit were applied to all the scenarios that included PK (Section 2.3).

2.1.2 Hydrodynamic Model

The A418, A154 and A21 models were developed using CE-QUAL-W2 (W2), which is a two dimensional (2-D), laterally averaged, hydrodynamic, and water quality model. The model is accessible within the public domain and is maintained and supported by the US Army Corps of Engineers Waterways Experiment Station.

The model simulates interactions of physical and chemical processes, including flow, thermal and substance mass loading regimes, meteorological forcing conditions, and lake-bottom interactions. The W2 model also includes a module to simulate ice-cover in the winter. The formation of a complete ice-cover prevents re-aeration, provides complete wind sheltering, and results in reduced thermal inputs via solar radiation. The model has established a well-recognized reputation as an effective and practical modelling tool for lake and reservoir hydrodynamics and water quality, and has been used extensively to simulate the potential performance of natural and constructed lakes, including mine pit lakes (Castendyk and Eary 2009; Castendyk et al. 2015; Vandenberg et al. 2015). The W2 model is in the public domain and has been used for similar studies in North West Territories (e.g., DDEC 2014; Vandenberg et al. 2015), as well as throughout North America and worldwide (Cole and Wells 2008).

The following constituents were included in the W2 hydrodynamic model: (1) TDS, (2) temperature, (3) a conservative, generic water quality constituent; and (4) a generic settleable water quality constituent. The generic water quality constituent (referred as tracer hereafter) was used to calculate the concentration of the all other water quality constituents. The generic settleable water quality constituent was included to evaluate fines resuspension associated with turbulent mixing of the lake.

The hydrodynamic parameters associated with the ice-module were maintained from the Jay Project (DDEC 2014) at the Ekati Mine, which was developed and calibrated for Lac de Sauvage for ice cover periods, ice thickness and annual evaporation. Given the geographical proximity between available ice-related observations and the project site, these data were determined to be suitable to use in A418, A154 and A21 pit lake models. Default model parameters were used for the thermal variables, with the following exceptions:

- The sediment temperature was set at a constant value of 5ºC.
- The maximum vertical eddy viscosity was set to 0.001 m^2/s.
- Albedo of ice was adjusted to 0.9 and water-ice heat exchange coefficient was adjusted to 15 $W/m^2/ºC$.

Initial conditions were set by assuming that the pit lake would be filled with Lac de Gras water.

2.1.3 Water Quality Model

A mass-balance approach was used to predict concentrations of major ions, nutrients, and metals in the A418, A154 and A21 pit lakes. In the modelling scenarios (Section 2.3) that included PK, a tracer concentration of 1 mg/L was defined for pore water being released to the bottom of the Pit Lake as a result of PK consolidation. The tracer was initialized to zero everywhere else in the model domain. This initial tracer distribution was set to understand mixing processes in the lake and to estimate the resulting water quality in the pit lakes resulting from PK pore water release to the bottom of the pit lakes. The tracer was assumed to behave conservatively in the water column, which means that it would not undergo chemical reactions (i.e., precipitation) or physical processes (i.e., settling). Water quality constituent concentrations were predicted using the following equation:

$$C_{Pit} = C_{Tracer} * (C_{PK} - C_{LdG}) + C_{LdG} \qquad \text{Equation 1}$$

where C_{Pit} is the constituent concentration in the pit lake at any time at any location of interest (mg/L); C_{Tracer} is the concentration of the tracer in the pit lake as a result of pore water release at any time at any location of interest (mg/L); C_{PK} is concentration of constituent in pore water; C_{LdG} is concentration of the constituent in Lac de Gras. Note that this equation is the same as the formula for dilution of a single effluent into a waterbody, which is essentially the case in this simplified model – the effluent is the PK pore water being released to the overlying water column that was filled with Lac de Gras water.

The generic settleable constituent was initialized with a value of 1 mg/L everywhere in the domain. The initial distribution of the settleable tracer was set to determine if full settlement of fine material would be likely over time.

The modelled constituents included in the water quality model were those most relevant to water quality and aquatic health in Lac de Gras (Table 1).

The site-specific surface water quality benchmarks, as defined in DDMI's Aquatic Effects Monitoring Program (AEMP) Version 5.0 (DDMI 2017a), were used to screen the modelled post-closure water quality projections for the pit lakes (Table 1).

2.2 Model Inputs

Inputs to the A418, A154 and A21 pit lake models include geometric, meteorological, hydrologic, and water quality data, as described in the following sections. Because the modelling is being completed for planning purposes, minor inflows such as groundwater were not included at this stage.

2.2.1 Geometric Data

A critical aspect of any hydrodynamic model involves reasonably accurate representation of the shape, depth, and volume of the waterbodies. Model segmentation is the discretization of a physical domain into small grid cells that can be used by the model to iteratively calculate state variables at all locations within the lake and to propagate momentum and mass among cells at each time step. For each pit lake, a 2-D grid was developed based on a volume-area-elevation curve to represent the A418, A154 and A21 pit lakes. Each model domain also included a small portion of Lac de Gras to account for circulation of water to and from the lake. The grids are illustrated in plan view in Figure 1.

The grid spacing for segments within each lake ranged as follows:

- **A418 Pit Lake**: between 200 and 300 metres [m] along the flow path, and vertical resolution from 1 m near the surface, to 5 m near the pit bottom. Width of segments covering the pit lake ranged between 520 and 700 m. The grid included a total of 7 active segments, and 105 active vertical layers.
- **A154 Pit Lake:** between 300 and 400 m along the flow path, and vertical resolution from 1 m near the surface to 5 m near the pit bottom. Width of segments covering the pit lake ranged between 500 and 950 m. The grid included a total of 14 active segments, and 130 active vertical layers.
- **A21 Pit Lake**: about 200 m along the flow path, and vertical resolution from 1 m near the surface to 5 m near the pit bottom. Width of segments covering the pit lake ranged between 430 and 715 m. The grid included a total of 9 active segments, and 115 active vertical layers.

These model grids were used for all simulations, although the simulations that included PK deposition (Section 2.3) only used the upper cells above the PK-water interface.

The models were oriented such that they extended laterally along the longest axis of the pit, and flow exchange with Lac de Gras occurred through the segments representing the breaches in the dikes.

The total volume of the A418, A154 and A21 Pit, as represented in the W2 model for the Base Case Scenario, was approximately 30.5, 60.1 and 23.3 million m^3, respectively.

The breach designs for A418, A21 and A154 pits were extracted from Golder (2008), Golder (2017) and Golder (2003), respectively.

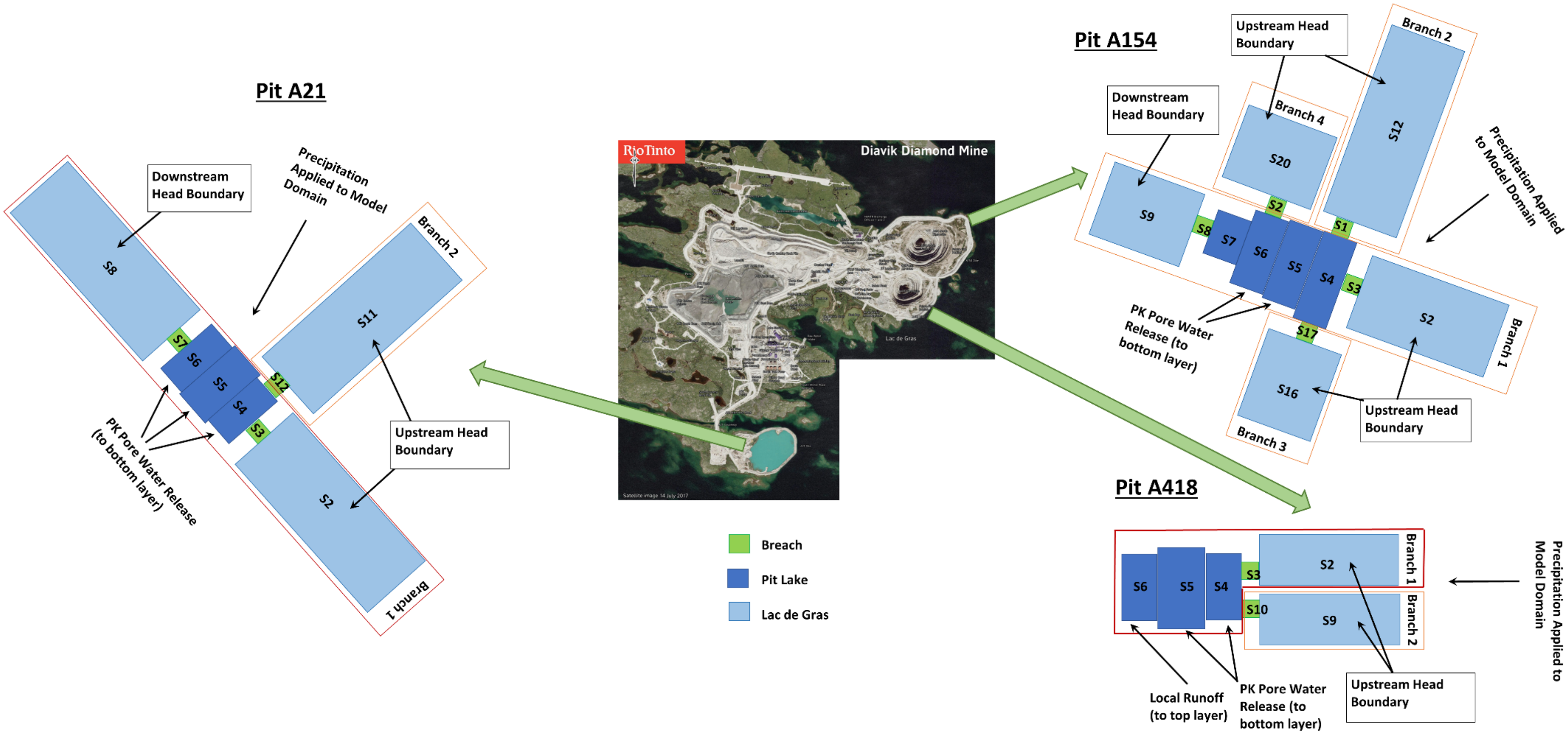

Figure 1: Model Segmentation and Inputs for A418, A154 and A21 Pit Lakes – Plan View

2.2.2 Meteorological Data

Meteorological inputs are key drivers of lake circulation and thermal dynamics, which could affect the mass balance of constituents within the lake. The following meteorological input data were required for this hydrodynamic model: air temperature, dew point temperature, wind direction, wind speed and solar radiation.

An hourly time-series was constructed for each of these inputs during the modelling time period (i.e., 2028 to 2128) based on observed data from on-site meteorological stations between 2014 and 2017 and data collected at nearby meteorological stations between 1999 and 2013. Both data sets have measured data for rainfall, temperature, relative humidity, solar radiation, wind speed, and direction. Where data gaps existed, those were either filled by interpolation (small gaps) or by the previous year's value for the specific hour (larger gaps).

An hourly time series of atmospheric pressure was constructed from the Environment Canada Yellowknife A Climatologic Station (ID 2204101). Hourly time series of wet bulb temperatures were calculated based on recorded air temperature, relative humidity, and atmospheric pressure.

2.2.3 Hydrologic Inputs

Hydrologic inputs to the A418, A154 and A21 Pit lakes were: (1) inflow from Lac de Gras into the pit lakes through the breaches in the dike; (2) direct precipitation on the lake; (3) local runoff from the mine area (included in the A418 Pit Lake model only) and (4) volume of pore water released to the pit lake as a result of PK consolidation (in scenarios which include PK). The outflows in the model were the outflow to Lac de Gras through the dike breaches and evaporation. Groundwater inflow into the filled pit and local runoff from the mine area was assumed to be negligible at this stage of modelling. Inflows and outflows included in the model are presented in Figure 1.

Inflow from Lac de Gras to the pits and outflow from the pits to the Lac de Gras were calculated by the model based on the difference in head boundary between observed water level elevations at the Lac de Gras and predicted water level elevations in the pit lakes at each time step. Observed water level elevations in Lac de Gras (2008 to 2013) were applied an as upstream head boundary condition in the models to the segments representing Lac de Gras.

Inflow associated with direct precipitation was evenly distributed over the entire domain as a function of the surficial area.

Inflow associated with pore water released by consolidation of PK to the pit lakes was assumed to enter the pits uniformly over the bottom layer and varying with time. Fine PK is predicted to settle in the pits over time, thus the volume liberated from PK consolidation and its corresponding chemical constituent mass were incorporated into the lowest layer in the overlying water body. This inflow was applied to all the deep segments within the pit lakes. The consolidation model is based on a one-dimensional section, so the fine PK settling is assumed to be distributed evenly horizontally across the pit. In reality, maximum settling would occur in the centre of the pit, resulting in a semi-elliptical surface with maximum fine PK elevations along the walls of the pit. Such non-uniform consolidation would lead to a more narrow, deeper lake bed, and consequently stronger stratification than what is predicted by the 2-D model.

The consolidation curves applied in the pit lake models are presented in Figure 2. The consolidation model for A418 Pit predicts an approximated inflow from PK pore water ranging from 0.0686 m^3/s in Year 1 to 0.0001 m^3/s in Year 200. The consolidation model predictions for inflow from PK pore water for A154 Pit ranges from 0.1282 m^3/s in Year 1 to 0.0003 m^3/s in Year 200. The consolidation curve developed for the A154 was applied to the A21 Pit Lake model as well.

A constructed time-series, with temporal resolution that varied according to the availability of information for each source, formed the basis of the water balance for the hydrodynamic model (Golder 2016). Daily information was available for precipitation. Modelled PK inflow, obtained from the consolidation model, provided annual estimates.

2.2.4 Water Quality Inputs

2.2.4.1 Lac de Gras

Water quality was represented by the average constituent concentration from water quality monitoring results for Lac de Gras collected between 2016 and 2018 (DDMI 2017a and unpublished data for 2018 provided by DDMI), during the open-water season, from the sampling locations near the pits: MF3-1 and MF3-2 representing quality of inflows from Lac de Gras to the A418 and A154 pit lakes and MF3-3 and MF3-4 representing quality of inflows from Lac de Gras to the A21 Pit Lake (Table 1).

Observed water temperature data was not available for Lac de Gras, therefore, temperature time-series was developed using data from Snap Lake dated from 2008 and 2012 (De Beers 2013). Temperature ranges from 0.5°C in the winter to 16.6°C in the summer.

2.2.4.2 PK Pore Water (Supernatant Water)

Water quality of the pore water (Table 1) was represented by the average constituent concentration from water quality monitoring results collected in beach pore water samples provided by DDMI (DDMI 2017b, pers. comm.).

The average concentrations applied as input chemistry are conservative because, for the non-detect values the detection limit was used in the calculations. This specifically applies to phosphorus concentrations with high detection limits analysed by ICP-MS method, with majority of samples being below detection limit. The lack of modelled settling or biological uptake of phosphorus results in highly conservative predictions for this constituent.

The samples provided did not include alkalinity or fluoride, thus TDS concentration was approximated based on the following ions: calcium, magnesium, sodium, potassium, sulphate, chloride, silica and nitrate.

Table 1: Lac de Gras and PK Pore Water Input Chemistry and Surface Water Quality Benchmarks

Parameter	Unit	Surface Water Quality Benchmark [(a)]	Average Observed PK Pore Water Concentrations [(f)]	Average Observed Concentrations at AEMP Sites: MF3-1 & MF3-2 [(g)]	Range of Observed Concentrations a AEMP Sites: MF3-1 and MF3-2 [(g)]	Average Observed Concentrations at AEMP Sites: MF3-3 & MF3-4 [(g)]	Range of Observed Concentrations a AEMP Sites: MF3-3 and MF3-4 [(g)]
Major Ions							
Calcium	mg/L	-	209	2.6	1.46 - 6.36	1.6	0.005 - 2.38
Chloride	mg/L	120	149	3.5	1.9 - 5.2	2.2	0.25 - 3
Fluoride	mg/L	0.12	0.14	0.034	0.029 - 0.038	0.031	0.005 - 0.04
Magnesium	mg/L	-	412	1.2	0.901 - 1.66	1.0	0.0025 - 1.48
Potassium	mg/L	-	166	1.1	0.757 - 1.48	0.88	0.005 - 1.28
Sodium	mg/L	52 [(b)]	155	3.1	1.44 - 8.32	1.7	0.005 - 2.58
Sulfate	mg/L	100 [(c)]	2315	3.9	2.19 - 5.47	3.3	0.052 - 5.81
Nutrients							
Nitrite as nitrogen	mg/L	0.06	0.42	0.00078	0.0005 - 0.003	0.00055	0.0005 - 0.0015
Nitrate as nitrogen	mg/L	3	96	0.055	0.001 - 0.105	0.015	0.001 - 0.0495
Ortho Phosphate	mg/L	-	0.06	0.0016	0.0005 - 0.0051	0.00078	0.0005 - 0.0016
Phosphorus	mg/L	-	0.065	0.0036	0.0024 - 0.0055	0.0032	0.0022 - 0.0051
Trace Elements							
Aluminum	µg/L	87 [(b)]	153	6.3	4.46 - 9.74	3.3	0.41 - 5.72
Antimony	µg/L	33 [(b)]	5.4	0.033	0.01 - 0.064	0.022	0.01 - 0.044
Arsenic	µg/L	5	3.0	0.28	0.202 - 0.401	0.23	0.01 - 0.332
Barium	µg/L	1000 [(c)]	449	3.5	2.02 - 8.17	2.3	0.01 - 3.27
Beryllium	µg/L	-	0.27	0.005	0.005 - 0.005	0.005	0.005 - 0.005
Boron	µg/L	1500	56	2.9	2.5 - 6.1	2.5	2.5 - 2.5
Cadmium	µg/L	0.1 [(d)]	0.92	0.0028	0.0025 - 0.0054	0.0025	0.0025 - 0.0025
Cobalt	µg/L	-	5.6	0.017	0.011 - 0.034	0.018	0.0025 - 0.034
Copper	µg/L	2	8.6	0.59	0.5 - 0.661	0.61	0.025 - 0.857

Parameter	Unit	Surface Water Quality Benchmark [(a)]	Average Observed PK Pore Water Concentrations [(f)]	Average Observed Concentrations at AEMP Sites: MF3-1 & MF3-2 [(g)]	Range of Observed Concentrations a AEMP Sites: MF3-1 and MF3-2 [(g)]	Average Observed Concentrations at AEMP Sites: MF3-3 & MF3-4 [(g)]	Range of Observed Concentrations a AEMP Sites: MF3-3 and MF3-4 [(g)]
Iron	µg/L	300	234	4.1	1.2 - 9.3	3.5	0.5 - 9.3
Lead	µg/L	1	0.88	0.0033	0.0025 - 0.007	0.0043	0.0025 - 0.017
Lithium	µg/L	-	3.8	2.0	1.56 - 3.59	1.7	0.25 - 2.46
Manganese	µg/L	-	82	3.3	1.16 - 7.74	1.9	0.025 - 3.99
Molybdenum	µg/L	73	504	0.88	0.265 - 2.79	0.28	0.025 - 0.442
Nickel	µg/L	25	189	0.77	0.642 - 0.886	0.92	0.01 - 1.32
Selenium	µg/L	1	18	0.02	0.02 - 0.02	0.02	0.02 - 0.02
Silicon	µg/L	2100 [(b)]	2605	186	25 - 885	28	25 - 52
Silver	µg/L	0.1	0.41	0.0025	0.0025 - 0.0025	0.0025	0.0025 - 0.0025
Strontium	µg/L	30000 [(e)]	6701	35	14.4 - 106	15.6	0.025 - 23
Sulfur	µg/L	-	782981	1571	1030 - 3020	1268	50 - 1740
Thallium	µg/L	0.8	0.65	0.0011	0.001 - 0.002	0.0012	0.001 - 0.0021
Tin	µg/L	73 [(b)]	7.3	0.011	0.005 - 0.055	0.026	0.005 - 0.088
Titanium	µg/L	-	1.8	0.51	0.25 - 2.34	0.28	0.25 - 0.71
Uranium	µg/L	15	1.1	0.12	0.092 - 0.157	0.096	0.001 - 0.206
Vanadium	µg/L	-	1.9	0.1	0.025 - 0.289	0.052	0.025 - 0.18
Zinc	µg/L	30	348	0.21	0.11 - 0.38	0.36	0.05 - 1.03

- = benchmark not available.
a) AEMP Design Plan Version 5.0 (DDMI 2017a); Table 5.3-1.
b) See AEMP Design Plan Version 5.0, Appendix B for description.
c) BCMOE (2013).
d) See Appendix IV.1 in DDMI (2007) and BCMOE (2001) for description.
e) Based on results from HydroQual (2009) and Pacholski (2009). See text for more information.
f) DDMI (2017b). Personal Communication.
g) DDMI (2017a).

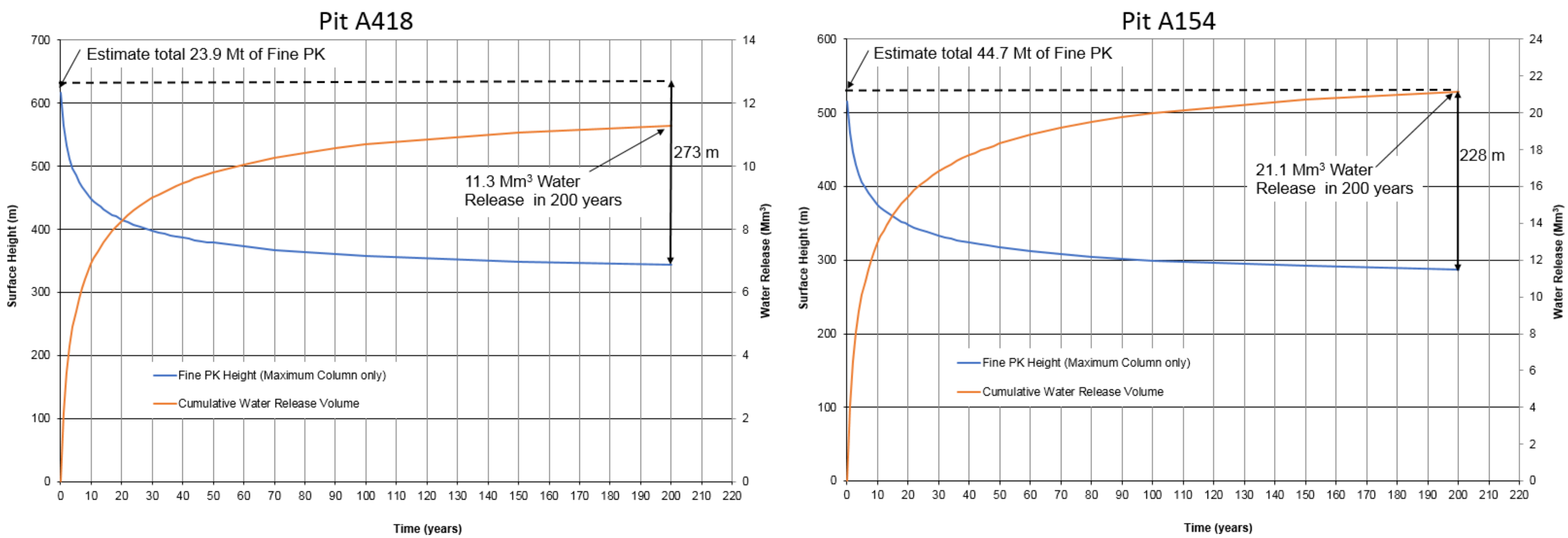

Figure 2: Estimated Pit Post Closure PK Settlement and Water Release

2.3 Model Scenarios

A key objective of the hydrodynamic model was to determine whether the A418, A154 and A21 pit lakes will turn over and bring soluble constituents to surface, or remain stratified and isolate mine-influenced water following the placement of PK in the pit and rapid filling of the pit water column. All simulations assumed the pits to be filled at the start of the simulation and extended for a period of 100 years. The selected modelling scenarios are described as follows:

- **Base Case Scenario**: No PK; represents the reference scenario to assess if, given the pit lake geometry, bathymetry and atmospheric conditions, the resulting pit lake would be meromictic. Sediment temperature was assumed as 5°C.
- **Development Case Scenario**: PK with 150 m fresh water cap - Pit lake geometry included only the top 150 m of the lake overlying deposited PK. Inflow corresponding to the volume of pore water released from the PK into the pit lake as a function of expected consolidation was included as a point source at the bottom of segments. Sediment and PK inflow temperatures were assumed as 5°C.

Three additional sensitivity scenarios were assessed to understand the depth at which the lake would begin to stratify, and whether mixing is sensitive to size of breaches in the dike.

- **Sensitivity Scenario 1**: PK with a 50 m freshwater cap above the PK.
- **Sensitivity Scenario 2**: PK with a 20 m freshwater cap above the PK.
- **Sensitivity Scenario 3**: increasing size of the two breaches in the dikes (only assessed at A418 pit lake with 20 m freshwater cap above PK).

In Base and Development cases and sensitivity scenarios 1 and 2, breaches were 30 m wide, 60 m long and 2 m deep. In Sensitivity Scenario 3 (only A418 Pit Lake model) the breaches were 60 m wide, 60 m long and 2 m deep.

2.4 Quality Assurance

Quality assurance procedures were implemented to check the following items against the objectives of the model:

- **Model framework** — Other modelling software packages were considered, and the W2 (a 2-D model) was selected as it provides the shortest simulation times while producing reliable vertical mixing predictions.
- **Model linkages** — Model linkages considered for this study include the flows from the GoldSim water balance (Golder 2016) modified to represent closure conditions, and predicted PK pore water discharge to the pit (as a function of consolidation) that was estimated using a one-dimensional tailings consolidation model.

- **Data used for model inputs** — The lake volume calculated based on the model grid and bathymetry were plotted to confirm the lake geometry was accurately represented (within 1% agreement at each 1-m layer increment and cumulatively). The meteorological data were plotted and reviewed visually to confirm there were no outliers or anomalies in the dataset.
- **Model set-up** — A grid was set up for the lake's physical domain using the bathymetry file. The model input files were loaded into the model to define boundary conditions, and model parameters were set up.
- **Calibration** — Because the pit lake is not yet constructed, model calibration is not possible at this time. However, rates and constants were applied from previous model calibrations in the region. The approach used is commensurate with the model set up for the Jay Project (DDEC 2014) at the Ekati Mine and the pit lakes at the Gahcho Kue Project (DeBeers 2012; Vandenberg et al. 2015). The parameter values in the ice module were taken from calibrated hydrodynamic models developed nearby, where water temperature data measured were available. The objective of the calibration was to match simulated and observed timing for ice formation/melting on the lake. The calibrated model predicts that ice starts forming on the lake around mid-October and melts by mid- to late June, in agreement with available measured proxy data. The predicted time for ice melting in the pit lakes leads to an open-water season which is longer than that observed at Lac de Gras, where ice melt generally occurs in mid-July. The extended open water season represents a more conservative approach, as the exposure to wind-driven forces over the pit lakes surface is extended over time.
- **Review** — Peer reviews and senior reviews of the model were performed at various stages throughout its development, which was an iterative process whereby issues were identified and addressed.

3.0 MODEL LIMITATIONS AND UNCERTAINTY

Modelling requires the use of many assumptions related to determining the physical and chemical characteristics of a system. Predictions are based on several inputs, all of which have inherent uncertainty. The modelling presented herein was intended to answer basic questions about lake hydrodynamics, and the following simplifying assumptions were employed:

- **Average water chemistry**: It is assumed that the water chemistry data used as inputs to the models are representative of their respective sources and will continue to be so in the future. Inflows to the model were characterized using representative water quality, estimated based on available measured, modelled or proxy data.
- **No groundwater inflows**: Under the assumption of a refilled pit lake, the estimated groundwater inflow is assumed to be negligible in terms of both volume and mass, in comparison to the flow exchange with Lac de Gras.
- **No local runoff from mine area**: Because the modelling is being completed for planning purposes, minor inflows such as local runoff from mine area was not included at this stage in the A154 and A21 Pit Lake models.
- **No wall rock runoff**: the mass load from flushing of wall rock was estimated to be negligible in comparison to the other inflows to the pit and was not included in the model.

- **Transient filling**: Initial conditions assumed the pit lake to be full up to Lac de Gras water elevation. As the pit lakes will be rapidly filled, the model was not used to simulate the transient period corresponding to the filling process and was assumed to be fully mixed at the start of the simulation.
- **2D modelling approach**: The governing equations in W2 are laterally averaged. Lateral averaging assumes that lateral variations in velocities, temperatures, and constituents are negligible. This limitation is not expected to materially affect pit lake simulations, which are primarily concerned with one-dimensional (vertical) water stratification.
- **Salt exclusion**: Although W2 can model formation of ice cover, it does not include salt exclusion. Salt exclusion is expected to be minimal in this system, which has low TDS in surface waters.
- **Fully mixed during filling period**: Initial concentration in the pit lake was estimated under the assumption that water from Lac de Gras would fill the pit lake from the top of the PK (or bottom of the pit if no PK is considered) to the water surface.
- **Static bathymetry**: Simulations including the PK were assumed to be static, where the bathymetry was not changing as the consolidation process advances. As a result, the PK pore water inflow (assumed to occur at the bottom cells) would force the water to move up overflowing on surface to Lac de Gras. In reality, as the consolidation process advances, there is available volume at the bottom of the pit, able to accommodate the additional volume. The assumption of static bathymetry overestimates the mixing potential of the pit lake and TDS concentration along the vertical column because it does not account for narrow, deepening lake beds.
- **Rates and coefficients**: Because the lake does not exist, and calibration is not yet possible, default rates and coefficients were applied throughout the model, except as listed in Section 2.4.
- **PK Consolidation**: is conceptual and based on estimates of PK material properties. The PK consolidation curves developed for 20 m freshwater cap was applied to 150 m, and 50 m freshwater caps. Consolidation curve estimated for A154 pit lake (20 m freshwater cap) was applied to A21 for all scenarios including PK.

With the limitations noted above, the results from the modelling scenarios and sensitivity cases are considered to represent the mixing conditions in the A418, A154 and A21 pit lakes under the modelling assumptions described in Section 2.0 and to satisfy the objectives listed in Section 1.0.

4.0 MODEL RESULTS

4.1 Hydrodynamic Results

The following sections describes the predicted mixing behaviour for A418, A154 and A21 pit lakes.

4.1.1 A418 Pit Lake

Temperature and TDS predicted vertical profiles are presented in Figures 3 and 4, respectively, for the modelled scenarios. Vertical profiles are graphed at selected representative dates in Year 100 of the simulation period (post closure). The dates shown in Figures 3 and 4 were selected to show under ice (15-April), early summer (01-July), late summer (15-August) and fall (15-October).

Predicted vertical temperature profiles show similar seasonal and spatial patterns in the top 20-m of water for all modelled scenarios (Figure 3). The thermocline is located at approximately 5 to 15 m below surface, depending on the season. The difference among scenarios relates only to water column depth, with uniform temperatures below the seasonal thermocline.

The TDS concentrations for the Base Case, sensitivity scenarios 2 and 3 are predicted to stay relatively constant along the vertical profile, indicating a lack of permanent stratification (Figure 4). For sensitivity scenarios 2 (20-m freshwater cap) and 3 (20-m freshwater cap and change in breach size), TDS concentrations are predicted to be similar to the Base Case Scenario because of a high volume of exchange with lake water by Year 100 post-closure.

Predicted TDS vertical profiles for the Development Case (150 m freshwater cap) and Sensitivity Scenario 1 (50 m freshwater cap) show permanent stratification along the water column created by the high TDS concentrations associated with the inflow of PK pore water at the bottom of the water column.

A time-depth profile (contour plot) of TDS and tracer in the deepest section of the A418 Pit Lake during the simulation period (100 years) are presented in Figures 5 and 6. Concentrations in the contour plots are depicted by discrete contour intervals, and concentrations in each interval are represented with an identical colour. Figure 6 does not include a graph for Base Case because there is no PK in the Pit Lake and thus no tracer from pore water release. These graphs (Figures 5 and 6) show that the A418 Pit Lake is predicted to:

- remain fully mixed in the Base Case Scenario
- permanently stratify in the Development Case and Sensitivity Scenario 1
- stratify for about 25 years and mixes vertically thereafter in the sensitivity scenarios 2 and 3

For the Development Case and Sensitivity Scenario 1, the contour plots show a reduced stability of the stratification over time (predicted TDS concentrations display diffusion over time, as seen in Figure 5).However, the diffusion is thought to be over-estimated in these simulations because they do not account for the dynamic settling of PK, which will lead to a substantially deeper and more narrow pool of water with elevated density, and both of these factors will increase the strength of stratification over the long term. Beyond these time scales, it is anticipated that a very small amount of this water will reach the surface through chemical diffusion and occasional wind mixing; however, both the conceptual and numerical models suggest that this amount will be very small compared to the exchange with lake water and will likely be unmeasurable. If such an exchange does occur, it will reduce the mass of constituents stored at the lake bottom over time.

The pattern observed for the pit lake with a 20-m freshwater cap (Sensitivity Scenario 2) is a result of continuous inflow of high TDS flow (PK pore water) to the bottom of the Pit Lake and low TDS flow (Lac de Gras) to the surface layers of the Pit Lake, with gradual breakdown of meromixis and full mixing of the lake which occurs 25 years post closure.

The TDS concentrations in the surface layers of the pit are predicted to remain below 30 mg/L, 120 mg/L and 300 mg/L over the simulation period (100 years post-closure) for Development Case, Sensitivity Scenario 1 and Sensitivity Scenario 2, respectively. At Year 100 post-closure TDS concentrations of surface layers for all modelled scenarios are predicted to be lower than 100 mg/L.

Predicted TDS and tracer concentrations for sensitivity scenarios 2 and 3 (Figures 5 and 6) show that the change in the breach size is not predicted to affect the mixing conditions in the Pit Lake, under the assumptions applied in Sensitivity Scenario 3.

Contour plots of settleable generic constituent concentrations for the Base Case and Sensitivity Scenario 2 (shallowest water cap) are presented in Figure 7. The results indicate that resuspension of fines would not occur following initial deposition (predicted concentrations of zero for this constituent everywhere in the pit lake over the simulation period). This finding is consistent with empirical data from another pit lake (Vandenberg and Litke 2017); in that case, tailings, process water and surface runoff were co-deposited and, even during co-deposition, settlement was rapid. Theoretical work by Lawrence et al. (1991) indicated that a 6-m water cap would be required to maintain solids settling in another pit lake with much larger fetch, and this work was recently verified through detailed field studies (Lawrence et al. 2016). Samad and Yanful (2005) suggested even shallower depths to minimize resuspension in tailings ponds.

Because this material is not predicted to resuspend in the 20-m deep pit lake, it would not be anticipated to resuspend in deeper lakes, so further modelling of fines resuspension is not necessary at this stage.

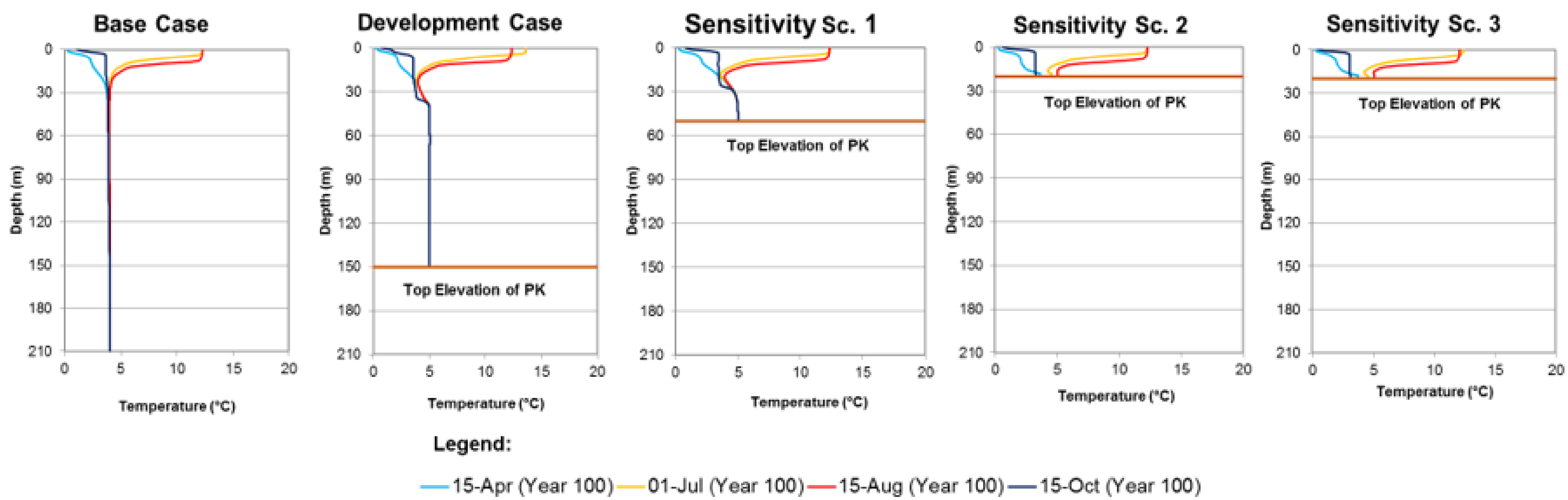

Figure 3: Predicted Vertical Profiles of Water Temperature in the A418 Pit Lake at Selected Dates of Year 100

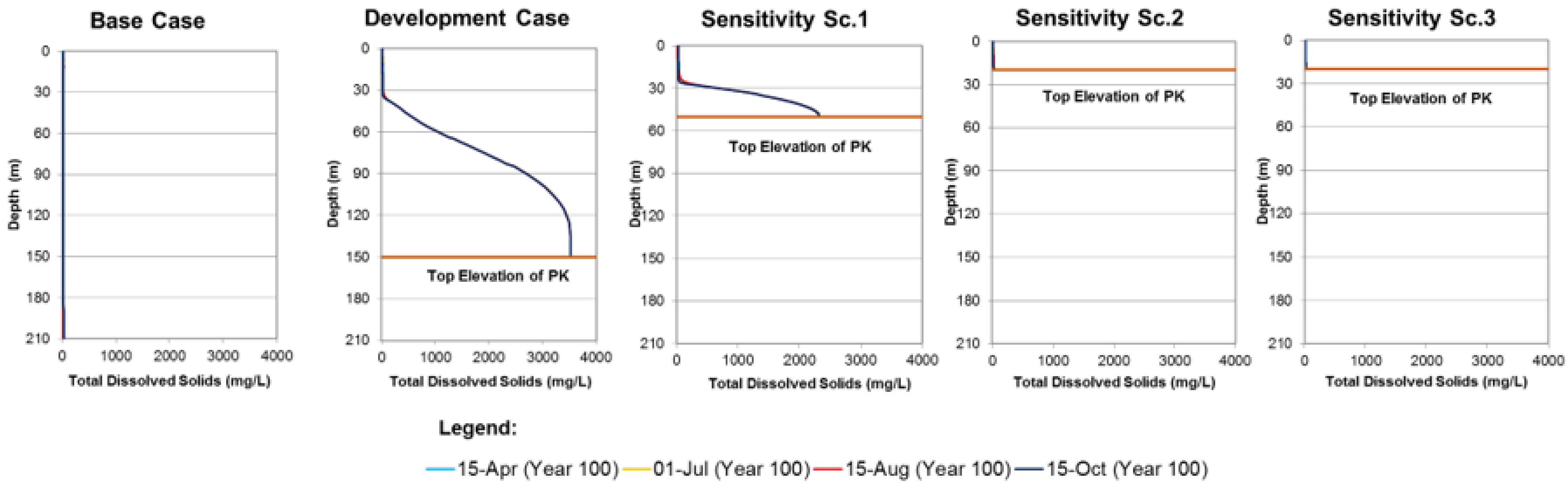

Figure 4: Predicted Vertical Profiles of Total Dissolved Solids Concentrations in the A418 Pit Lake at Selected Dates of Year 100

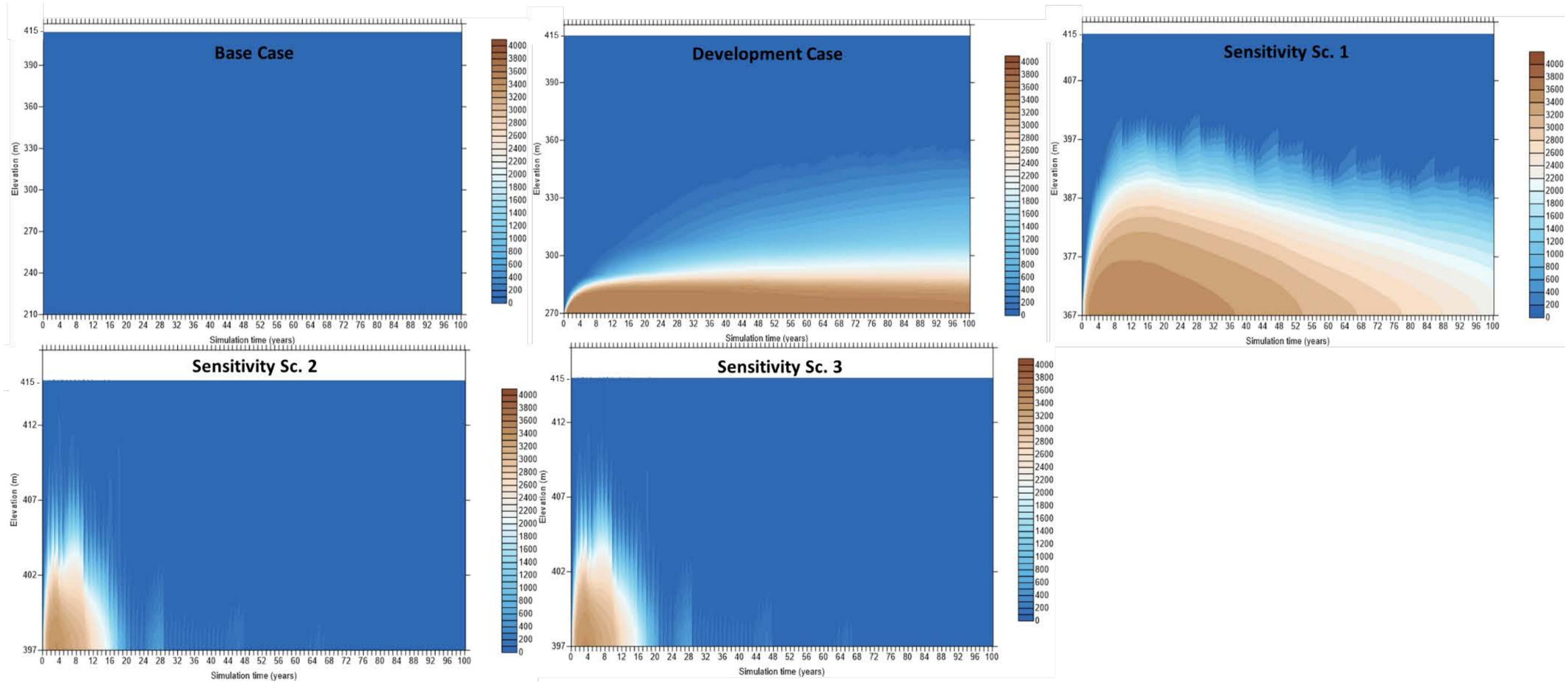

Figure 5: Contour Plots of Predicted Total Dissolved Solids Concentrations in the A418 Pit Lake over the Simulation Period (100 Years Post-Closure)

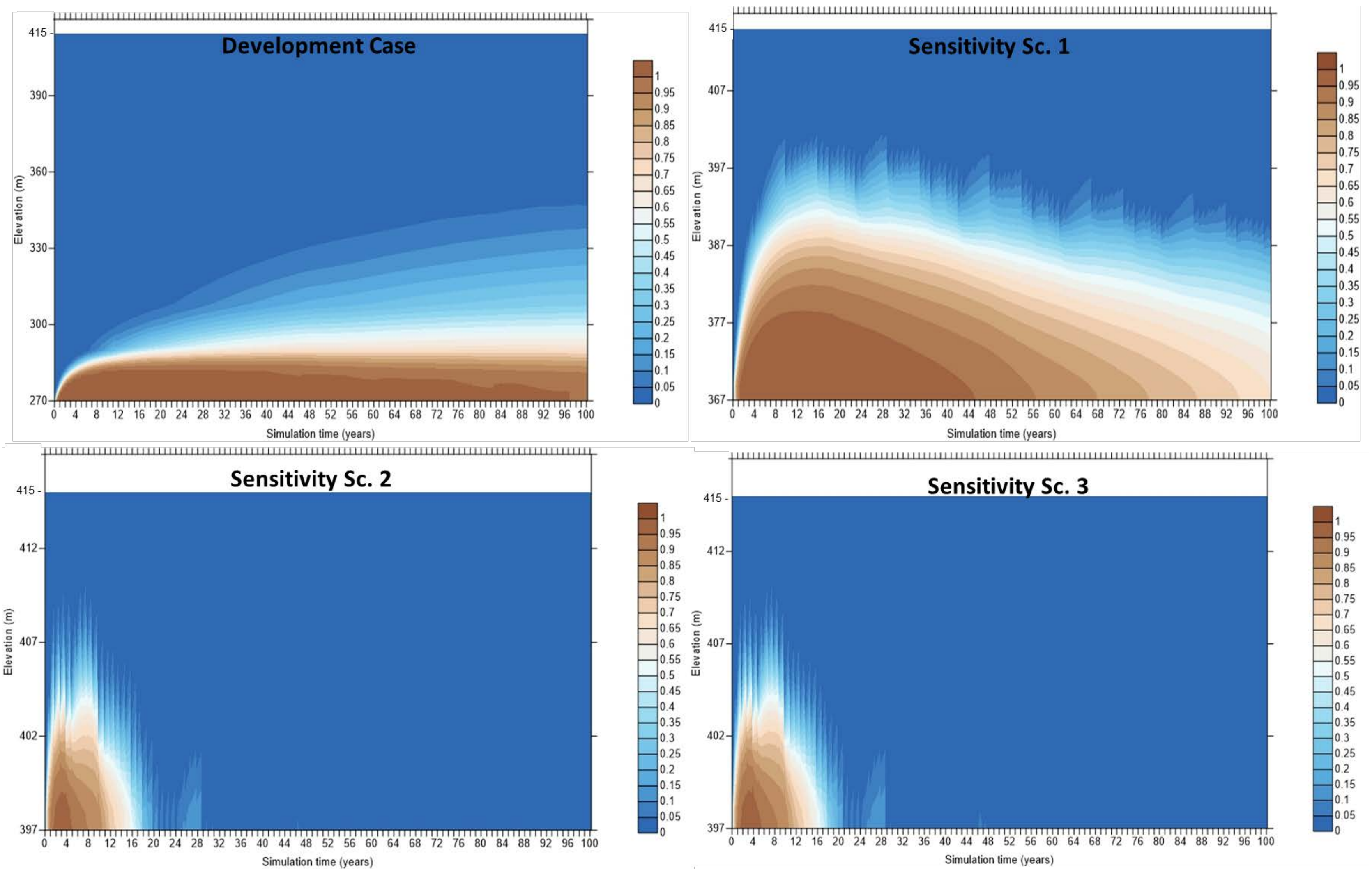

Figure 6: Contour Plots of Predicted Tracer Concentrations in the A418 Pit Lake over the Simulation Period (100 Years Post-Closure)

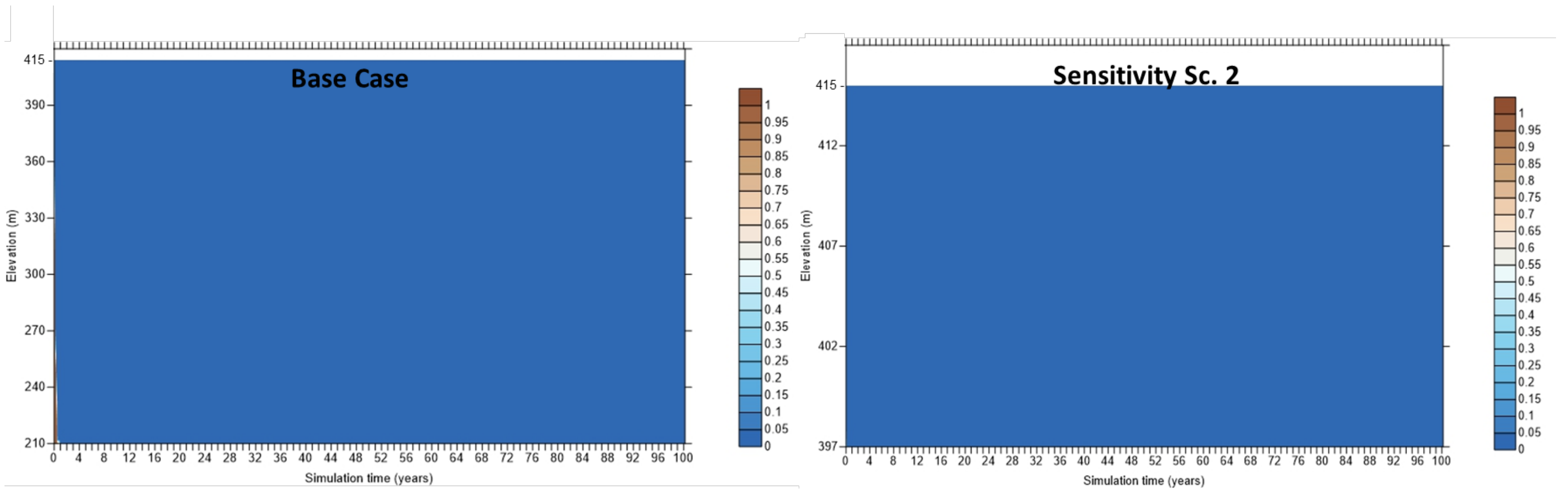

Figure 7: Contour Plots of Predicted Settleable Constituent in the A418 Pit Lake over the Simulation Period (100 Years Post-Closure)

4.1.2 A154 Pit Lake

Temperature and TDS predicted vertical profiles are presented in Figures 8 and 9, respectively, for the modelled scenarios. Similar to the A418 Pit Lake predicted vertical temperature profiles for the A154 Pit Lake show similar seasonal and spatial patterns in the top 20-m of water for all modelled scenarios (Figure 8). The difference among scenarios relates only to water column depth, with uniform temperatures below the seasonal thermocline.

The TDS concentrations for the Base Case, Sensitivity Scenarios 2 are predicted to stay relatively constant along the vertical profile, indicating a lack of permanent stratification (Figure 9) because of a high volume of exchange with lake water by Year 100 post-closure.

Predicted TDS vertical profiles for A154 Pit Lake for the Development Case (150-m freshwater cap) and Sensitivity Scenario 1 (50-m freshwater cap) show permanent stratification along the water column created by the high TDS concentrations associated with the inflow of PK pore water at the bottom of the water column.

Contour plots of TDS and tracer concentrations during the simulation period (Figures 10 and 11) show that the A154 Pit Lake is predicted to:

- remain fully mixed in the Base Case Scenario
- permanently stratify in the Development Case and Sensitivity Scenario 1
- stratify for about 14 years and mixes vertically thereafter in the Sensitivity Scenario 2

For the Development Case and Sensitivity Scenario 1, the contour plots show a reduced stability of the stratification over time (predicted TDS concentrations display scattering over time, as seen in Figure 10). Similar to the rationale provided for A418 pit lake, stability is expected to be stronger than indicated by these simulations over the long term.

Similar to the A418 Pit Lake, the pattern observed for the A154 Pit Lake with a 20-m freshwater cap (Sensitivity Scenario 2) is a result of continuous inflow of high TDS flow (PK pore water) to the bottom of the Pit Lake and low TDS flow (Lac de Gras) to the surface layers of the Pit Lake, with gradual breakdown of meromixis and full mixing of the lake which occurs 14 years post closure.

The TDS concentrations in the surface layers of the pit are predicted to remain below 20 mg/L, 40 mg/L and 100 mg/L over the simulation period (100 years post-closure) for Development Case, Sensitivity Scenario 1 and Sensitivity Scenario 2, respectively. At Year 100 post-closure TDS concentrations of surface layers for all modelled scenarios are predicted to be lower than 50 mg/L.

Contour plots of settleable generic constituent concentrations for the Base Case and Sensitivity Scenario 2 (shallowest water cap) are presented in Figure 12. The results indicate that resuspension of fines would not occur following initial deposition. As discussed in Section 4.1.1, this finding is consistent with empirical data from another pit lake (Vandenberg and Litke 2017).

Because this material is not predicted to resuspend in the 20-m deep pit lake, it would not be anticipated to resuspend in deeper lakes, so further modelling of fines resuspension is not necessary at this stage.

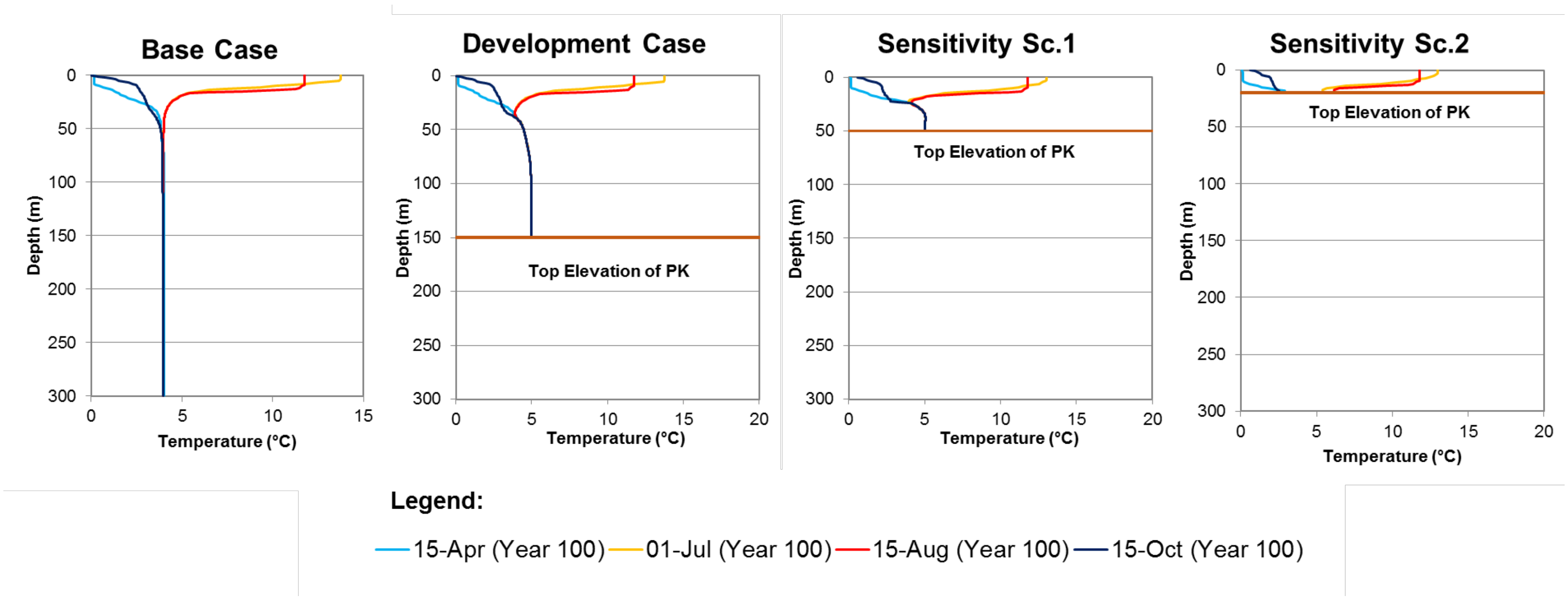

Figure 8: Predicted Vertical Profiles of Water Temperature in the A154 Pit Lake at Selected Dates of Year 100

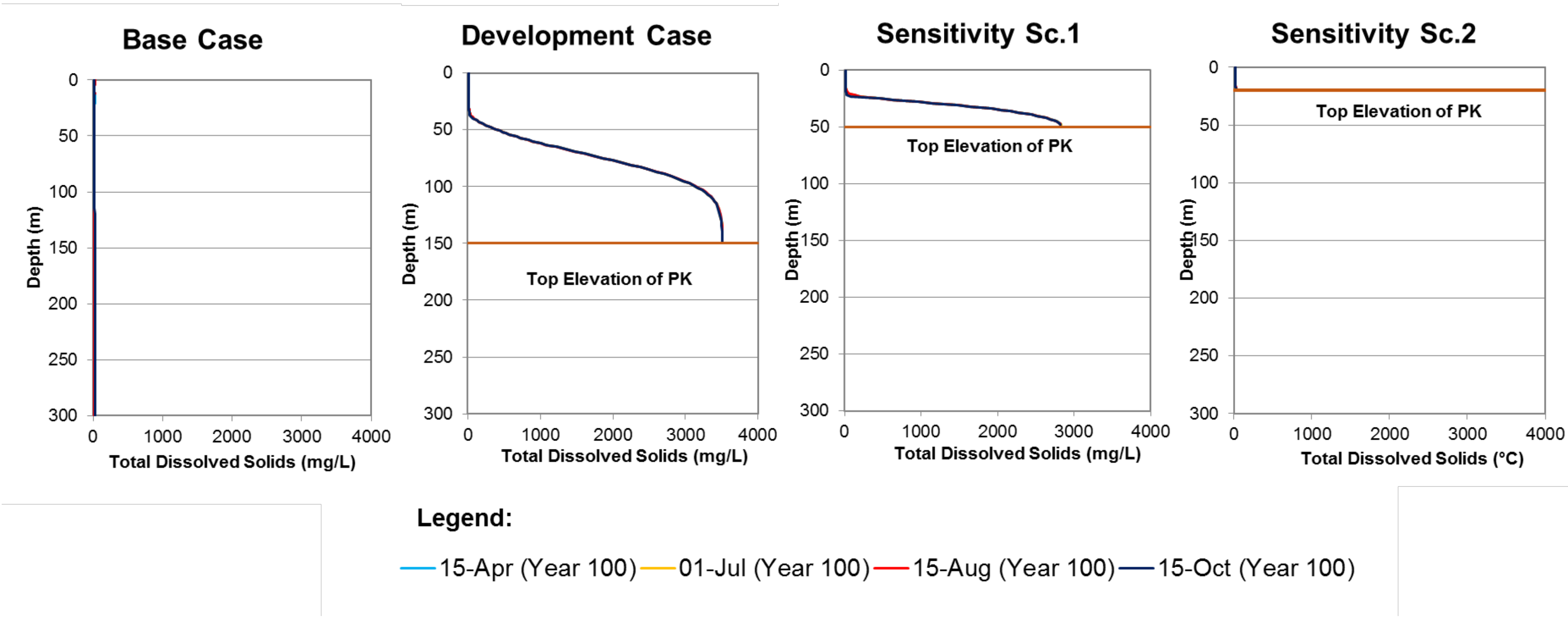

Figure 9: Predicted Vertical Profiles of Total Dissolved Solids Concentrations in the A154 Pit Lake at Selected Dates of Year 100

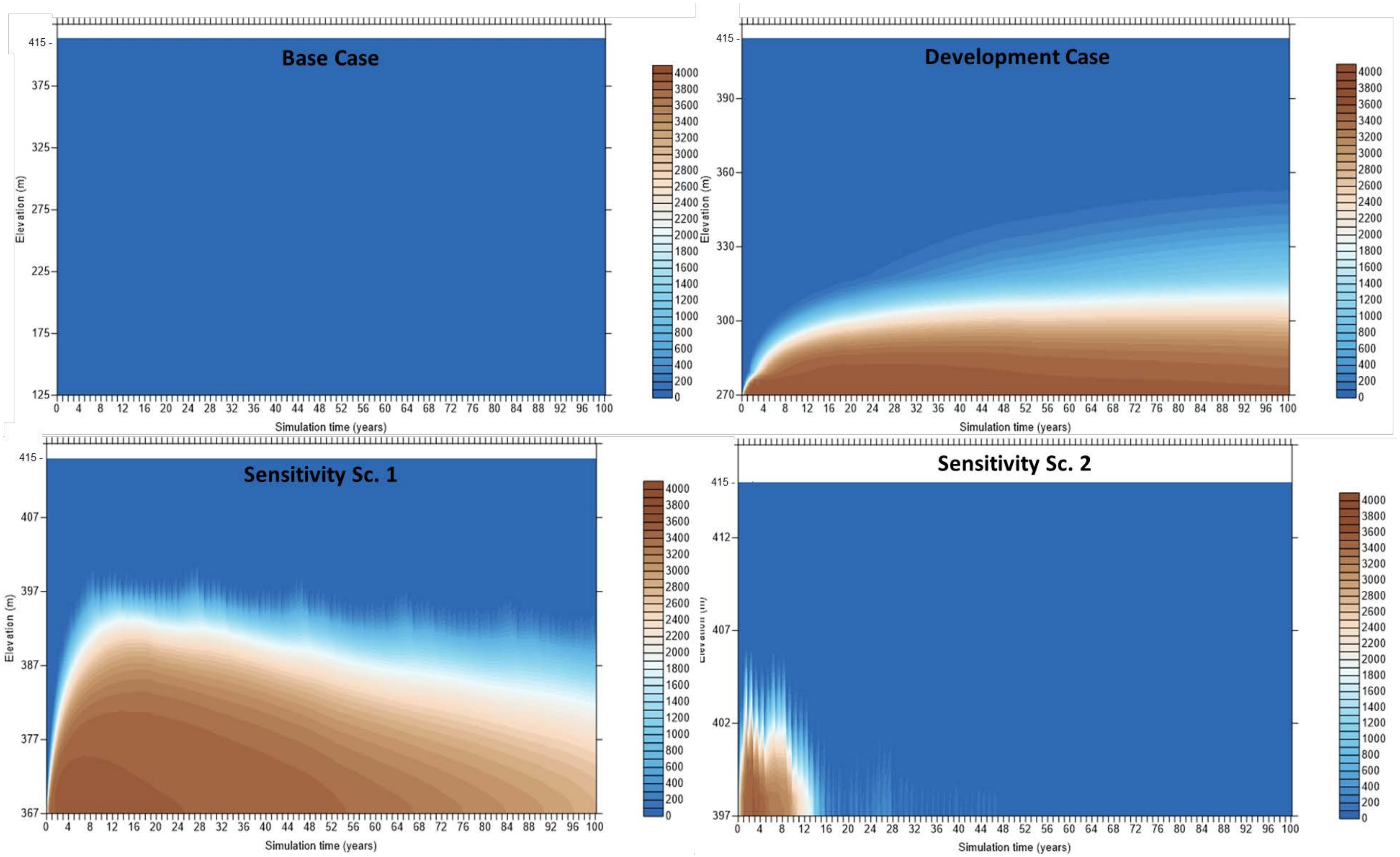

Figure 10: Contour Plots of Predicted Total Dissolved Solids Concentrations in the A154 Pit Lake over the Simulation Period (100 years Post-Closure)

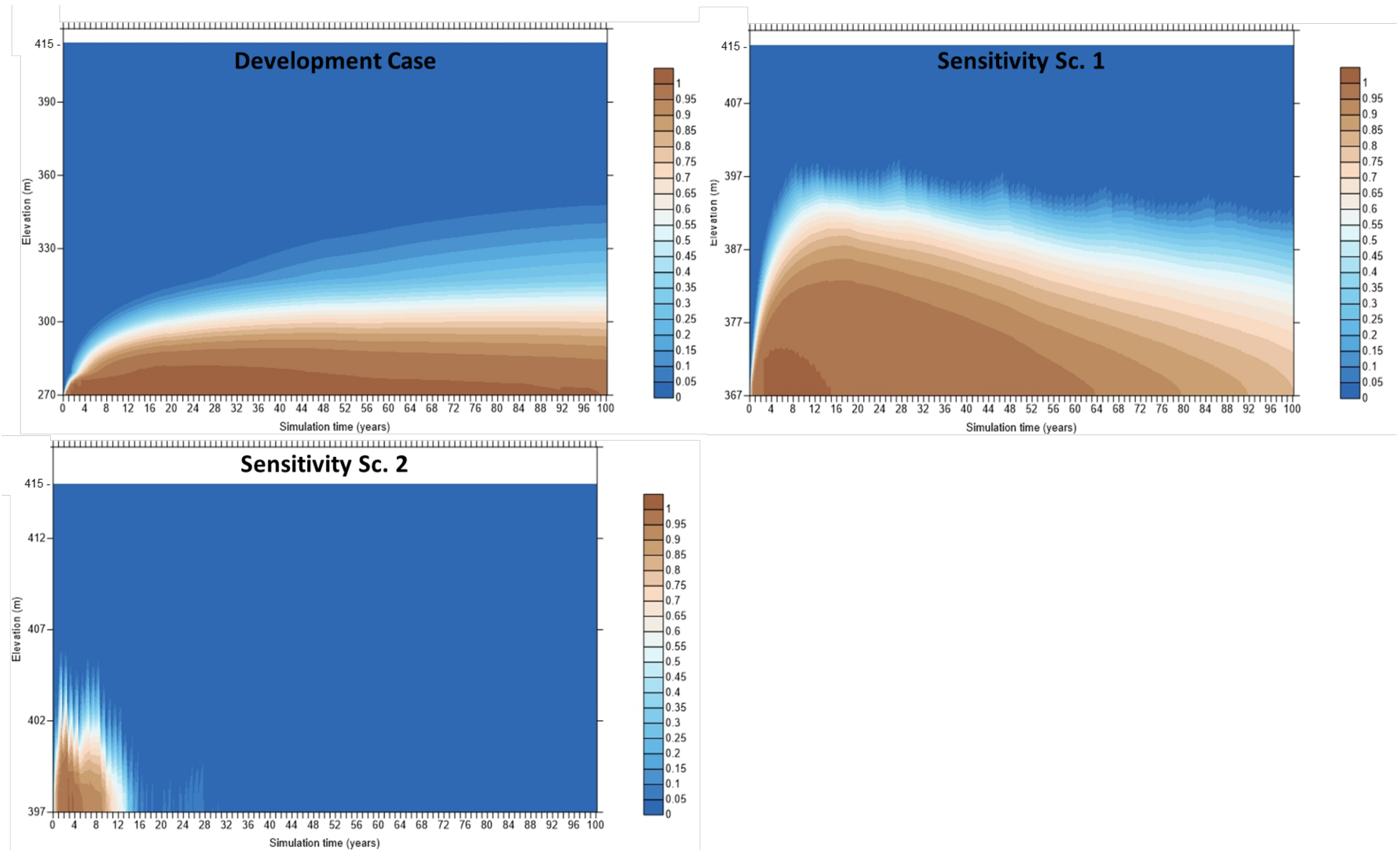

Figure 11: Contour Plots of Predicted Tracer Concentrations in the A154 Pit Lake over the Simulation Period (100 years Post-Closure)

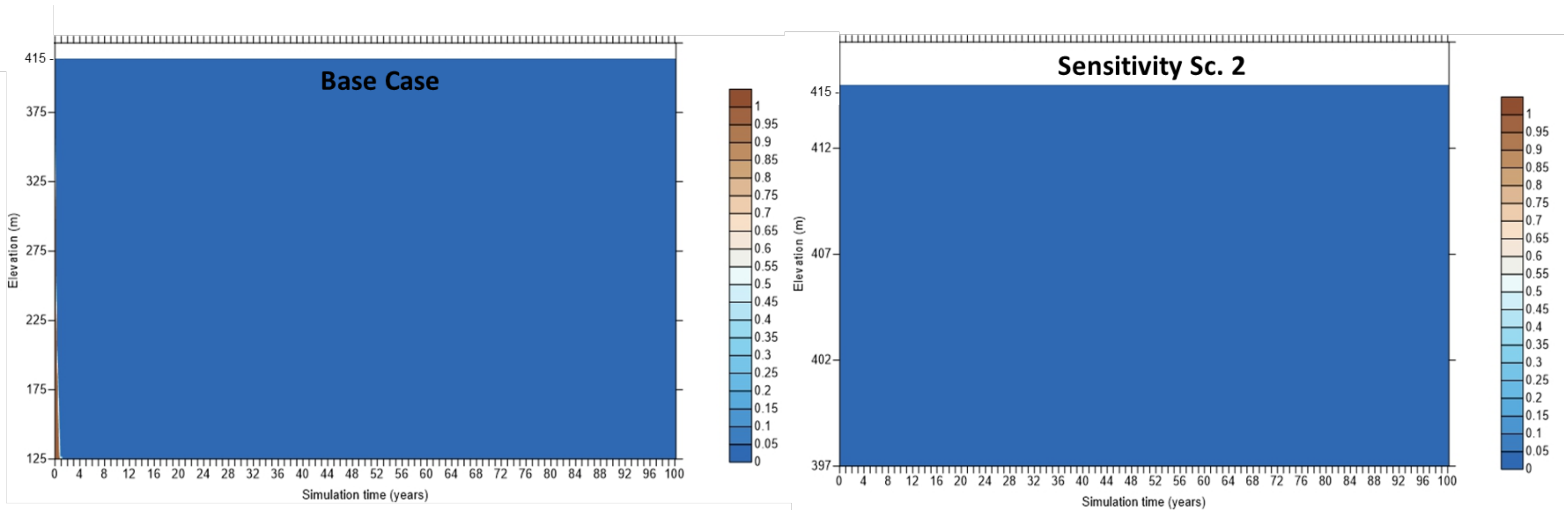

Figure 12: Contour Plots of Predicted Settleable Constituent in the A154 Pit Lake over the Simulation Period (100 years Post-Closure)

4.1.3 A21 Pit Lake

Temperature and TDS predicted vertical profiles are presented in Figures 13 and 14, respectively, for the modelled scenarios. Similar to the A418 and A154 pit lakes, predicted vertical temperature profiles for the A21 Pit Lake show similar seasonal and spatial patterns in the top 20-m of water for all modelled scenarios (Figure 13).

The TDS concentrations for the Base Case, Sensitivity Scenarios 2 are predicted to stay relatively constant along the vertical profile, indicating a lack of permanent stratification (Figure 14) because of a high volume of exchange with lake water by Year 100 post-closure.

Predicted TDS vertical profiles for the Development Case (150 m freshwater cap) and Sensitivity Scenario 1 (50 m freshwater cap) show permanent stratification along the water column created by the high TDS concentrations associated with the inflow of PK pore water at the bottom of the water column. These results are consistent with predictions made for A418 and A154 pit lakes.

Contour plots of TDS and tracer concentrations during the simulation period (Figures 15 and 16) show that the similar to A418 and A154 pit lakes, the A21 Pit Lake is predicted to:

- remain fully mixed in the Base Case Scenario
- permanently stratify in the Development Case and Sensitivity Scenario 1
- stratify for about 10 years and mixes vertically thereafter in the Sensitivity Scenario 2

Similar to the rationale provided for A418 pit lake, stability is expected to be stronger than indicated by these simulations over the long term.

Similar to the other two pit lakes, the pattern observed for the A154 Pit Lake with 20 m freshwater cap (Sensitivity Scenario 2) is a result of continuous inflow of high TDS flow (PK pore water) to the bottom of the Pit Lake and low TDS flow (Lac de Gras) to the surface layers of the Pit Lake, with gradual breakdown of meromixis and full mixing of the lake which occurs 10 years post closure.

The TDS concentrations in the surface layers of the pit are predicted to remain below 20 mg/L, 30 mg/L and 80 mg/L over the simulation period (100 years post-closure) for Development Case, Sensitivity Scenario 1 and Sensitivity Scenario 2, respectively. At Year 100 post-closure TDS concentrations of surface layers for all modelled scenarios are predicted to be lower than 80 mg/L.

Contour plots of settleable generic constituent concentrations for the Base Case and Sensitivity Scenario 2 (shallowest water cap) are presented in Figure 17. The results indicate that resuspension of fines would not occur following initial deposition. As discussed in Section 4.1.1, this finding is consistent with empirical data from another pit lake (Vandenberg and Litke 2017).

Because this material is not predicted to resuspend in the 20-m deep pit lake, it would not be anticipated to resuspend in deeper lakes, so further modelling of fines resuspension is not necessary at this stage.

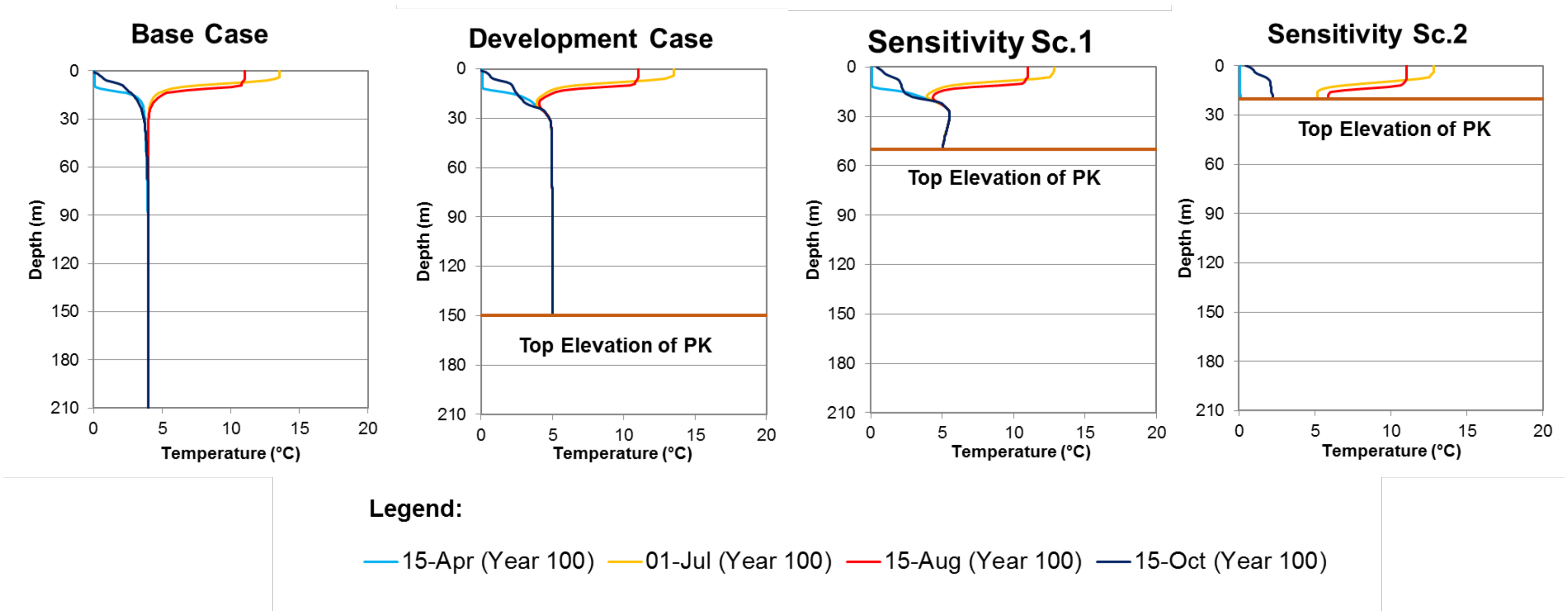

Figure 13: Predicted Vertical Profiles of Water Temperature in the A21 Pit Lake at Selected Dates of Year 100

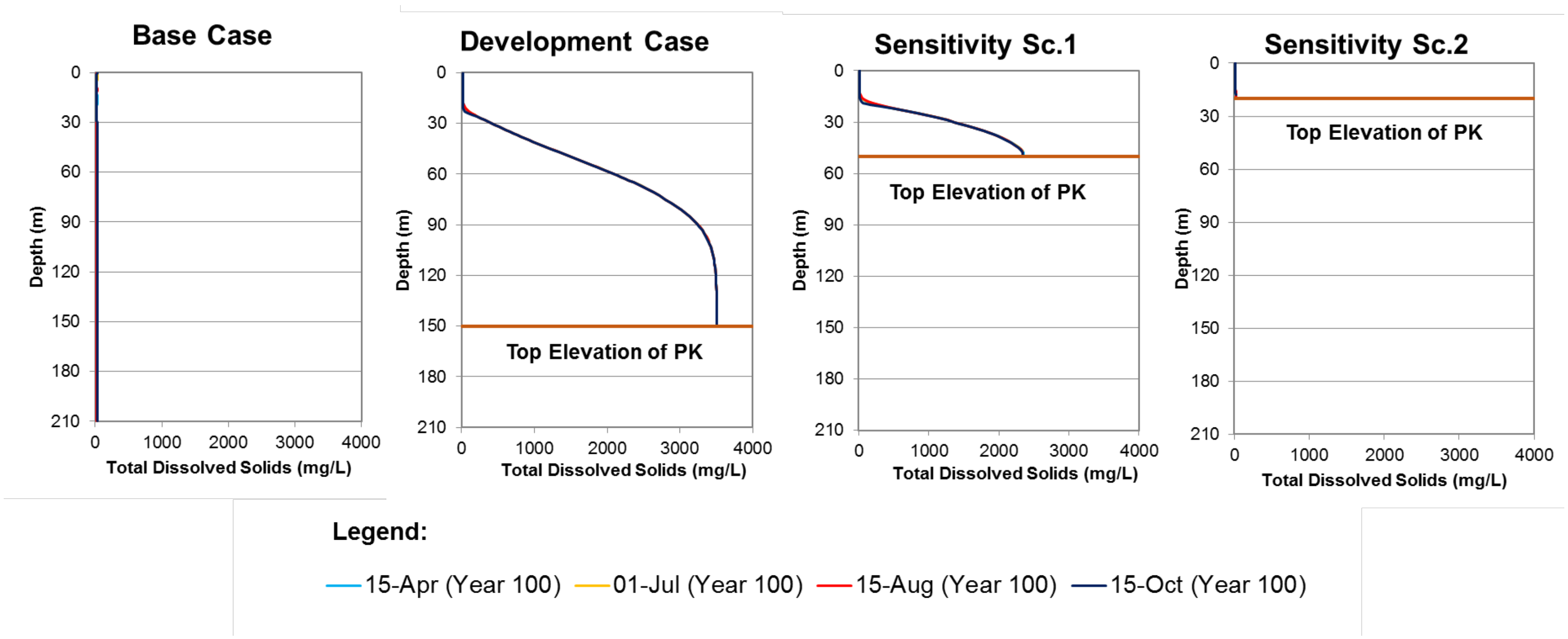

Figure 14: Predicted Vertical Profiles of Total Dissolved Solids Concentrations in the A21 Pit Lake at Selected Dates of Year 100

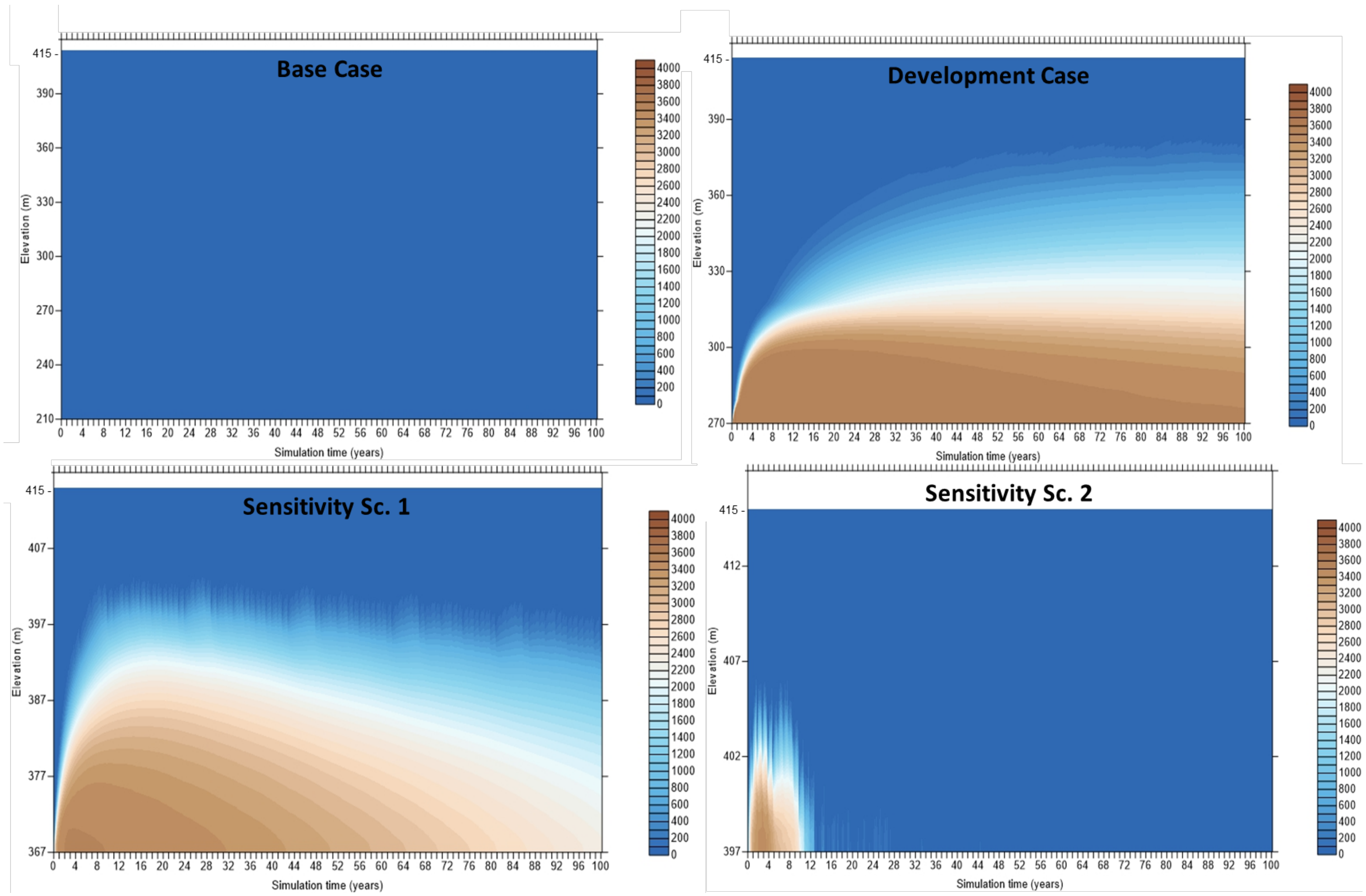

Figure 15: Contour Plots of Predicted Total Dissolved Solids Concentrations in the A21 Pit Lake over the Simulation Period (100 years Post-Closure)

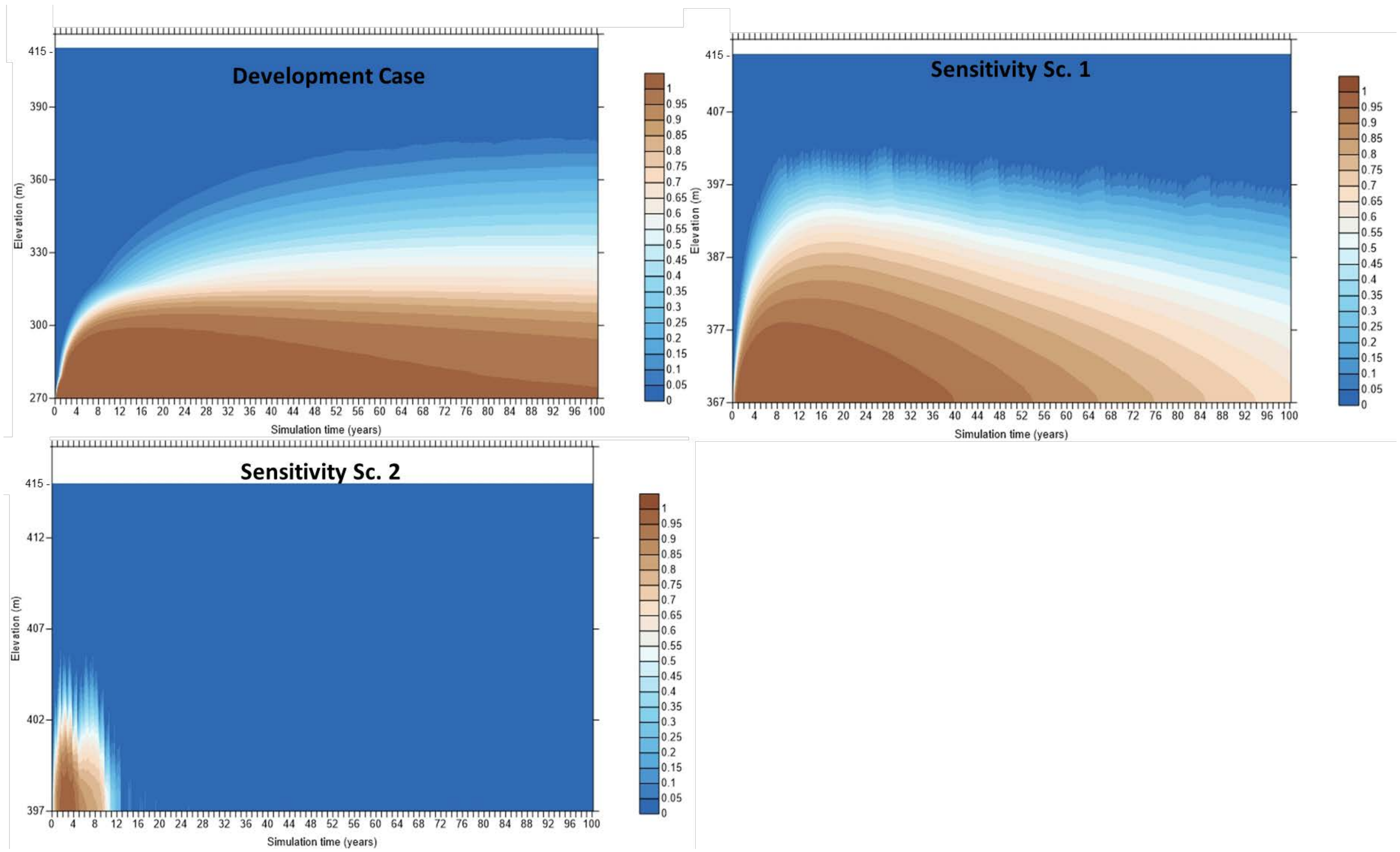

Figure 16: Contour Plots of Predicted Tracer Concentrations in the A21 Pit Lake over the Simulation Period (100 years Post-Closure)

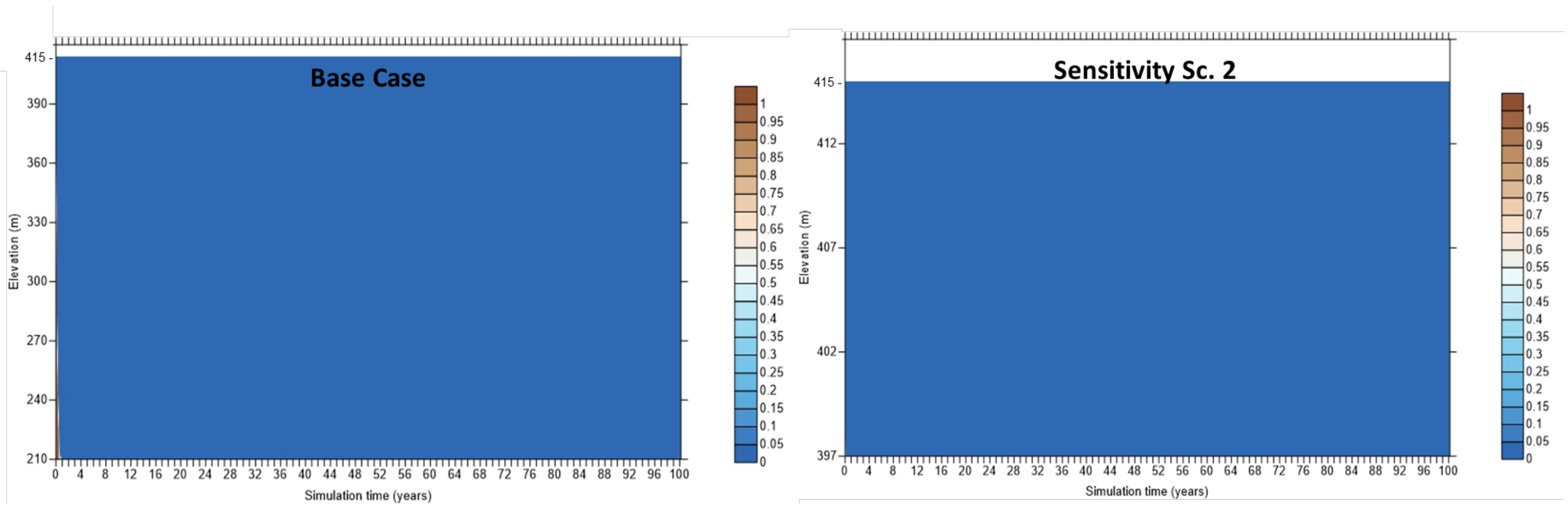

Figure 17: Contour Plots of Predicted Settleable Constituent in the A21 Pit Lake over the Simulation Period (100 years Post-Closure)

4.2 Water Quality Results

Timeseries of predicted average tracer concentration in the top five and bottom five layers of each pit lake (water column) are presented in Appendix A, Figures A-1 to A-9 for the modelled scenarios. Water Quality predictions are not presented for the Base Case and Sensitivity Scenario 3 (A418 Pit Lake) because in the Base Case there are no PK pore water inflow, so the pit lakes' water quality is similar to Lac de Gras water quality, and for the Sensitivity Scenario 3, results are similar to the Sensitivity Scenario 2 (A418 Pit Lake).

Diavik's surface water quality benchmarks and range of observed concentrations in Lac de Gras (Table 1) are also presented on the timeseries graphs.

As can be seen from the timeseries graphs, for the scenarios in which the pit lakes are predicted to be stratified (Development Case and Sensitivity Scenario 1), concentrations of all water quality constituents are predicted to remain below the surface water quality benchmarks (Figures A-1, A-2, A-4, A-5, A-7, A-8).

For the Sensitivity Scenario 2 in which pit lakes are predicted to reach fully mixed conditions between 10 to 25 years post-closure, concentrations of all constituents are predicted to remain below surface water quality benchmarks in the surface and bottom layers of the pit lake once the pit lakes reach fully mixed conditions (25 years for A418, 14 years for A154, and 10 years for A21).

Maximum projected daily concentrations over 100-year post closure modelled timeframe are presented in Table 2 and compared to the surface water quality benchmarks for Development Case and sensitivity scenarios. The maximum modelled concentrations of all constituents in the pit lakes are projected to remain below surface water quality benchmarks under all modelled scenarios, with the exception of sulphate, nitrate as nitrogen and selenium in the A418 Pit Lake under Sensitivity Scenario 2 (20-m freshwater cap). The concentrations of these three constituents are predicted to exceed benchmarks several times during the first 25 years of the simulation period. Each exceedance is predicted to last for approximately 10 days (Figure A-3).

Table 2: Predicted Maximum Daily Concentrations in the Surface Water (Top Section) of A418, A154 and A21 Pit Lakes over 100-year Period after Closure

Year for the Predicted Peak Concentration		Benchmarks [(a)]	A418			A154			A21		
			Development Case	Sensitivity Scenario 1	Sensitivity Scenario 2	Development Case	Sensitivity Scenario 1	Sensitivity Scenario 2	Development Case	Sensitivity Scenario 1	Sensitivity Scenario 2
			2126	2050	2031	2123	2049	2030	2108	2051	2031
Calcium	mg/L	-	2.9	7.7	19	2.7	3.6	6.6	1.9	2.5	5.0
Chloride	mg/L	120	3.7	7.1	15	3.6	4.1	6.3	2.3	2.8	4.5
Fluoride	mg/L	0.12	0.034	0.037	0.043	0.034	0.035	0.036	0.031	0.031	0.033
Magnesium	mg/L	-	1.7	11	34	1.4	3.0	9.0	1.4	2.7	7.7
Potassium	mg/L	-	1.3	5.1	14	1.2	1.8	4.2	1.1	1.6	3.6
Sodium	mg/L	52	3.3	6.8	15	3.2	3.8	6.0	1.8	2.3	4.2
Sulfate	mg/L	100	7.2	61	**186**	5.1	14	48	5.7	13	41
Nitrite as nitrogen	mg/L	0.06	0.0014	0.011	0.033	0.00098	0.0027	0.0087	0.00098	0.0023	0.0073
Nitrate as nitrogen	mg/L	3	0.19	2.4	**7.6**	0.1	0.49	1.9	0.11	0.42	1.6
Phosphate, Ortho	mg/L	-	0.0017	0.003	0.0061	0.0016	0.0018	0.0027	0.00083	0.001	0.0017
Phosphorus	mg/L	-	0.0037	0.0051	0.0084	0.0036	0.0038	0.0047	0.0033	0.0035	0.0042
Aluminum	µg/L	87	6.5	9.9	18	6.4	7.0	9.1	3.4	3.9	5.7
Antimony	µg/L	33	0.04	0.17	0.46	0.036	0.057	0.14	0.028	0.045	0.11
Arsenic	µg/L	5	0.28	0.35	0.5	0.28	0.29	0.33	0.23	0.24	0.27
Barium	µg/L	1000	4.1	14	39	3.7	5.5	12	2.8	4.2	9.6
Beryllium	µg/L	-	0.0054	0.012	0.026	0.0051	0.0062	0.01	0.0053	0.0061	0.0094
Boron	µg/L	1500	3.0	4.2	7.1	2.9	3.1	3.9	2.6	2.7	3.4
Cadmium	µg/L	0.1	0.0041	0.026	0.075	0.0033	0.007	0.02	0.0035	0.0064	0.017
Cobalt	µg/L	-	0.025	0.15	0.45	0.02	0.042	0.12	0.024	0.041	0.11
Copper	µg/L	2	0.6	0.79	1.2	0.6	0.63	0.75	0.62	0.64	0.74

Year for the Predicted Peak Concentration		Benchmarks [a]	A418			A154			A21		
			Development Case	Sensitivity Scenario 1	Sensitivity Scenario 2	Development Case	Sensitivity Scenario 1	Sensitivity Scenario 2	Development Case	Sensitivity Scenario 1	Sensitivity Scenario 2
			2126	2050	2031	2123	2049	2030	2108	2051	2031
Iron	µg/L	300	4.4	9.8	22	4.2	5.2	8.5	3.8	4.5	7.3
Lead	µg/L	1	0.0045	0.025	0.072	0.0037	0.0073	0.02	0.0052	0.0079	0.018
Lithium	µg/L	-	2.0	2.1	2.2	2.0	2.0	2.1	1.7	1.7	1.7
Manganese	µg/L	-	3.4	5.2	9.5	3.3	3.6	4.8	2.0	2.3	3.2
Molybdenum	µg/L	73	1.6	13	41	1.1	3.2	11	0.8	2.4	8.5
Nickel	µg/L	25	1.0	5.4	16	0.86	1.6	4.4	1.1	1.7	4.0
Selenium	µg/L	1	0.046	0.47	**1.5**	0.029	0.1	0.37	0.039	0.097	0.32
Silicon	µg/L	2100	189	246	376	187	197	232	31	39	70
Silver	µg/L	0.1	0.0031	0.013	0.035	0.0027	0.0044	0.01	0.0029	0.0042	0.0092
Strontium	µg/L	30000	44	199	560	38	65	162	23	44	124
Sulfur	µg/L	-	2667	20828	63093	1965	5123	16519	2076	4552	13964
Thallium	µg/L	0.8	0.002	0.017	0.052	0.0014	0.0041	0.014	0.0019	0.0039	0.012
Tin	µg/L	73	0.021	0.19	0.58	0.014	0.044	0.15	0.034	0.057	0.14
Titanium	µg/L	-	0.52	0.54	0.61	0.51	0.52	0.54	0.28	0.29	0.3
Uranium	µg/L	15	0.12	0.14	0.2	0.12	0.12	0.14	0.097	0.1	0.11
Vanadium	µg/L	-	0.11	0.15	0.24	0.11	0.11	0.14	0.054	0.059	0.081
Zinc	µg/L	30	0.7	8.8	28	0.38	1.8	6.9	0.72	1.8	6.0

NOTE:

BOLD font indicates concentration exceeds chronic guideline.

(a) = No guideline/No data.

4.3 Impacts of Unanticipated Mixing

The impacts of unanticipated mixing in the pit lakes was assessed by estimating the timeseries of TDS and tracer concentrations, under the assumption of fully mixed conditions along the vertical column for the Development Case Scenario. This was assessed as a “what if” scenario and was not predicted by the hydrodynamic model; in fact, this follows the opposite behaviour of the hydrodynamic predictions. The stage-storage curve of each pit lake and hydrodynamic modelled concentration (per vertical layer) were used to calculate the mixed concentration along the depth. Timeseries of predicted TDS and tracer concentrations for each pit are presented in Figures 18 to 20.

These timeseries show predicted instantaneous fully mixed concentration of the water column that would be observed if the pit lake were to suddenly overturn at any time along this time series. Based on the results of hydrodynamic modelling for the Sensitivity Scenario 2 (Section 4.1), it is predicted that surface water concentrations in the pit lakes reach Lac de Gras concentrations between one to two months after each turn over in the lake. Thus, it is expected, that shortly after lake turnover, concentrations in the pit lake, at least near the surface, to quickly return closer to lake concentrations due to the high volume of water exchange with Lac de Gras. Conceptually, this process would be similar to the rapid flushing of surface waters predicted in sensitivity scenarios 2 and 3 (Figure 5).

For the Development Case scenario, the maximum calculated mixed daily concentrations over the 100-year period, and for year 5 and year 100 into post-closure are presented in Table 3 and compared to the surface water quality benchmarks. In the event of unanticipated mixing, the maximum estimated mixed concentrations would generally exceed the benchmark for the following constituents: sodium, sulfate, nitrate and nitrite as nitrogen, cadmium, copper, molybdenum, nickel, selenium, silver and zinc. The exceedances are projected to occur generally on all pits, with the maximum exceedance occurring in pit A21 and exceeding the benchmark for sulfate by approximately one order of magnitude. As noted above, such an unexpected turnover would be unlikely, and the elevated concentrations are expected to be short lived.

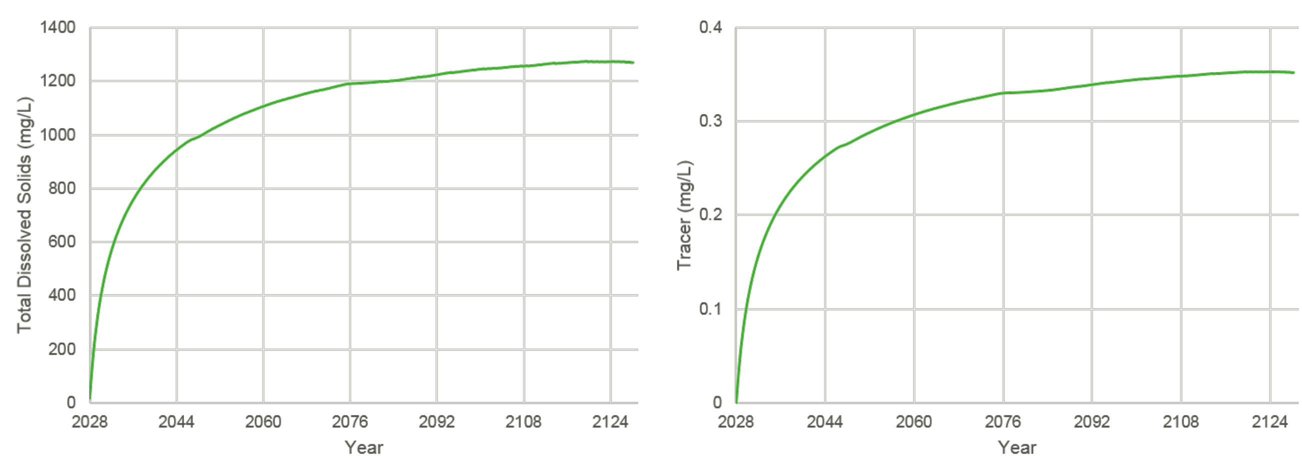

Figure 18: Time Series of Predicted Instantaneous TDS and Constituent Concentrations in the A418 Pit Lake for the Development Case Scenario over the Simulation Period (100 years Post-Closure)

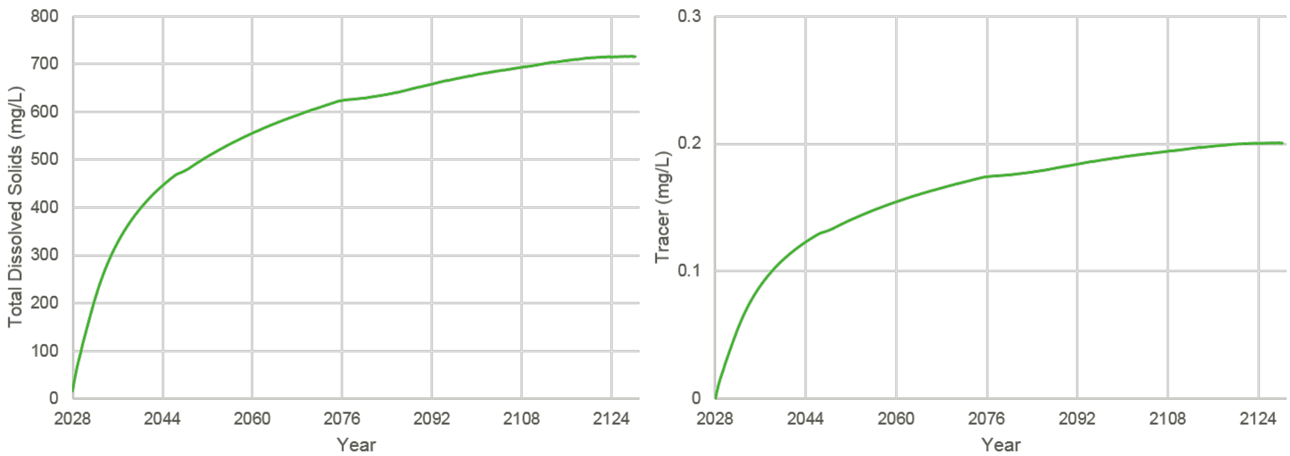

Figure 19: Time Series of Predicted Instantaneous TDS and Constituent Concentrations in the A154 Pit Lake for the Development Case Scenario over the Simulation Period (100 years Post-Closure)

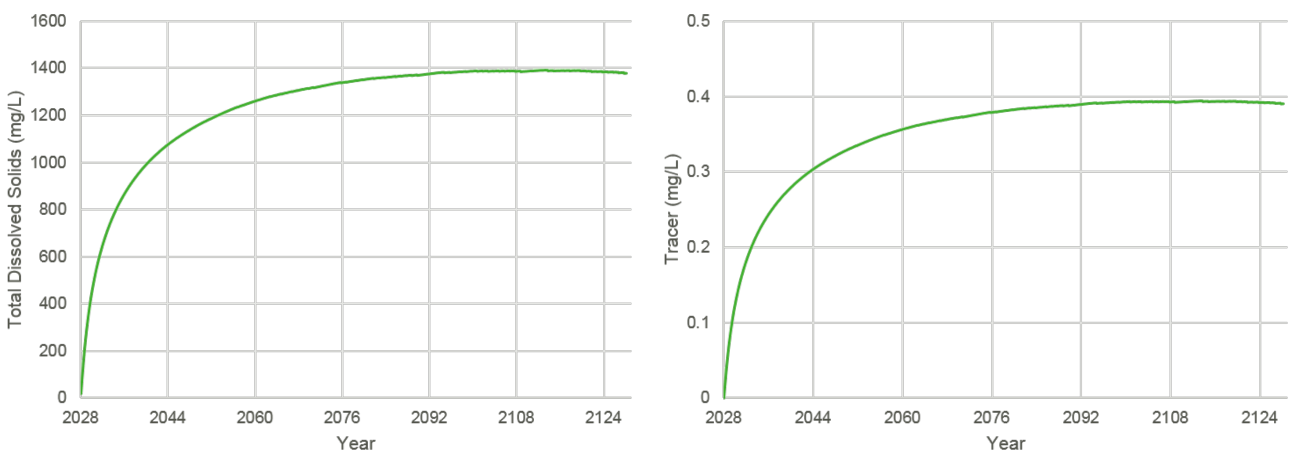

Figure 20: Time Series of Predicted Instantaneous TDS and Constituent Concentrations in the A21 Pit Lake for the Development Case Scenario over the Simulation Period (100 years Post-Closure)

Table 3: Predicted Fully Mixed Concentrations of A418, A154 and A21 Pit Lakes over 100-year Period after Closure

Year for the Predicted Concentration		Benchmarks	A418			A154			A21		
			Peak Concentration	Year 5 Average	Year 100 Average	Peak Concentration	Year 5 Average	Year 100 Average	Peak Concentration	Year 5 Average	Year 100 Average
			2124	2032	2127	2127	2032	2127	2113	2032	2027
Calcium	mg/L	-	75	37	75	44	15	44	83	41	83
Chloride	mg/L	120	55	28	55	33	12	33	60	30	60
Fluoride	mg/L	0.12	0.072	0.052	0.071	0.055	0.041	0.055	0.074	0.052	0.074
Magnesium	mg/L	-	146	69	146	84	26	84	163	80	162
Potassium	mg/L	-	59	28	59	34	11	34	66	33	65
Sodium	mg/L	52	**57**	28	**57**	34	12	34	**62**	31	**62**
Sulfate	mg/L	100	**819**	**387**	**818**	**467**	**144**	**467**	**916**	**448**	**908**
Nitrite as nitrogen	mg/L	0.06	**0.15**	**0.07**	**0.15**	**0.084**	0.026	**0.084**	**0.16**	**0.08**	**0.16**
Nitrate as nitrogen	mg/L	3	**34**	**16**	**34**	**19**	**5.9**	**19**	**38**	**19**	**38**
Phosphate, Ortho	mg/L	-	0.022	0.011	0.022	0.013	0.005	0.013	0.024	0.012	0.023
Phosphorus	mg/L	-	0.025	0.014	0.025	0.016	0.0073	0.016	0.028	0.015	0.027
Aluminum	µg/L	87	58	31	58	36	15	36	62	32	62
Antimony	µg/L	33	1.9	0.93	1.9	1.1	0.36	1.1	2.2	1.1	2.1
Arsenic	µg/L	5	1.2	0.73	1.2	0.83	0.45	0.83	1.3	0.76	1.3
Barium	µg/L	1000	161	77	160	93	30	93	179	88	177
Beryllium	µg/L	-	0.1	0.05	0.1	0.059	0.021	0.059	0.11	0.057	0.11
Boron	µg/L	1500	22	12	22	14	6.1	14	24	13	23
Cadmium	µg/L	0.1	**0.33**	**0.16**	**0.33**	**0.19**	0.059	**0.19**	**0.37**	**0.18**	**0.36**
Cobalt	µg/L	-	2.0	0.94	2.0	1.1	0.35	1.1	2.2	1.1	2.2
Copper	µg/L	2	**3.4**	1.9	**3.4**	**2.2**	1.1	**2.2**	**3.8**	**2.2**	**3.8**

Year for the Predicted Concentration		Benchmarks	A418			A154			A21		
			Peak Concentration	Year 5 Average	Year 100 Average	Peak Concentration	Year 5 Average	Year 100 Average	Peak Concentration	Year 5 Average	Year 100 Average
			2124	2032	2127	2127	2032	2127	2113	2032	2027
Iron	µg/L	300	85	42	85	50	18	50	94	48	94
Lead	µg/L	1	0.31	0.15	0.31	0.18	0.056	0.18	0.35	0.17	0.35
Lithium	µg/L	-	2.7	2.3	2.7	2.4	2.1	2.4	2.5	2.1	2.5
Manganese	µg/L	-	31	16	31	19	8.1	19	34	17	33
Molybdenum	µg/L	73	**179**	**84**	**178**	**102**	31	**102**	**199**	**97**	**198**
Nickel	µg/L	25	**67**	**32**	**67**	**39**	12	**39**	**75**	**37**	**75**
Selenium	µg/L	1	**6.5**	**3.1**	**6.5**	**3.7**	**1.1**	**3.7**	**7.3**	**3.5**	**7.2**
Silicon	µg/L	2100	1039	587	1038	671	332	671	1045	524	1036
Silver	µg/L	0.1	**0.15**	0.071	**0.15**	0.085	0.027	0.085	**0.16**	0.082	**0.16**
Strontium	µg/L	30000	2387	1141	2383	1372	438	1371	2654	1301	2631
Sulfur	µg/L	-	277235	131226	276767	158291	48852	158192	309709	151521	307060
Thallium	µg/L	0.8	0.23	0.11	0.23	0.13	0.04	0.13	0.26	0.13	0.26
Tin	µg/L	73	2.6	1.2	2.6	1.5	0.45	1.5	2.9	1.4	2.9
Titanium	µg/L	-	0.96	0.72	0.96	0.77	0.59	0.76	0.87	0.57	0.86
Uranium	µg/L	15	0.47	0.29	0.47	0.32	0.18	0.32	0.5	0.29	0.5
Vanadium	µg/L	-	0.72	0.4	0.72	0.46	0.21	0.46	0.76	0.4	0.76
Zinc	µg/L	30	**123**	**58**	**123**	**70**	21	**70**	**138**	**67**	**136**

NOTE:
BOLD font indicates concentration exceeds chronic guideline.
(a) = No guideline/No data.

5.0 CONCLUSIONS

Hydrodynamic and water quality models of Diavik A418, A154 and A21 mined-out pits were developed to understand lake mixing behaviour in pit lakes with no PK (Base Case) and pit lakes with PK under different thicknesses of freshwater cap.

The Base Case scenario was a pit lake containing only water. This lake was predicted to fully overturn at least once per year. Under scenarios that include PK with 150-m and 50-m freshwater cap thickness, all three of the pit lakes are predicted to stratify over the simulation period. Beyond that time, the conceptual model suggests long-term stability of the predicted stratification for the three pits, possibly with a very small amount of upward diffusion of mass. Under scenarios that included PK with a 20-m freshwater cap, model results indicated that all three the pit lakes will start to turn over at around 10 to 25 years post closure, which mixes the inflows from Lac de Gras with the high TDS water at the bottom of the pits.

In all modelled scenarios with different thickness of freshwater cap, for all three pit lakes (A418, A154 and A21), concentrations of modelled constituents in the top layers are predicted to remain below surface water quality benchmarks during the simulation period, except for A418 pit under the assumption of 20 m fresh water cap.

Results of the sensitivity scenarios indicated that, under the modelling assumptions, a water cap of approximately 50 m or more would be necessary to isolate PK pore water from the surface.

In the event of unanticipated mixing along the vertical columns, concentrations of some of the modelled constituents are predicted to exceed the surface water quality benchmarks during the simulation period for all of the pits. The maximum exceedance is predicted to be in the range of one order of magnitude higher than the benchmark. It is noted that this information is presented as a “what if” scenario, even though the hydrodynamic model suggests it will not occur; furthermore, it is expected that such an event to lead to short-lived concentrations throughout the pit lake due to a high volume of exchange with Lac de Gras.

6.0 CLOSURE

The reader is referred to the Study Limitations section, which follows the text and forms an integral part of this memorandum.

We trust that the content of this technical memorandum meets your expectations. Please do not hesitate to contact the undersigned should you have any questions or comments.

Golder Associates Ltd.

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Attachments: Study Limitations
Attachment 1: Water Quality Results - Figures A-1 to A-9

https://golderassociates.sharepoint.com/sites/22444g/deliverables/issued/1698-tm-rev1-3000-pit lakes wq modelling/1893614-1698-tm-rev1-3000-pit_lakes_wq_modelling_02nov_18.docx

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STUDY LIMITATIONS

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ATTACHMENT 1

Water Quality Results - Figures A-1 to A-9

Figure A-1: Predicted time Series of A418 Pit Lake Constituent Concentrations – Development Case Scenario

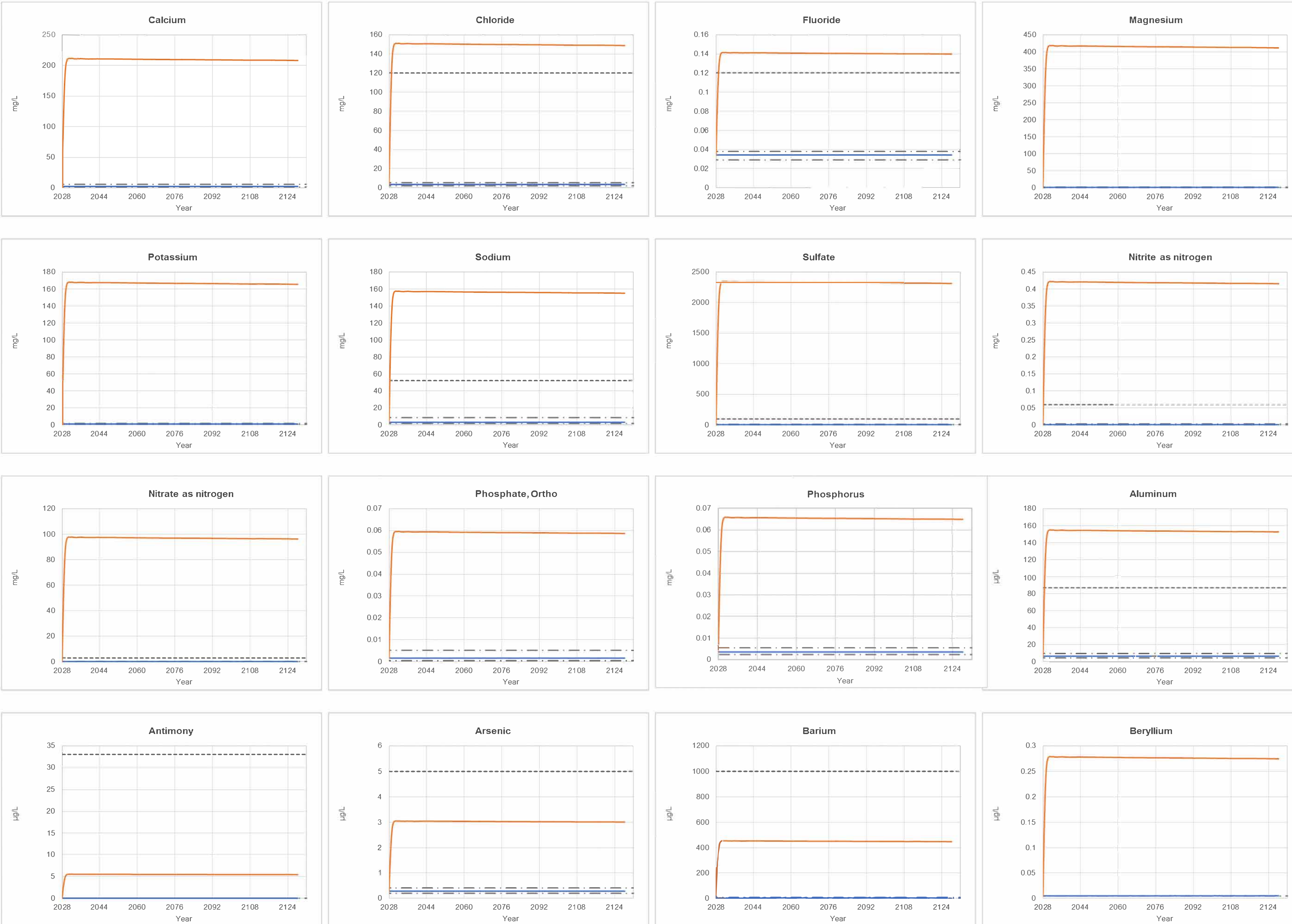


Figure A-1: Predicted time Series of A418 Pit Lake Constituent Concentrations – Development Case Scenario (continued)

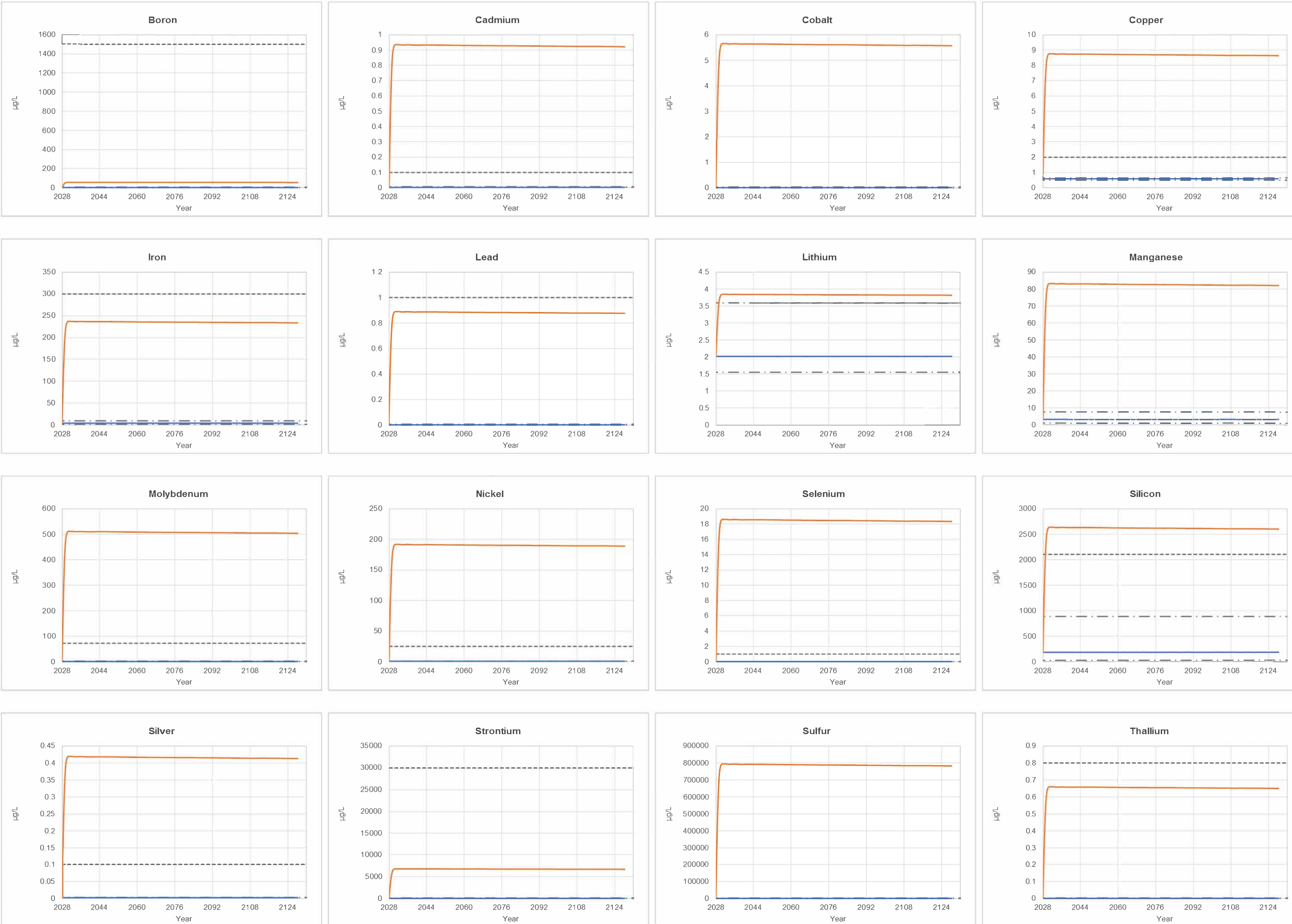


Figure A-1: Predicted time Series of A418 Pit Lake Constituent Concentrations – Development Case Scenario (continued)

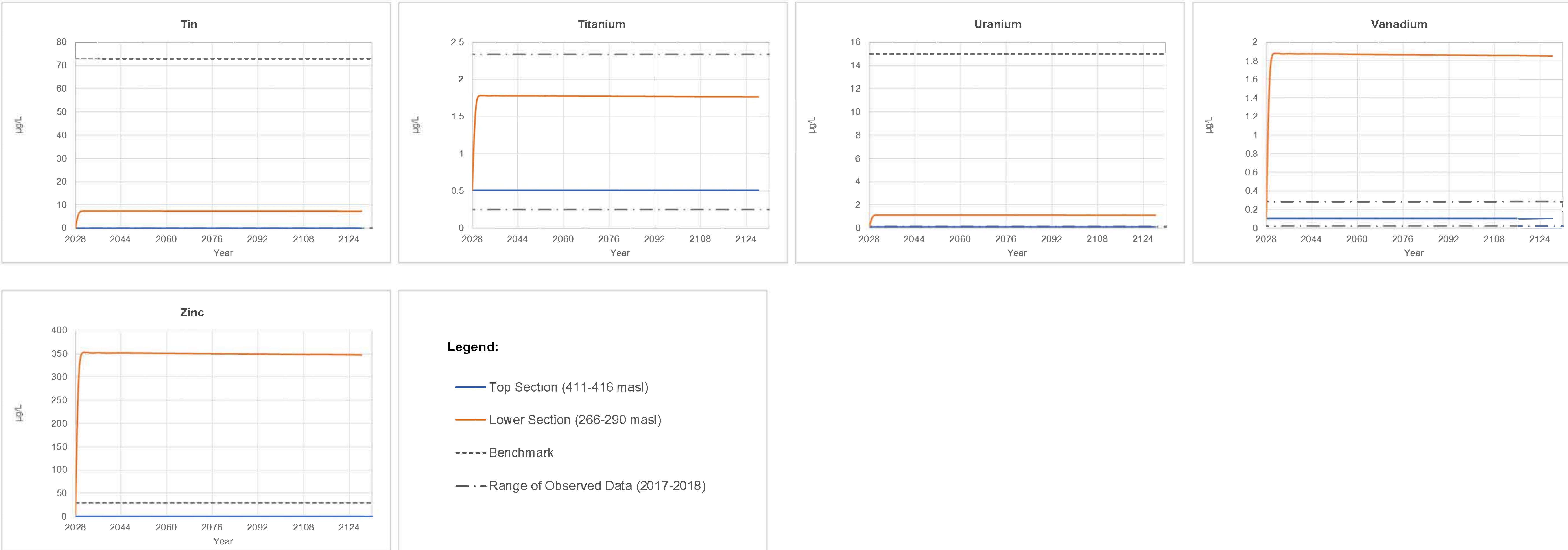


Figure A-2: Predicted time Series of A418 Pit Lake Constituent Concentrations – Sensitivity Scenario 1

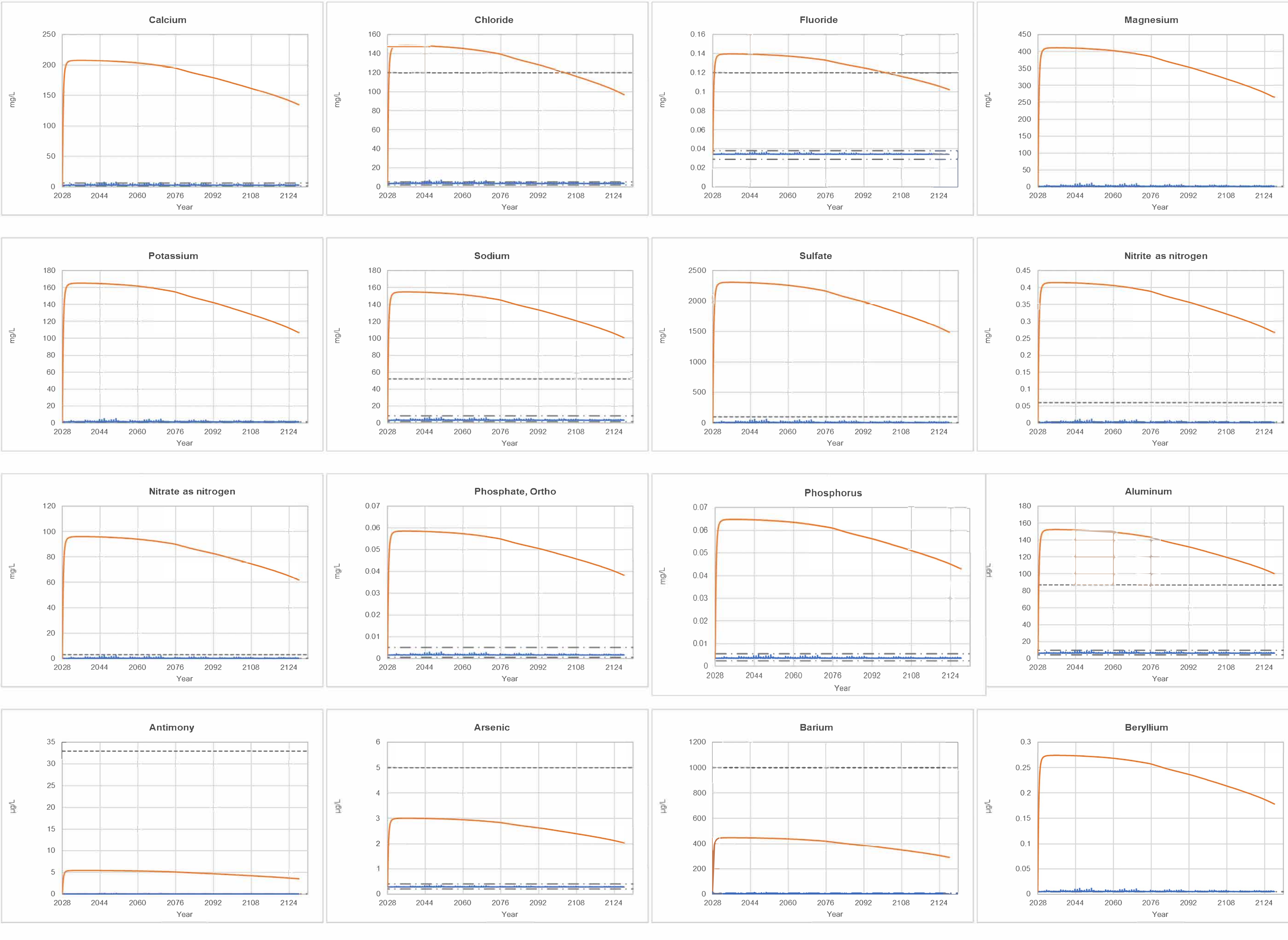


Figure A-2: Predicted time Series of A418 Pit Lake Constituent Concentrations – Sensitivity Scenario 1 (continued)

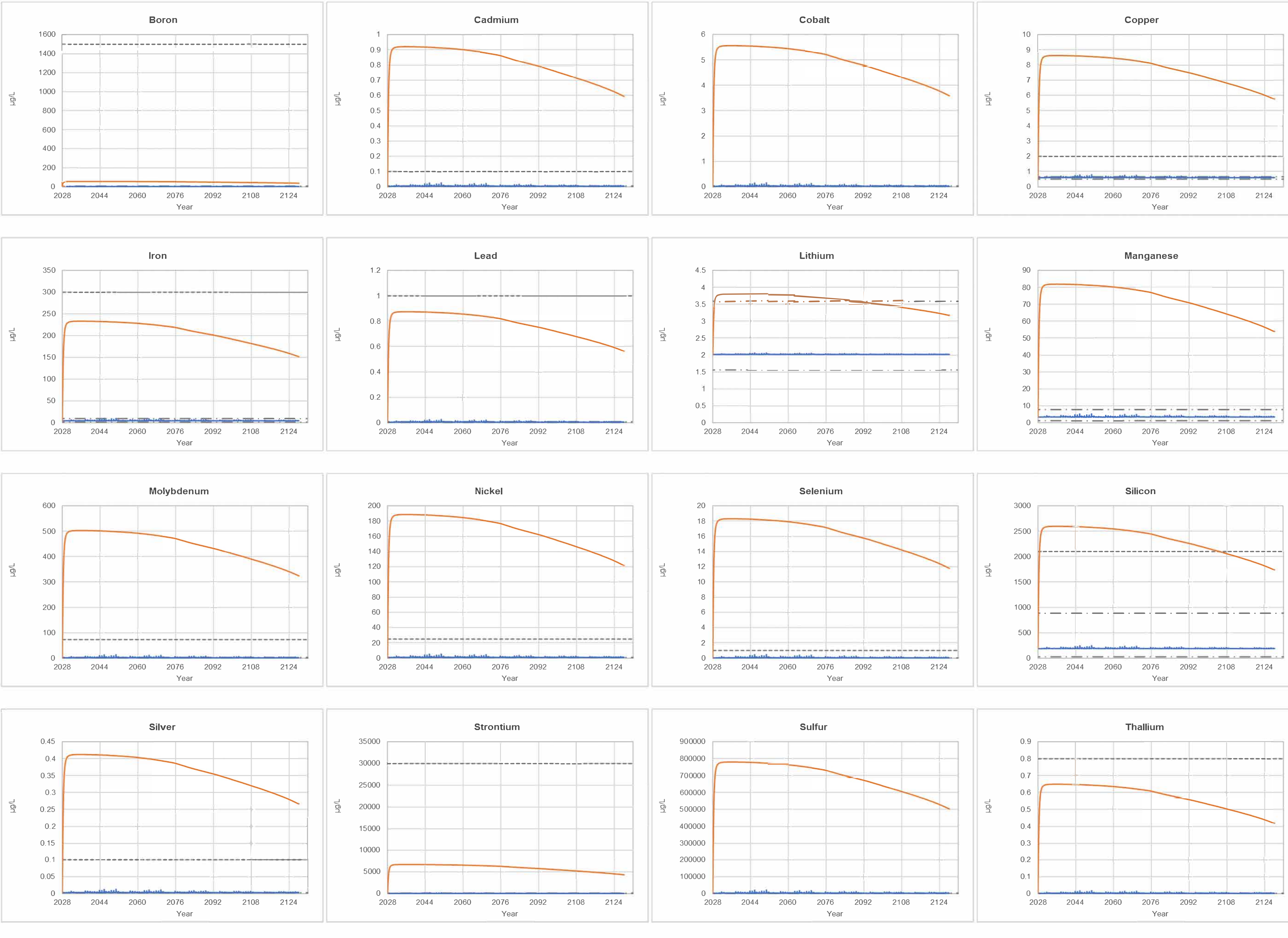


Figure A-2: Predicted time Series of A418 Pit Lake Constituent Concentrations – Sensitivity Scenario 1 (continued)

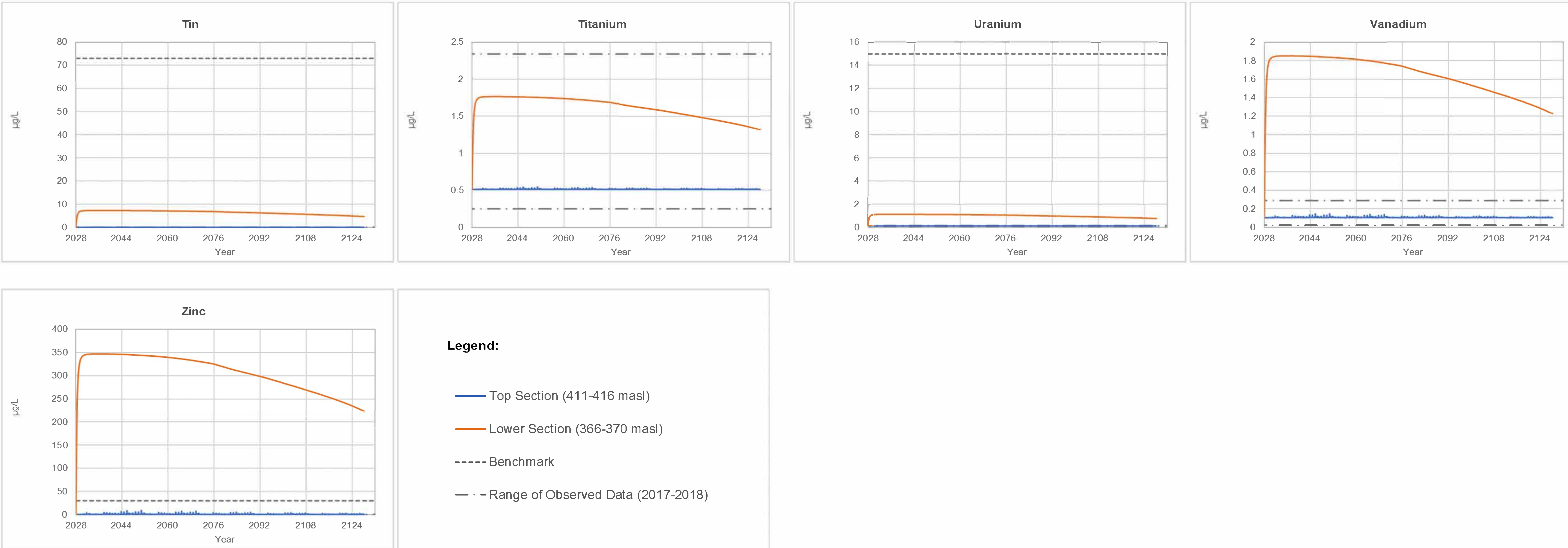


Figure A-3: Predicted time Series of A418 Pit Lake Constituent Concentrations –Sensitivity Scenario 2

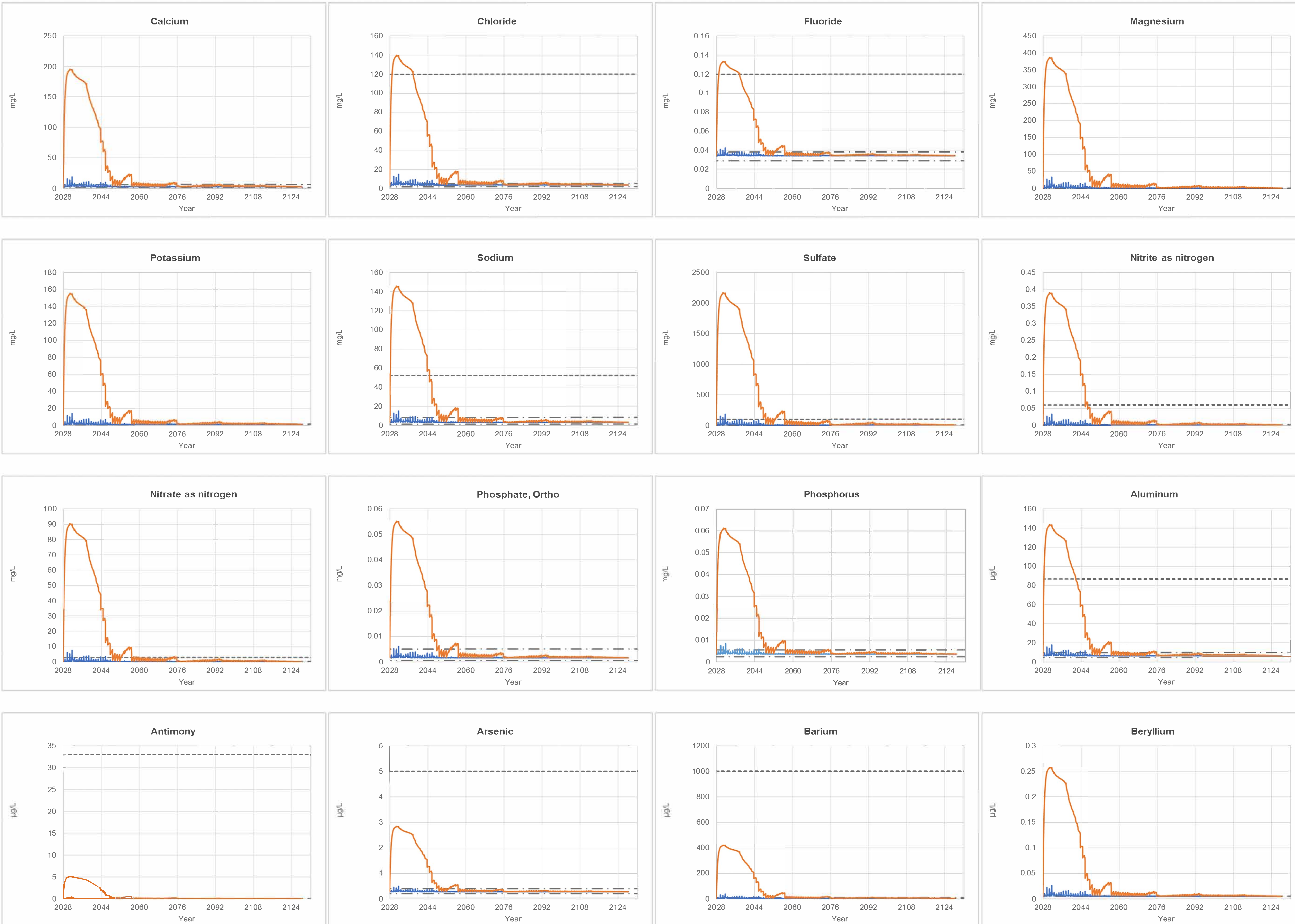


Figure A-3: Predicted time Series of A418 Pit Lake Constituent Concentrations – Sensitivity Scenario 2 (continued)

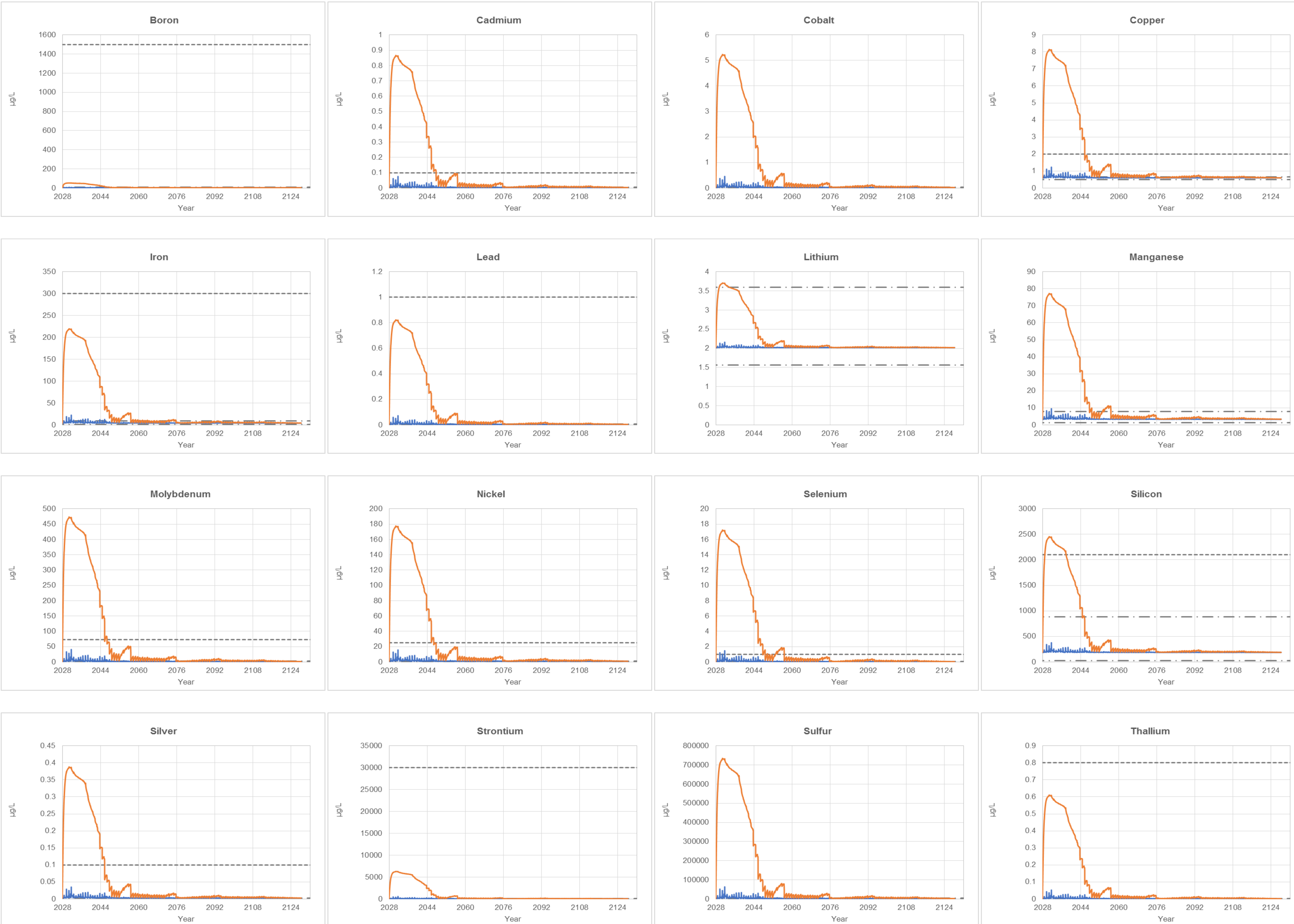


Figure A-3: Predicted time Series of A418 Pit Lake Constituent Concentrations – Sensitivity Scenario 2 (continued)

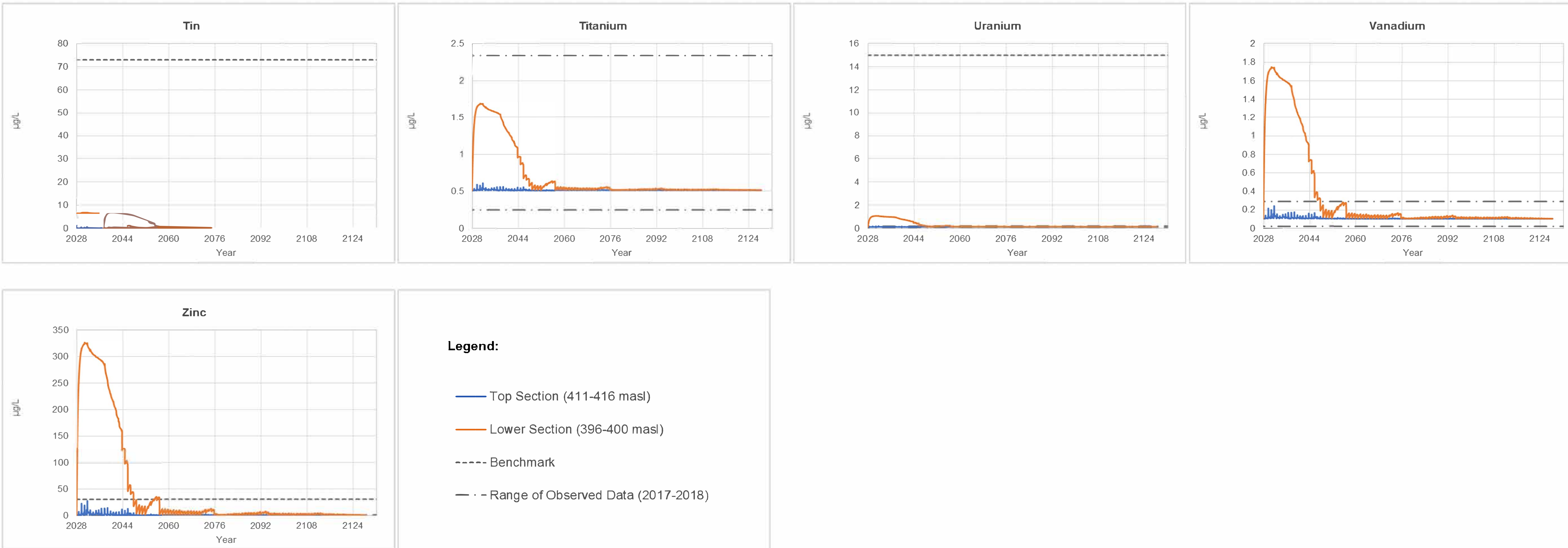


Figure A-4: Predicted time Series of A154 Pit Lake Constituent Concentrations – Development Case Scenario

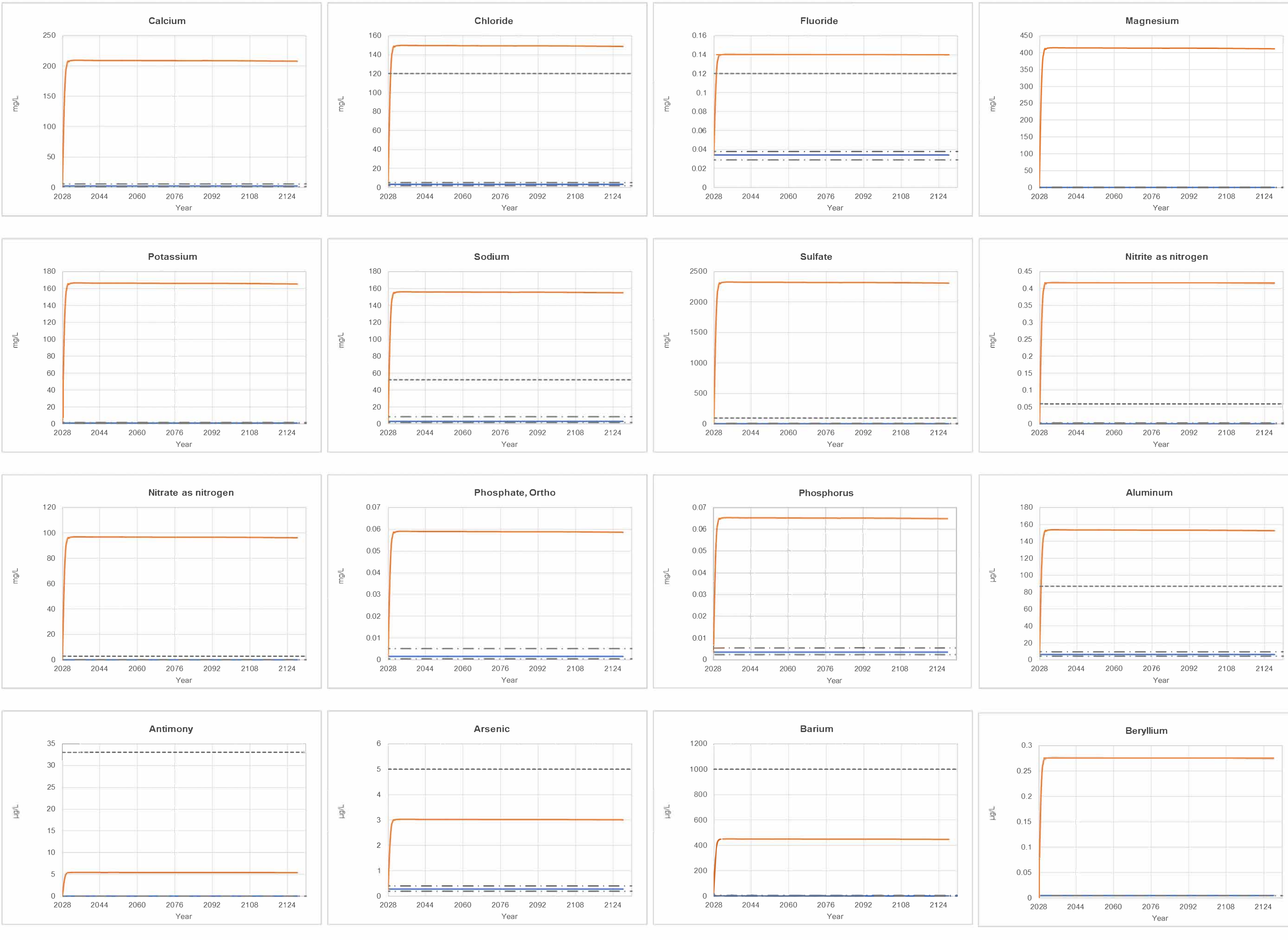


Figure A-4: Predicted time Series of A154 Pit Lake Constituent Concentrations – Development Case Scenario (continued)

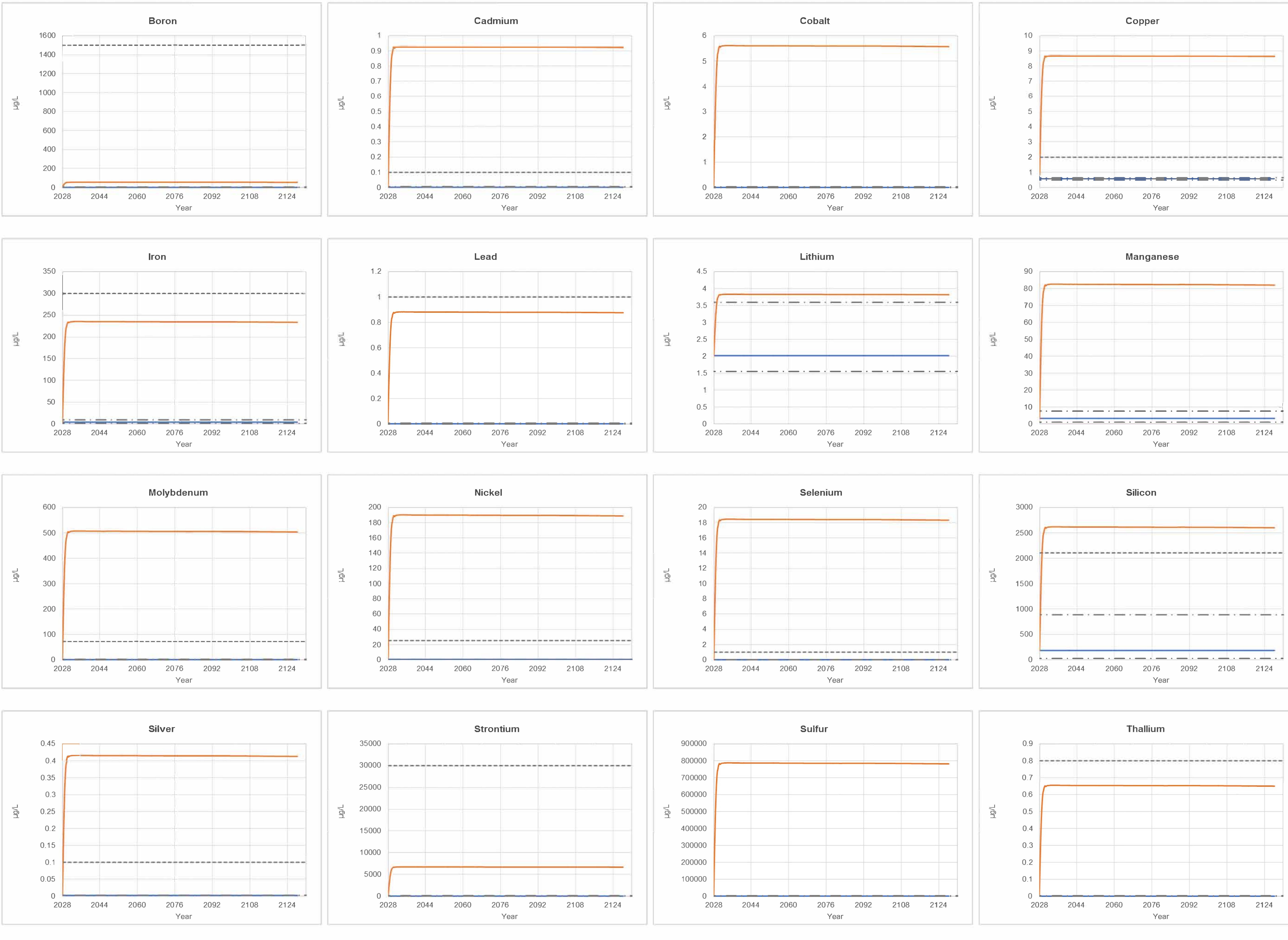


Figure A-4: Predicted time Series of A154 Pit Lake Constituent Concentrations – Development Case Scenario (continued)

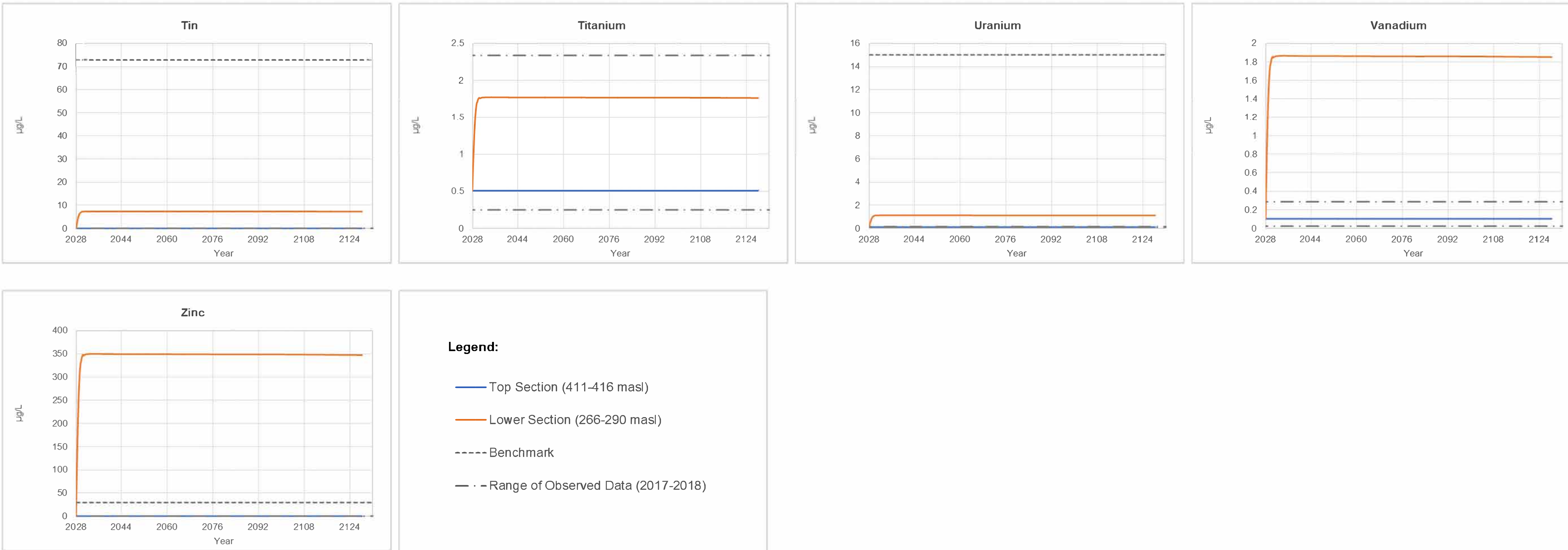


Figure A-5: Predicted time Series of A154 Pit Lake Constituent Concentrations – Sensitivity Scenario 1

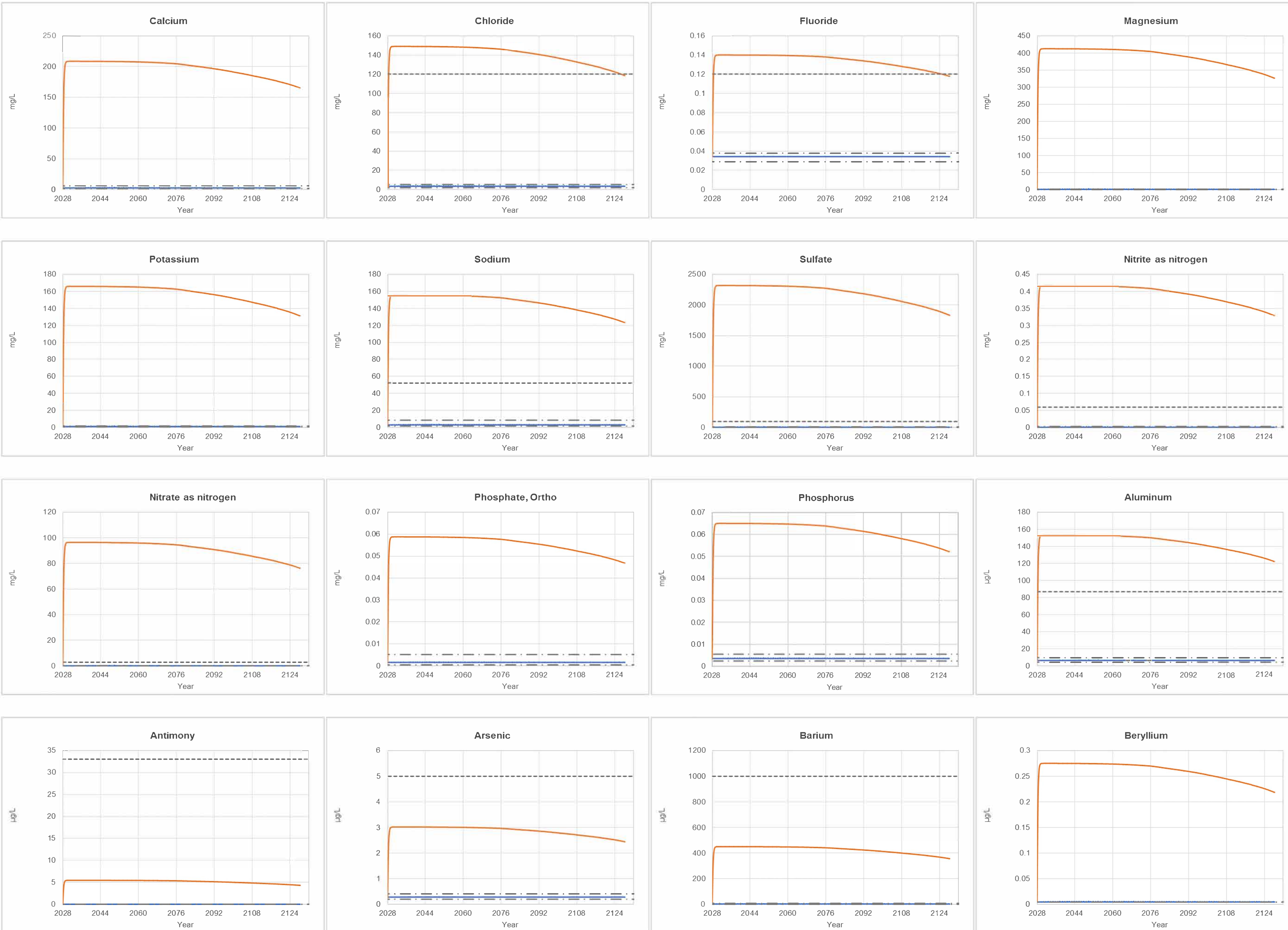


Figure A-5: Predicted time Series of A154 Pit Lake Constituent Concentrations – Sensitivity Scenario 1 (continued)

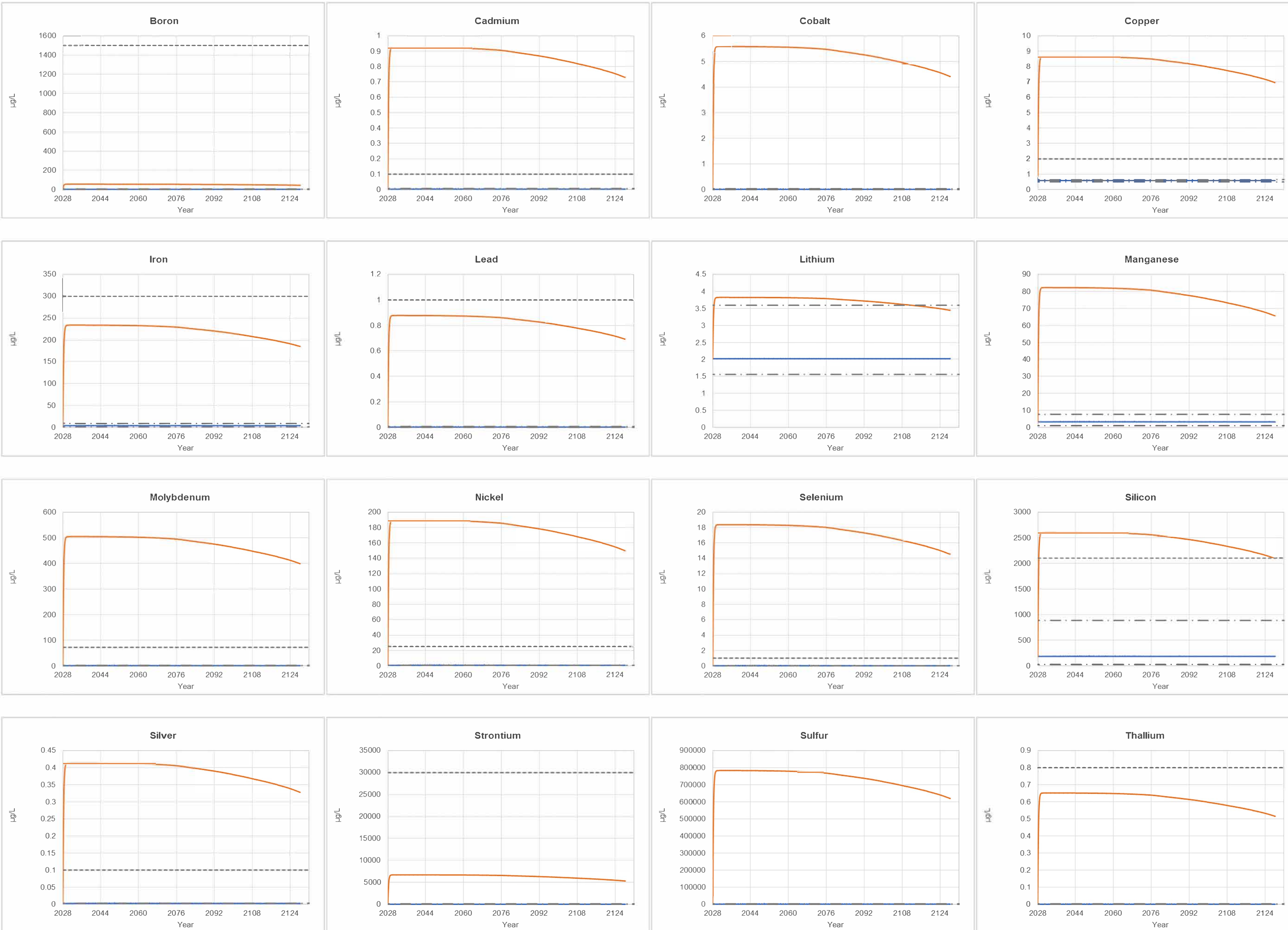


Figure A-5: Predicted time Series of A154 Pit Lake Constituent Concentrations – Sensitivity Scenario 1 (continued)

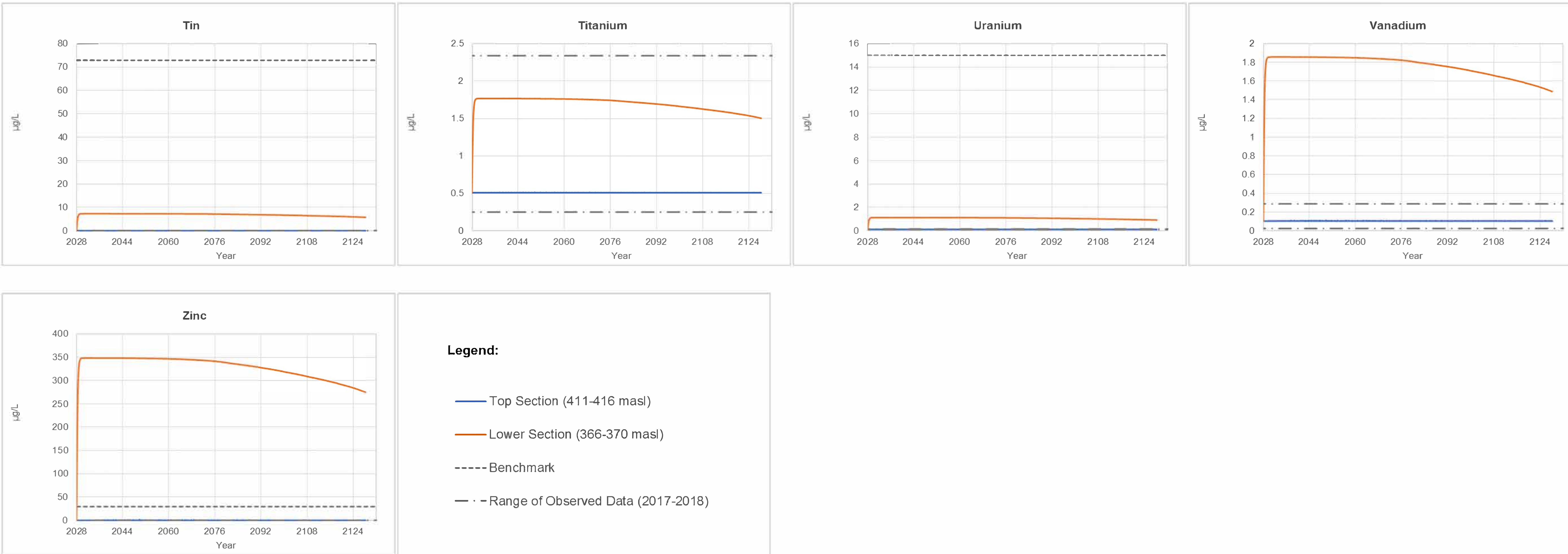


Figure A-6: Predicted time Series of A154 Pit Lake Constituent Concentrations – Sensitivity Scenario 2

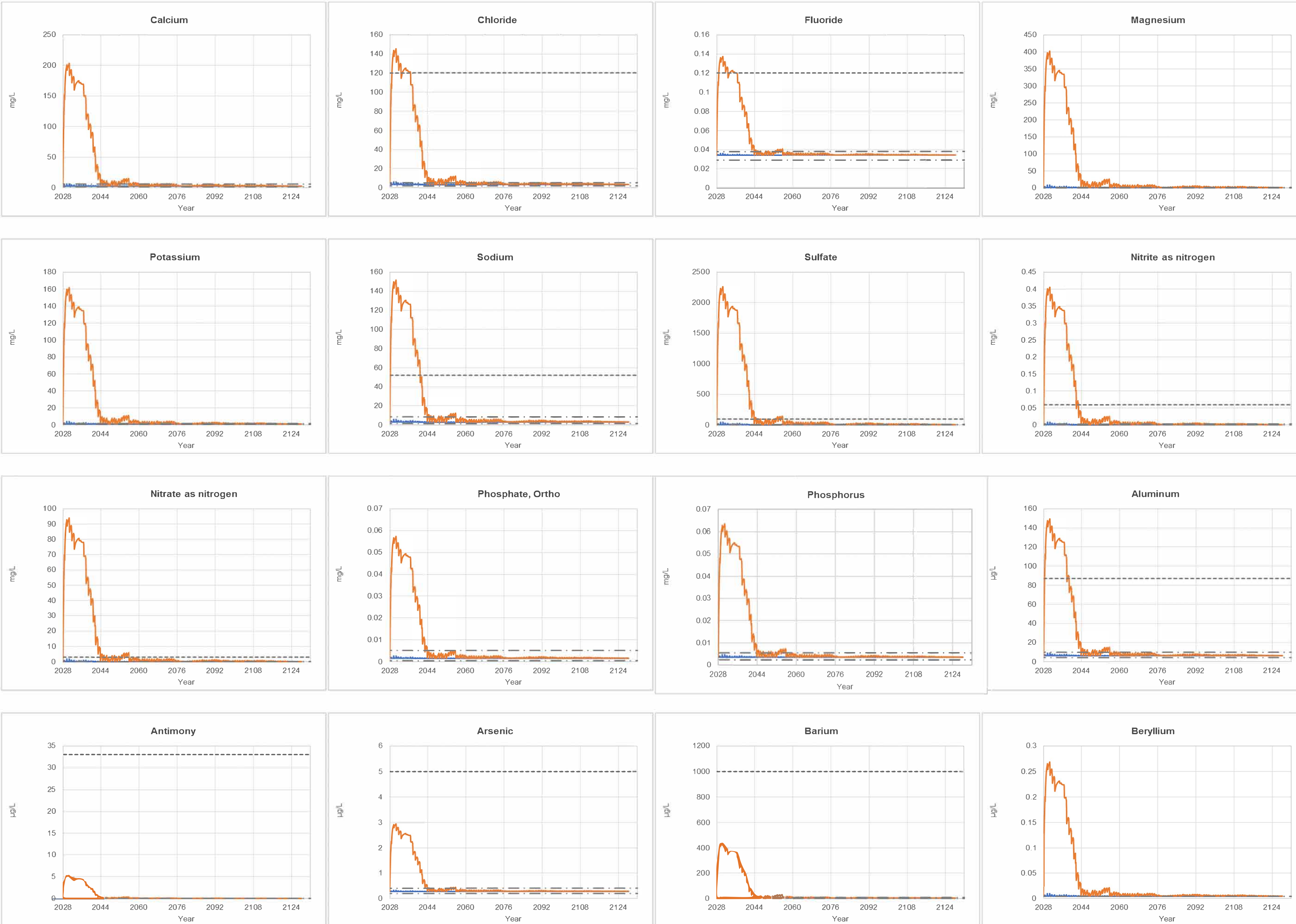


Figure A-6: Predicted time Series of A154 Pit Lake Constituent Concentrations – Sensitivity Scenario 2 (continued)

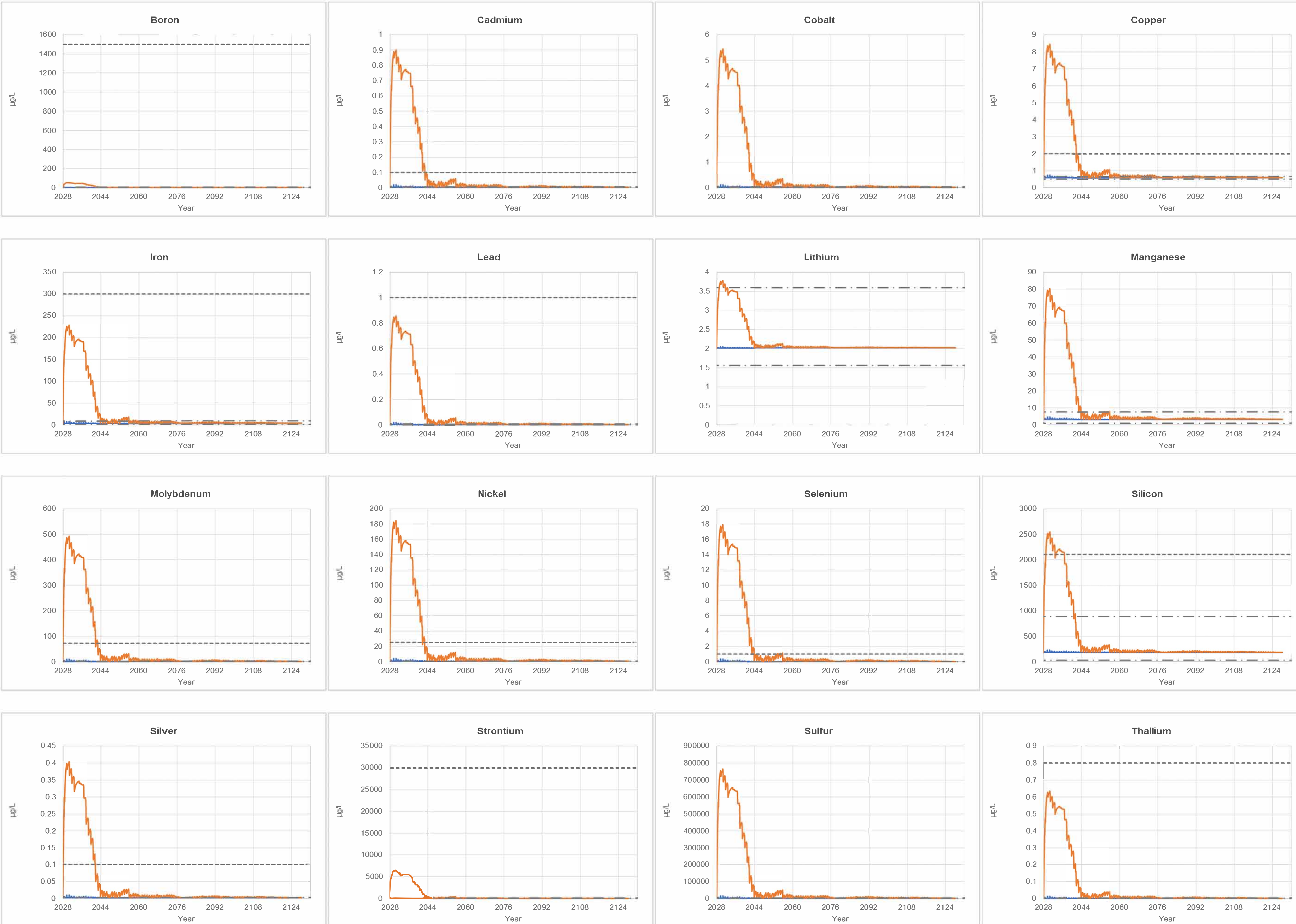


Figure A-6: Predicted time Series of A154 Pit Lake Constituent Concentrations – Sensitivity Scenario 2 (continued)

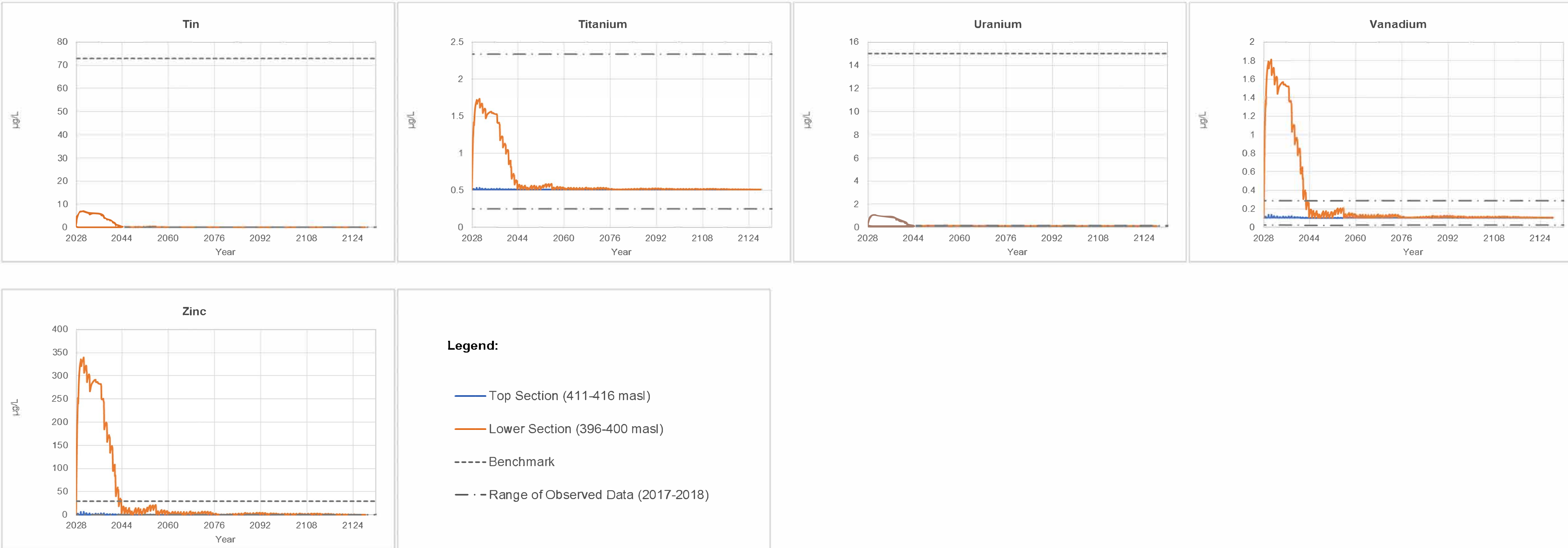


Figure A-7: Predicted time Series of A21 Pit Lake Constituent Concentrations – Development Case Scenario

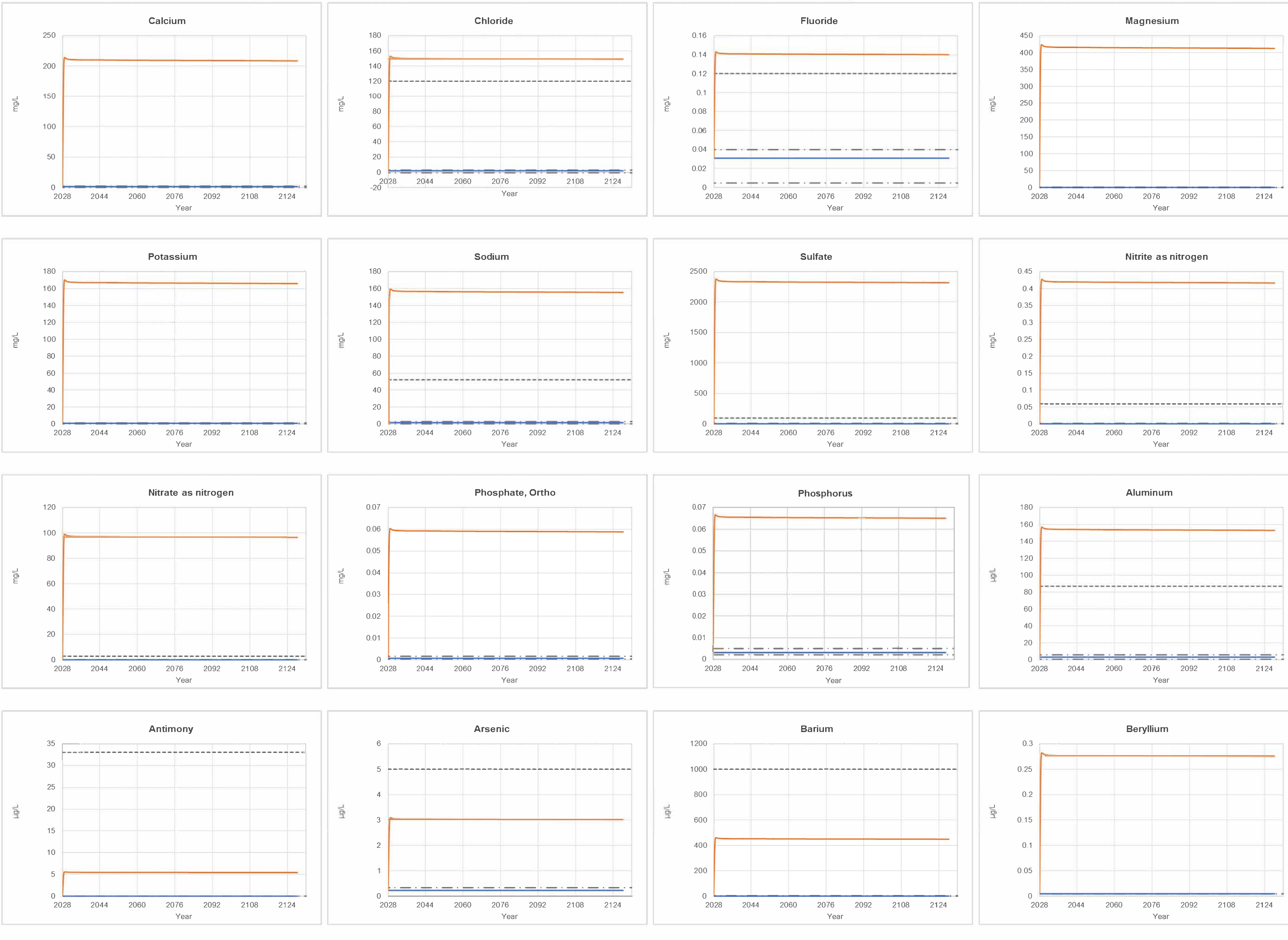


Figure A-7: Predicted time Series of A21 Pit Lake Constituent Concentrations – Development Case Scenario (continued)

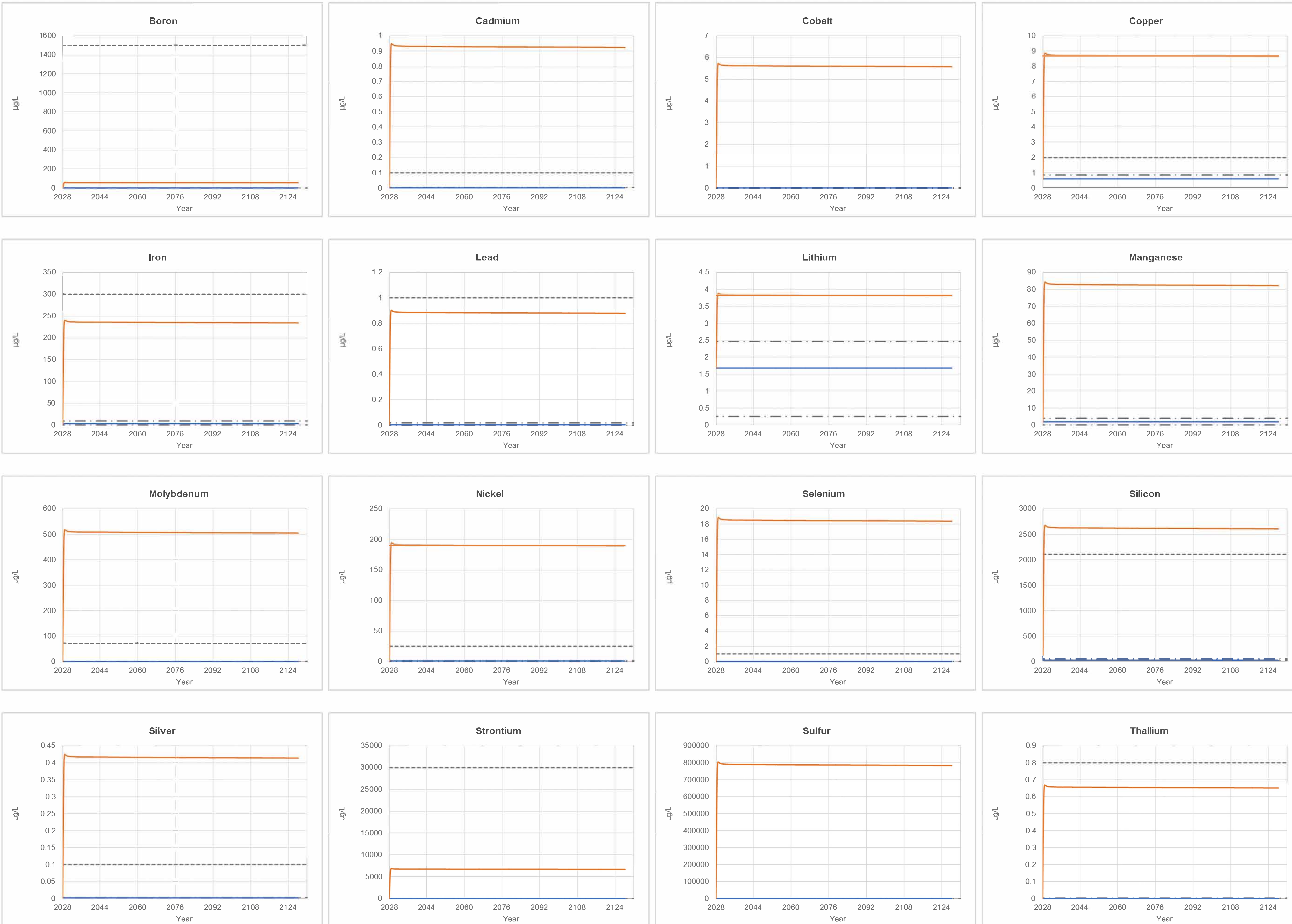


Figure A-7: Predicted time Series of A21 Pit Lake Constituent Concentrations – Development Case Scenario (continued)

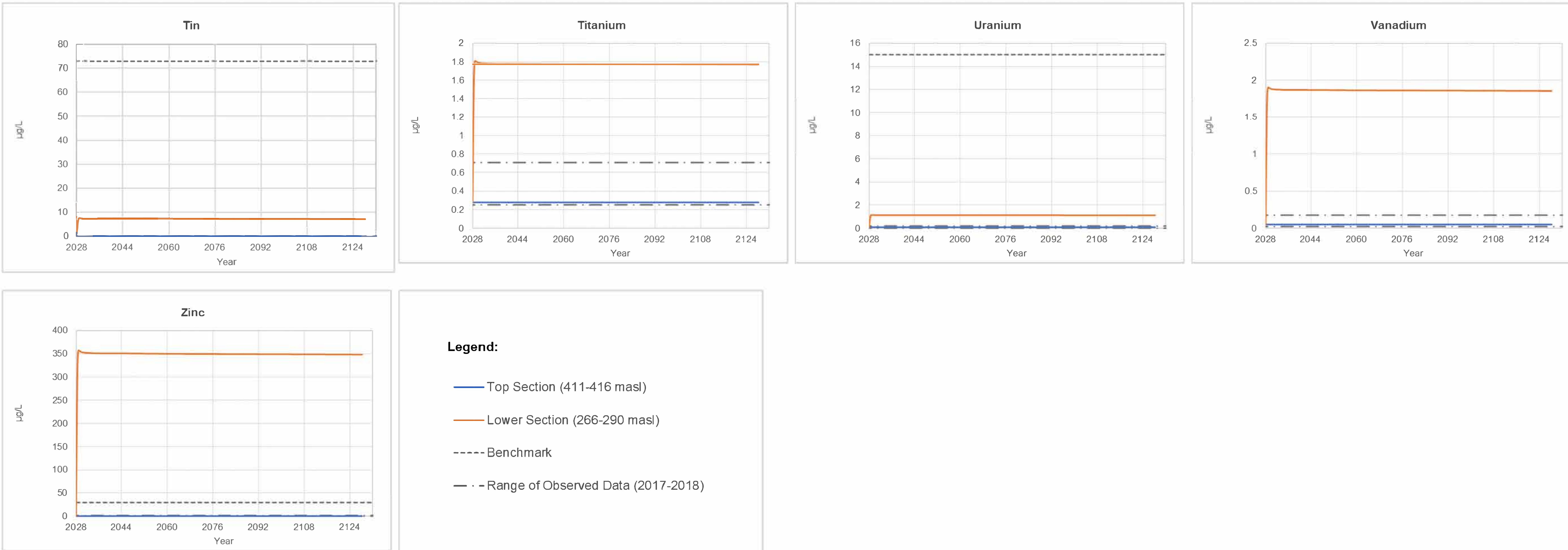


Figure A-8: Predicted time Series of A21 Pit Lake Constituent Concentrations – Sensitivity Scenario 1

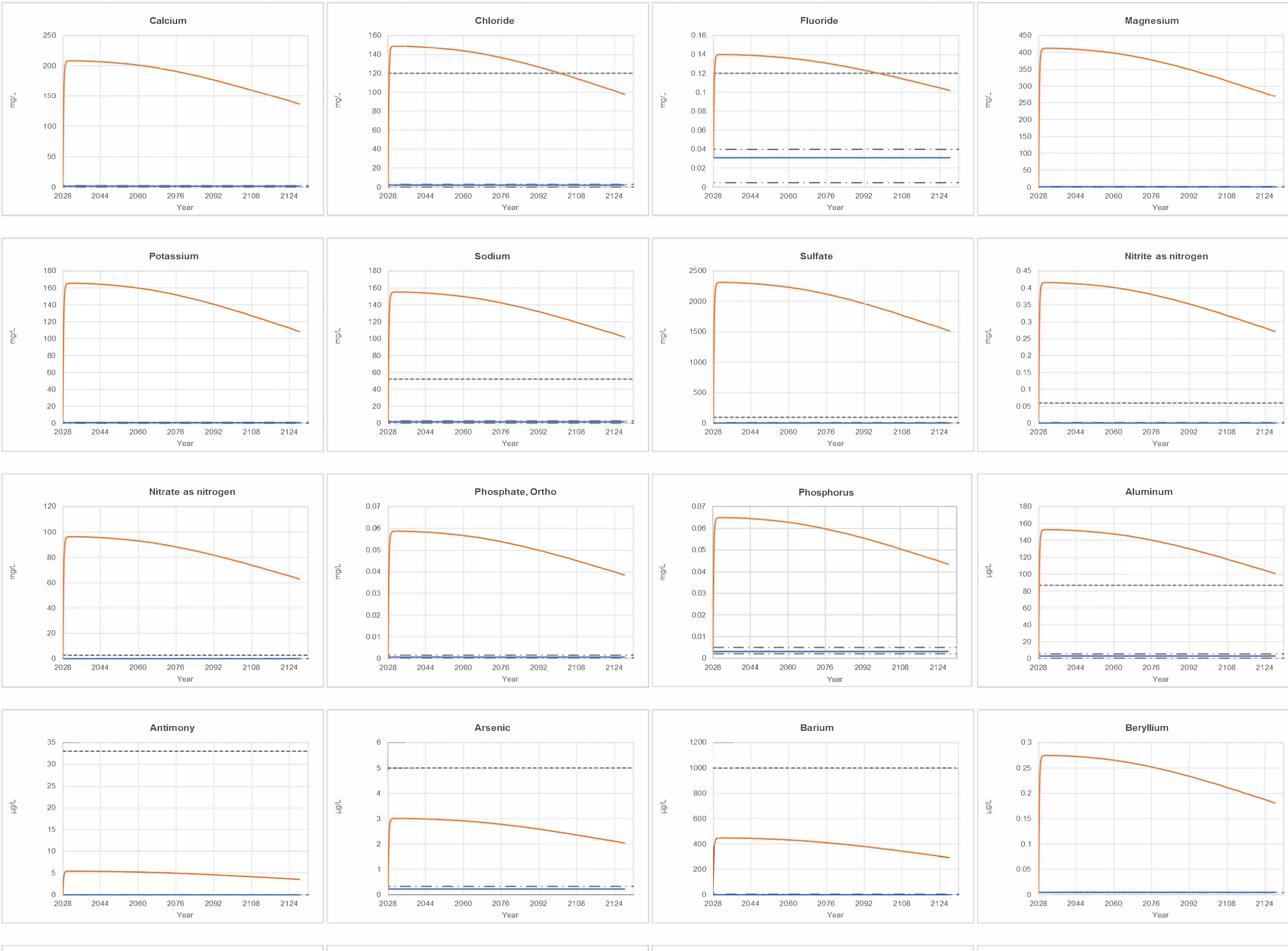


Figure A-8: Predicted time Series of A21 Pit Lake Constituent Concentrations – Sensitivity Scenario 1 (continued)

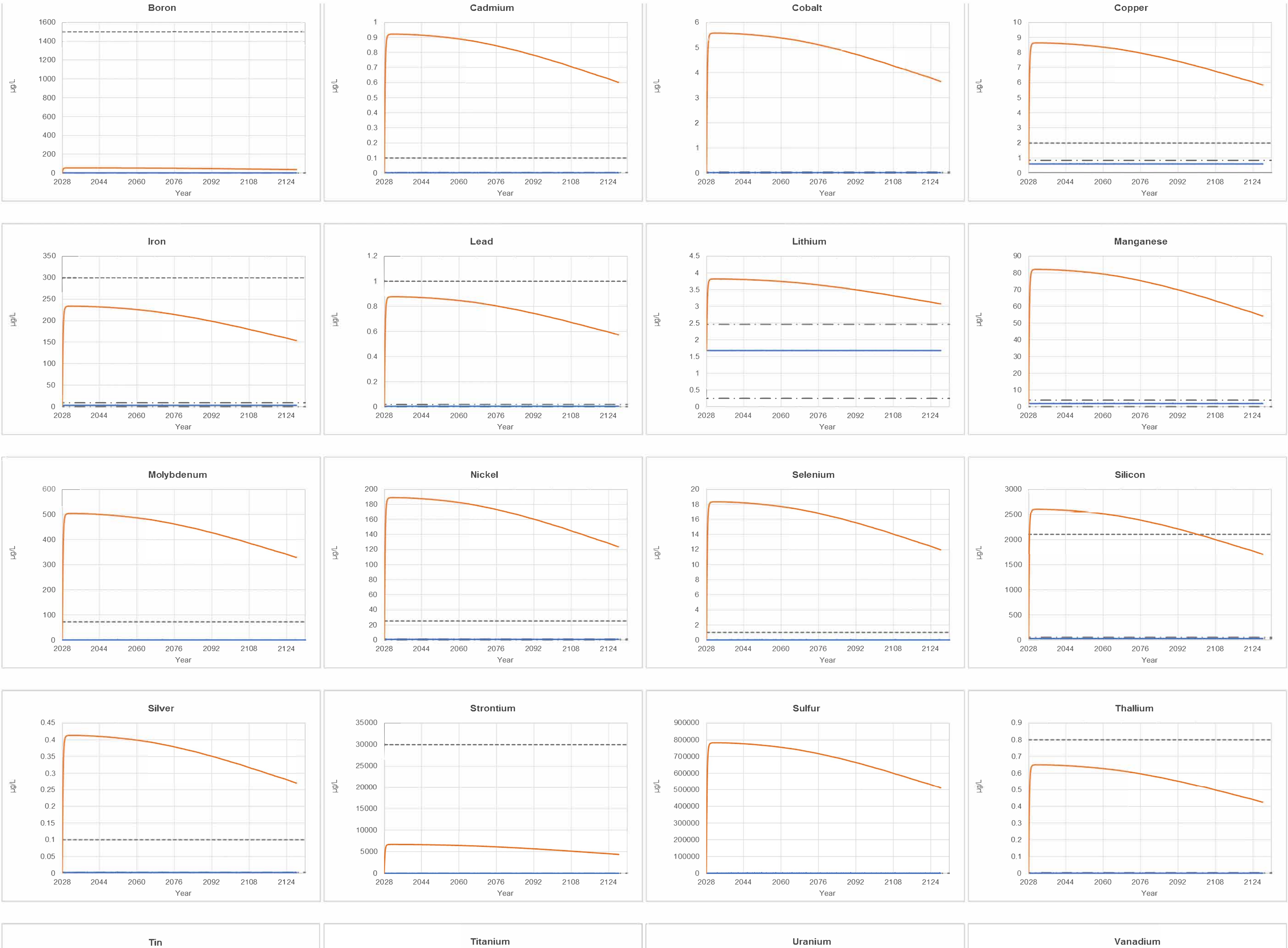


Figure A-8: Predicted time Series of A21 Pit Lake Constituent Concentrations – Sensitivity Scenario 1 (continued)

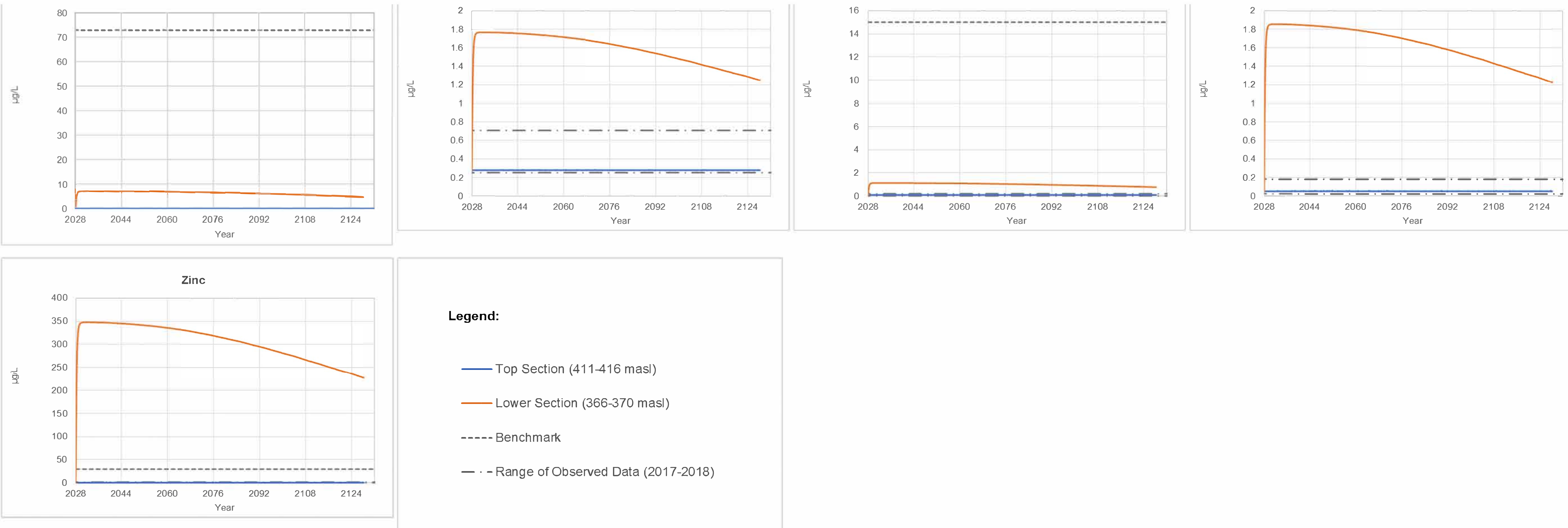


Figure A-9: Predicted time Series of A21 Pit Lake Constituent Concentrations – Sensitivity Scenario 2

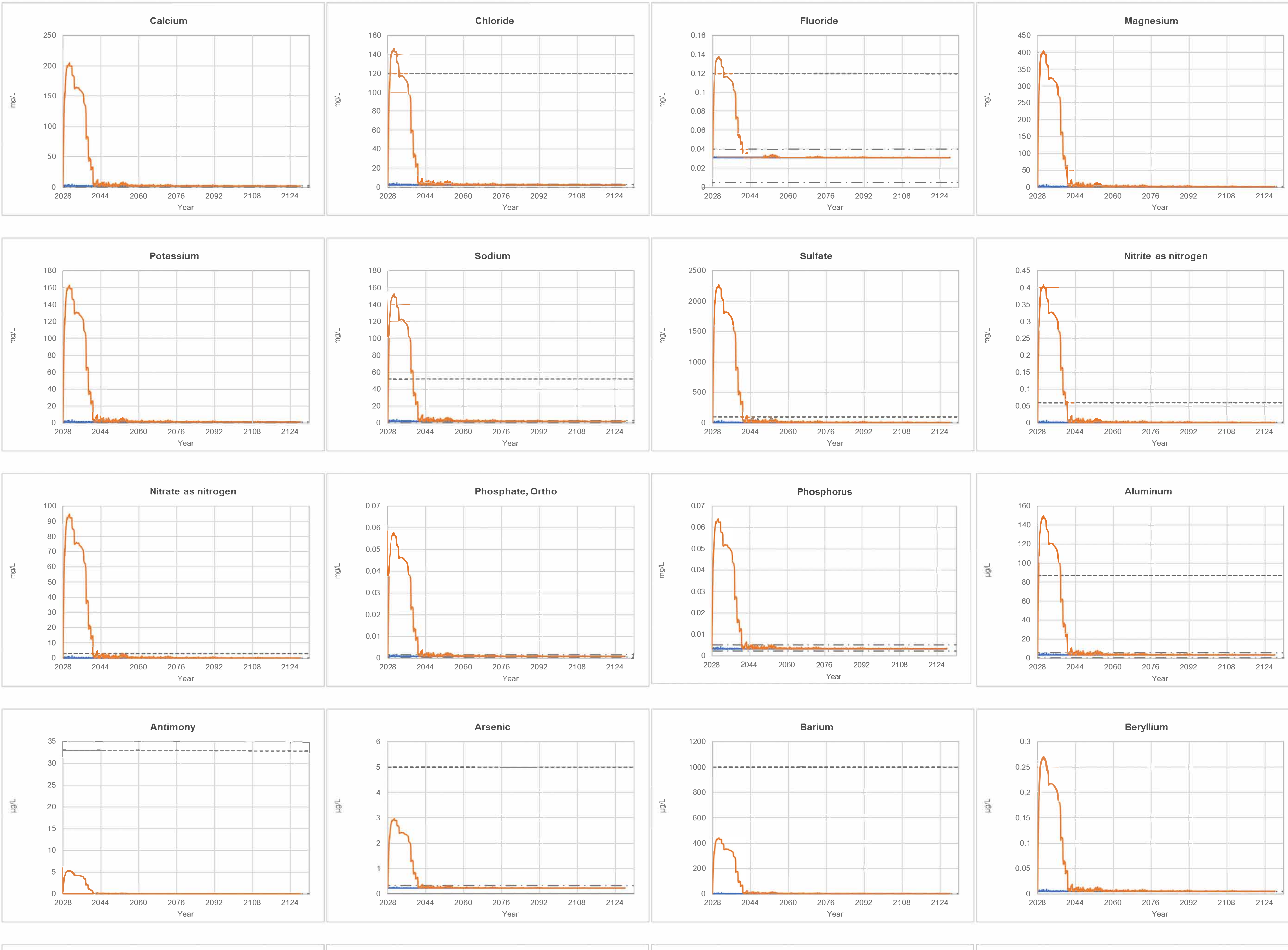


Figure A-9: Predicted time Series of A21 Pit Lake Constituent Concentrations – Sensitivity Scenario 2 (continued)

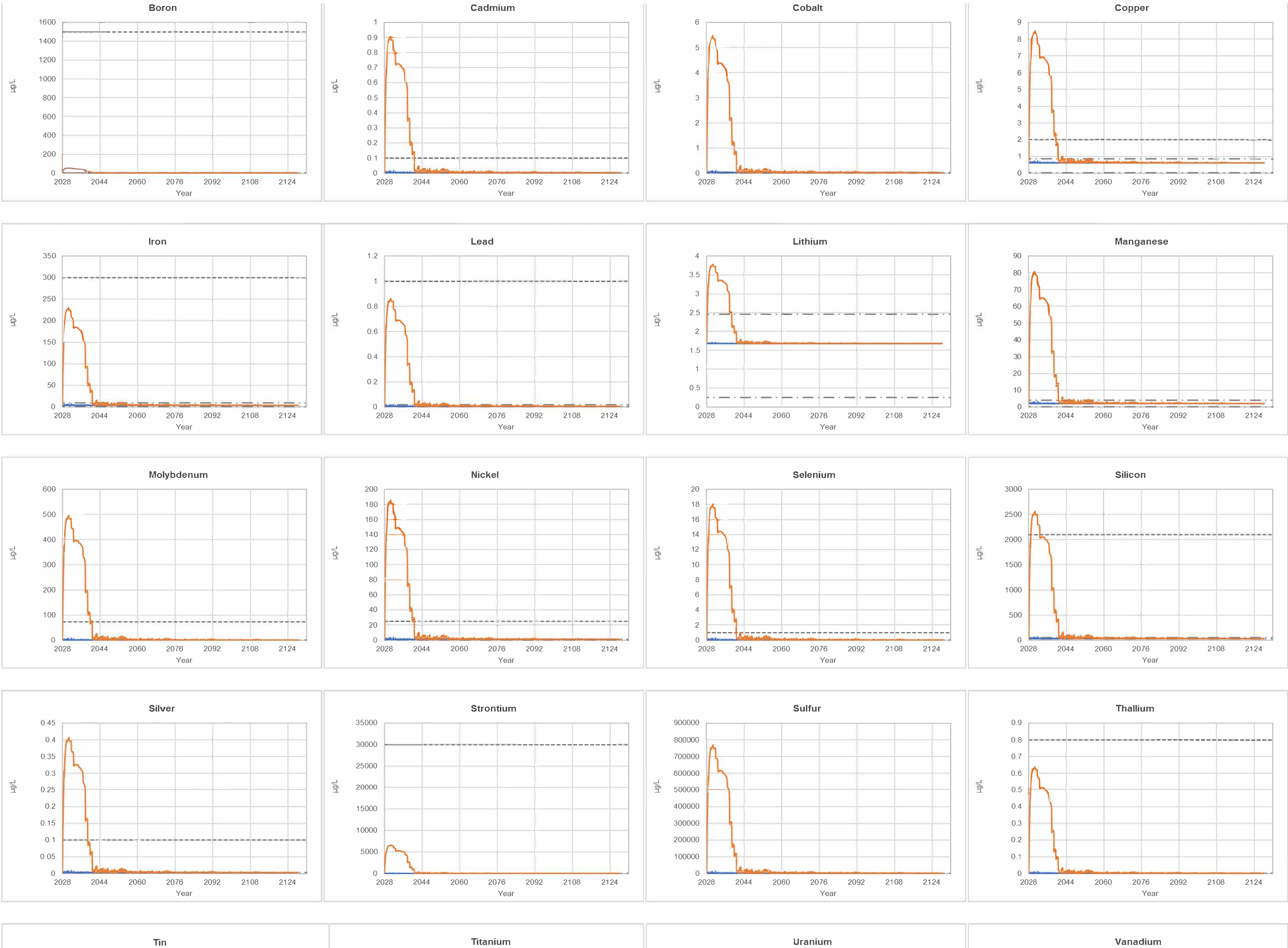
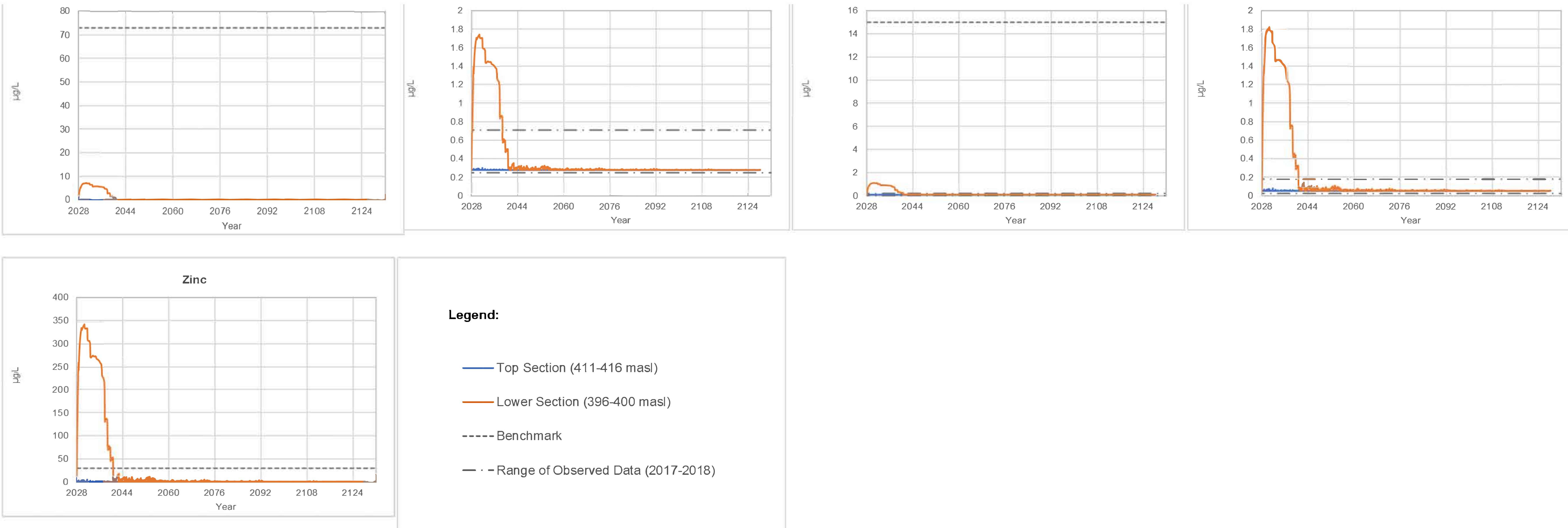


Figure A-9: Predicted time Series of A21 Pit Lake Constituent Concentrations – Sensitivity Scenario 2 (continued)



DDMI Traditional Knowledge Panel Session #11

OPTIONS FOR PROCESSED KIMBERLITE

Diavik Diamond Mine, NT

May 10–14, 2018

Thorpe Consulting Services

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Diavik Diamond Mines (2012) Inc.
Traditional Knowledge Panel Report

Session #11: *Options for Processed Kimberlite*

Diavik Diamond Mine, NT
May 10–14, 2018

Facilitation

Joanne Barnaby, Joanne Barnaby Consulting
Natasha Thorpe, Thorpe Consulting Services

Participants

Kitikmeot Inuit Association	Bobby Algona, Nancy Kadlun, Regan Adjun (youth)
Łutsel K'e Dene First Nation	Doris (Terri) Enzoe, Cecelia Sarazine (Sara) Boucher, Kohlman Enzoe (youth)
North Slave Métis Alliance	Kathy Arden, Wayne Langenhan
Tłı̨chǫ Government	Dora Migwi, Louis Zoe, Mason Beaverho (youth), Peter Huskey (interpreter), James Rabesca (interpreter)
Yellowknives Dene First Nation	Rose McKenzie, Angus Martin

Observers/Presenters/Visitors

Environmental Monitoring Advisory Board	John McCullum, Allison Rodvang (observers on May14)
Tłı̨chǫ Government Lands Department	Joline Huskey (observer)
Diavik Diamond Mines Inc.	Peter Gillies, Steve Rowles, Shelby Skinner, James Sovka, Nathan Wolfenden
C&E Consulting	Colleen English
Thorpe Consulting Services	Kaylee McKinney (transcriber)

Interpreting equipment provided by Pido Productions.

Background

Since 2011, the Traditional Knowledge (TK) Panel has guided Diavik Diamond Mines (2012) Inc. (Diavik) to appropriately and meaningfully consider of Traditional Knowledge (TK) in operations, environmental management and monitoring as well as closure planning at the Diavik Diamond Mine. The TK Panel has been meeting since 2012 and continues to gather at least once a year to discuss select issues and concerns related to the Diavik Diamond Mine (Figure 1). The most recent gathering was held at the Diavik Diamond Mine from May 10–14, 2018 to consider various options for handling processed kimberlite on-site through operations and closure.

Session Purpose and Overview

The purpose of TK Panel Session #11 was for participants to explore options for processed kimberlite (PK) for operations and closure/post-closure, "see with their own eyes" the open pit and underground mining areas (A154 and A418) and processing plant, and respond to Session #10 recommendations around the South Country Rock Pile and watching/monitoring made by TK Panel members.

The possibility and technicalities of placing PK into the A418 mine workings—possibly moving much of the PK from the current containment facility (i.e., the processed kimberlite containment, or PKC) as well as the option to put PK from the process plant in the mine areas without emptying the PKC—were discussed. Finally, the TK Panel considered the implications of continuing PK disposal within the current containment. Panelists were asked about their comfort around each option.

During previous sessions, TK Panelists suggested that an underground and open pit tour would help them to understand the nature of mining kimberlite for diamonds to better provide guidance on closure options for PK. During this session, DDMI accommodated this request. These learnings built upon previous session discussions around PK, PKC and closure and enabled people to provide informed guidance and recommendations. In particular, the TK Panel revisited findings from Session #6 which focused on the PKC.

A short presentation highlighted PK disposal at other mines (e.g., Ekati) and spoke of diamond mines facing similar challenges around waste rock throughout the world. The Diavik mine is unique given that the kimberlite pipes are located under a lake. This background information provided additional context for the Panel members when evaluating PK disposal options on-site.

Diavik also presented revisions to the site-wide Closure and Reclamation Plan (CRP V4) which informed the subsequent discussions around the proposed flooding/filling of the open pits, inert waste disposal in pits and PK to underground/pit options, focusing on A418.

In addition, details on underground dewatering were highlighted in a presentation that also touched on fault systems, the water table and drill holes to manage water in the underground. These explanations provided context for individuals and aided in the discussions around potential impacts from filling pits with water, PK, waste, etc. at closure.

Finally, the TK Panel reviewed responses from Diavik to recommendations from the TK Panel Session #10 Focus on 'Watching' and the South Country Rock Pile. In addition, they developed new recommendations for review and consideration by Diavik, including suggestions for future TK Panel sessions. This format is the same as that of previous sessions and provides strong consistency, feedback, and communications between the TK Panel members and Diavik staff.

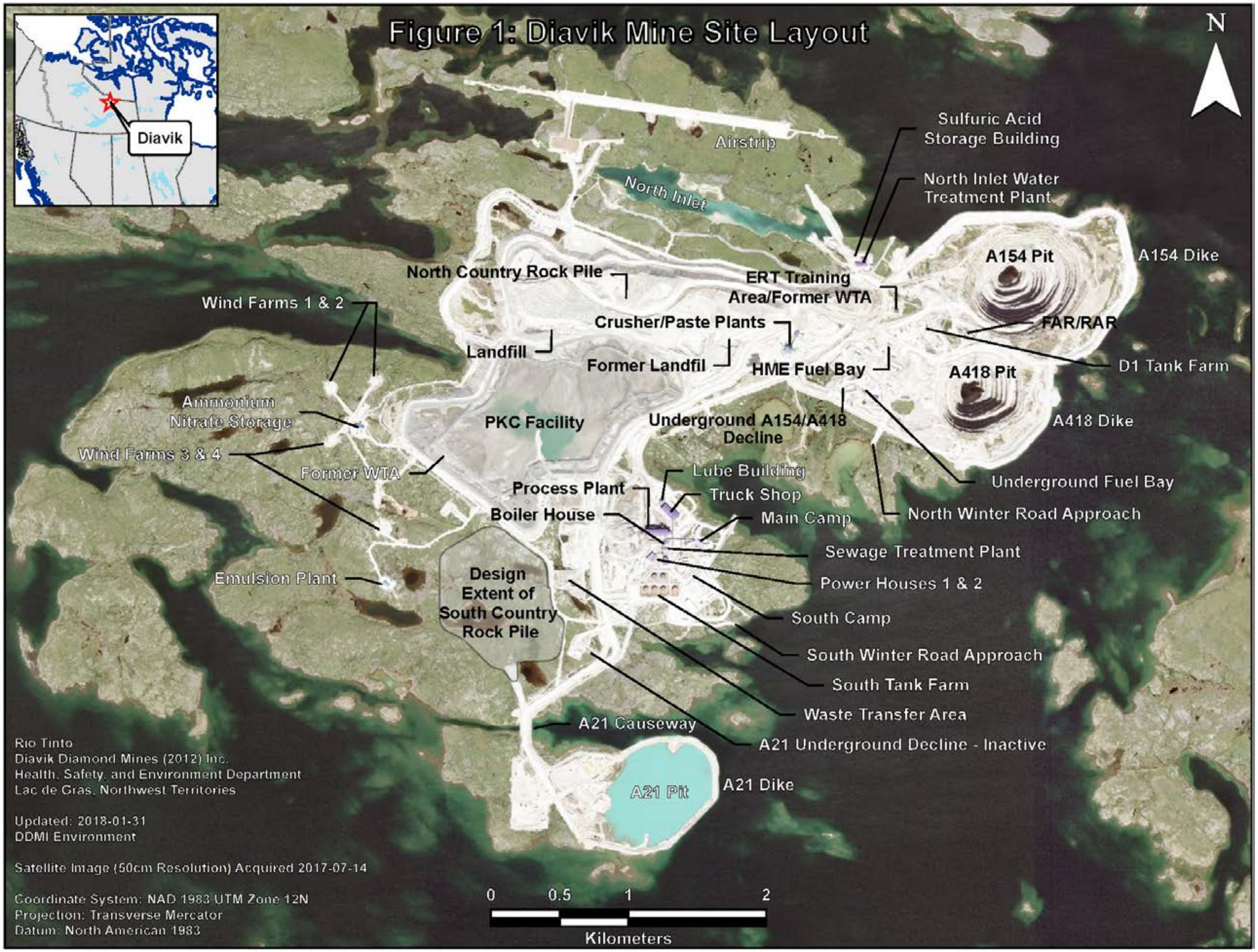


Figure 1: Diavik Mine Site Layout
N
Diavik
Airstrip
North Inlet
Sulfuric Acid
Storage Building
North Inlet Water
Treatment Plant
A154 Pit
A154 Dike
North Country Rock Pile
ERT Training
Area/Former WTA
Wind Farms 1 & 2
Crusher/Paste Plants
FAR/RAR
Landfill
Former Landfil
HME Fuel Bay
A418 Pit
D1 Tank Farm
Ammonium
Nitrate Storage
PKC Facility
Underground A154/A418
Decline
A418 Dike
Wind Farms 3 & 4
Former WTA
Lube Building
Underground Fuel Bay
Process Plant
Truck Shop
Boiler House
Main Camp
North Winter Road Approach
Sewage Treatment Plant
Emulsion Plant
Design
Extent of
South Country
Rock Pile
Power Houses 1 & 2
South Camp
South Winter Road Approach
South Tank Farm
Waste Transfer Area
A21 Causeway
A21 Underground Decline - Inactive
A21 Dike
A21 Pit
Rio Tinto
Diavik Diamond Mines (2012) Inc.
Health, Safety, and Environment Department
Lac de Gras, Northwest Territories
Updated: 2018-01-31
DDMI Environment
Satellite Image (50cm Resolution) Acquired 2017-07-14
Coordinate System: NAD 1983 UTM Zone 12N
Projection: Transverse Mercator
Datum: North American 1983
0 0.5 1 2
Kilometers

Session Goals and Activities

The TK Panel reviews closure plans for various areas of the mine, shares their knowledge in relation to each topic, and presents recommendations to Diavik. In this way, they are continually building their understanding of the mine site and its closure challenges, while also directly influencing Diavik's closure plans.

The goals for Session #11 were to:

- Review input incorporated to date and provide an opportunity for input on progressive reclamation opportunities (i.e., North Inlet, WRSA-NCRP, PKC, infrastructure, pits and underground);
- Review options for PK disposal and provide input to the proposed plans for disposal of PK in the pits and underground;
- Visit the pit/underground at A154/A418; and
- Review and suggest future session topics for the TK Panel.

The session format followed an established routine, modified according to participant feedback and learnings over the previous ten sessions. At the outset of each session, the group reviews and approves the proposed format and agenda. An evaluation process held at the end of the session then helps to inform and improve future sessions.

As with previous sessions, participants took a brief surface tour of the mine upon arrival to re-familiarize with the site and to have recent changes to the site highlighted by Diavik. On the third day of the session, participants visited the A154 open pit and then selected to go underground or visit the process plant.

The tour of the process plant included an explanation of how the kimberlite moves through the plant, diamonds are extracted, technology automates both recovery of the diamonds and the entire process throughout the plant and safety precautions to keep workers safe. TK Panel members climbed seven stories high into the plant in order to look down at the impressive labyrinth of conveyor belts, crushers, screens, video cameras and platforms.

The tour underground began with a thorough safety briefing and gearing up for going underground. Participants tagged in with their host and learned about the tracking, communication and retrieval systems in place for workers underground. Diavik's hosts took participants to the area where the A418 underground mine connects to the open pit and they were able to see across the space where the kimberlite used to be present. They also visited an area deep in the A418 mine where backfill was being placed into a drift that had been mined out, in addition to visiting two different sump stations to see how water is managed underground. They were able to meet some of the underground employees and see firsthand the type and size of vehicles that operate underground. They travelled across one of the connecting drifts over to the

A154 mine and ultimately exited the underground into the A154 open pit before returning to the mine dry.

As in previous sessions, staff from the Environmental Monitoring Agency Board (EMAB) attended the last day in order to hear the TK Panel present their recommendations to Diavik. EMAB distributed a one-pager, inquired about how EMAB could best support the TK Panel, and asked whether it would be appropriate for EMAB staff to attend future sessions in their entirety rather than just on the final day.

Report Outline

This report outlines key themes related to PK disposal options considered by the TK Panel and presents their subsequent recommendations.

Appendix A includes photos from the session and field trip. Appendix B contains the session agenda while Appendix C provides a blank copy of the informed consent form that was signed by participants or observers new to the TK Panel. Session notes were reviewed and verified by the speakers and included in Appendix D. Appendix E contains a background presentation on PK and highlights previous recommendations related to PK and the PKC made by the TK Panel. Appendix F contains presentations given to the TK Panel by Diavik related to the CRP V4, underground dewatering, and the proposed PK to A418 water licence amendment.

The TK Panel gave their guidance and recommendations on options for PK disposal as shown in Appendix G. Diavik presents their response to TK Panel Session #10 recommendations on watching/monitoring and the South Country Rock Pile in Appendix H. A short presentation used for discussion on the next steps and session topics is included in Appendix I, followed by participant evaluations summarized in Appendix J.

Proceedings: Key Questions and Themes

The TK Panel was tasked with exploring guiding questions during this session. The original questions proposed by the facilitators as well as the general direction of the session were modified with input from the TK Panel over the course of the session. Key guiding questions included:

- What other information do you need to feel comfortable with PK material being placed in mine areas? What questions do you have that you want answered?
- Can you share your knowledge of how fish use deeper waters to help predict fish behavior in the pits once they are filled with water?
- If Diavik goes ahead with putting the PK in the pits and the mineshafts, what would you want to watch at closure to know that it is good? For example, once the pits are filled with water and before connecting back to Lac de Gras as well as once reconnected.

Throughout discussions to consider these questions, the following key observations emerged:

- Seeing A154 was important in helping the TK Panel to think about and consider the option to put PK in the mine area;
- Results presented from the PK toxicology study previously recommended by the Panel helped people feel more comfortable about various disposal options for PK in mine areas;
- Stability of the pits (cracks, fissures) and underground areas are a significant concern, particularly around the potential for water leakage;
- Contamination in the mine areas remains one of the biggest concerns, particularly around water; and
- When considering options for PK, the significance of climate change impacts must be acknowledged and part of any plan.

This session slightly differed from previous sessions in that time for plenary discussion was reduced in order to facilitate the process plant and underground tours and the technical discussions and presentations that were invaluable in providing a strong understanding for members considering underground disposal of PK.

The TK Panel made a total of 16 recommendations, as outlined above and presented in Appendix G.

The resulting recommendations centred on the following themes as detailed above and summarized below:

- Closure Planning (PKC versus Pits)—Three recommendations pertained to moving the PK and PKC slimes from the PKC into the pits.
- Fish—Three recommendations spoke directly to fish, fish habitat, and movement particularly if the pits and underground were to be filled with PK.
- Water—The quality of water in the North Inlet and the pits were highlighted in two recommendations. However, water quality was at the core of almost all of the recommendations made during this session.
- Watching (Monitoring)—With caring for and protecting the land for future generations at the forefront of people’s minds, the TK Panel put forth six recommendations specific to monitoring PK.
- Wind—Two recommendations related to how wind behavior could affect water quality and overall mixing of lake waters both inside and outside the dikes.

Recommendations are numbered to reflect the TK Panel session identification (i.e., Session 11) and to subsequently identify each specific recommendation (i.e., 11.1–11.16). Diavik will consider these and add them to their Recommendations Tracking Table. Diavik’s response will be presented back to the TK Panel at the next session.

1. Closure Planning

Diavik gave an overview of the updated site-wide Closure and Reclamation Plan (V4) after which Panel members spoke about their observations of change and concerns about planning for climate change during reclamation. There was also discussion about how scrap metals and materials should be sorted. Diavik responded that a demolition inventory will be created. Community members continue to want to know what materials will be left behind upon closure and what might be donated or taken off site. It was suggested that this could be the topic of a future session.

Comments around onsite monitoring were made, in particular with respect to the importance of watching wildlife and reporting types observed and their behavior. The Environment Department explained that there is ongoing monitoring of wildlife, as well as water quality as part of the AEMP and SNP programs. The TK Panel had questions around caribou safety near the pits and on roads, contaminants and nutrient loading in water, dust and mercury levels in both fish and water. The TK Panel was pleased to learn that Diavik has adopted the TK Panel recommendation to leave the wall between the North Country Rock Pile (WRSA-NCRP) and the PKC steep as a barrier to prevent wildlife from moving from the top of the pile down into the PKC area at closure.

Questions were asked around whether there were other examples of diamond mine closure in Canada, but there isn't yet and there are no other examples in the world where closure of pits in a lake has taken place. A backgrounder on diamond mine closure was presented the next day and discussions followed noting that mining practices in Canada have changed over the years such that companies can no longer simply walk away. Diavik is required to carry out closure and reclamation. As a safeguard, Diavik was required to post a multi-million dollar security deposit with the government.

In the words of one TK Panel member, specific ideas around closure were offered since "we need to help the company make the right decisions and do the best clean up and reclamation so we aren't leaving the problem for future generations."

Processed Kimberlite and Pits/Underground

Another Diavik presentation followed, detailing the possibility and logistics of putting PK into the underground and pit mine areas, starting with A418, and then possibly A154 and A21. It was acknowledged that timing is an issue in terms of filling pits given that A418 will be ready to be filled while A154 and A21 will still be in operation. Follow-up discussion provided clarification on groundwater, connectivity between underground chambers, monitoring, PK properties and more. The TK Panel weighed the options of placing PK in the PKC versus A418. Much of the session was spent exploring details around this concept which required considerations such as the size of the pit and underground voids, stability, groundwater, physical and chemical properties of PK. Specifically, the TK Panel explored the question: *What other information do* *you need to feel comfortable with PK material being places in mine areas? What questions do you have that you want answered?*

The TK Panel was interested in learning about the dimensions and volume of A418 compared to the volume of PK generated for operations and closure. For A418, there is approximately 7.5 million cubic metres in the underground and when combined with the pit volume, the total is approximately 25 million cubic metres. The volume of materials presently in the PKC has not yet been calculated. The operational slurry is expected to be approximately 5 million cubic metres.

Other participants questioned whether the PK might generate heat or at least conduct heat thereby not freezing when placed in the underground/pits. Diavik confirmed that the PK does not generate heat, and that they don't expect it to freeze in the mine working areas.

The TK Panel discussed whether there was anything different that should be planned or monitored around the pit given the new proposal to put PK in the mine areas and cover it with water. The group was reminded of their recommendations to convert the road going into the pits into wildlife ramps in particular places (see Session # 6). One member suggested that there should be gentle slopes of the pits while another recounted previous discussions of the PKC where large boulders would be placed at the edge of the pond to prevent wildlife from falling or jumping in and not being able to get out and wondered if the same should be applied at the dike. The TK Panel generally agreed that the wildlife ramps would remain and that the break in the 1 km cliff on A418 was still important. Further discussion may be required to provide additional clarification or direction.

Panel members weighed the options of disposing PK into the PKC versus the pits/underground, considering the potential effects on wildlife, fish and the environment. As discussed during previous sessions, Diavik reminded the Panelists that a concern about the PKC are the slimes that form a consistency like toothpaste and can be harmful to wildlife or people that may get stuck in it owing to its physical properties. After much consideration, the TK Panel put forth the following recommendations:

- 11.1 If the PK goes to the mine area, the TK Panel recommends that all of the PKC slimes also be put into the pits. There is interest in moving as much of the slimes as possible from the PKC into the mine area and away from the surface where wildlife might gain access.
- 11.2 If Diavik moves ahead with putting PKC slimes into the mine areas, the Panel requests to review any changes to the PKC closure plan. For example, if it is not possible to move all of the slimes in the PKC to the mine area and some of the slimes remain in the PKC, the TK Panel may recommend that the PKC is topped with large boulders to discourage wildlife and people from entering.
- 11.3 The beach materials and rough kimberlite should stay in the PKC area (i.e., anything that can support a rock cover).

2. Fish and Water

Discussions around fish were guided by the question: *Can you share your knowledge of how fish use deeper waters to help predict fish behavior in the pits once they are filled with water?*

Panelists were particularly interested in knowing whether PK would affect fish and water, and expressed significant concern that fish might ingest PK or that PK may affect fish gills. The differences between the types of PK were reviewed (e.g., slimes, fines, coarse), and Diavik presented results from the PK toxicology study that found that PK does not contaminate water or chemically harm fish.

Panel members advised Diavik that sunlight doesn't penetrate to deep water so that fish generally remain in water where nutrients can grow, where the pressure is not too great and where oxygen is plentiful. Panelists expressed concern that the PK could create a "dead" lake given that PK does not support much growth.

When considering filling the underground and pit with PK, Diavik is interesting in learning from the Panel how far from the surface of the water the PK should be filled, if that option is preferred and approved. The Panel discussed at length what this level might be and did not come to a consensus. However, they talked about setting nets 6–7 metres deep since that is where fish can be found. One panel member said that they have set nets 12–14 metres deep on an extremely hot day. One suggestion was to make sure PK was at least 30 metres below the surface of the water, as this is deep enough and fish will not go that deep without a food source to attract them. However, the Inuit contingent suggested that fish can go much deeper, up to roughly 100 metres, which may be a regional difference.

Another suggestion was to spread the PK into each of the three pits rather than filling only one pit, or one pit followed by another. This approach would mean that the PK would not be as deep in each pit in case fish wanted to go into extremely deep water. One suggestion from the women's breakout group was to put PK from operations into the mine areas first and then PK from the PKC afterwards into another pit. Most TK Panel members expressed concern about PK coming in contact with aquatic life. However, if it is decided that PK will be put in the underground/pits, then it was recommended that the PK from the PKC also go underground. In general, the idea that all PK slimes should be removed from the PKC was supported if it is decided that PK will go into the underground/pit.

The TK Panel discussed ways to make the lake bottom more hospitable to fish if the pits were filled with PK. The suggestions to add sediment, sand or rocks/pebbles were made but it was explained that these would just sink into the PK slimes.

The TK Panel recognizes the importance of water to life. The TK Panel questioned whether PK might affect water quality. Discussions centred around how PK may affect fish and how PK in the pits might create a dead lake given that PK does not support much growth. These same concerns have been expressed in previous sessions and prompted Diavik to fund a toxicological study. Once new participants at the session were informed of the results of these studies, the issue was less of a concern.

Questions around fish (e.g. minnows) returning to the pits once the dikes are breached were also asked. The closure plan is for water to flow freely back and forth from inside the dike areas and within Lac de Gras.

Following much discussion and weighing options with fish in mind, the TK Panel put forth the following:

- 11.4 TK holders know that fish generally go where there is food (nutrients) and oxygen so they are unlikely to go to the depth where PK would be.
- 11.5 The Panel would like additional scientific research to see what the effects of PK (ingestion) might be on fish specific to Lac de Gras.
- 11.6 If PK were to go in any mine area, the Panel requests an opportunity to learn more about the depth of water for fish habitat to cover PK (TK and western science).

3. Watching PK

Building on recommendations expressed at TK Panel Session #10, the TK Panel discussed watching (monitoring) requirements for PK whether in the PKC or pits/underground guided by the following question: *If Diavik goes ahead with putting the PK in the pits and the mineshafts, what would you want to watch at closure to know that it is good? For example, once the pits are filled with water and before connecting back to Lac de Gras as well as once reconnected.*

The TK Panel discussed ways of minimizing the suspension of PK once it is put in the underground/pit ranging from installing screens to covering pit walls to adding soil, sediment or aquatic vegetation to try to stabilize the lake bottom. The TK Panel suggested that the PK should be monitored for a time before the dikes are breached to ensure the PK is as expected.

The TK Panel put forth the following recommendations related to watching / monitoring:

- 11.9 The TK Panel recommends that their members are present for at least some of the time when the slimes are moved from the PKC into the A418.
- 11.10 The TK Panel wants to monitor how water behaves when placed on PK. They would like to see the PK and water in the A418 as soon as it is safe to do so and when there is a good visual of the material, as well as at regular intervals afterwards.
- 11.11 The TK Panel recommends that they monitor the fish habitat within the pits, shoreline modifications (e.g., ramps) for wildlife as well as the stability of the dikes on a regular and ongoing basis.

- 11.12 The TK Panel recommends that they monitor freeze-up and break-up within the contained areas (i.e., within the dikes) to see if the formation and melting is any different—with a view towards safety for people and wildlife.
- 11.13 The TK Panel would like to see the PK vegetation plots again.
- 11.14 The TK Panel recommends that we test slimes/PK in a fish tank to see if any water plants would grow on the PK.

4. Wind

Concerns were expressed about the effects of wind on the pit areas at closure, particularly nowadays with climate change and winds becoming stronger. If PK were stored below the water and the pit areas were connected back to Lac de Gras, they want to be sure that the PK would not be stirred up by the movement of the water on windy days. People expressed interest in better understanding wind patterns in and around the contained pits/dikes both now and when they are filled with water as well as in Lac de Gras over a period of time (e.g., throughout all seasons). There were discussions around how wind could affect water movement and mixing, for example, after the pits were closed. Some participants expressed concern that churning waters might mix the slimes. It was discussed that wind can travel across a big lake but some people thought that the dike would protect the filled pits from these big winds. Some participants thought that wind might pose a problem whereas other members expected that the wind wouldn't be much of a problem given the height of the dike walls. The TK Panel decided that they needed to have a clearer understanding of the prevailing winds to understand the potential impact of wind on the pits at closure. One member commented on how the weight of the water above the lake bottom of the pit once it is refilled would be so heavy that there would not be much sediment mixing regardless of the wind.

- 11.15 The TK Panel would like to see wind behaviour on water within the contained pits/dikes over a period of time (i.e. throughout all seasons).
- 11.16 The TK Panel would like to see wind behaviour on Lac de Gras in and around the dikes. [How is the water on the outside of the dikes and breach areas affected by wind?]

5. Tours of the Underground, Pits and Processing Plant

On the third day of the session, TK Panel members first went on a tour to the A154 pit together and then people divided and went either on a tour of the underground or the process plant. The group pit tour included a drive along the dikes of A418 and A154 with an extended stop at the viewing trailer in the pit of A154. From this station, people could visualize the "ice cream cone/carrot" and "ice cream" analogy they had been discussing when considering the PK to pit/underground options (i.e., the cone/carrot is the underground and the ice cream is the open pit). People observed the rock faces and got a sense of the scale of the operations. While driving along the dikes, TK Panel members were able to revisit the areas slated for special fish habitat construction (e.g., shoals and reefs discussed in Session 8) as well as viewing the areas where the dike will be breached upon closure.

There were five Panel members plus two facilitators that took a tour of the underground mining areas at A418 and A154 led by Peter Gillies and Steve Rowles from Diavik. People commented on water seepage, water in the underground, the grouting process that Diavik uses to mitigate water flowing and the extensive network of sumps, pumps and piping systems to move water to the surface (i.e., North Inlet) from the underground. Some people talked about the feeling that it was a wet environment deep in the underground while others talked of it being cold and dry higher up in the pit. People were happy to see some kimberlite as well as garnets and to learn more about the dust suppression (water sprayed in dry areas) so that silica is not inhaled. Everybody who went on the tour commented on how it helped them better understand or visualize what filling up the underground and pit might look like upon closure. Some members talked about the sensors underground that monitor any movement. One member commented on how it seemed to dispel a lot of fears on what could happen underground and that containment of the PK underground would be the best approach. There was also recognition of the strong safety protocols in place.

The group that viewed the process plant commented on the complex conveyor belts and multiple sorting screens. One participant was concerned about the dust within the plant, particularly for employees breathing in fine material, while another suggested that it was less dusty than any other mines he had visited. People spoke of the various screens filtering different sizes of kimberlite and holding PK in their hands to feel the consistency.

TK Panel Next Steps

During each TK Panel session, participants typically re-visit the list of session topics carried out to date and those suggested for the future (Appendix I). During this session, the TK Panel reviewed the list of potential future TK Panel topics:

- Watching / monitoring at Closure
- Updates on PKC closure options
- North Inlet – fish and water health
- Closure Details: building demolition, metal disposal, waste disposal, contaminants, laydown areas, airports, roads, etc.
- Closure Inspection Criteria
- 2018 Aquatic Effects Monitoring Program (AEMP) TK Camp

Further to the EMAB presentation, another topic was to look at how the TK Panel functions and possibly conducting a more thorough review of the recommendations to date. EMAB's presentation also revisited the idea of hosting a women's panel on vegetation. In reviewing the possible future topics list, the following questions were asked: *Are there any questions on these topics? Did we miss anything? Are any not important? Do any of them stand out as a priority?* The TK Panel members reviewed each possible topic and raised their hands in support of all of them.

Other general discussions included the suggestion that both a male and female youth from each group could attend future sessions and to hold the TK Panel meetings during times when the youth are off school. One participant suggested that the next Aquatic Effects Monitoring Program (AEMP) contain a focus on rivers so that people can look at the rivers draining into Lac de Gras. During the session, it was suggested there be a colour code applied to the Recommendations Tracking Table to show which ones have been accepted, in-progress or rejected.

In conclusion, the following recommendations were put forth:

- 11.7 The TK Panel recommends a future TK Panel session dedicated to the health of the North Inlet upon closure and to decide if there is anything to address with the sediments.
- 11.8 The Panel requests that Diavik provide a list of items/equipment that will remain and be removed from underground before flooding or filling the mine with PK/water.

Appendix A

TK Panel Session #11 Photos


Throughout the sessions, caribou gathered outside the sleeping quarters.

Front: Peter Huskey

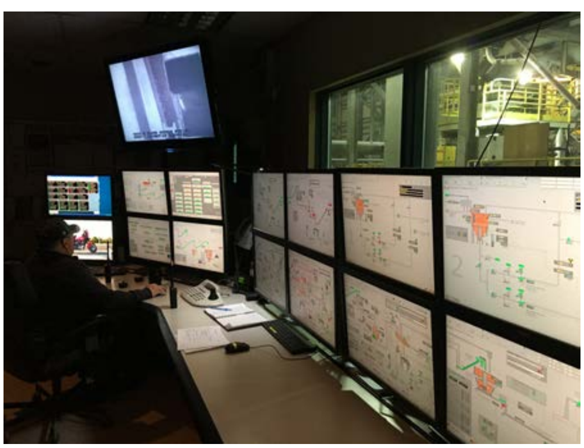
Middle (L to R): Colleen English, Terri Enzoe, Kathy Arden, Nancy Kadlun, Dora Migwi, Joline Huskey, Bobby Algona, Natasha Thorpe, Angus Martin

Rear (L to R): Rose McKenzie, Joanne Barnaby, Louis Zoe, Regan Adjun, James Rabesca, Mason Beaverho, Wayne Langenhan

Processing Plant Tour

Conveyor belts move crushed rock.

Inside the plant. Note the large covered square pipe on the right where mined rock enters the plant.



Cameras and sensors make for an efficient, automated and safe process.

Mason inspects a piece of kimberlite.


Processed kimberlite ready to go to the processed kimberlite containment.


Multiple screens separate out crushed rock.

Underground Tour


Photo by Regan Adjun
Preparing to enter the underground.


Photo by Colleen English
The group learns about diamond mining underground.

Photo by Colleen English
The group views kimberlite.

Photo by Colleen English
TK Panel members underground.

Photo by Regan Adjun
Managing water in the underground.

Photo by Regan Adjun
Driving underground. Note the green lights indicate where the location on the winding road underground.

Photo by Regan Adjun
Looking out of the underground and into the pit.

Photo by Regan Adjun
Common sightings underground.

Viewing A154

Peter Huskey walks with Dora Migwi.

Dora Migwi and Regan Adjun.

View into A154. Note road into pit.

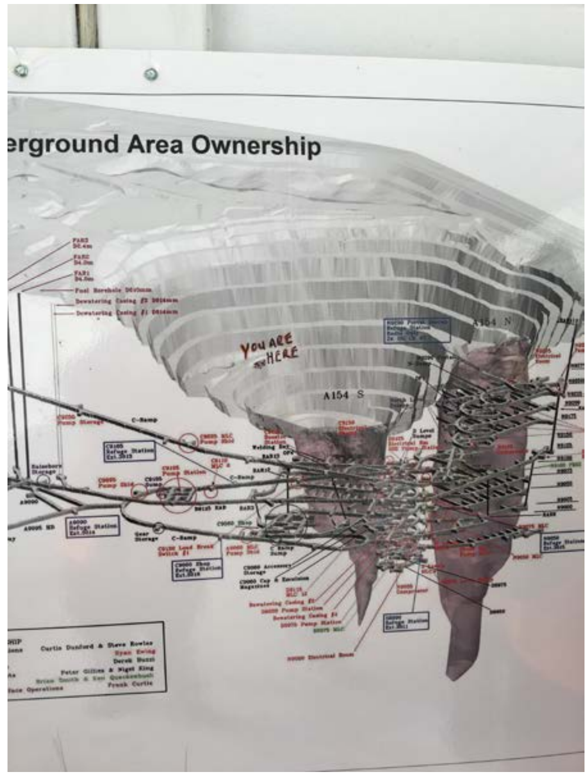
Colleen English points out key features.

Kathy Arden and Rose McKenzie.

Angus Martin And Wayne Langenhan.

TK Panel in the viewing container.

Natasha Thorpe and Nancy Kadlun.



"You are Here" located the viewing container.

Note:
All photos Natasha Thorpe unless otherwise indicated

Appendix B

TK Panel Session #11 Agenda

Thorpe Consulting Services

Final Agenda

Diavik Diamond Mines Inc.
Traditional Knowledge Panel
Session #11: Options for Processed Kimberlite (PK)
May 10–14, 2018

Thursday, May 10

3:00 pm	Arrive onsite - quick surface tour en route to camp (~1.5 hr) Security, Orientation & camp tour (~1 hr) Saturday Tour Preference Discussion Rooms & Luggage assistance

Friday, May 11

8:30 am	Opening Prayer, Welcome, Round Table Introductions, Review Draft Agenda, Workshop Purpose Overview
9:00 am	Presentation: Site overview, Closure and Reclamation Plan, community engagement, Responses to previous session recommendations
	Group Discussion
10:40 am	Presentation: Processed Kimberlite to A418
	Question 1: What other information do you need to feel comfortable with PK material being placed in mine areas?
11:30 am	Lunch
12:30 pm	Group Discussion
	Presentation: Review of TK Panel Discussions of Processed Kimberlite
	Question 2: Can you share your knowledge of how fish use deeper waters to help predict fish behaviour in the pits once they are filled with water?
	Break-Out Discussion
	Report to Plenary
4:30 pm	Close

Saturday, May 12

8:30 am	Presentation: Summary of TK Panel Recommendations Related to PK
10:30 am	Surface Tour (A154) and Underground or Process Plant Tours
4:30 pm	Close

Thorpe Consulting Services

Sunday, May 13

9:30 am	Opening
9:45 am	Debrief from Site Tour
	Plenary or Break Out Group Discussion
	Question 3: If Diavik goes ahead with putting the PK in the pits and mine shafts, what would you want to watch at closure to know that it is good?
11:30 am	Lunch
12:30 pm	Plenary or Break-Out Group Discussion
3:30 pm	Next Steps / Next Sessions, AEMP Camp, EMAB request
4:30 pm	Close

Monday, May 14

7:30 am	Bags & belongings out of rooms, store under stairs in lobby
8:30 am	Opening
8:35 am	Facilitators present draft of TK Panel recommendations for discussion
	Group Discussion: Finalize recommendations
11:20 am	Next Steps/Next Session Group Discussion
11:40 pm	TK Panel Presentation to Diavik: TK Panel recommendations,
	Diavik Response and Group Discussion
12:40 pm	Closing Circle and Prayer
1:00 pm	Lunch
3:00 pm	Check out for return flight

Note: Frequent breaks will be scheduled throughout the day, as needed. Each day will close at 4:30 pm.

Appendix C

TK Panel Session #11 Informed Consent Form

Diavik Diamond Mines Inc. Traditional Knowledge Panel

Informed Consent Form

I, ______________ _________________on May 11, 2018 give permission for Diavik Diamond Mines (2012) Inc. and its Contractors (i.e., Thorpe Consulting Services, Joanne Barnaby Consulting, PIDO Productions) to take notes, photographs and / or audio and video recordings related to my participation in meetings, workshops and events related to the Traditional Knowledge Panel established for the Diavik Diamond Mine. I understand that my participation includes meetings and workshops held throughout each year either in communities in the NWT or NU or at the Diavik Diamond Mine.

Through my signature below, I understand that:

1. I consent to have my words, activities and responses regarding and related to my knowledge recorded on maps, in notes and photographs, and using audio- and video-recording equipment (collectively referred to as Traditional Knowledge Data);
2. I am free to choose not to respond to any questions asked or participate in any discussions without prejudice or penalty;
3. I can choose to be anonymous in my participation without penalty;
4. My representative Aboriginal Organization, DDMI and / or its contractors may use the information collected to contribute to operations and closure planning at the Diavik Diamond Mine;
5. DDMI and its contractors may share my information which I have verified and given permission to share in either reports and/or photographs and provide such information to my Aboriginal organization and other regulators:
6. I agree that my contributions may also be used for future educational, cultural, heritage, and environmental purposes that are outside the scope of the TK Panel and that my representative Aboriginal organization, DDMI and/or its contractors will make all reasonable efforts to consult me, or my descendants, before using my information for purposes not indicated above;

7. I will receive financial compensation for my participation in accordance with DDMI policy;
8. I am free to request that any information I share is removed, erased or deleted and that I will have the opportunity to verify draft video-documentaries, reports and maps to make edits before I sign them off and that final copies will be provided to me;
9. I also understand that DDMI cannot ensure the protection of the Traditional Knowledge from public release once the reports are released (e.g., via youtube.com, Facebook, other social media, or Aboriginal group websites);
10. The Traditional Knowledge Data will be summarized and included in a report which will be publicly available.

Signed on May 11, 2018 in Diavik, Northwest Territories.

Signatures:

______________________	______________________
Participant	Aboriginal Organization
______________________	______________________
Diavik Diamond Mines Inc.	Witness / Contractor

Appendix D

TK Panel Session #11 Daily Notes

Appendix E

Presentation on PK—Backgrounder and Previous TK Panel Recommendations on PK and PKC

Presented to the TK Panel
TK Panel Session #11
May 11, 2018

Processed Kimberlite Backgrounder

Why are we talking about Processed Kimberlite now?

- Diavik needs input from the TK Panel regarding options for dealing with processed kimberlite on-site
- Timing is good in terms of planning for closure at DDMI (early and meaningful input)

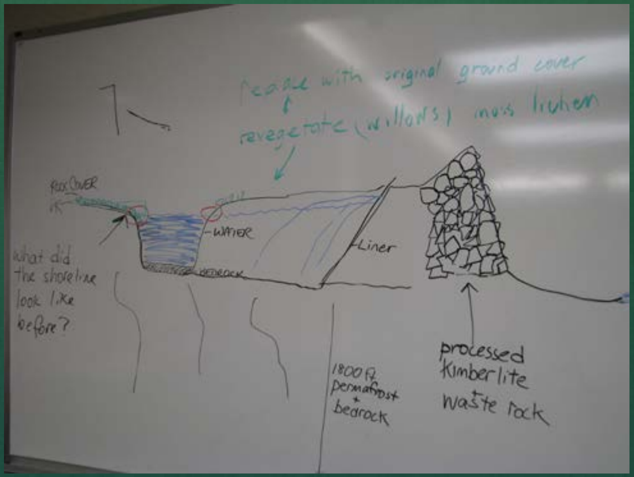
Haven't we talked about Processed Kimberlite before?

- The focus of TK Panel Session #6 in October 2013
- Idea of putting processed kimberlite underground introduced at TK Panel Session #10 in September 2017

Examples of Concerns about PK On-the-Land

- Is there something else that can be done like put in a rock or something so that the rock can settle down into the bottom of that PKC area? . . . if [caribou] tend to jump in, maybe because of that slurry . . .they're going to have a hard time getting out or maybe sinking in the pond. - Bobby Algona (2013)

I prefer that no aquatic things be put back in the PKC pond. I don't think any human being will eat that fish. – Alfred Baillargeon (2013)



TK Panel Recommendations to Date

6.7 Removing the slime offsite remains the preferred option until Diavik can demonstrate through chemical and toxicological analysis that the slime is not harmful to the environment (i.e. plants, wildlife, fish, and humans).

- ✓ Toxicological analysis done (2015-2016)

6.10 Once the slime is removed, line the lake bottom with granite / gravel and rocks and other natural materials that were there before.

TK Panel Recommendations to Date

9.25 Given that the pits are going to be refilled with water, that Diavik is considering putting processed kimberlite and ‘slimes’ into the pits and underground shafts and concerns about tremors and seismic activity, the TK Panel requests a tour of the pits and underground shafts to see the ‘receiving environment’ with their own eyes.

TK Panel Guidance (TK Panel #10)

- There is a concern if slimes were to be put into a pit that they may be released into the environment.
- As long as there are no chemical contamination or physical suspension issues (i.e. the slimes don't mix with the lake water), the TK Panel generally supports Diavik researching this alternative for disposal of the PK into the pits. The rationale for this guidance is that the TK Panel wants the WRSA-SCRP and disturbance footprint on the tundra to be as small as possible – move slimes out of the PKC and use WRSA-SCRP rock to cover the PKC area. It was hoped that this might help prevent wildlife access.

Example: PK in Underground

Ekati

- Currently putting PK into Beartooth
- Plans to put PK into Panda/Koala
- 30 m freshwater cap on top of processed kimberlite (considered conservative and thus under review)

Appendix F

DDMI Presentations on Closure and Reclamation Plan Overview, Water License Amendment and Underground Dewatering

Closure and Reclamation Plan (CRP Version 4) Overview

TK Panel

11 May 2018

Status of Diavik's Closure Plans

- The NCRP Final Closure Plan was submitted to the WLWB for review; it has been approved!
- The site-wide Closure and Reclamation Plan (Version 4) was also submitted to the WLWB and is under review
- A workshop was held by the WLWB during fall 2017
- Likely update to CRP V4.1 based on comments

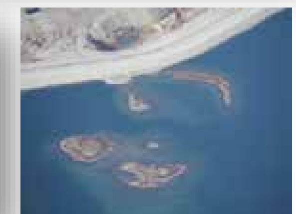
Review of the NCRP Final Closure Plan

- Your hard work paid off!
- Community organizations that reviewed the Plan felt the Panel's recommendations and DDMI's responses were valuable and meaningful
- DDMI met with leadership from each of your organizations to review the Plan and your contributions; your recommendations were echoed and supported by leadership
- Regulatory and DDMI financial approvals were received and progressive reclamation has begun.

Closure Plan by Area – CRP V4

1. Open Pits & Underground
2. North Country Rock Pile
3. Infrastructure
4. North Inlet
5. Processed Kimberlite Containment

1. Open Pits & Underground



CRP V4

- Flood piping/fill options
- Inert waste to pit option
- PK to underground/pit option

TK Panel Recommendations on Open Pits & Underground

- Do not breach the dikes until communities are satisfied that the water quality is okay
- Leave the lake bottom between the dikes and open pit as-is; plants that have grown will help re-growth after flooding; do not build reefs in these areas
- Leave the dikes as they are; do not modify the slope
- Vary the depths of reefs built within the dike areas
- Ensure good habitat for rearing, feeding and resting inside dikes
- Stock water with bugs to improve quality
- Break up 1 km cliff on A418 pit wall
- Leave current road into pits

2. North Country Rock Pile

CRP V4

- NCRP cover construction
- SCRP not yet included
- Re-sloping work has started; cover placement will begin soon

TK Panel NCRP Recommendations

- Do not allow water to pool on top of the pile; include a domed top to promote water drainage
- Have a ‘moat’ around the pile to collect and monitor water coming off/out of the pile
- Focus re-vegetation on the base of the pile, around the ponds; allow the rest to naturally re-vegetate
- Simulate an esker for the final shape of the pile
- Ensure safe wildlife access for all seasons and soft material for caribou feet
- Keep the height as low as possible while ensuring contaminants are contained
- Cap materials with the best material for biodiversity

Rio Tinto

TK Panel NCRP Recommendations Cont’d

- Consider using wetlands for filtering runoff/seepage water around the base of the pile
- Slopes similar to that of the test pile so it is safe for wildlife
- Long-term scientific monitoring to ensure the core remains frozen
- Place a limited number of large boulders on top of the pile for wildlife shelter, and place boulders along the edge between the PKC and NCRP to deter wildlife
- Study wind and snow accumulation on wildlife pathways prior to finalizing slopes and cover

NCRP Re-sloping Underway

3. Infrastructure

CRP V4

- Updated building inventory
- Updated re-vegetation information
- Updated timing for building demolition

TK Panel Infrastructure Recommendations

- Ensure meaningful employment for communities to be involved with closure work
- Create safe passage for wildlife at the site after closure; evaluate ways to keep animals away from certain areas
- Add rock cover and do not re-vegetate areas that were used for waste or hazardous materials storage (e.g. fuel bays, waste transfer areas, etc.)
- The TK Camp and airstrip should remain after closure
- Create safe slopes on the sides of roads and the airstrip, similar to test pile surface
- Do not disturb new areas, except where re-sloping would assist with safe wildlife movement
- Remove equipment, unused buildings, pipes, toxic materials and non-biodegradable items from site
- Scarify (roughen) the surface of old plant sites to support re-vegetation
- Re-vegetate certain areas of the site

4. North Inlet

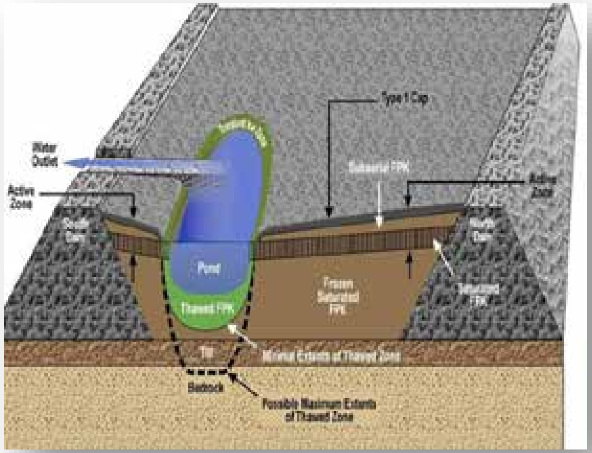
CRP V4

- Evaluated hydrocarbon option
- Change default plan to limited breach

TK Panel North Inlet Recommendations

- Further consideration is required to determine if this area would be a no-go zone for wildlife, or if wildlife use would be encouraged in this zone
- Do not reconnect the North Inlet to Lac de Gras unless the sediments and water are of the same quality as the lake

5. Processed Kimberlite Containment



CRP V4

- Updated to approved closure concept
- Option to go to underground

TK Panel PKC Recommendations

- Cover the area with sand and soil and promote re-vegetation, restore eskers, create wildlife habitat and marshy areas and plant willows
- Return the PKC lake and shoreline to their natural condition, line the lake with rock, re-vegetate with water plants and re-stock with bugs and fish
- Provide safe access for wildlife over the dam by re-sloping and open some sections of the dam to re-create water flow to Lac de Gras
- Leave some areas steep to encourage denning for wolverine, bear, foxes, etc.
- Remove the PK slimes from the mine site at closure
- Conduct toxicological testing on the PK slimes to determine if it is harmful

TK Panel PKC Recommendations Cont'd

- Create barriers to prevent wildlife from moving between the NCRP and the PKC, e.g. steep slopes, boulders
- Filter streams flowing from the PKC by using mosses; monitor this water
- Place a circle of boulders around the PKC pond to deter wildlife from accessing the pond and unstable shore

Additional Questions?

RioTinto

Diavik Dewatering
May 11, 2018

Community Presentation

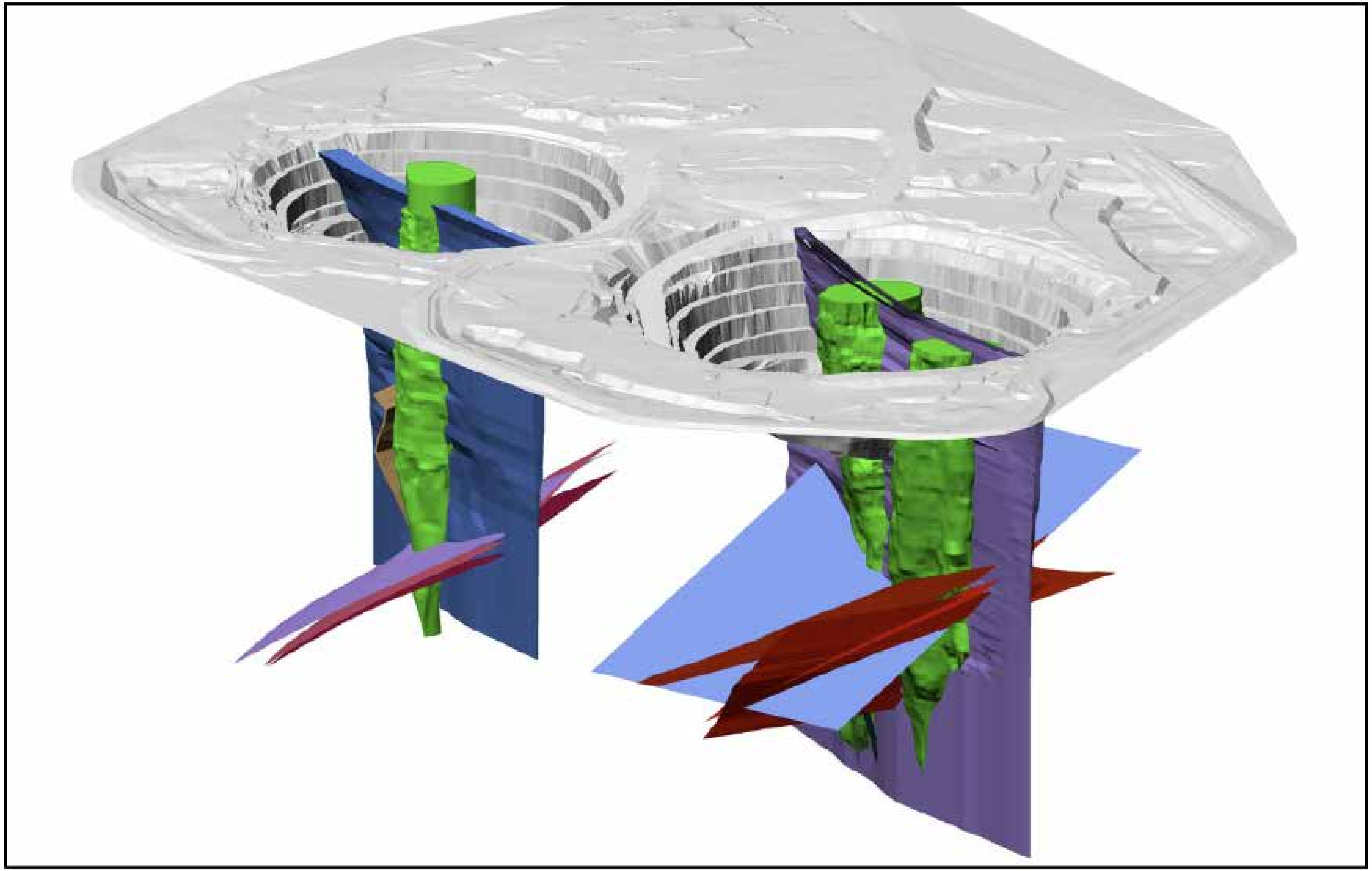
James Sovka

Why Dewater?

- To mine safely.
- Minimize risk of inflows into the workings.
- Maintain stability of the pit walls.
- To efficiently separate clean and dirty water.
- Two systems to handle clean or dirty water.

Fault Systems – Primary Conduits

- Faults and cracks in the ground carry water from the lake.
- This water is clean!
- Goal: intercept this clean water before it reaches the mine workings.
- Method: drill holes to capture water.
- The faults are the primary target.



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The “Mackenzie Diabase Dyke” in the A418 pit.

The “Mackenzie Diabase Dyke” in the A418 pit.

The “East-West Fault” in the lower A418 A-ramp.

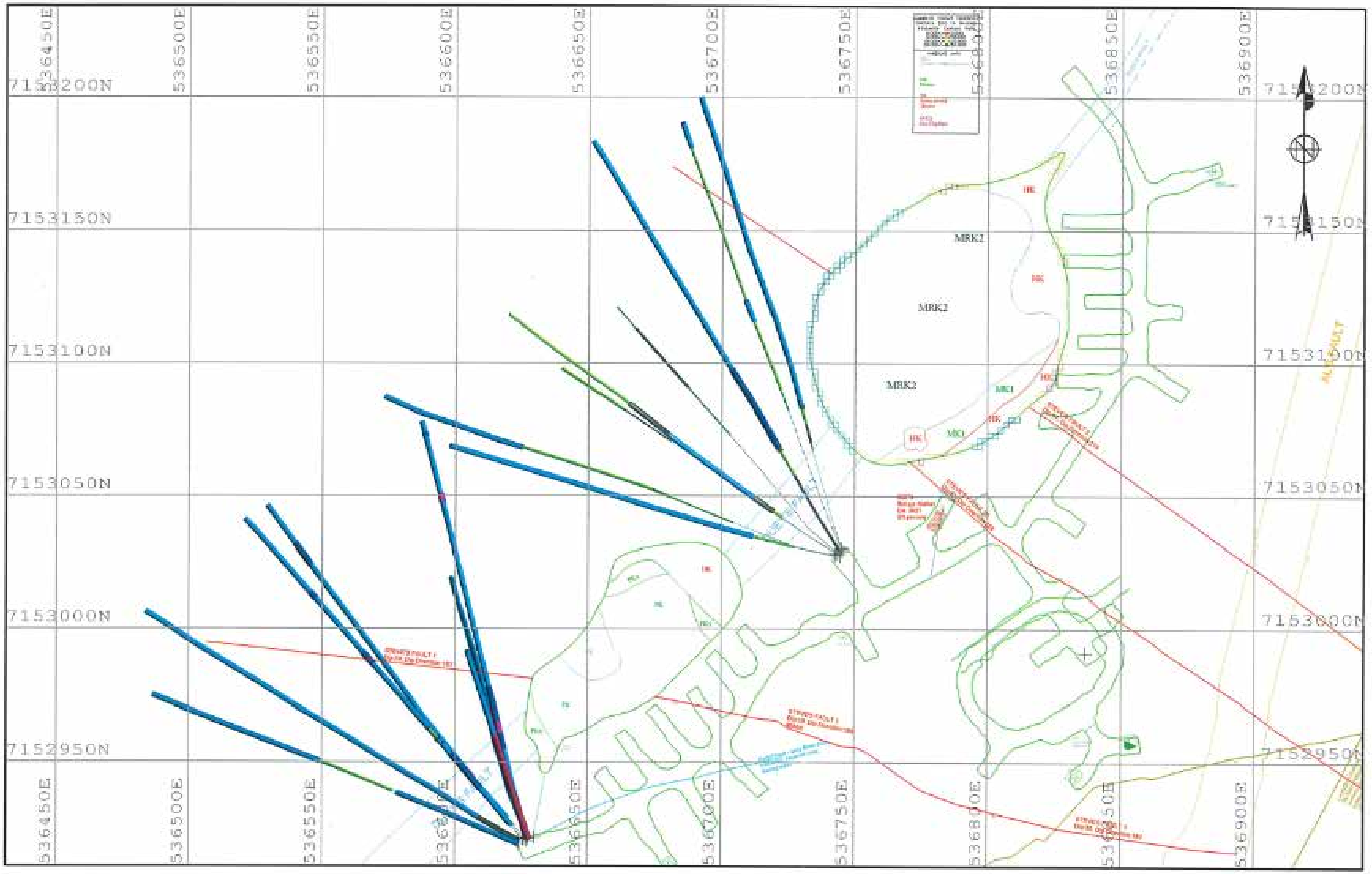
RioTinto

The “Amir’s Fault 3” in the lower A418 A-ramp.

The “Amir’s Fault 3” in the lower A418 A-ramp.

Drill Holes

- We've drilled several thousand kilometers of drill holes!
- Some holes hit over 500gpm of water!
- But other holes are dry…
- Understanding the geology is critical.



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Diamond drill set up on a hole in progress.

Drain Holes

- Drain holes contain clean water, from the faults, which is drawn from the lake.
- Need pipe to connect.
- This water is flown into the pump stations.
- Very good “security” in the case of high inflow or high pressure.

RioTinto

Hole connected with proper collar security.

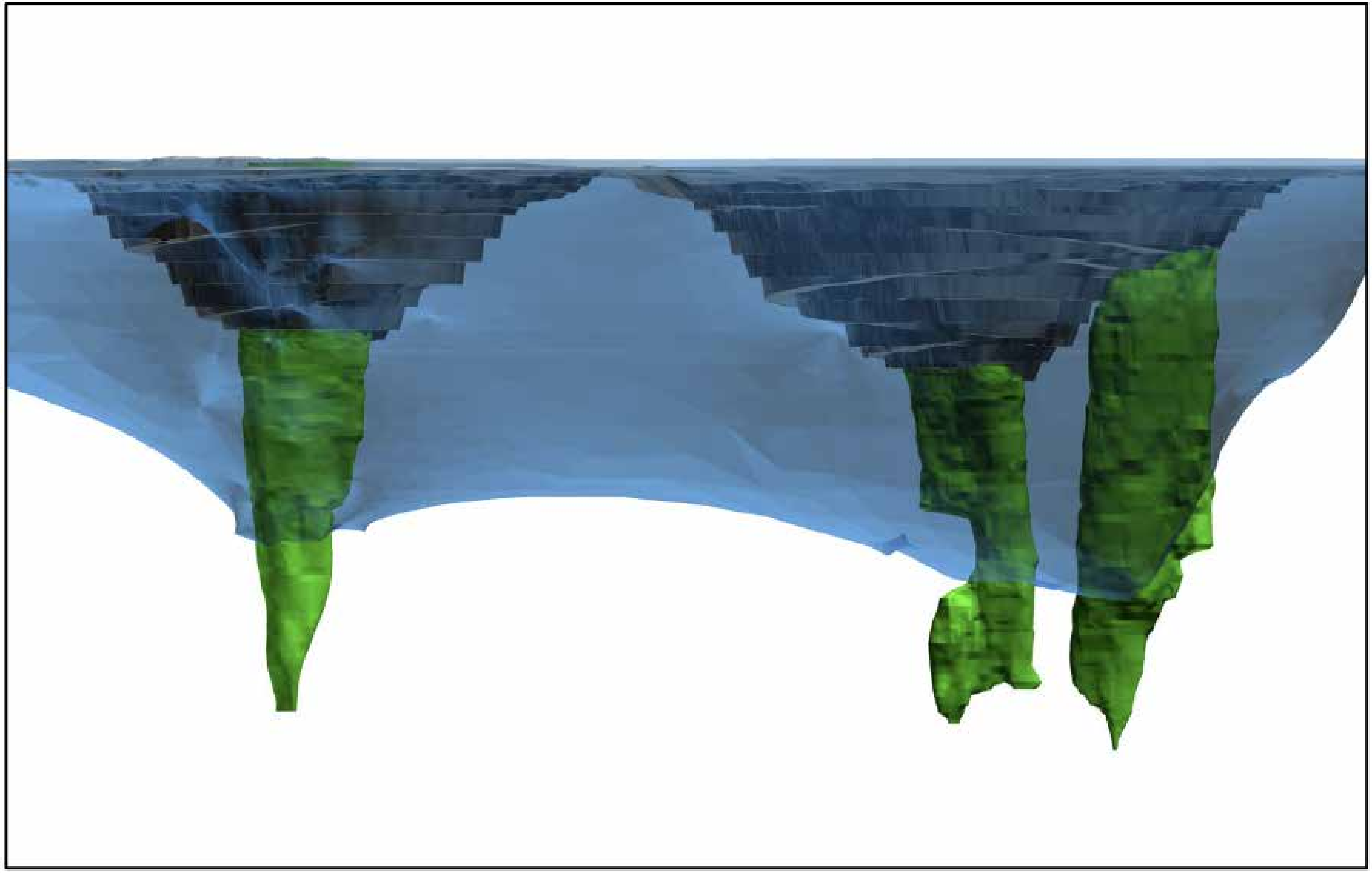
RioTinto

Drill controls and a recently completed drain hole, piped into the system.

Configurations can get a little crazy!

The Water Table

- We've drawn down the water table.
- This is a model of the current water table.
- It can still be wet above, but there will be no pressure.
- The drawdown affects the pressure, which affects the safety of the mine workings.



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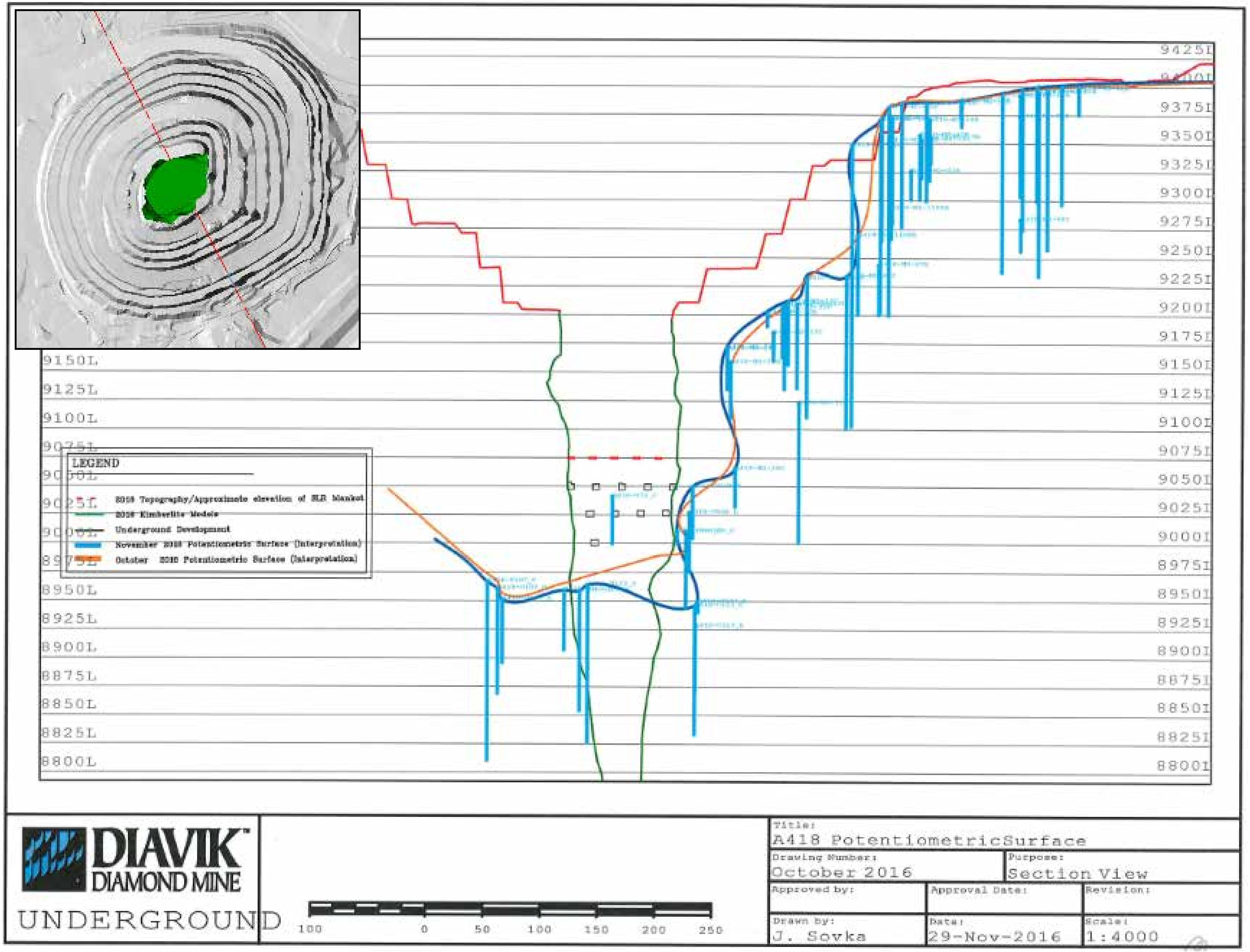
The Water Table

- Section View.
- Each instrument reads a certain level of water above it.
- From many instruments, we can compose a contour.
- This allows for detailed control of when it is safe to release levels for mining.



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Questions?

PK to A418

Water License Amendment

1. Overview
2. Processed Kimberlite Production and Storage Options
3. A418 Pit and Underground, Concept Drawings
4. Environment – Monitoring and Closure
5. Next steps and how you can help

Overview

- Kimberlite is the rock that contains diamonds.
- It is processed on site and any remaining material is deposited on site.
- The remaining material is referred to as ‘processed kimberlite’ (PK).

Overview

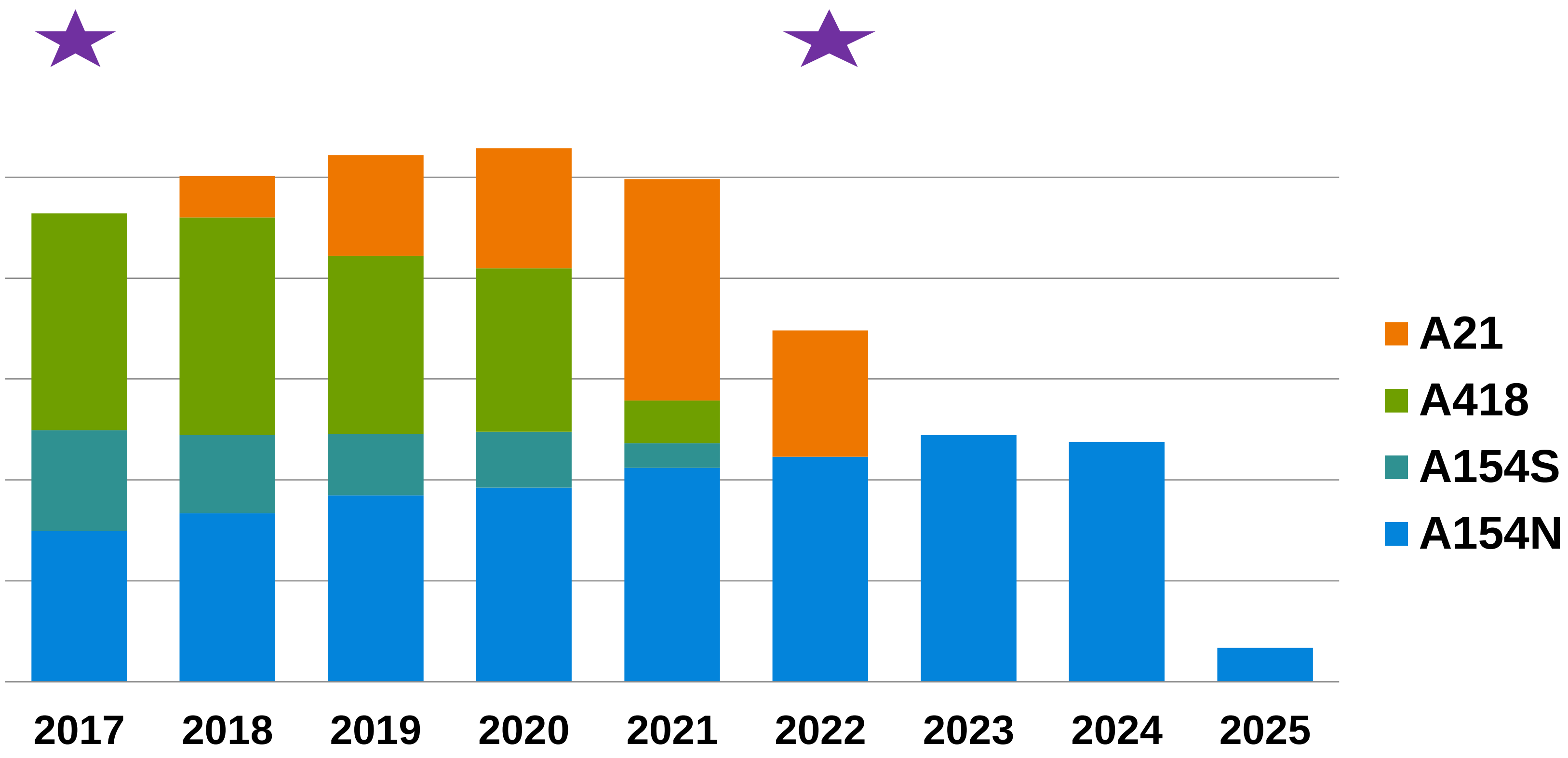
- Processed kimberlite is currently stored within the Processed Kimberlite Containment (PKC) Facility

RioTinto

PK Production and Storage

- Based on the current mine plan, the PKC will be full in 2021.

★ DDMI requires a short-term option for PK deposition (2017-2022), and a long-term option (2022-closure)



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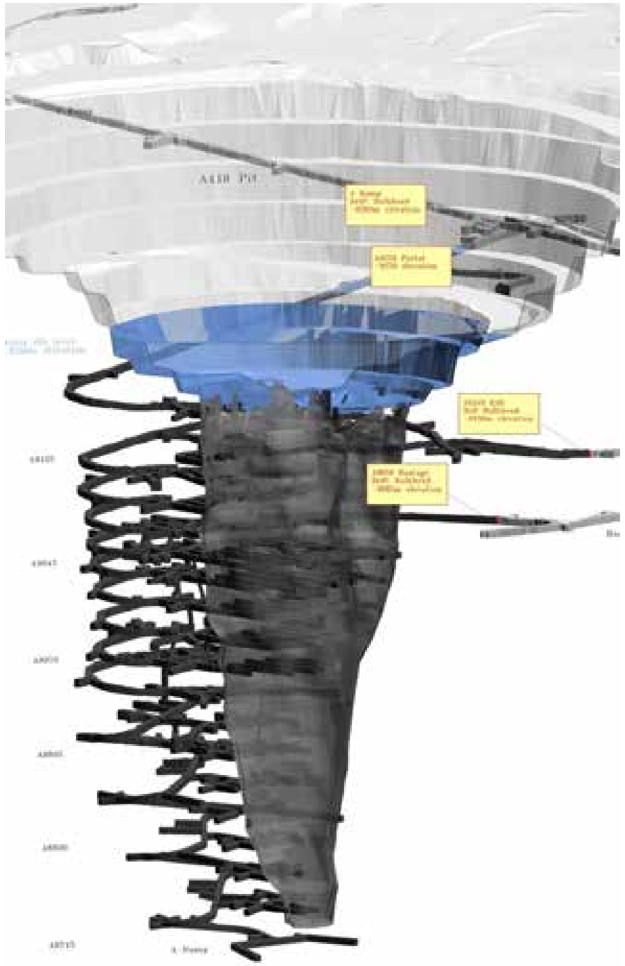
PK Storage Options Analysis

- Multiple options were explored for PK storage:
  1. Traditional PKC Dam raise to hold full PK volume
  2. Remaining PK stored in A418 once mining is complete
  3. Alternative storage locations (North Inlet, collection ponds, etc.)
  4. Combination PKC Dam Raise and A418 storage

- Option 4 was the preferred option based on technical, engineering, closure and cost factors.

PK Storage – Current and Future Operations



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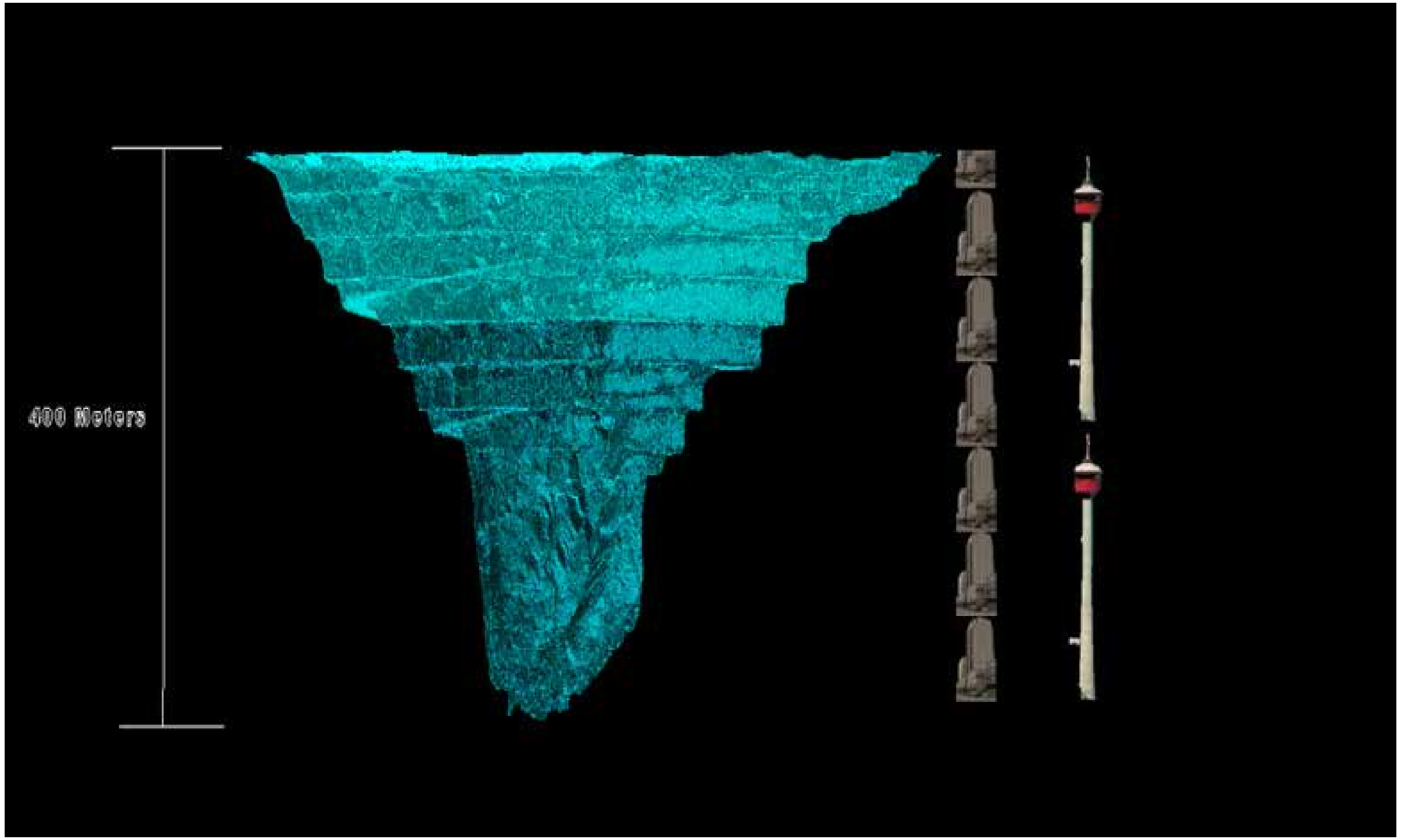
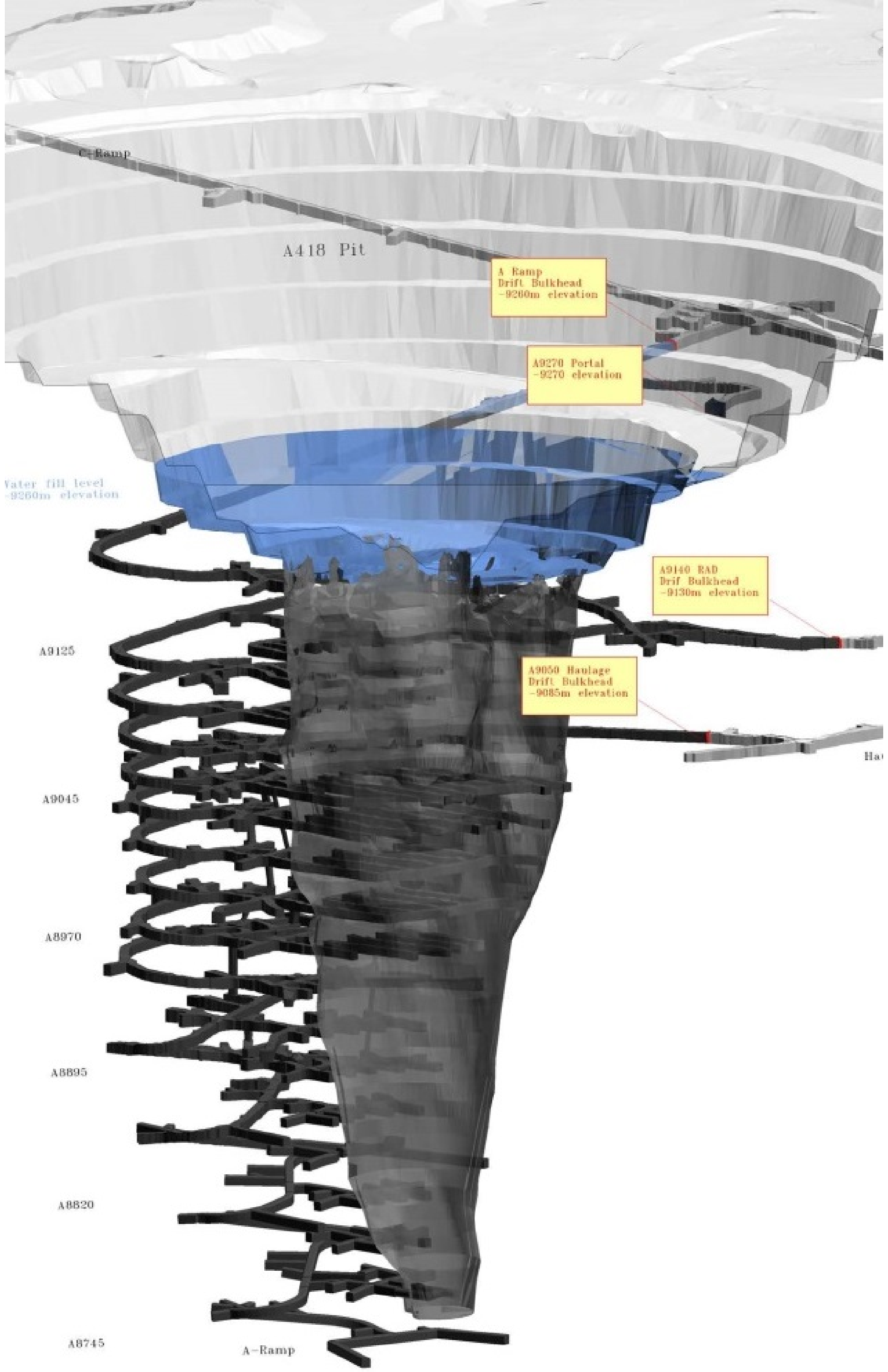
A418 Pit and Underground

- We have explored options for what we can to do with PK, using existing facilities within the mine footprint.





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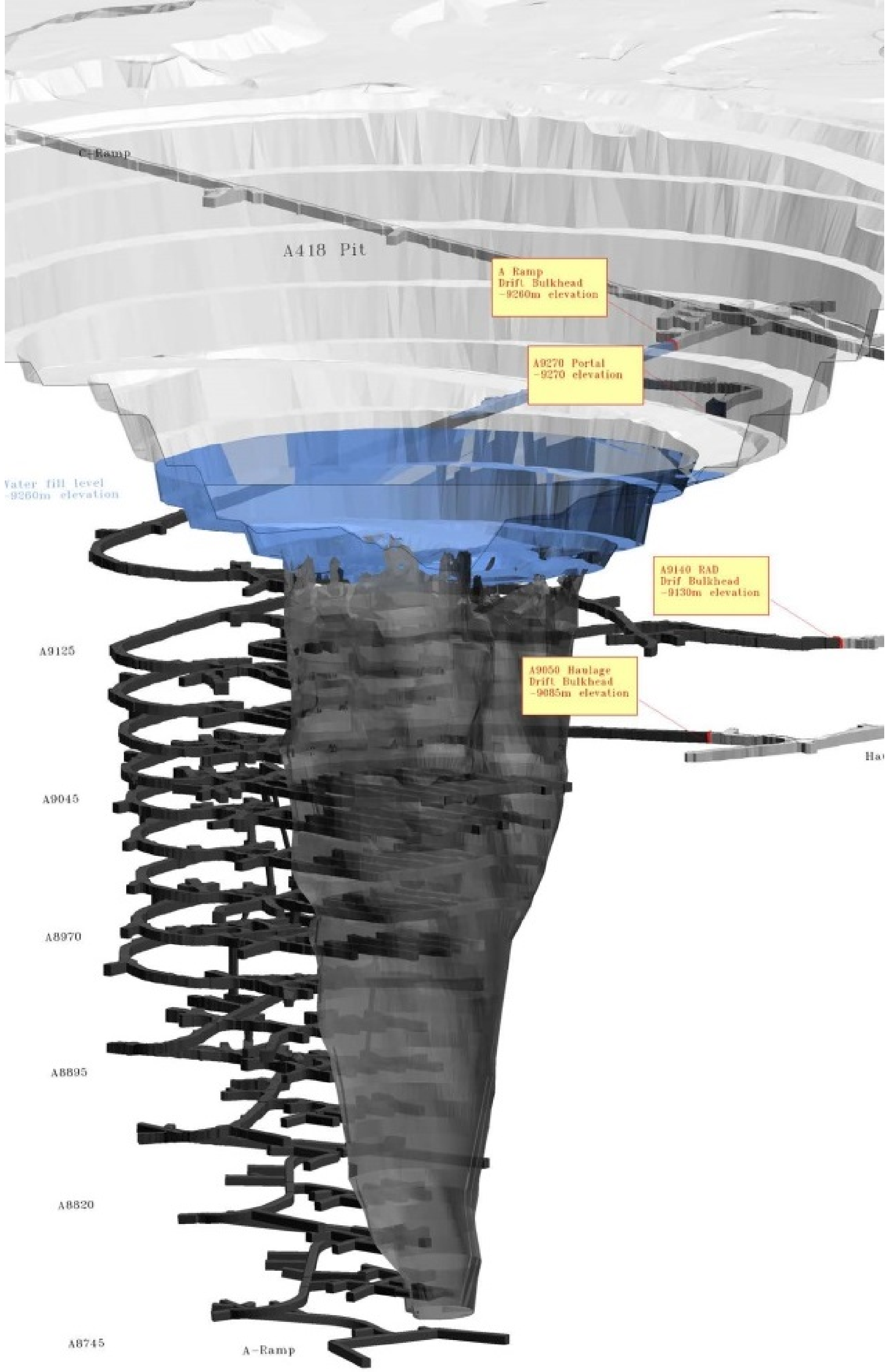
A418 Pit and Underground

- A Water Licence Amendment is required to place and store PK in A418

Conceptual Drawing



Environmental Considerations – Monitoring & Closure

- **Monitoring:**
  - Aquatic Effects Monitoring Program (AEMP) in Lac de Gras will continue (lake water quality, sediment, fish and bugs within the water and sediment), including the AEMP TK Study; and
  - More Surveillance Network Program (SNP) stations (site water quality) for A418 PK deposition.
- **Closure Plans:**
  - Likely a positive change to the PKC Facility closure concept; and
  - Closure concept for A418 remains the same with plans to reconnect the area to LDG
- **Toxicological Studies:**
  - Study of PK has been done by the University of Saskatchewan at the TK Panel's request.

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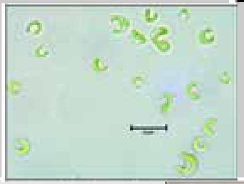
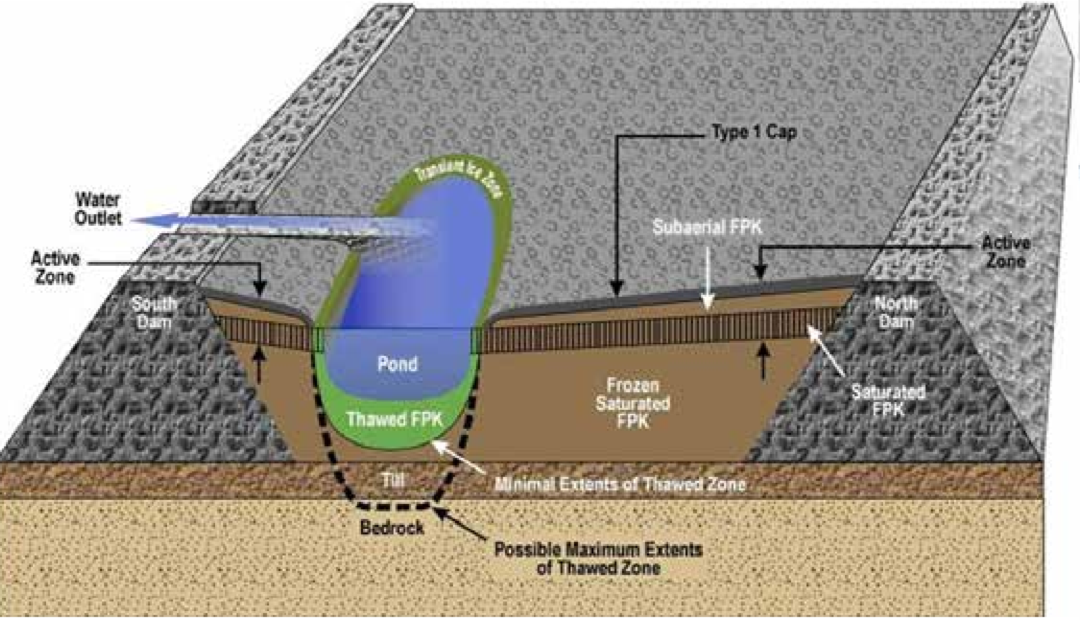
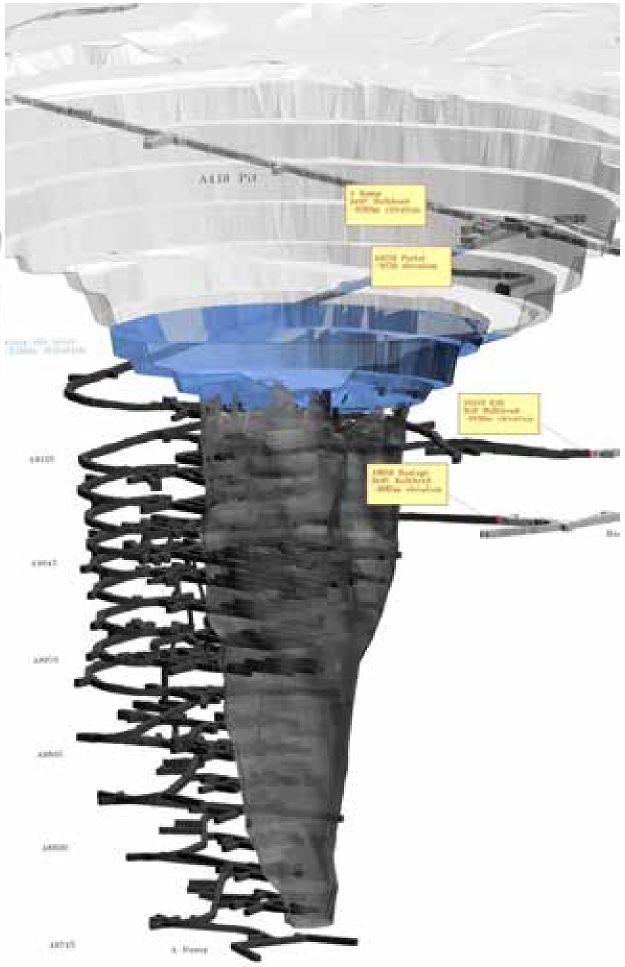
Summary of Toxicology Test Results

Toxicity Test	PK Slimes	Pore Water	Leachate
Fish 			OK
Water Flea 		OK OK	OK
Algae 		OK	OK
Benthic (1) 	Reduced survival in [100%]		
Benthic (2) 	Reduced growth in 100%	Reduced growth in 100% and 50%	Reduced growth in 100%

Closure Options for PK





Timelines and Schedule – PK Management

	Spring 2018	June 2018	Summer 2018	Feb 2019	Summer 2019	Summer 2020	2022	2023-2025
PK Management/Operations	Submit updated PKC Facility Plan to WLWB (March)							Commence progressive closure of PKC
		Submit phase 7 dam design	Commence dam raise		Continue dam raise	Complete dam raise	Placement of PK in A418	Placement of PK in A418
Amendment	Amendment Submission (May)				Revised Water Licence – proceed with additional studies & approvals			
A418							A418 UG Completed	

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Next Steps - Regulatory

- We have engaged with communities and regulators about the Amendment
- We will submit a Water License Amendment application to the WLWB in May 2018
- The amendment process will follow the WLWB process which includes additional engagement (i.e. initial comments, technical hearing, public hearing, etc.)
- The amendment process is anticipated to take approximately 12 months
- If approved, the amendment will likely allow for deposition of PK in A418, provided Diavik meets certain conditions and additional approvals

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Diavik needs your help!

- What other information do you need to feel comfortable with PK material being placed in mine areas?
  - What questions do you have that you want answered?

- Can you share your knowledge of how fish use deeper waters to help predict fish behaviour in the pits once they are filled with water?

- If Diavik goes ahead with putting the PK in the pits and the mine shafts, what would you want to watch at closure to know that it is good?
  - For example, once the pits are filled with water and before connecting back to Lac de Gras, as well as once re-connected.

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Appendix G

TK Panel Session #11 Recommendations Presented to DDMI

Traditional Knowledge Panel Guidance and Recommendations

Session #11: Options for Processed Kimberlite
May 10-14, 2018

General Comments

- Seeing A154 "with our own eyes" was really important in helping us to think about and consider the option to put PK in the mine area.
- Results from the PK toxicology study helped us feel more comfortable about various options for PK on-site.
- One of our biggest concerns is contamination
- We are always thinking about water
- Climate change impacts are significant and need to be part of any plan: people are noticing increased snow, ice, winds, floods and changing temperatures
- There is concern about stability of the pits (cracks/fissures) and underground and leakage of water

PK and A418 - General

- The TK Panel was interested in learning about the dimensions and volume of A418 compared to the volume of PK generated for operations and closure. Detailed discussions followed and the TK Panel weighed the options of PK in the PKC versus A418.

A418 and Water - General

- The TK Panel recognizes the importance of water to life. The TK Panel questioned whether water quality in the pit might be affected by PK. Discussions centred around how PK may affect fish and how PK in the pits might create a dead lake given that PK does not support much growth.
- The TK Panel is satisfied by the results of the toxicological study of PK and discussions and presentations by Diavik staff.

PKC versus Pits - Recommendations

- 11.1 If the PK goes to the mine area, the TK Panel recommends that all of the PKC slimes also be put into the pits. There is interest in moving as much of the slimes as possible from the PKC into the mine area.
- 11.2 If Diavik moves ahead with putting PKC slimes into the mine areas, the Panel requests to review any changes to the PKC closure plan. For example, if it is not possible to move all of the slimes in the PKC to the mine area and some of the slimes remain in the PKC, the TK Panel may recommend that the PKC is topped with large boulders to discourage wildlife and people from entering.
- 11.3 The beach materials and rough kimberlite should stay in the PKC area (i.e. anything that can support a rock cover).

Fish - Recommendation

- 11.4 TK holders know that fish generally go where there is food (nutrients) and oxygen so they are unlikely to go to the depth where PK would be.
- 11.5 The Panel would like additional scientific research to see what the effects of PK (ingestion) might be on fish specific to Lac de Gras.
- 11.6 If PK were to go in any mine area, the Panel requests an opportunity to learn more about the depth of water for fish habitat to cover PK (TK and western science).

Water - Recommendation

- 11.7 The TK Panel recommends a future TK Panel session dedicated to the health of the North Inlet upon closure and to decide if there is anything to address with the sediments.
- 11.8 The Panel requests that Diavik provide a list of items/equipment that will remain and be removed from underground before flooding or filling the mine with PK/water.

Monitoring PK - Recommendations

- 11.9 The TK Panel recommends that their members are present for at least some of the time when the slimes are moved from the PKC into the A418.
- 11.10 The TK Panel wants to monitor how water behaves when placed on PK. They would like to see the PK and water in the A418 as soon as it is safe to do so and when there is a good visual of the material, as well as at regular intervals afterwards.
- 11.11 The TK Panel recommends that they monitor the fish habitat within the pits, shoreline modifications (e.g. ramps) for wildlife as well as the stability of the dikes on a regular and ongoing basis.
- 11.12 The TK Panel recommends that they monitor freeze-up and break-up within the contained areas (i.e. within the dikes) to see if the formation and melting is any different - with a view towards safety for people and wildlife.
- 11.13 The TK Panel would like to see the PK vegetation plots again.
- 11.14 The TK Panel recommends that we test slimes/PK in a fish tank to see if any water plants would grow on the PK

Wind - General

- 11.15 The TK Panel would like to see wind behaviour on water within the contained pits/dikes over a period of time (i.e. throughout all seasons).
- 11.16 The TK Panel would like to see wind behaviour on Lac de Gras in and around the dikes. [How is the water on the outside of the dikes and breach areas affected by wind?]

Questions

Appendix H

Presentation of DDMI Responses to TK Panel Session #10 Recommendations

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Diavik Response to TK Panel Session 10 Recommendations

TK Panel

10-14 May 2018

Response to Session 10 – SCRP & Monitoring

Supported

- Diavik must return East Island to a caribou-friendly state (as defined by the TK Panel and Elders), other than those areas identified as ‘no-go’ zones. Caribou pathways should follow caribou corridors identified through traditional knowledge. (10.9) – *to be developed for SCRP*
- Consider alternative uses for A21 material: Cover the Processed Kimberlite Containment (PKC) area after removing slimes; Assuming the slimes are gone, slope the south face/wall between the NCRP and the north end of the PKC to allow for caribou movement; Extend the west end of the NCRP and slope it for caribou; Cover areas that may have been contaminated after clean-up like the hydro-carbon containment area. (10.10) – *most of these uses are being evaluated*
- Avoid disturbing new areas (e.g. tundra) with A21 material at the SCRP as much as possible. The proposed SCRP area is part of a major caribou migration and feeding corridor and should not be disturbed.(10.1) – *trying to use A21 rock/till for other purposes, e.g. NCRP cover, to reduce size*
- We recommend that rock from A21 that could go to SCRP be used to cover the NCRP. (10.4) – *approvals are complete and this work has begun*

Response to Session 10 – SCRP & Monitoring

Supported Cont'd

- Drain the pond that would be covered by the SCRP before using the proposed area. (10.5) – *completed, fall 2017*
- Have all SCRP water tested (both science and TK) before releasing into Lac De Gras. (10.6) - *DDMI plans to establish a monitoring station in this location*
- Use natural filtration methods in areas where water will run off the SCRP on site. (10.7) – *this will occur in the area downstream of the SCRP*
- Research or monitoring methods that are offensive to elders (e.g. caribou collars) should lead to getting alternative method advice from elders. (10.24) Also want to learn more about operational monitoring programs, methods and results in order to determine if they are suitable for closure monitoring(10.20) *- provide presentation on Diavik's operational monitoring programs to the Panel at future session*

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Response to Session 10 – SCRP & Monitoring

Modify

- Encouraging communities working together and supporting each other long into the future will give us strength. Diavik has helped us do this and we must continue into the future. (10.21)
  - Diavik sees this as a recommendation to the TK Panel members and community organizations; we are pleased that the Panel recognizes the efforts Diavik has undertaken to encourage collaborative work

Response to Session 10 – SCRP & Monitoring

Pending

- If this area (SCRP) must to be used, minimize the size (i.e. volume/amount) and height of the SCRP and slope all sides like an esker so that animals can easily walk over it. We recommend the slope should be at 3:1. (10.2, 10.8)
    - SCRP closure plan has yet to be developed; currently not planned to re-slope the entire pile, as no closure cover is necessary for the SCRP.
- If the SCRP is large, designated pathways become more important and must follow caribou routes known through TK. (10.3)
    - SCRP Design included all A21 materials, as approval of NCRP cover was pending. Will need to re-evaluate final size and work with Panel/communities to determine preferred route for caribou.
- Many recommendations related to monitoring that would require another TK Panel session to discuss further. Includes:
    - 10.11, 10.12, 10.13, 10.14, 10.15, 10.16, 10.17 and 10.18
- Plan to leave some buildings (and possibly the airstrip) to support Watching Programs for this and other mines in the surrounding area. (10.22)
    - Options for this will continue to be discussed with communities and regulators.

Response to Session 10 – SCRP & Monitoring

Pending Cont'd

- Start training for watching programs during mine operations by inviting community members to site, i.e. train-the-trainer program. For example, bring up people to work with Environment dept, starting with one weekend a month and scaling up over time (10.19)
  - Diavik currently invites and involves community members in some of their on-site monitoring, largely program-specific. Evaluate options for some weekend community assistants.
- Diavik should support the development of a 'best practices' document that explains the Panel's approach to integrating TK into mine closure planning. (10.23)
  - The Panel's presentations and reports do a good job of summarizing the process and principles that underly the Panel's recommendations and guidance. Something like this may be more valuable further in the future, once closure plans advance and more is learned about how to practically apply these recommendations and guidance.

Appendix I

Next Steps

Next Steps

Session	Original Plan (2013)	Completed & Revised Plan
6	PKC	PKC
7	Re-vegetation	Re-vegetation
8	Review of Closure Landscape	Fish Habitat Design & Water Quality
9	Post-closure monitoring: Wildlife & Water	Post-closure Wildlife Monitoring
10	Fish Habitat Design Reviews	SCRP & TK Monitoring Plan
11	PK Management (A418)	**PK Management (A418)**

Reached the end of the topics you'd originally suggested

Need to plan for future sessions – 1/year is realistic

Future Topics/Sessions

Monitoring at Closure

Updates on PKC closure options

North Inlet

Closure Details: building demolition, metal disposal, waste disposal, contaminants, laydown areas, airports, roads, etc.

Closure Inspection Criteria

2018 Aquatic Effects Monitoring Program (AEMP) TK Camp

Appendix J

TK Panel Session #11 Evaluation Summary

2018 Diavik TK Panel, Session 11: Evalution Form Summary

Question	Very Good	Good	Neither Good nor Poor	Poor	Very Poor	Total Responses	Comments
How would you rate the session for working and communicating together?	11	3		0	0	**14**	
How would you rate the session for mutual respect among participants?	10	4		0	0	**14**	
How would you rate the recording and documenting of TK during the session?	8	5		1	0	**14**	Lots of good info to bring back
How would you rate the facilitation of the session?	9	5		0	0	**14**	Keeping all/everyone on track
How would you rate the outcomes and findings of the session?	7	7		0	0	**14**	Good info. Lots of sharing. For the elders, should be closer to the kitchen from their rooms.
How would you rate the venue and food for the session?	8	4	2	1	0	**15**	Always good. Too much!
How would you rate the logistics for the session (e.g. hotel, travel, honoraria)	7	5	1	1	0	**14**	Very well done. This may be better if done through EMAB due to the processing of cheques.
Overall, how would you rate the session?	8	5		0	0	**13**	1 blank response.

Question	Too long/ many	Enough	Too short/few	Total Responses	Comments
How would you rate the opportunities for you to share your knowledge and experiences?	2	11		**13**	
How would you rate the amount of time to discuss the topics during the session?	3	7	3	**13**	ed to do break exercises. 1 blank response.

What were the strengths of the session? What did you enjoy most about the session?

Everybody coming together and expressing their concerns. I enjoyed being here and hopefully I come back in the next session. It is very important that we continue to share our knowledge with the youth. There was a lot of information on the cone (pit) and fish and caribous and water. Presentation to DDMI. Always double checking that we are happy with our comments and recommendations. Reviewing and clarifying that each statement is what we mean. You always do a good job! Communication and understanding. Given knowledge from different cultures. Listening to Elders about the animals and especially the land given to us. Given information about Diavik closure and how they want us to nurture. Understand gave more so I can understand in good way. I felt the session had a very friendly atmosphere and was pleased with the ideas and findings from the group. The respect of the panel. Working together giving advice while learning from one another. Change in venue. Different subject entirely.

How could the session be improved?

Future improvements to closure plan be implemented as the mine is coming into closure. More youth. More youth from the region, one female and one male. This is my first time here and I couldn't say much except for the hospitaility. Would be good to have more visuals for the Elders.That is the only one and to have the elders stay closer to the kitchen area so it is not too far to walk for them. Would be good to have a table out for those who would like to take notes. Information from the previous sessions to the newcomers and follow-up slideshow for topics and ideas given. For next time if you have a meeting at Diavik Mine make elders stay closer. Also people who have problems with knees. This will be good. Thank you for your understanding. Can't think of anything.