Water and Load Balance Model Report 2016

Prepared for

Minto Explorations Ltd.

Prepared by

SRK Consulting (Canada) Inc.
1CM002.024
August 2016

Water and Load Balance Model Report 2016

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1 Introduction

This report describes the water and load balance model developed for the Minto Mine 2016 Reclamation and Closure Plan (RCP 2016-01(Minto 2016)). This report was written in accordance with the Water Use License (WUL) requirements (YWB 2015; Clause 110c):

The water and load balance model builds on previous water balance modelling work prepared for Minto Explorations Ltd. as part of past water license applications, environmental assessments, annual reporting and operational water management efforts. The model covers the end of the operations phase, as well as the active closure and post-closure phases. The project schedule is summarized in **Table** 1**-**1.

As shown in **Table** 1**-**1 below, closure at the Minto Mine has been subdivided into three primary closure periods: Active Closure (AC), Post-Closure I (PCI) and Post Closure II (PCII) (Minto 2016).

The general arrangement of the site at the end of mine life is described in RCP 2016-01 and is shown in Figure 1-1.

The model uses a stochastic approach where annual precipitation rates are varied to evaluate effects of wet and dry climatic on the water balance. Water quality results are based on estimates of geochemical loadings applied to modelled water flow. Water quality predictions are presented for ‘expected case’ and ‘reasonable worst case’ scenarios, which represent the best estimate geochemical loading rates and loading rates that are unlikely to be exceeded, respectively.

Section 2 describes inputs to and components of the water balance model. Section 3 summarizes the load balance model inputs. Model scenario implementation is described in Section 4 and modelling results are presented in Section 5 followed by a discussion in Section 6.

1.1 Closure Summary

As shown in **Table** 1**-**1 below, closure at the Minto Mine has been subdivided into three primary closure periods: Active Closure (AC), Post-Closure I (PCI) and Post Closure II (PCII) (Minto 2016).

Table 1-1 Project Schedule

Year	Summary of Main Project Activity
2016	Expected completion of the Minto North Pit, Mill Valley Fill Extension Stage 2 and Main Waste Dump Expansion. Underground mining continues in the Minto South Deposit. Stripping in Area 2 Stage 3 pit begins as the final benches of Minto North are mined out.
2017	Underground production continues from the Minto South underground portal. Open pit mining continues in Area 2 Stage 3 until the pit is completed in the second quarter of the year.
2018	Underground mining from the Minto East deposit and milling continue until the third quarter of the year. Active closure to begin.
2019 – 2021	Active closure period continues (total duration expected three years) with post closure one beginning near the end of 2021.
2022 – 2026	Post closure one period continues (total duration expected five years but will be performance based) with post closure two beginning near the end of 2026
2027-2036	Post closure two period continues (total duration of post closure two is ten years) until near the end of 2036.

The Active Closure period includes the implementation and construction of the large majority of the selected closure measures. Closure measures completed during this period include, but are not limited recontouring, soil placement, closure water conveyance construction, revegetation, construction of passive water treatment facilities, decommissioning of the Water Storage Dam, demobilization and demolition. During the AC period, operational water quality objectives/effluent standards will still apply and active treatment is expected to be the primary source of water treatment. The AC period is expected to span three years but may be completed sooner as closure measures are completed.

The PCI period is intended to provide time which allows the closure measures to establish and assessments to be completed on the performance of the chosen closure measure. During this period, maintenance on soil covers will be undertaken as required as vegetation begins to establish. Water conveyance features will be commissioned along with the passive treatment system. A pump back system will be established from the passive treatment system to the water treatment plant as there is potential that water quality will not meet effluent standards without active treatment. During PCI operational water quality objectives/effluent standards will still apply. Passive treatment will be commissioned and will become the primary water treatment system utilizing active treatment as required to meet operational water quality objectives and manage site water inventory. The PCI phase nominally spans five years but facilities may advance into PCII as closure criteria/expected performance of the closure measures are met.

The PCII period is intended as a confirmational period which will monitor that the closure measures continue to perform as expected. PCII is primarily a monitoring phase with maintenance activities as required. During PCII the closure water quality objectives will apply and passive treatment will be the primary water treatment onsite.

Source: Adapted from Figure 5-3 (prepared by Access Consulting Group) in Minto Explorations Ltd. 2016. Minto Mine Reclamation and Closure Plan Revision 2016-01.

srk consulting	capstone MINTO MINE OPERATED BY MINTO EXPLORATIONS LTD.	Water and Load Balance Model Report 2016
		General Arrangement- End of Mine
Job No: 1CM002.024 Filename: Fig_1-1_EOM_GeneralArrangement.pptx	Minto Mine	Date: July 2016 / Approved: DBM / Figure: 1-1

2 Water Balance Model Description

2.1 Water Balance Overview

Figure 2-1 shows a schematic of the conceptual water balance for the Minto Site. The water balance can be described as:

$$Water\ Input = Water\ Storage + Water\ Output \tag{1}$$

Precipitation is the only source of water to site and therefore the only input. The open pits and the Water Storage Pond (WSP) are the primary water storage reservoirs on site during the Operational Period. Water outputs include water released to Minto Creek and water lost to evapotranspiration. The net input of water to the reservoirs on site, or net yield, can be expressed as:

$$Net\ Yield = Precipitation + Groundwater\ Discharge\ - Evapotranspiration - Groundwater\ Recharge \tag{2}$$

Note that the yield term includes both surface and groundwater terms. Net yield is a measure of the total volume of water that report to the reservoirs on site, regardless of flow path. Net yield can be described in terms of a yield coefficient, defined as follows:

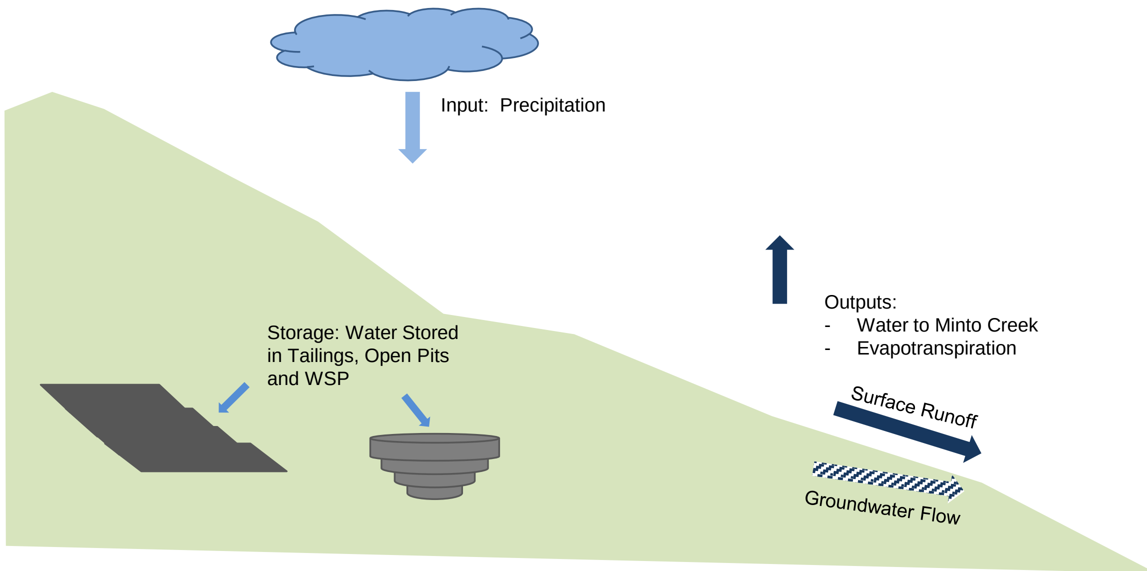
$$Net\ Yield = Precipitation * Yield\ Coefficient \tag{3}$$

The yield coefficient approach allows the water balance to be simplified to:

$$Net\ Yield - Water\ stored\ on\ Site = Water\ Released\ to\ Minto\ Creek \tag{4}$$

Figure 2-2 shows a schematic of the simplified water balance. In a year with average annual precipitation (329 mm/year) the net yield from catchments within the Minto Mine site is approximately 950,000 m^3. Of that, approximately 500,000 m^3 will report to tailings pores during the period when the mill is running. This leaves (in an average year) approximately 450,000 m^3 of surplus water that must be stored on site or released to Minto Creek.

At Minto, the cross section of the Minto Creek Valley at the Water Storage Dam is narrow and bedrock is relatively shallow. As such, the majority of groundwater that flows toward Minto Creek is expected to report to the stream as surface water and only a small fraction is expected to flow from site via subsurface pathways (SRK, 2015a). Inclusion of a discrete groundwater flow path was considered but was not deemed appropriate as the majority of the groundwater reports to the surface upstream of the Water Storage Pond (WSP) (SRK, 2015a).



Source: Z:\01_SITES\Minto\1CM002.024_Water_Balance_Support\!080_Deliverables\2016_RCP_Water_and_Quality_Report\040_Figures\Figure 2.1 and 2.2 Water_Balance_Schematic_Minto_REV00.pptx

Figure 2-1 Water Balance Schematic

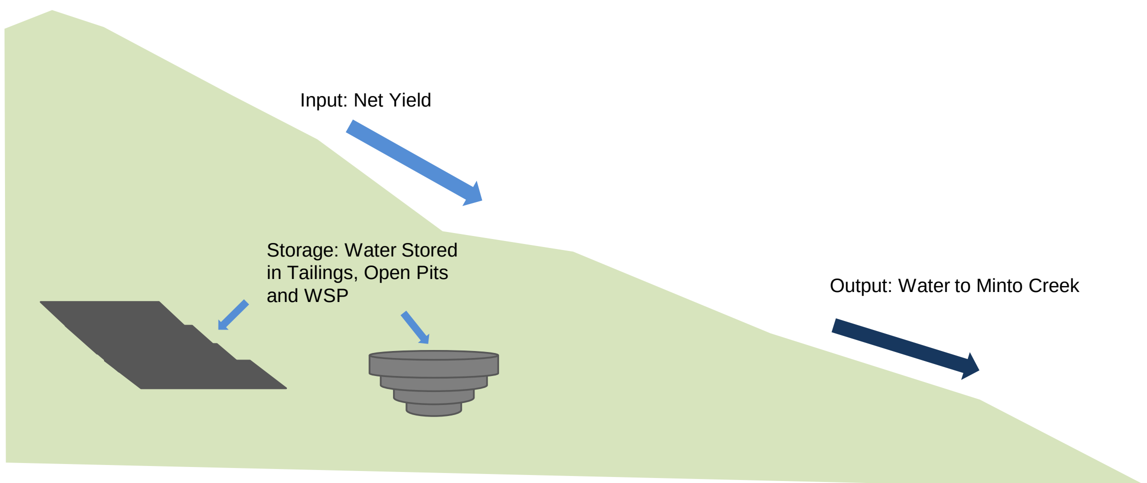


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Figure 2-2 Simplified Water Balance Schematic

2.2 Water Balance Inputs

Inputs required for the water balance model are summarized in Table 2-1 and are discussed in the following sections.

Table 2-1 Input Required for Water Balance Model

Water Balance Component	Input Required
Net Yield	Annual precipitation rates Open water evaporation rates Sub-catchment areas Site-wide yield coefficient Typical hydrograph
Water storage	Open pit volumes Tailings and waste rock deposition schedules
Water Released to Minto Creek	Historical WSP pumping schedule for calibration

2.2.1 Precipitation

Precipitation is the only input of water to the Minto Mine site water balance model. The water balance model calculates annual yield based on annual precipitation and a site-wide yield coefficient. Therefore, a reliable estimate of the frequency and intensity of total annual precipitation is important for the accuracy of model predictions.

Rainfall data collected on site was used in conjunction with long-term regional precipitation records to estimate the distribution of annual precipitation rates. The precipitation record for the Minto site is shown in Table 2-2. Rainfall data has been recorded at site beginning in September 2005. In October 2011, Minto installed an adapter for measuring snowfall as water equivalent. At the time of writing, on-site rainfall and total precipitation data were available for the period September 2005 through December 2015.

Table 2-2 Monthly Rainfall and Total Precipitation Measured at Minto

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2005	**	**	**	**	**	**	**	**	21.60	23.00	11.60	4.60	60.8
2006	0.00	0.40	2.80	**	22.84	35.80	28.63	29.20	12.20	12.20	0.00	0.00	144.1
2007	0.20	0.00	0.40	5.80	4.60	36.00	47.80	21.00	33.80	11.80	0.00	0.00	161.4
2008	1.20	2.00	0.80	1.80	9.60	26.20	**	100.60	21.80	6.40	0.00	0.00	170.4
2009	5.20	0.00	0.80	3.23	**	**	6.08	50.76	7.20	16.60	0.00	0.00	89.9
2010	0.00	0.00	0.00	0.00	7.60	48.8	75.6	46.4	18.0	16.3	3.05	0.00	215.8
2011	0.00	6.40	0.20	0.40	15.3	56.0	101.8	64.8	15.6	4.40[(A)]	0.15**	3.94**	269.0
2012	9.0**	9.9**	34.9	0.0	0.1**	32.1	44.8	20.6	26.1	16.5	17.1	18.4	229.5
2013	4.4	73.8	7.4	0.0	7.9	21.0	113.5	46.8	59.7	13.6	36.6	27.0	441.7
2014	16.9	8.0	0.0	3.8	15.0	12.0	50.5	13.4	30.5	22.0	2.9	21.0	196.0
2015	12.4	0.0	10.9	8.0	4.9	20.5	37.7	80.3	16.7	27.7	7.1	11.5	237.7

Source: Minto Site Data: X:\01_SITES\Minto\1CM002.024_Water_Balance_Support\2015_Water_Balance_Update\Minto Water Balance\2016 Met Station DataSummary.xlsx

Notes:

** partial data only.

[(A)]) Measurement transitioned from rainfall to total precipitation on Oct. 15/2011.

Green highlight: total precipitation measurements.

Regional precipitation data were available from a number of meteorological stations in the Yukon (Table 2-3). Rainfall data up until 2012 from each station were correlated with precipitation data collected from the Minto site to determine whether long-term regional precipitation data would be suitable for use as a basis for estimating annual precipitation at the site.

As expected, the rainfall data at the closest regional meteorological station at Pelly Ranch (Climate ID: 2100880), located 23 km from the Minto Mine, resulted in the best correlation with rainfall data from the site. The precipitation record at Pelly Ranch dates back to December 1951 and has continued to the present day. Figure 2-3 shows a plot of monthly rainfall values at Minto and at the Pelly Ranch station. The correlation can be expressed as:

$$Minto\ Rainfall = 0.88 * Pelly\ Ranch\ Rainfall \qquad (6)$$

Table 2-3 Regional Meteorological Stations

Station	Latitude	Longitude	Distance From Site (km)	Elevation (m)	Record Begins	Record Ends
Minto Site	62°36'59"	137°15'00"	0	887	Sep-05	Present
Burwash Airport	61°22'00"	139°03'00"	168	807	Oct-66	Present
Carmacks	62°06'00"	136°18'00"	109	525	Aug-63	Present
Dawson Airport	64°02'35"	139°07'40"	184	370	Jan-76	Present
Faro Airport	62°12'27"	133°22'33"	205	717	Dec-77	Present

Station	Latitude	Longitude	Distance From Site (km)	Elevation (m)	Record Begins	Record Ends
Haines Junction	60°46'21"	137°34'49"	206	595	Oct-44	Present
Mayo Airport	63°37'00"	135°52'00"	131	504	Oct-11	Present
McQuesten	63°36'00"	137°31'00"	110	457	Oct-86	Present
Pelly Ranch	62°49'00"	137°22'00"	23	454	Dec-51	Present
Whitehorse Airport	60°42'34"	135°04'07"	241	706	Apr-42	Present

Source: SRK, :\01_SITES\Minto\!020_Site_Wide_Data\Water_and_Load_Balance_Files\02_Hydrology_and_Meteorology\Regional_Analysis\Regional Precipitation Data\Regional_Met_Station_Summary_1CM002.003_Rev01_TC.xlsx

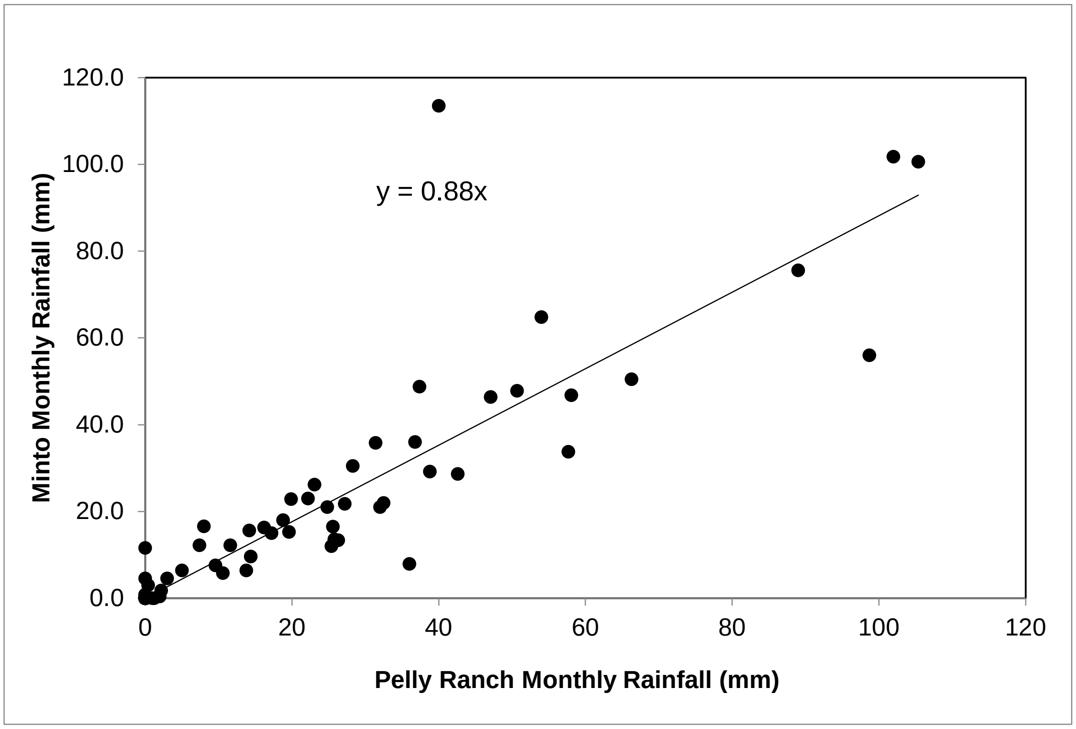

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Figure 2-3 Comparing Minto Mine and Pelly Ranch Rainfall (Sept. 2005 to March 2015)

A comparison of snow-water equivalent data from Minto and Pelly Ranch (not shown) resulted in the following correlation:

$$Minto\ Snowfall = 1.24 * Pelly\ Ranch\ Snowfall \quad (7)$$

Based on these correlations the annual precipitation at Minto correlates to the annual precipitation at Pelly Ranch as follows:

$$Minto\ Annual\ Total\ Precip. = 1.09 * Pelly\ Ranch\ Annual\ Total\ Precip. \quad (8)$$

Table 2-4 shows the estimated average total annual precipitation values for Minto based on the correlation with Pelly Ranch precipitation data. A frequency (or probability) distribution of total annual precipitation was developed for the Minto site based on the long-term total precipitation record available for the Pelly Ranch station. Pelly Ranch precipitation values were only used if a calendar year contained valid information for more than 95% of the total number of days in that year. The use of this data quality criteria resulted in a total of 51 years of valid data to be included in the frequency distribution analysis.

The 51 years of annual precipitation data were fitted against six different statistical distributions: Normal, Log-Normal, Gumbel, Log-Pearson, Pearson III, and GEV. The best fit was obtained with a Pearson III Distribution ($r^2 = 0.99$). This Intensity/frequency distribution was used as input for the water balance model. The final results are presented in Figure 2-4 and Table 2-5.

Table 2-4 Estimated Average Precipitation at Minto Based On Pelly Ranch Precipitation Data

Month	Average Rainfall (mm/month)	Average Snowfall (mm/month)	Average Total Precipitation (mm/month)
Jan	0.08	28.6	28.7
Feb	0.08	20.3	20.4
Mar	0.14	15.9	16.0
Apr	3.10	9.29	12.4
May	19.16	0.63	19.8
Jun	32.38	0.00	32.4
Jul	47.85	0.00	47.9
Aug	34.98	0.02	35.0
Sep	22.91	3.07	26.0
Oct	6.72	22.0	28.7
Nov	0.30	37.3	37.6
Dec	0.08	30.4	30.4
Total (mm/year)	167.8	167.5	335.3

Source:Z:\01_SITES\Minto\!020_Site_Wide_Data\Water_and_Load_Balance_Files\2_Hydrology_and_Meteorology\Met_Data\Minto_MasterStationFile_20130607.xlsx

The estimated average total precipitation for Minto was slightly lower for the frequency analysis (329 mm/year) than for the direct computation using the average total precipitation value from Pelly Ranch (335 mm/year). This difference is a result of the imperfect fit between the data and the distribution model that is used. In the interest of consistency with frequency distribution approach, the total precipitation value generated by the Pearson III distribution (329 mm) was used as input to the water balance model.

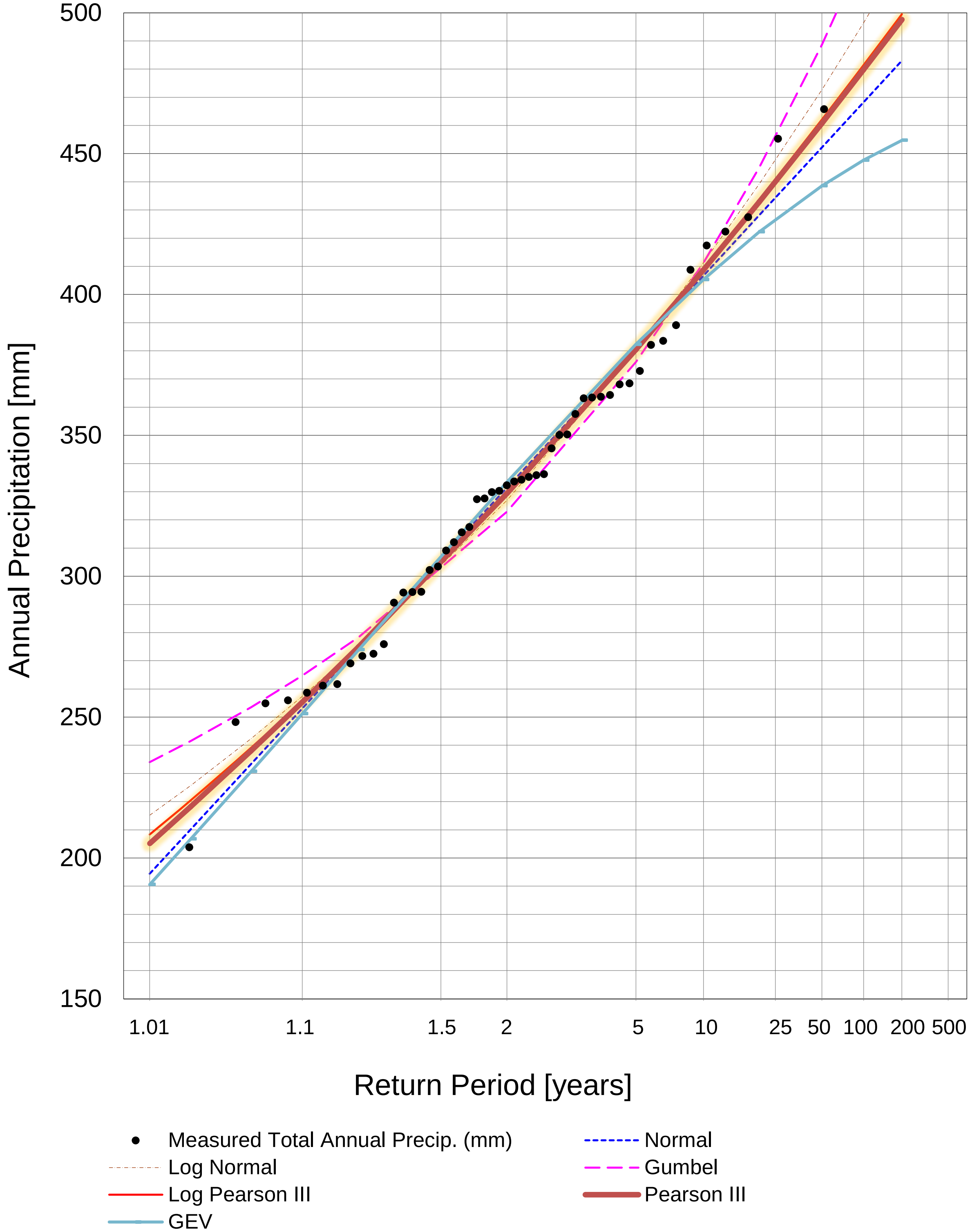

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Figure 2-4 Precipitation Frequency Analysis for the Minto Mine Site

Table 2-5 Precipitation Frequency Analysis Statistics

Cumulative Probability	Return Period	Season	Normal	Log Normal	Gumbel	Log Pearson III	Pearson III	GEV
0.005	200	Wet	483	519	554	499	498	455
0.01	100		468	496	521	481	480	448
0.02	50		452	473	489	462	461	439
0.05	20		428	439	445	434	433	422
0.1	10		407	411	411	409	409	405
0.2	5		381	380	376	380	380	382
0.5	2		331	327	323	329	329	333
0.8	5	Dry	275	275	278	275	275	274
0.9	10		253	257	265	256	255	251
0.95	20		233	242	254	239	238	231
0.98	50		210	226	242	220	218	207
0.99	100		194	215	234	208	205	191
	R^2		0.98	0.98	0.97	0.98	0.99	0.97

Source: Z:\01_SITES\Minto\!020_Site_Wide_Data\PMP Hershfield Estimation & Freq Distribution_VM_Rev4_SRJ.xlsx

2.2.2 Evaporation

Evaporation is not measured at the Minto site. Monthly lake evaporation (aka potential evaporation) has been recorded at the Pelly Ranch station from 1965 to 2005; the mean annual lake evaporation value is 452 mm. In historical revisions of Minto's water balance, open water evaporation and evapotranspiration were estimated based on the regional data and model estimates.

Estimated evaporation values for the site were adopted from work completed by Clearwater Consultants Ltd. as part of the previous year's water balance update completed for the mine site (CCL 2010). Table 2-6 shows the adopted monthly evaporation values, which for modelling purposes were assumed to be constant for each year included in the scenario runs.

Evaporation estimates are associated with considerable uncertainty. However, in the present model revision, evaporation losses were only discretely applied to open water bodies, including the pit lakes and the Water Storage Pond. A sensitivity analysis was completed to quantify the effect of uncertainties associated with the annual evaporation rate. The analysis showed that a difference of +/- 100 mm of annual evaporation would make a +/- 2.6% difference to the annual water balance (net inflow) estimate, which was considered to be relatively insignificant in the context of other uncertainties and year-to-year variability.

Table 2-6 Estimated Monthly Open Water Evaporation Values for Minto

Month	April	May	June	July	August	September	Total
Evaporation (mm)	12	83	119	112	83	30	439

Source:
Z:\01_SITES\Minto\!020_Site_Wide_Data\Water_and_Load_Balance_Files\01_Project_Phases\04_Amendment_8_Support\02_Source_Term_Archive\[Minto Mine Water Balance_2011 Update Modified Goldsim_SRJ_Rev01

2.2.3 Catchments

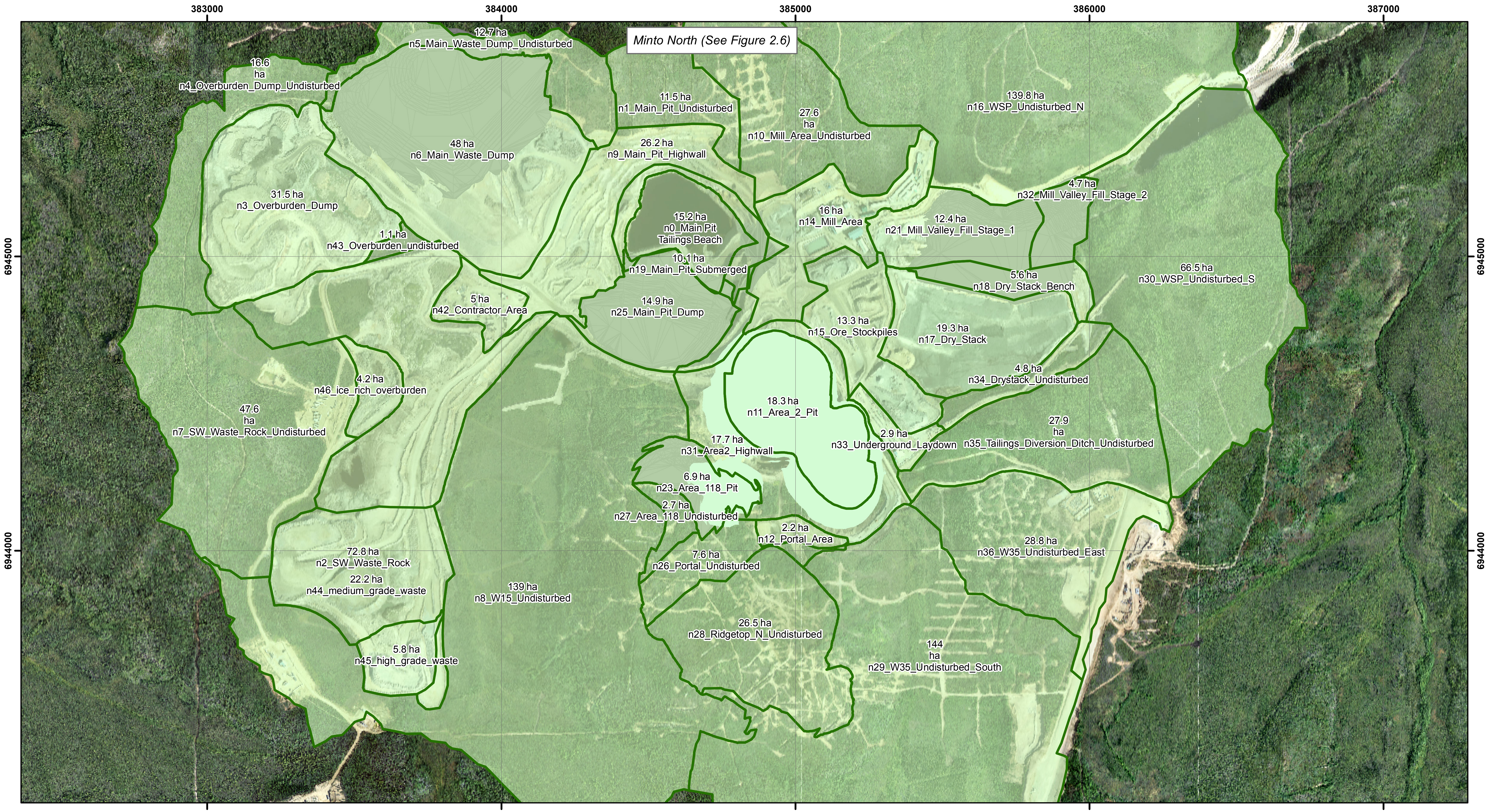
The Minto Mine site, excluding the proposed Minto North Pit, is located within the Upper Minto Creek watershed. For the purposes of this report, Upper Minto Creek will refer to the portion of the Minto Creek catchment upstream of the Water Storage Dam. The catchment downstream of the Water Storage Dam will be referred to as Lower Minto Creek. The Upper Minto Creek catchment covers an area of 1,065 ha, which has been divided into sub-catchments for modeling purposes. Table 2-7 and Figure 2-5 show Upper Minto Creek sub-catchments that were delineated for the Phase V/VI water balance model.

The Minto North Pit is located within the McGinty Creek catchment to the north of the Minto Mine. Table 2-8 and Figure 2-6 shows McGinty Creek sub-catchments delineated for the Phase V/VI water and load balance model.

Table 2-7 Upper Minto Creek Catchment Areas

Sub-Catchment	Area (ha)
n0_Main Pit Tailings Beach	15.2
n1_Main_Pit_Undisturbed	11.5
n2_SW_Waste_Rock	72.8
n3_Overburden_Dump	31.5
n4_Overburden_Dump_Undisturbed	16.6
n5_Main_Waste_Dump_Undisturbed	12.7
n6_Main_Waste_Dump	48
n7_SW_Waste_Rock_Undisturbed	47.6
n8_W15_Undisturbed	139
n9_Main_Pit_Highwall	26.2
n10_Mill_Area_Undisturbed	27.6
n11_Area_2_Pit	18.3
n12_Portal_Area	2.2
n15_Ore_Stockpiles	13.3
n16_WSP_Undisturbed_N	139.8
n17_Dry_Stack	19.3
n18_Dry_Stack_Bench	5.6
n19_Main_Pit_Submerged	10.1
n21_Mill_Valley_Fill_Stage_1	12.4
n25_Main_Pit_Dump	14.9
n27_Area_118_Undisturbed	2.7
n29_W35_Undisturbed_South	144
n30_WSP_Undisturbed_S	66.5
n31_Area2_Highwall	17.7
n32_Mill_Valley_Fill_Stage_2	4.7
n33_Underground_Laydown	2.9
n34_Drystack_Undisturbed	4.8
n35_Tailings_Diversion_Ditch_Undisturbed	27.9
n36_W35_Undisturbed_East	28.8
n42_Contractor_Area	5
n43_Overburden_undisturbed	1.1
n44_medium_grade_waste	22.2
n45_high_grade_waste	5.8
n46_ice_rich_overburden	4.2
n0_Main Pit Tailings Beach	15.2
n1_Main_Pit_Undisturbed	11.5
n2_SW_Waste_Rock	72.8
n3_Overburden_Dump	31.5
Total Catchment Area	**1080**

Source: Z:\01_SITES\Minto\!020_Site_Wide_Data\Water_and_Load_Balance_Files\04_Catchments\RCP_Catchments\Minto_RCP_Catchment_Table



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Legend

Upper Minto Creek Sub-Catchments

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Water and Load Balance Report 2016

Upper Minto Creek Sub-Catchments

Job No: 1CM002.024

Filename: PhV_VI_Minto_Sub_Catchments_REV03_AMD

Minto Mine

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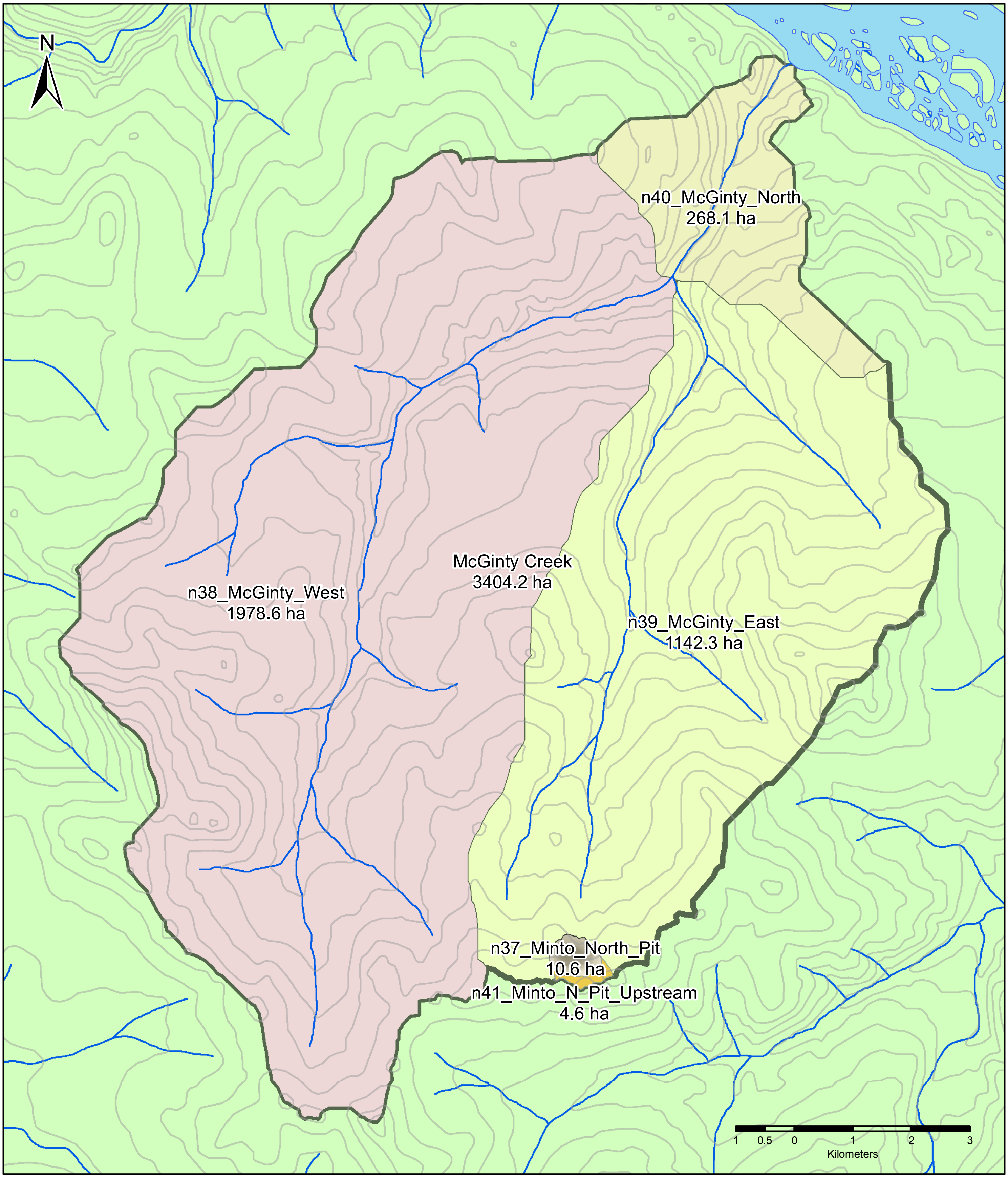

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Job No: 1CM002.024 Filename: PhV_VI_Minto_North_REV06_AMD	Minto Mine	McGinty Creek Sub-Catchments
		Date: August 2016 / Approved: KNK / Figure: 2.6

Table 2-8 McGinty Creek Sub-Catchments

Sub-Catchment	Area (ha)
n37_Minto_North_pit	10.6
n38_McGinty_West	1978.6
n39_McGinty_East	1142.3
n40_McGinty_North	268.1
n41_Minto_N_Pit_Upstream	4.6
Total Catchment Area	**3404.2**

Source:X:\01_SITES\Minto\!020_Site_Wide_Data\Water_and_Load_Balance_Files\04_Catchments\Phase_V_VI_Catchments\Minto_Phase_V_VI_Catchment_Table.xlsx

2.2.4 Yield Coefficient

As described in Section 2.1, annual yield (water that reports to reservoirs on site) can be estimated by multiplying the total annual precipitation by a site-wide yield coefficient (Equation 3).

For the 2016 water and load balance, the use of a site-wide yield coefficient for land areas was found to be more appropriate than assigning specific yield coefficients to areas with different land use and surface cover characteristics. Firstly, flow measurements on site (hydrological monitoring stations and flow meters) measure water collected from different land use areas, *i.e.* a combination of undisturbed and developed mine areas. This makes it difficult to evaluate yield coefficients for any one type of land use area based on actual site performance data. Therefore, uncertainties associated with area-specific yield coefficients would magnify the uncertainty of the site-wide water balance and it would be necessary to arbitrarily adjust each of the yield coefficients to match the site-wide water balance. Secondly, during the operations and closure (pit filling) phases the available water storage capacity on site is generally greater than the annual volume of surface yield, and therefore reliable forecasts of total site-wide annual yield volumes are more important for water management planning than forecasts of yield from individual sub-catchments.

Monitoring data collected on site since 2007 was used to estimate the value of the site-wide yield coefficient for Upper Minto Creek. The yield coefficient estimate is updated once a year in conjunction with the annual water balance update for the site. The 2015 water balance update (Appendix B) generally agreed with the established yield coefficient value of 0.30, which was derived based on previous years' water balance data.

The estimated total annual precipitation at the Minto Mine has generally been greater than 300 mm/year for the period 2007 to 2015. Consequently, the site-wide yield coefficient of 0.30 was effectively derived for annual precipitation greater than 300 mm/year. However, this yield coefficient may overestimate yield in relatively dry years. In order to account for this the site-wide yield coefficient for dry years was assigned lower values in the water balance model. The dry year coefficients were based on work completed by Clearwater Consultants Ltd. (CCL 2010) for the Minto Mine site as follows:

- A yield coefficient of 0.15 was used for dry years with less than 190 mm total precipitation.
- A yield coefficient of 0.30 was used for years with greater than 309 mm total precipitation.

- Yield coefficients for years with total precipitation between 190 mm and 309 mm were interpolated values between 0.15 and 0.30.

Figure 2-7 shows yield coefficient values used in the model as a function of total annual precipitation.

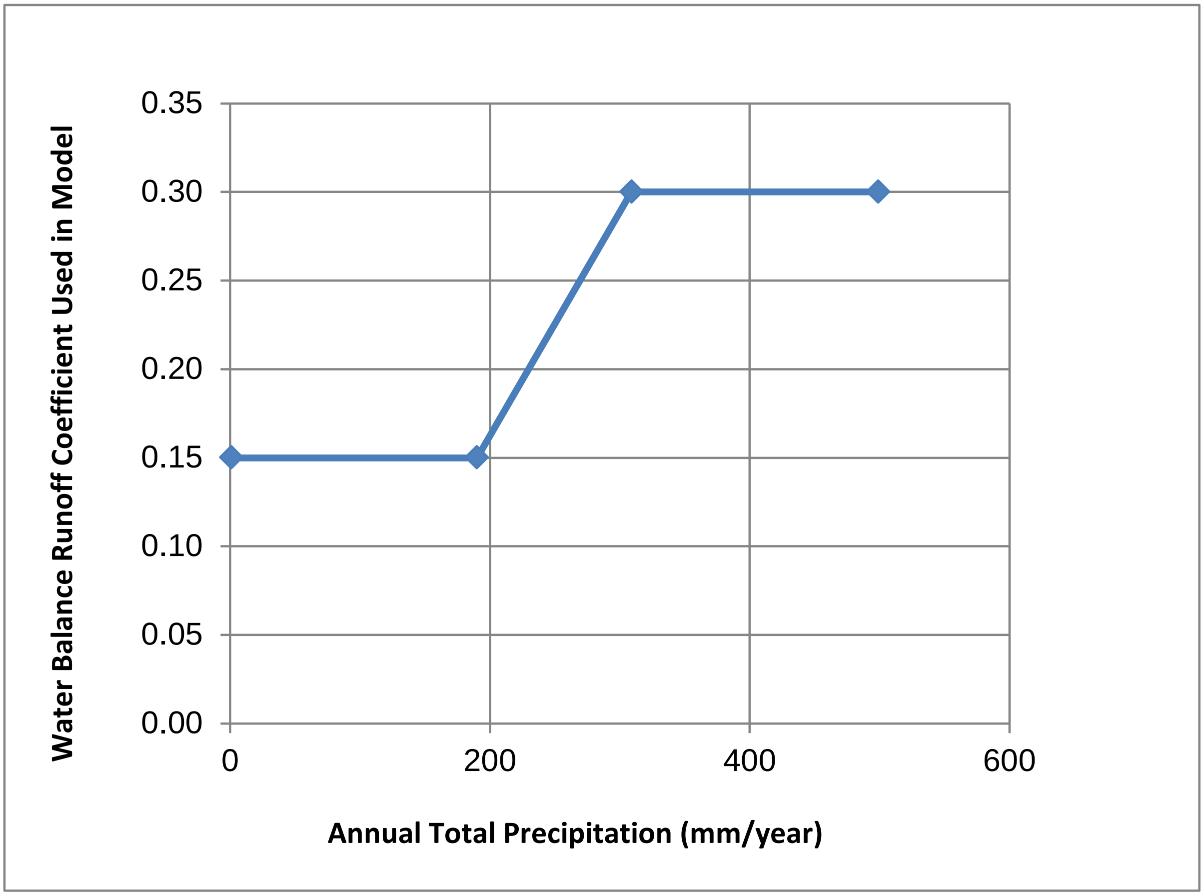

Figure 2-7 Water Balance Yield Coefficient vs. Total Annual Precipitation

The one exception is that open water areas (flooded pits and the WSP) were treated differently than land areas. Open water were assigned a yield coefficient of 1.0 along with an annual evaporation rate. This approach relies on the assumptions that any precipitation that falls on a water body becomes part of the water inventory and that the open water evaporation rate is relatively constant from year to year. As discussed in Section 2.2.2, the effect of uncertainty associated with the estimate of annual evaporation on the site-wide water balance is relatively insignificant.

2.2.5 Runoff Distribution

The natural hydrograph for the Minto Creek catchment can vary considerably from year to year. This variability is an important consideration when designing conveyance structures and storage reservoirs for shorter-term storm events. However, the specific daily or monthly runoff distribution does not significantly affect Minto's site-wide water balance during operations and closure.

Because Minto's site-wide water balance is relatively unaffected by short-term runoff events, a fixed monthly runoff distribution was adopted for the water balance model. The fixed monthly runoff distribution used in the water balance model was based on observed monthly flows rates at the hydrometric stations at W3 and W1 in Minto Creek. Figure 2-8 shows the measured runoff distributions at W3 and W1 as well as the distribution that was used in the model.

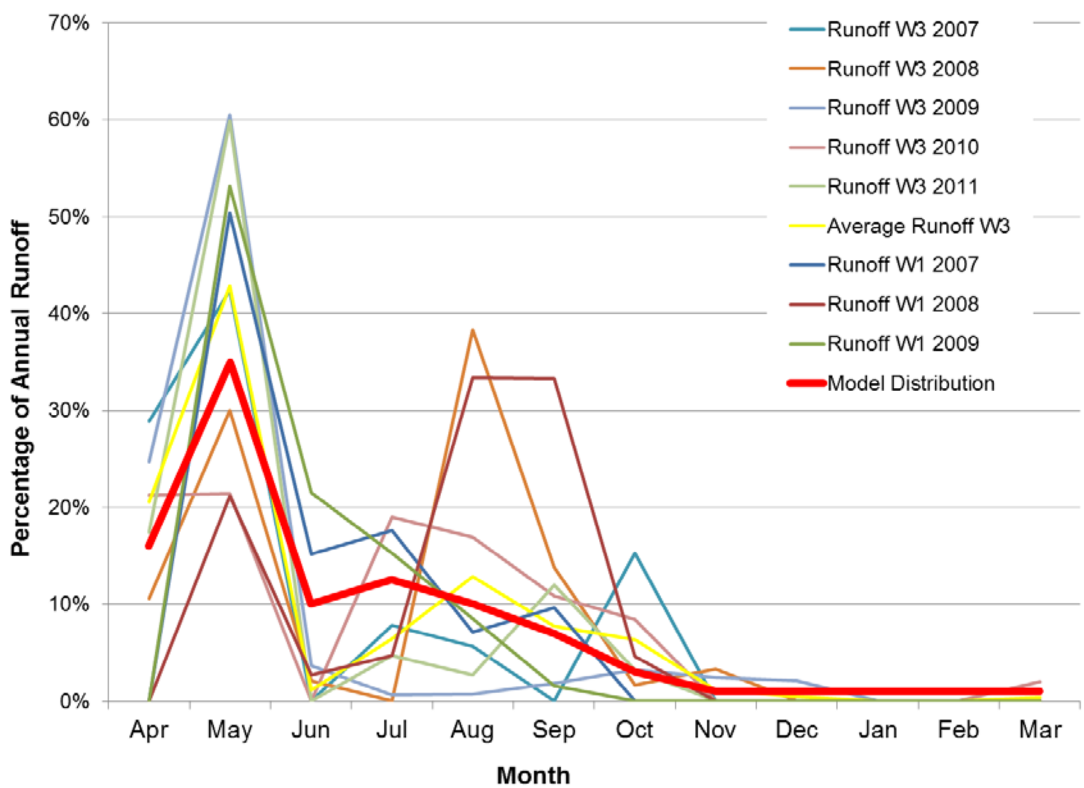

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Figure 2-8 Runoff Distribution Model

2.2.6 Reservoirs

Reservoirs on the Minto Mine site include the Main Pit and the Area 2 Pit Tailings Management Facilities (TMFs) and the Water Storage Pond. Historically, the dry-stack tailings was also considered a reservoir because of the pore water stored in the tailings mass. In the model, the available storage capacities of the open pit TMFs are defined as the volume that can be filled with water, waste rock and tailings solids. Requirements for freeboard and contingency storage are not considered to be available storage and are therefore not included in values for available storage capacity.

Main Pit

The Main Pit was mined between 2007 and 2011. Since completion of mining, the pit has been used for storage of mine water and for deposition of waste rock and tailings. The estimated total storage capacity of the Main Pit below an elevation of 789 m is 4,700,000 m^3. In March 2016 approximately 1,200,000 m^3 of free mine water was stored in the Main Pit along with approximately 2,600,000 m^3 of bulk saturated waste rock and tailings. During the operations phase, reclaim water for processing of ore is sourced from the Main Pit TMF. After the end of the milling operation, excess water will be diverted to the Area 2 Pit until the pit is full. At that time, the Main Pit TMF outflow will be directed towards the lower Minto Creek via constructed channels that will be built as part of the closure water conveyance system.

Area 2 Pit

Development of the Area 2 Pit commenced in 2011 and mining is expected to be completed in 2016. The available storage capacity of the Area 2 Pit was approximately 3,700,000 m^3 as of early 2015 when mining of Stage 2 was complete and will be approximately 7,000,000 m^3 following the completion of Stage 3 in 2016. At the end of the mine life in 2018 it is anticipated that approximately 2,900,000 m^3 of bulk tailings and 50,000 m^3 of waste rock will be stored sub-aqueously in the Area 2 Pit.

Following the operations phase, the Area 2 Pit will be allowed to fill. Water from the Main Pit TMF will be directed to the Area 2 Pit through the filling phase. When full, water discharging from Area 2 Pit will flow through the primary water conveyance system via constructed channels toward lower Minto Creek.

Area 118 Pit

The Area 118 Pit is relatively small with estimated storage capacities of approximately 210,000 m^3. The pit is expected to be filled in with overburden during mining of Area 2 Stage 3 Pit. Therefore, Area 118 Pit is not considered to be a reservoir for storage of mine water or runoff.

Minto North

Development at the Minto North Pit began in 2015 and mining is expected to be completed in 2016. During that time, mine water was collected in the pit and pumped to Main Pit TMF. When mining is complete the pit will be allowed to fill; a pit lake is expected to form (based on baseline groundwater levels in the area) but the influence of groundwater losses via pit wall fractures will only be known through performance monitoring once the pit is completed. There are no plans to store tailings or waste rock in the Minto North Pit, or to actively use the pit as a reservoir for water management purposes.

Water Storage Pond

The WSP was constructed in 2007 and has a maximum water storage volume of 320,000 m^3. Initially, the WSP was used as a source of process water for the mill. However, when the Main Pit was converted to a tailings management facility following completion of mining, reclaim from the pit supplied water for the mill, the WSP transitioned to function as a storage reservoir for clean runoff and treated water destined for release to Minto Creek. During Active Closure, the Water Storage Dam will be lowered and the footprint of the existing WSP will be converted to a Constructed Wetland Treatment System and a parallel High Flow Bypass Channel (Contango 2016).

2.2.7 Tailings Management Facilities

Minto halted deposition of tailings to the Dry Stack Tailings Storage Facility in November 2012 and transitioned to sub-aqueous deposition of tailings in the Main Pit TMF. From now until the end of mine life, tailings will primarily be deposited such that they will be saturated over the long term, with a minor volume forming unsaturated beaches in the Main Pit TMF. The water and load balance model incorporates projected water volumes associated with tailings slurry, with mill reclaim water, and with pore-water in the settled tailings mass based on the life-of-mine production schedule provided by Minto.

2.2.8 Waste Rock and Tailings Cover

During the active closure period a cover system will be constructed on all waste rock piles and the Dry Stack Tailings Storage Facility. The water and load balance model assumes that the cover will reduce the infiltration of mean annual precipitation from 30% to 20%. This is consistent with previous modelling efforts for the Minto project and is supported by recent soil cover modelling results (SRK, 2015b).

3 Load Balance Inputs

All geochemical sources in the load balance model, including sources representing mine components and background catchment runoff were incorporated as dissolved loadings. Historically, the model accounted for increases in parameter concentrations arising from suspended solids in mine discharge by adding a separate source term for suspended solids at the point of discharge. Although the model retains this capability, this revision only reports on dissolved constituent loadings and concentrations; this is consistent with the dissolved nature of both effluent standards and receiving environment water quality objectives in the current site water use licence (WUL QZ14-031).

Table 3-1 Summary of Load Balance Source Terms

Source Term	Units	Applies to
Background Upper and Lower Minto Creek	mg/L	Undisturbed catchments within and downstream of the Minto Mine site
Dry Stack Tailings Seepage	mg/L	Seepage from the Dry Stack Tailings Storage Facility
Main Pit TMF Unsaturated Tailings Load	mg/year	Main Pit TMF
Mill Area Loadings	mg/year	Mill Area
Minto North Background	mg/L	Undisturbed sub-catchments in McGinty Creek
Minto North Pit Loadings	mg/year	Minto North Pit
Nitrogen Contribution	mg/L	Added to all water released from the mine to account for loadings of nitrogen species
Ore Stockpile Concentrations	mg/L	Ore Stockpile Area, Operations
Ore Stockpile Loadings	mg/year	Ore Stockpile Area, Closure
Pit Wall Loadings	mg/year	All pit walls
Tailings Slurry	mg/L	Tailings slurry supernatant
Waste Rock Loadings	$mg/m^3/year$	Large Waste Rock Dumps and Mill Valley Fill Expansion (Stage 1 and Stage 2)

Source: Z:\01_SITES\Minto\1CM002.024_Water_Balance_Support\!080_Deliverables\2016_RCP_Water_and_Quality_Report\020_Tables\Source_terms_Summary_REV00_SRJ_KNK

3.1 Minto Creek

The load balance model was developed to evaluate the potential effects of water quality parameter loadings from mine components on water quality in lower Minto Creek. Table 3-1 shows a summary of updated geochemical source terms used in the load balance. Figure 3-1 shows the allocation of source term by sub-catchments within Upper Minto Creek. Each source term represents an estimate of runoff water quality (mg/L) or parameter loadings (mg/year) contributed by a sub-catchment or mine component.

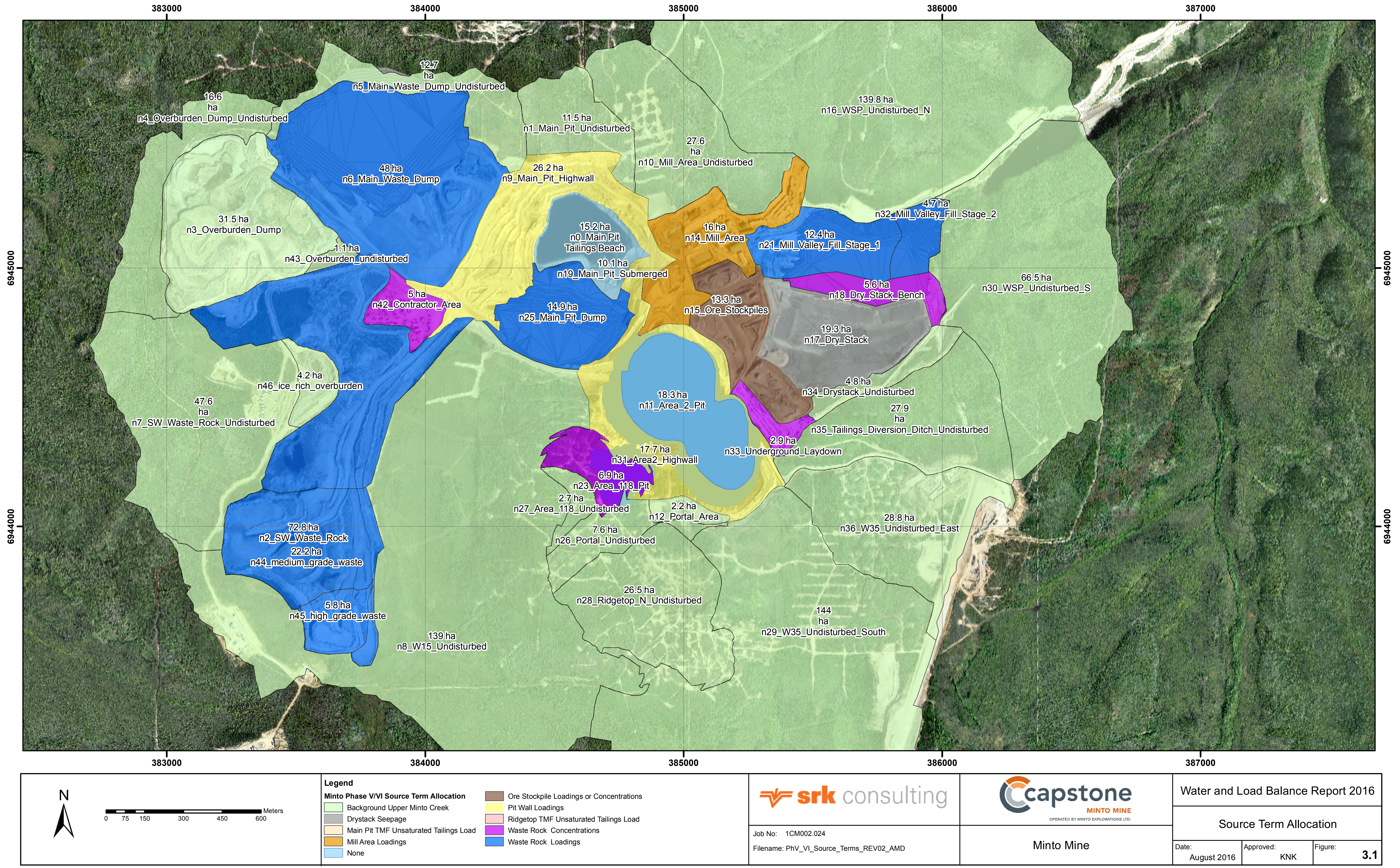
Source term estimates were generated for two scenarios described as "Expected Case" and "Reasonable Worst Case". The Expected Case scenario is intended to represent typical geochemical loadings (including the scale of variability observed to date) while the Reasonable Worst Case represents an upper limit to water quality parameter concentrations that may be observed in the mine water on site and consequently in Lower Minto Creek.

Source terms defined as concentrations (mg/L) were incorporated in the load balance model by assigning the water quality to all flow from the corresponding sub-catchment. Alternately, source terms which were defined as loadings were added as a "dry" load to the appropriate flow or water reservoir.

Details concerning the development of source terms are described in the Minto Mine Expansion-Phase V/VI ML/ARD Assessment and Post-closure Water Quality Predictions report (SRK 2013) and in the 2015 Water Balance and Water Quality Model Summary for the Minto Mine Site provided in Appendix C. Source terms used in the model are provided in Appendix B.

Estimates of background water quality were initially developed by Minnow Environmental in 2009. Minto Creek water quality monitoring data was compiled into a pooled data set that reflected background conditions (i.e. conditions not affected by mine development activities). The data set was updated and refined in 2016 as part of a process for development of post-closure water quality objectives (WQOs). Details can be found in the Background Water Quality report (Minnow 2016). Interim Post-closure WQOs, based on the summary statistics calculated by Minnow, have been defined by Minto. Details regarding the Interim Post-closure WQOs can be found in the Minto Mine 2016 Reclamation and Closure Plan (RCP 2016-01(Minto 2016)).

It is important to note that both the Interim Post-closure WQOs and background water quality source terms used in the model were derived from the same data set, however the interim WQOs were calculated on an annual basis and the background water quality source terms were calculated on a monthly basis. Some months, particularly in the winter, have very few measured data points. This results in individual data points in these months having a much higher statistical weighting than the more numerous individual data points from summer months in the generation of the background water quality source terms. One outcome of this artifact is that some of the resulting modelled background concentrations are higher than the interim WQOs. Water quality constituents for which this is a concern are copper and iron. Figure 3-2 and Figure 3-3 compare the measured background data with the interim WQOs for copper and iron respectively. Months where background water quality source terms are derived from few data points with elevated measured background concentrations will show consistent exceedance of interim WQOs in the model results.



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Water and Load Balance Report 2016

Source Term Allocation

Job No: 1CM002.024

Filename: PhV_VI_Source_Terms_REV02_AMD

Minto Mine

Date: August 2016 | Approved: KNK | Figure: 3.1

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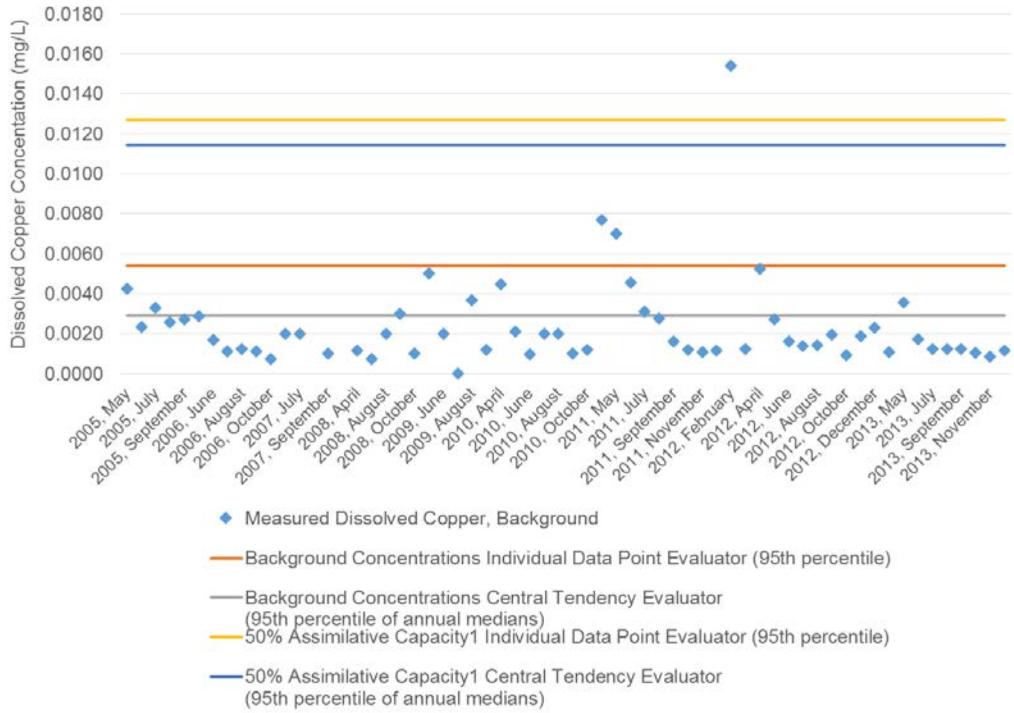

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Figure 3-2 Measured Background Water Quality and WQOs for Dissolved Copper

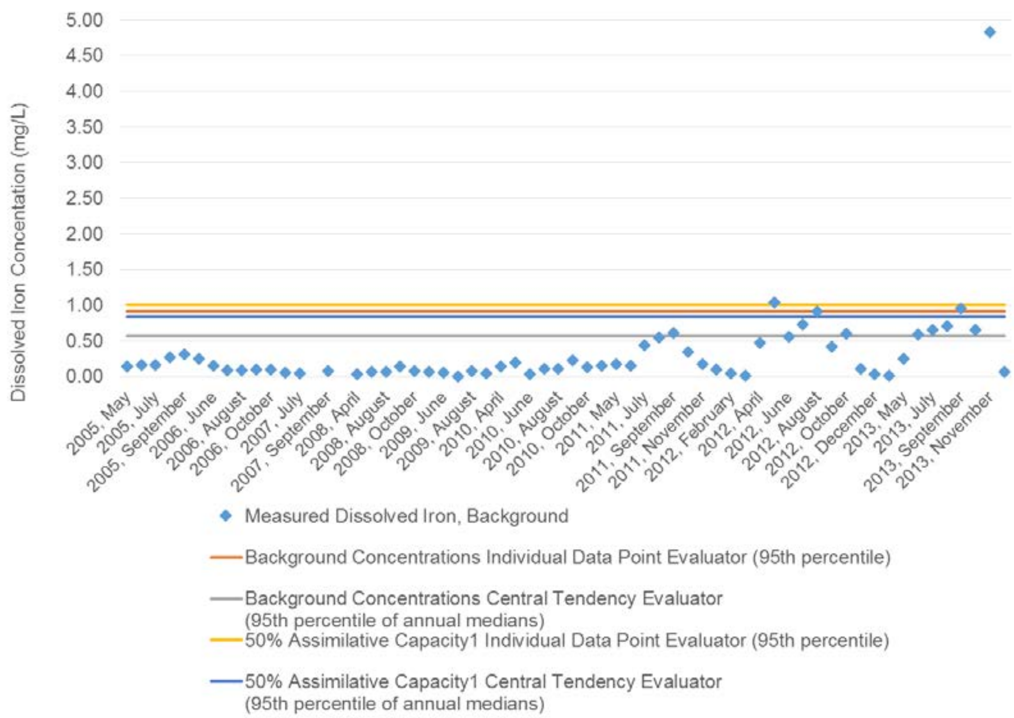

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Figure 3-3 Measured Background Water Quality and WQOs for Dissolved Iron

3.2 McGinty Creek

Background water quality data for McGinty Creek is available for the months of April to November. The McGinty background water quality used in the model for all undisturbed sub-catchments was the average of the water quality data at the monitoring station located in McGinty Creek upstream of the confluence with the Yukon River.

The source terms for the Minto North Pit were determined based on humidity cell test results. The Minto North water quality evaluation was based on worst case assumptions including:

- Maximum loading rates measured in all humidity cells including initial flush rate; and
- Assumption that the entire Minto North Pit wall would remain exposed in the post-closure phase (maximum exposed area acting as a loading source).

The combination of maximum loading rates and maximum pit area exposed is considered to be a very conservative estimate of future loading rates. Partial flooding of the Minto North Pit or application of steady state loading rates, as observed in the humidity cell tests, would result in lower loading rates. Source terms derived for the Minto North Pit are listed in Appendix B.

4 Model Implementation

4.1 Model Version

The water and load balance model for Minto was developed using the GoldSim software package (version 11.1). The model scenarios described here were implemented in model Version #59.

4.2 General Modelling Approach

4.2.1 Stochastic Water Balance Model

Water balance results for the 2016 water balance model were generated by running the model as a Monte Carlo simulation. Monte Carlo simulations are well suited for situations where the value of a key input cannot be predicted but where the distribution of the input is known or can be adequately estimated. Total annual precipitation for the Minto site is an example of such a variable. Although it is not possible to predict the rate of annual precipitation in any given year, it is possible to develop a probability distribution (see Section 2.2.1).

In the 2016 water balance Monte Carlo run, the model randomly selected a value for total annual precipitation from the probability distribution developed for the site (see the Pearson III distribution shown in Table 2-5, Section 2.2.1). Annual runoff volumes were then calculated by multiplying total annual precipitation by a runoff coefficient and catchment area (see Sections 2.2.3 and 2.2.4). The calculated runoff would then be distributed over all months of the year according to the typical hydrograph used in the model (described in Section 2.2.5). The model was run in this manner from year 2015 through 2050, each year with a randomly selected precipitation value, and all results were recorded and stored by the model. A total of 1000 model runs were completed in this way.

At the end of 1,000 model runs, all results were compiled and probability distributions of the results were generated. Figure 4-1 shows an example of model results for a single year from the Monte Carlo simulation. For illustration purposes, a year well into the post-closure two period is shown to avoid having the example be affected by active water management at site or by transient conditions that correspond to filling of pits in the closure periods. The results show the possible range of flow rates from Upper Minto Creek to W3 as represented by the model. The most likely flow distribution is the mean flow (black line).

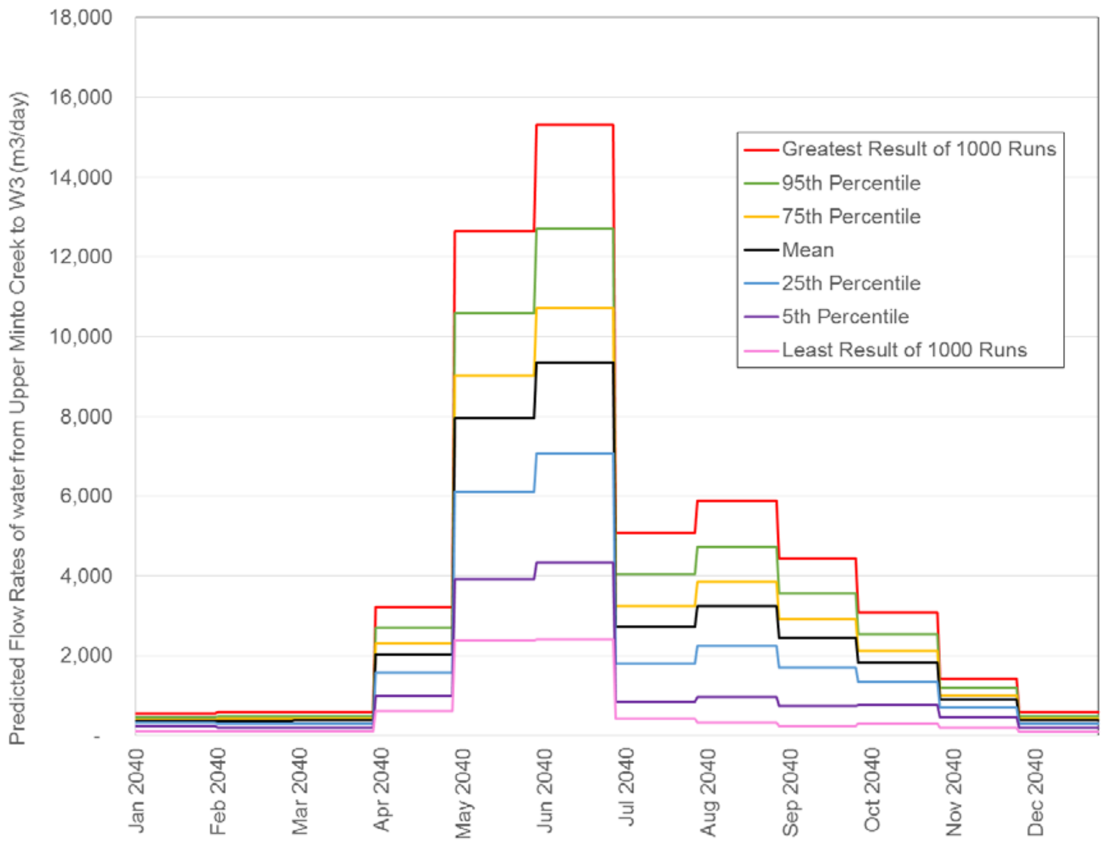

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Figure 4-1 Example of Result Generated by the Monte Carlo Simulation – Predicted Range of Average Flow from Upper Minto Creek to W3 in 2040

Routing of runoff in the model followed the plan detailed in the water management plan and closure plan as described in Section 4.3. The modelling period began on January 1, 2015 and ended on January 1, 2050. The operations period was modelled as ending at the end of June 2018, followed by the closure periods. The water and load balance model assumed that all closure activities were implemented instantaneously at the end of operations.

4.2.2 Loading Balance Model

Loadings were incorporated in the model by associating loadings source terms with the corresponding water flows or mine components as follows:

- Concentration based source terms were applied as constant values to monthly runoff volumes from corresponding sub-catchments as described in Section 3.

- Loading based source terms were incorporated into the model as a “dry” load either to runoff or to water reservoirs. For example, loadings from tailings solids were applied to the water in the reservoir where tailings were deposited.

The development of loadings source terms is discussed in Section 3. The source terms have been updated periodically as new data becomes available. The most recent source term update is described in Appendix B.

4.3 Water Management

The focus of the water management strategy during the operations phase is to maintain a minimal but adequate inventory of mine water on site. The water inventory will, to the extent possible, be managed by diverting clean (i.e. discharge compliant) surface runoff away from developed mine areas and towards the WSP to potentially be released to Minto Creek. The modelling representation of water conveyance and water diversion options are described in the following section.

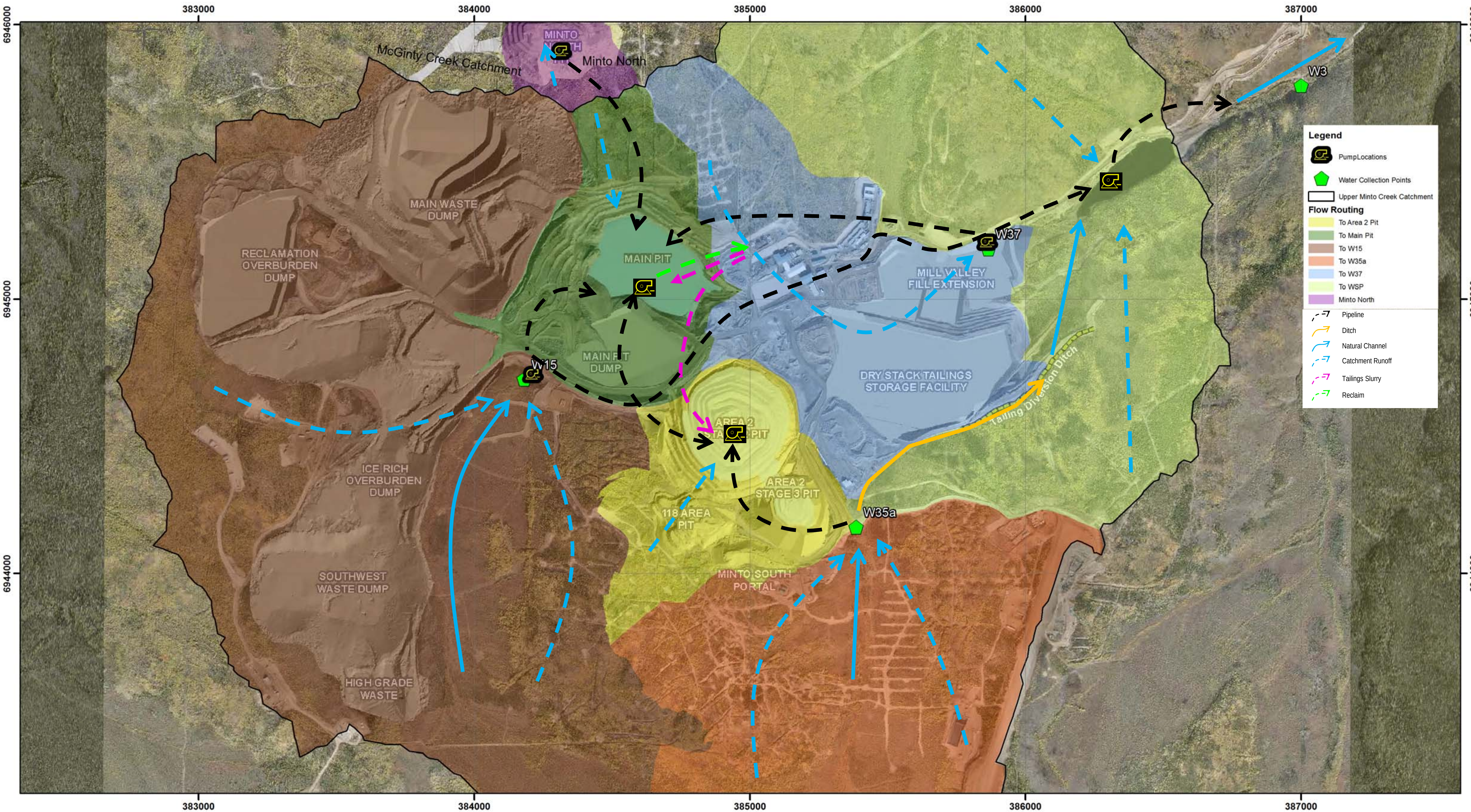
Figure 4-2 and Figure 4-3 show schematics of how water was routed in the water balance model during operations and in the post-closure phases.

During the operations period water collected at W15 is directed to the Main Pit or to the WSP through the piping network on site. Runoff collected by the W35a channel is directed to the WSP via a pipeline. Mine water collected at W37 is pumped to the Main Pit, as was mine water from Minto North. Slurry tailings were deposited in the Main Pit until April 2015 and in the Stage 2 area of the Area 2 Pit thereafter. Tailings are planned to be deposited in the Area 2 Pit Stage 2 and 3 until the end of mine life. All mill reclaim water is sourced from the Main Pit throughout the operations period.

The model assumes that the mine enters the post-closure phases immediately following the end of mine life in June 2018. During post-closure (Figure 4-3), water conveyance structures were assumed to be constructed to direct runoff as follows:

- Water collected at W15 reports to the Main Pit along with runoff from upstream catchment areas.
- The Main Pit outflow reports to the Area 2 Pit, until the pit has filled with water and a post-closure pit lake has formed.
- When the Area 2 Pit Lake has formed, the outflow from the Main Pit area reports to the former mill site area, through a channel along the mine access road to the WSP Wetland.
- Catchments upstream of the Area 2 Pit reported directly to the Area 2 pit lake.
- Water in the Area 2 Pit flows via a spill-way through the former mill site and through a channel along the mine access road to the WSP Wetland.
- Runoff from the former mill area and from slopes along the Mill Valley reported directly to the WSP Wetland.
- Water treated by the WSP Wetland report directly to Minto Creek.

Table 4-1 provides further details concerning the implementation of water routing in the water balance model.



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0 100 200 400 600 800 Meters

Notes: catchment delineation by Access Consulting Group (2013)

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Water and Load Balance Report 2016

Modelled Routing of Water: Operations

Date: August 2016

Approved: KNK

Figure: 4.2

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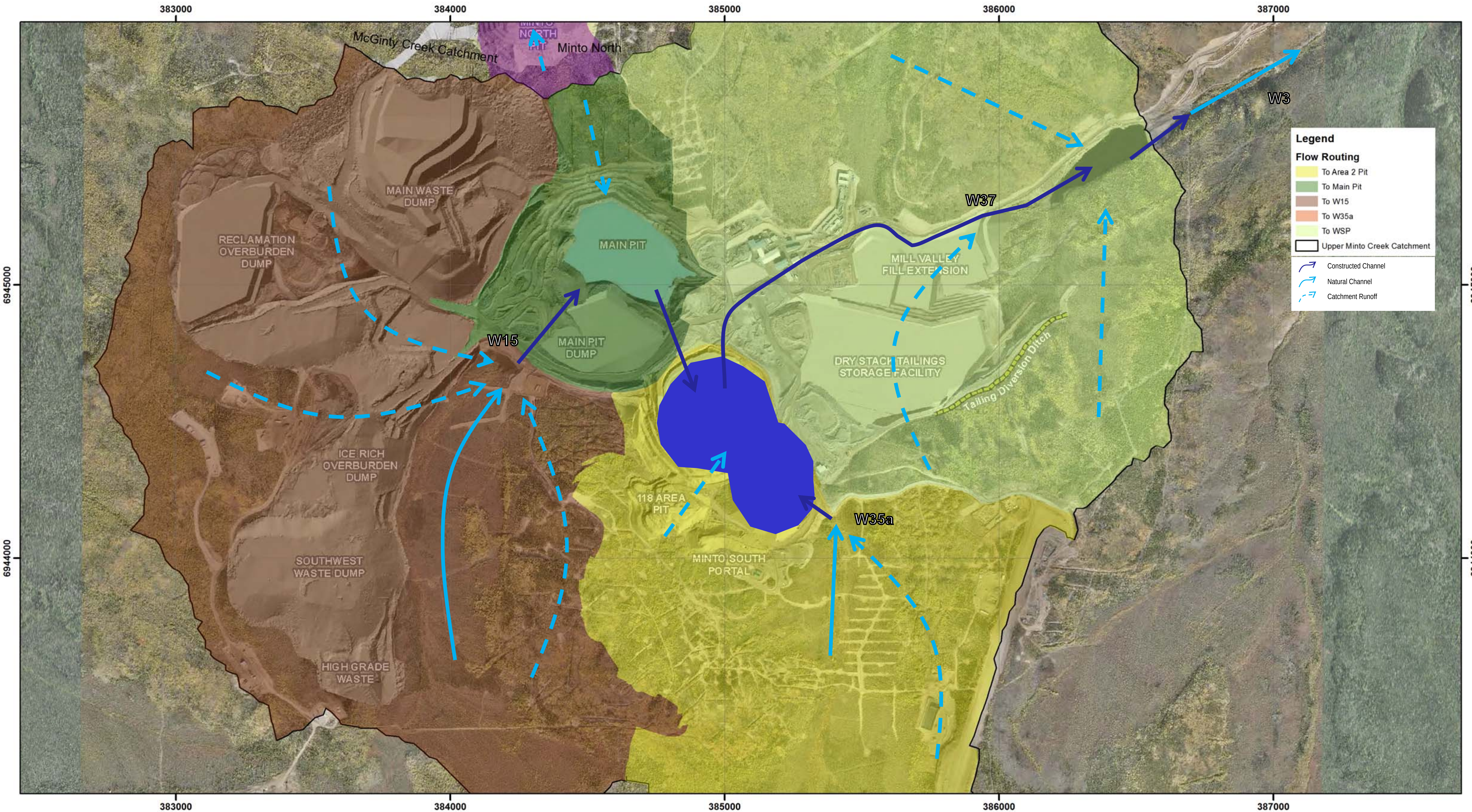

Notes: catchment delineation by Access Consulting Group (2013)

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Water and Load Balance Report 2016

Modelled Routing of Water: Post-Closure

Date:	Approved:	Figure:
August 2016	KNK	4.3

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Table 4-1 Modelled Routing of Runoff and Mine Water Conveyance

Input	Period	Reservoir	Output	Period
Catchment Yield	Always	**WSP (WSP Wetland as of 2023)**	Minto Creek	Always
W15	Until 2018			
W35a	Until 2022			
Area 2 Pit	2025 onwards			
W37	Until 2020	**Main Pit**	to Area 2	2018 to 2024
Catchment Yield	Always			
Minto North Pit	2015 to 2016		to Water Treatment	Intermittently during operation
W15	Always		Evaporation	Open water seasons
			WSP Wetland	2025 onwards
Tailings Slurry Water	Intermittently 2015 to 2018		Reclaim Water	2015 to 2018
Catchment Yield	Always	**Area 2 Pit**	Main Pit	2015-2018
W35a	Always		to Water Treatment	Intermittently during operation
Main Pit	2018 onwards		Evaporation	Open water seasons
Tailings Slurry Water	Intermittently 2015 to 2018		WSP Wetland	2025 onwards
Catchment Yield	Always	**Minto North Pit**	to Main Pit	2015 to 2016
			to McGinty Creek	2018 onwards

4.4 Tailings Slurry Deposition

Tailings slurry deposition was implemented in the water balance as follows:

- Q1 2015 to Main Pit TMF
- Q2 2015 to Main Pit TMF and Area 2 Pit TMF
- Q3 2015 to Q2 2018 to Area 2 Pit TMF

The dry bulk tailings density was assumed to be 1.35 tonnes/m^3. Details concerning tailings slurry deposition for the operations period were provided by Minto.

4.5 Model Calibration

4.5.1 Water Balance Model Calibration

The approach used to calibrate the water model was a site wide yield coefficient that correlated the total annual precipitation to the total annual yield. This approach avoids the large uncertainties inherent in quantifying appropriate input values for individual parameters (evaporation, evapotranspiration, sublimation, etc.) by determining a single site wide yield coefficient based on measured values of both precipitation and catchment yield (stream flows) from historical records. The yield coefficient approach integrates all catchment processes into a single empirical factor that describes the relationship between precipitation and catchment yield.

In years for which the total annual precipitation was known, the actual (measured) total annual yield was compared to the modelled total annual yield. The modelled data was calibrated to the measured data by adjusting the yield coefficient to achieve a best fit. After a suitable yield coefficient was identified, it was used to model future site yield estimates.

4.5.2 Loading Balance Model Calibration

The load balance was calibrated by comparing constituent concentrations in the Main Pit and Area 2 Pit water to model predictions and then adjusting source terms accordingly to improve the fit between measured and modelled concentrations. The main sources of loadings to pit water is waste rock seepage and tailings slurry. Source terms for waste rock seepage are based on measured seepage water quality and are therefore, in a sense, already calibrated. Also, waste rock seepage water quality is not expected to change abruptly because of the size of the waste rock areas. Loadings from tailings slurry, on the other hand, are directly related to the characteristics of the ore processed, which can change in short order as the ore type changes. Therefore, the load balance calibration was focused on making adjustments to the ore source term.

The modelled data was calibrated to the measured data by adjusting the tailings slurry loading term for each water quality parameter to achieve a conservative best fit. Once suitable calibration factors were identified, they were used to model future load contributions from tailings slurry.

4.6 Water Treatment

4.6.1 Active Treatment

The water treatment plant at Minto can be operated in a number of different configurations depending on the quality of feed water to be treated. Treatment options range from simple TSS removal to sulphide precipitation to reverse osmosis (RO) treatment, which removes 95% to 99.5% of all constituents in the mine water.

In the load balance model, it was assumed that no active water treatment activities were performed. This assumption is conservative and allows the effectiveness of the passive water treatment options to be assessed independently.

4.6.2 Passive Treatment

The Minto Mine plans to construct a wetland where the WSP is currently located in an effort to ensure long-term passive treatment of water flowing from the mine site during the post-closure phases. The WSP wetland is expected to remove a variety of water quality constituents as described in (Contango 2016). In the load balance model, it was assumed that the wetland will be operational at the start of 2023, approximately 5 years from the end of mine life. The actual commissioning date of the WSP wetland will be contingent on the wetland testing phase that will begin once the wetland has been constructed after the end of mine life. Once the wetland is operational and treats water to an acceptable standard all active water treatment facilities will be decommissioned.

Implementation of the wetland in the water and load balance model was based on the preliminary design basis and operational philosophy. Accordingly, the model assumes that the WSP Wetland will have a total active volume of approximately 2,000 m^3 and a maximum inflow of 3,000 m^3/day. This results in a minimum Hydraulic Retention Time (HRT) of about 16 hours. Should the flow rate into the WSP Wetland exceed 3,000 m^3/day, excess water will be diverted around the wetland untreated. Estimates of removal rates for dissolved cadmium, copper and selenium were incorporated in the model. The estimates rates were based on results of the wetland testing program carried out by Minto (Contango 2016). The estimated removal rate equations are shown in Table 4-2.

Table 4-2 WSP Wetland Load Balance Dissolved Metal Removal

WQ Constituent	Rate Equation	Order	Removal Limit
Cadmium – Cd	$[Cd]e^{-0.065/hr*HRT}$	First	0.000009 mg/L
Copper – Cu	$[Cu]e^{-0.05/hr*HRT}$	First	0.015 mg/L
Selenium - Se	$[Se] - \frac{0.0001\frac{mg}{L}}{hr} * HRT$	Zero	0.004 mg/L

Notes:

(1) HRT = Hydraulic Retention Time in hours

(2) [Cd] = Concentration of dissolved cadmium in WSP Wetland Influent in mg/L

(3) [Cu] = Concentration of dissolved copper in WSP Wetland Influent in mg/L

(4) [Se] = Concentration of dissolved selenium in WSP Wetland Influent in mg/L

The modelled performance of the WSP Wetland was not explicitly adjusted for hydraulic efficiency. Rather, hydraulic efficiencies were assumed to be on the same order of magnitude (or higher) than hydraulic efficiencies associated with the pilot-scale or field scale wetlands that were used as a basis for estimating removal rates.

5 Model Results

5.1 Water Balance Results

5.1.1 Minto Creek Water Balance Results

The primary water management challenge for the Minto Mine is to ensure that sufficient storage capacity is available to meet the anticipated life-of-mine storage requirements and that sufficient stored water is available to meet the needs of the milling operation.

The volume of water that must be released from site each year in order to maintain an appropriate water inventory is an important factor for managing water on site. By quantifying the volume of water that can be added to the inventory in a given year, and consequently the volume of water that should be released, water management staff can implement diversions or plan water treatment campaigns, if required.

Figure 5-1 shows projected volumes of tailings and free mine water in the Area 2 Pit through the operations and post-closure periods for the modelled scenarios. Note that, in the modelled scenarios, filling of Area 2 Stage 2 Pit reaches the saddle elevation at approximately the same time that mining in Area 2 Stage 3 is complete. The results indicate that, under the model scenario, the Area 2 Pit will be full of water by mid-2025.

5.1.2 McGinty Creek Water Balance Results

The water balance for the Minto North Pit simply consists of inflows from a small upgradient catchment and from direct precipitation on the open pit. During development and mining of the pit the mine water is being transferred to the Main Pit in the Upper Minto Creek catchment. After mining is complete, the open pit will be allowed to fill. Although it appears that there is a slight net positive water balance for the pit (including the contributions from the upgradient catchment), it is expected that it will take years for the pit to fill and discharge as surface flow to lower McGinty Creek, if it fills at all. Depending on the rate of groundwater flow into and out of the pit area, it is possible that the pit may never discharge via surface overflow (as noted in Section 2.2.6). At this stage of the project, it is not possible to definitively predict whether a lake will form, and what steady state water surface elevation will be established if a lake does form.

The catchment area influenced by the proposed pit is a small component of the overall McGinty Creek catchment (roughly 15 ha vs. 3,400 ha) and therefore the Minto North development is expected to have minimal (i.e. no measurable) effect on flow volumes in McGinty Creek.

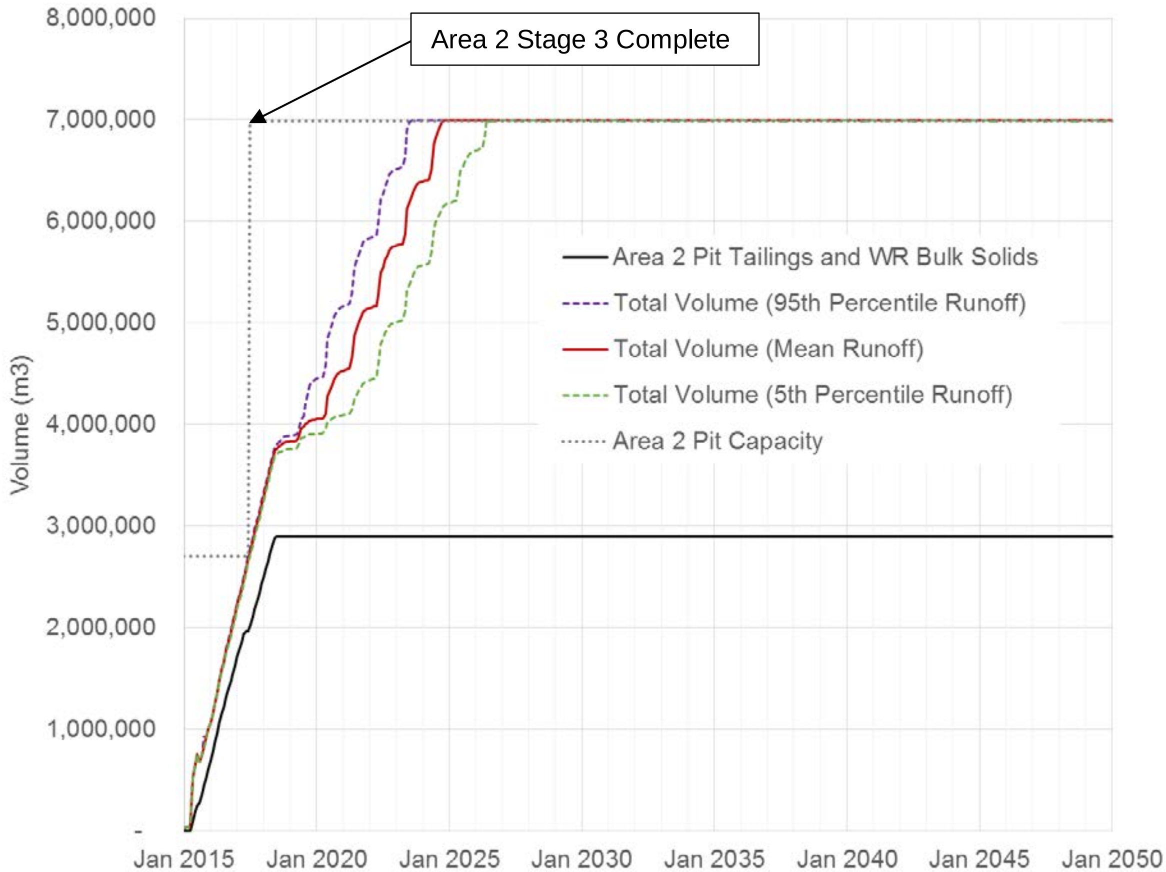

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Figure 5-1 Modelled Area 2 Pit Water and Tailings Volumes

5.2 Water Quality and Parameter Loadings Results

5.2.1 Interim Post-Closure Water Quality Objectives

Water Quality Objectives (WQOs) are in the process of being developed by Minnow Environmental. The following excerpt from the Background Water Quality for Post-Closure WQOs memo (Minnow 2016) describes the criteria for generating WQOs as outlined in the Water Use License (WUL).

The Minto Mine's WUL includes Water Quality Objectives (WQOs) for lower Minto Creek at water quality monitoring station W2. These WQOs apply during the operational period and are anticipated to also apply during post-closure 1. A separate set of WQOs will be developed for the post-closure 2 period. The Minto Mine's WUL requires a Reclamation and Closure Plan (RCP) that includes WQOs for post-closure that meet the criteria for non-degradation of background concentrations. Two approaches have been provided in the WUL as guidance to developing closure WQOs (YWB 2015; Clause 112):

1. *Establish closure WQOs that meet the criteria for non-degradation of background concentrations in Minto and McGinty creeks.*
2. *If non-degradation of water quality is not achievable, the closure WQOs shall be set at no more than 50% of the assimilative capacity of Minto Creek using the following formula:*

Closure WQO = BKGD + (0.5[WQOOperations – BKGD])*

where: BKGD = background concentration

The interim post-closure 50% assimililative capacity WQOs as calculated using the above equation utilizing the background water quality summary statistics provided by Minnow (2016) are included in the water quality results for station W1 for comparison purposes. A complete list of the Interim Post-closure WQOs is provided in Minto (2016).

5.2.2 Minto Creek Water Quality Results

Water quality predictions for RCP 2016-01 were produced for the following four scenarios:

- Scenario 1: *Expected Case* source terms + no passive treatment implemented
- Scenario 2: *Reasonable Worst Case* source terms + no passive treatment implemented
- Scenario 3: *Expected Case* source terms + passive treatment implemented
- Scenario 4: *Reasonable Worst Case* source terms + passive treatment implemented

All four scenarios include the effect of soil covers as described in Section 2.2.8.

The *Reasonable Worst Case* is considered to be a conservative case while the *Expected Case* can be considered to be the most likely outcome, based on the available information. The water quality results shown below include concentrations of copper, selenium, and cadmium, which are considered to be parameters of potential concern and are demonstrative of the effectiveness of passive treatment. Copper and selenium are generally indicative of the behaviour of other parameters.

The four scenarios were selected to show the potential effects of the WSP wetland on the quality of water immediately downstream of site (reported as concentrations at W3) as well as concentrations at W1 in Lower Minto Creek. These scenarios allow for comparison of wetland performance in cases where the inflow water quality has been influenced by the *Reasonable Worst Case* source terms and by *Expected Case* source terms. Scenario 3 and 4 demonstrate the load removal mathematically using the load removal rate equations shown in Table 4-2.

Model results for water quality in pits, water released to station W3 in upper Minto Creek and at station W1 in Lower Minto Creek for the entire modelled period (2015 to 2050) are included in Appendix A1. Tabular monthly results are provided for a single year well into post-closure (2030) in Appendix A2 to illustrate typical modelled seasonal variability during the post-closure period. Results are included for open water season only (April to October) as the background water quality source terms for the winter months are highly variable and poorly characterized, and therefore produced misleading results when used as inputs for modelling.

Figure 5-2 to Figure 5-4 show predicted dissolved copper, selenium, and cadmium concentrations for mine water in the Main Pit and Area 2 Pit over time. Concentrations in the pits are expected to increase during the operational stage when waste rock and tailings are deposited. Selenium concentrations increase markedly during periods when tailings are deposited to the pit. After closure, copper, selenium, and cadmium concentrations are expected to decline to steady-state levels that are representative of long-term post-mining geochemical loading rates. Concentrations in the Main Pit remain relatively constant, again reflecting geochemical loading rates.

Figure 5-5 to Figure 5-7 show model predictions for dissolved copper, selenium, and cadmium concentrations for mine water in the WSP as released to station W3 in Minto Creek. Both profiles show relatively low concentrations during the operational period followed by a modest increase in concentrations at closure. This is due to the fact that residual mine water stored in the Area 2 TMF begins reporting to Minto Creek at that time.

Figure 5-8 to Figure 5-10 shows modelled values total copper, selenium, and cadmium concentrations in Lower Minto Creek (the W1 water quality station). Copper and selenium concentrations follow the trends noted for the W3 water quality predictions but the difference between concentrations during the operations stage and post-closure periods is less pronounced because of dilution from the Lower Minto Creek catchment. Concentrations of nitrate, nitrite and ammonia (not shown) are expected to decrease gradually following the end of active mining in 2018. Residual ammonium nitrate/fuel oil (ANFO) explosives in tailings and water rock contribute the vast majority of nitrogen species to the mine water. Once mining is complete and ANFO use ends, there will be no new sources of nitrate and ammonia loadings.

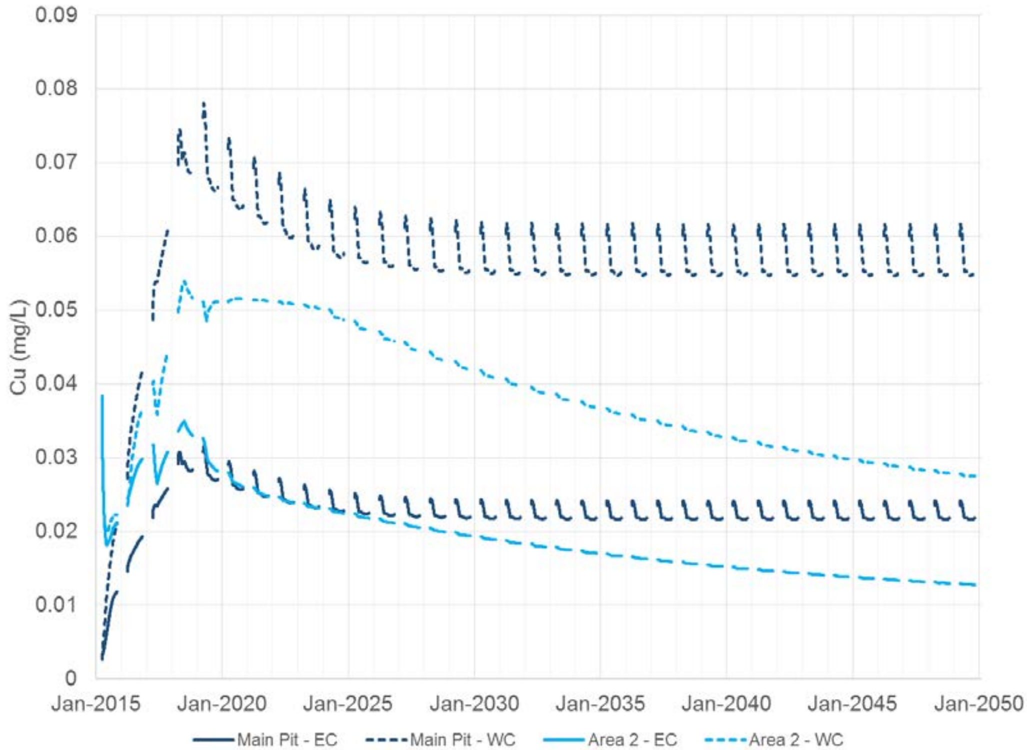

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Figure 5-2 Model Predictions of Dissolved Copper Concentrations in Pit Lake Water

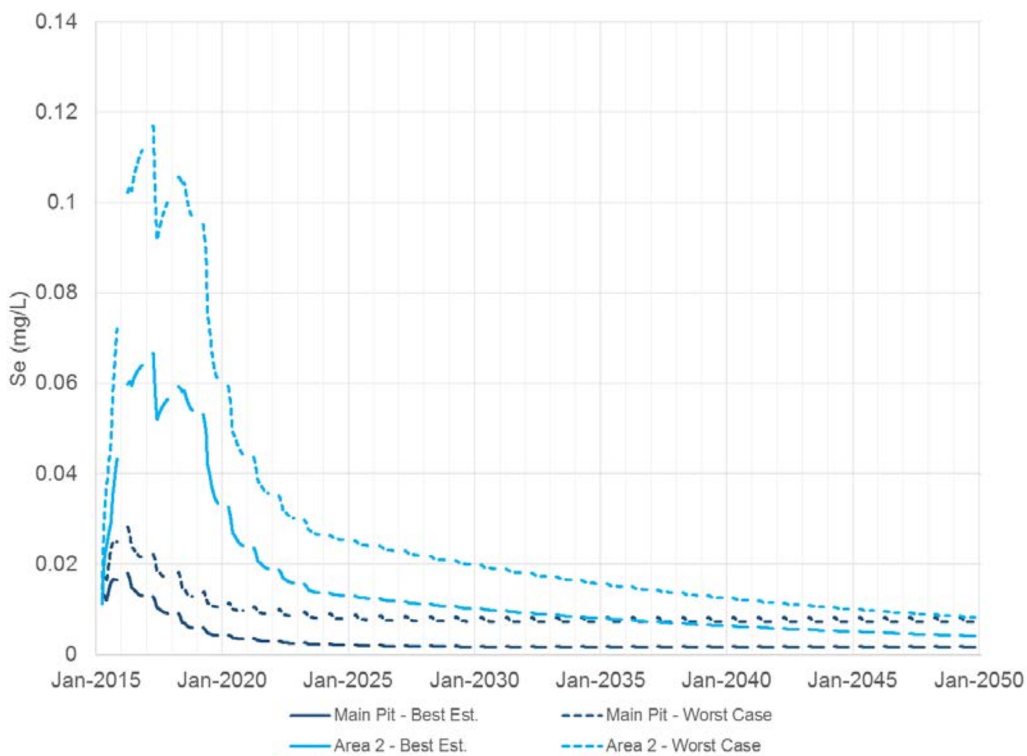

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Figure 5-3 Model Predictions of Dissolved Selenium Concentrations in Pit Lake Water

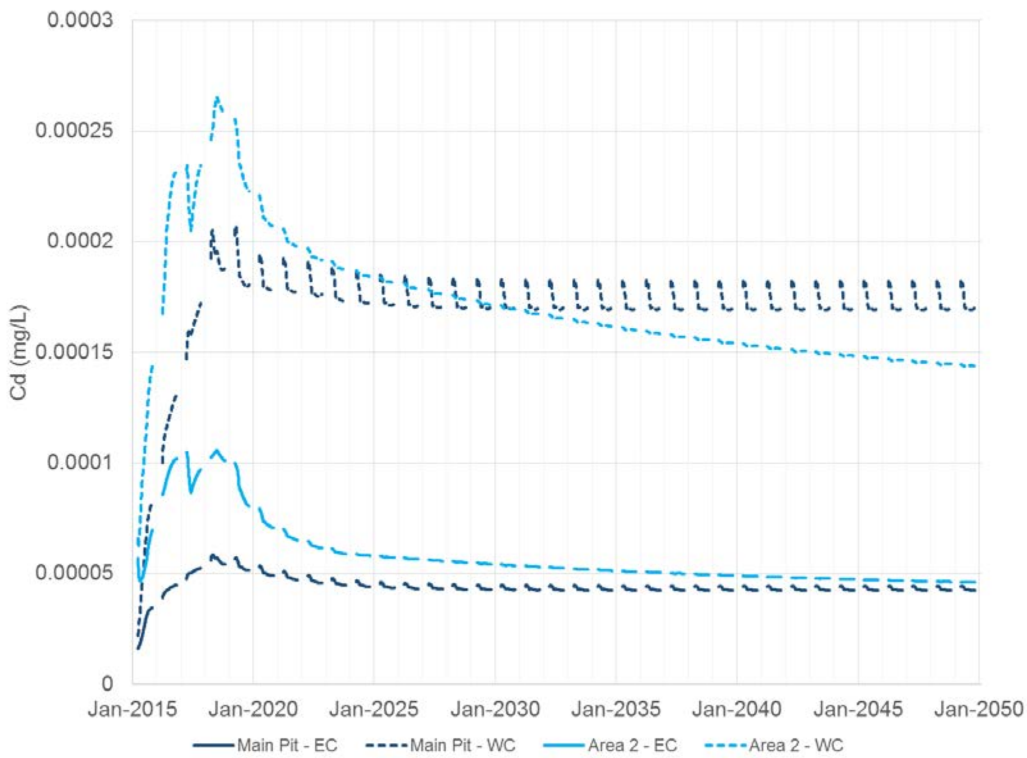

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Figure 5-4 Model Predictions of Dissolved Cadmium Concentrations in Pit Lake Water

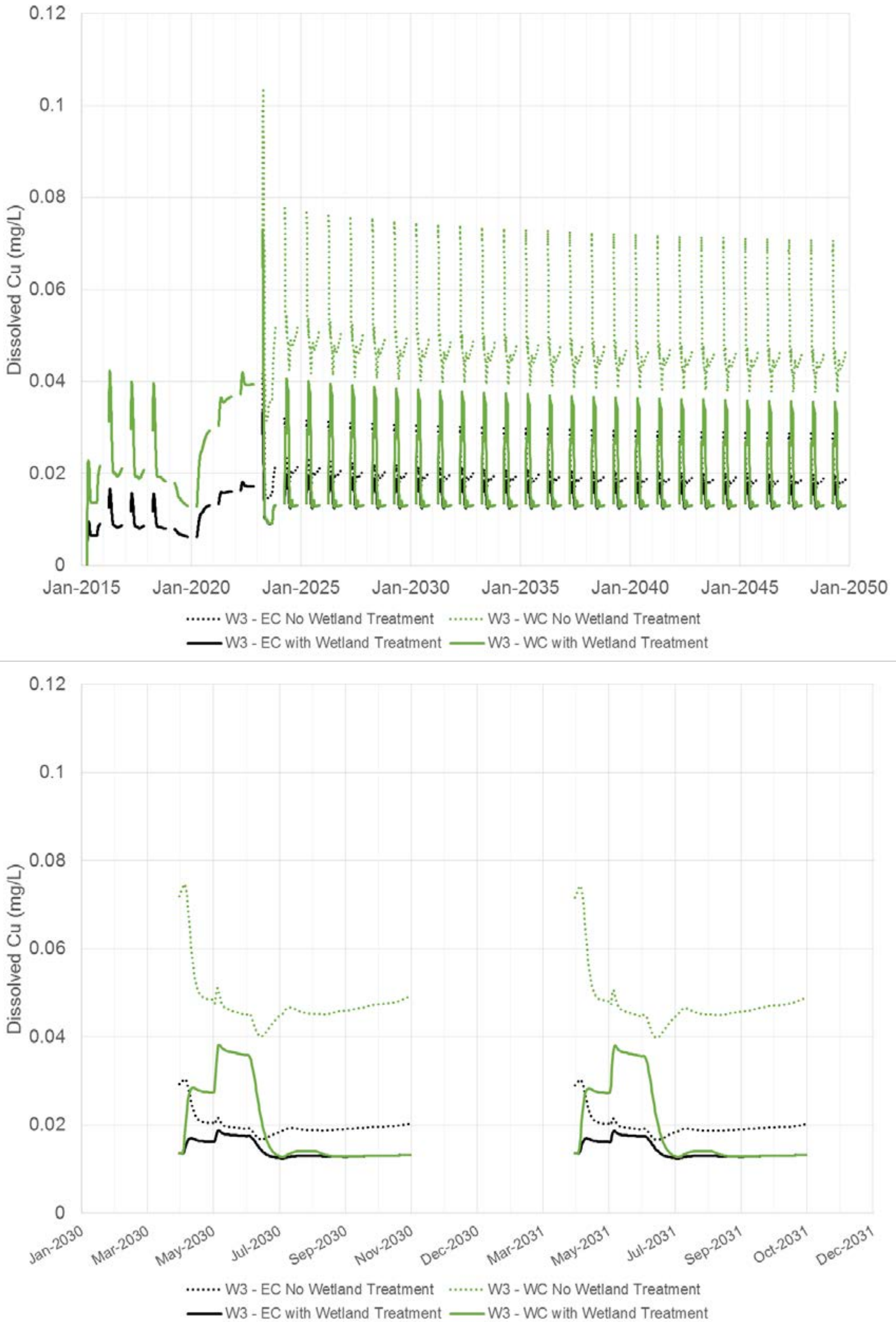

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Figure 5-5 Model Predictions of Dissolved Copper Concentrations at W3

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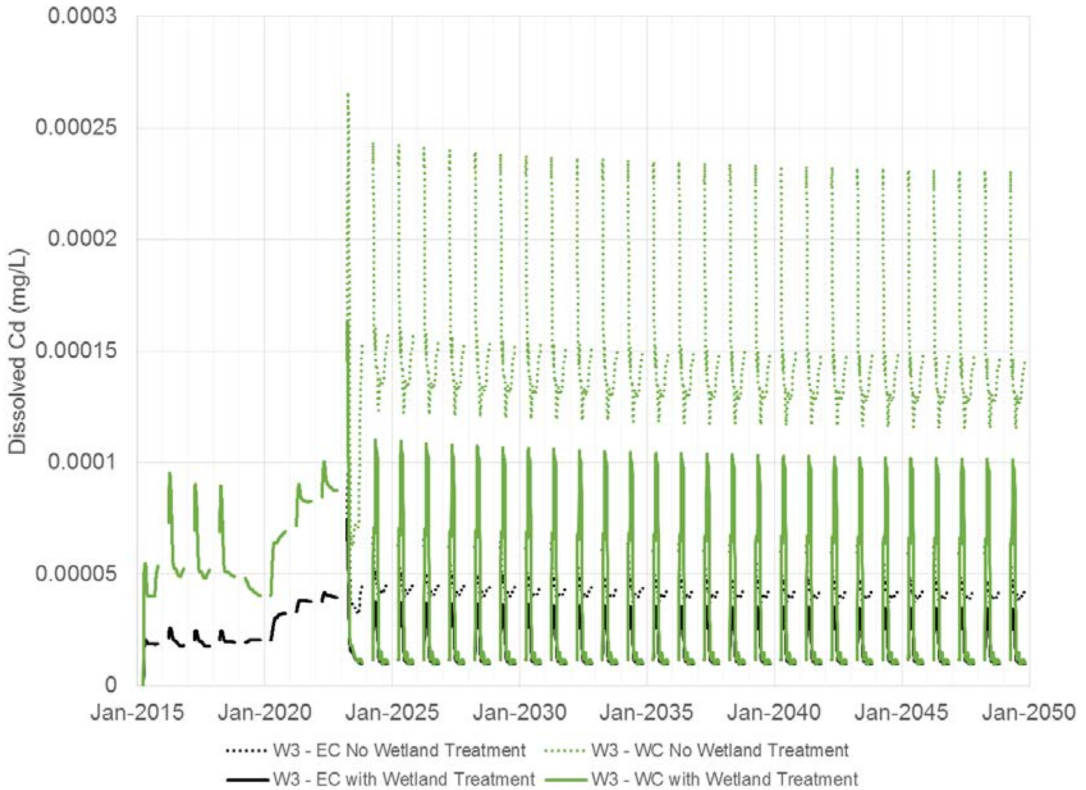
Figure 5-6 Model Predictions of Dissolved Selenium Concentrations at W3



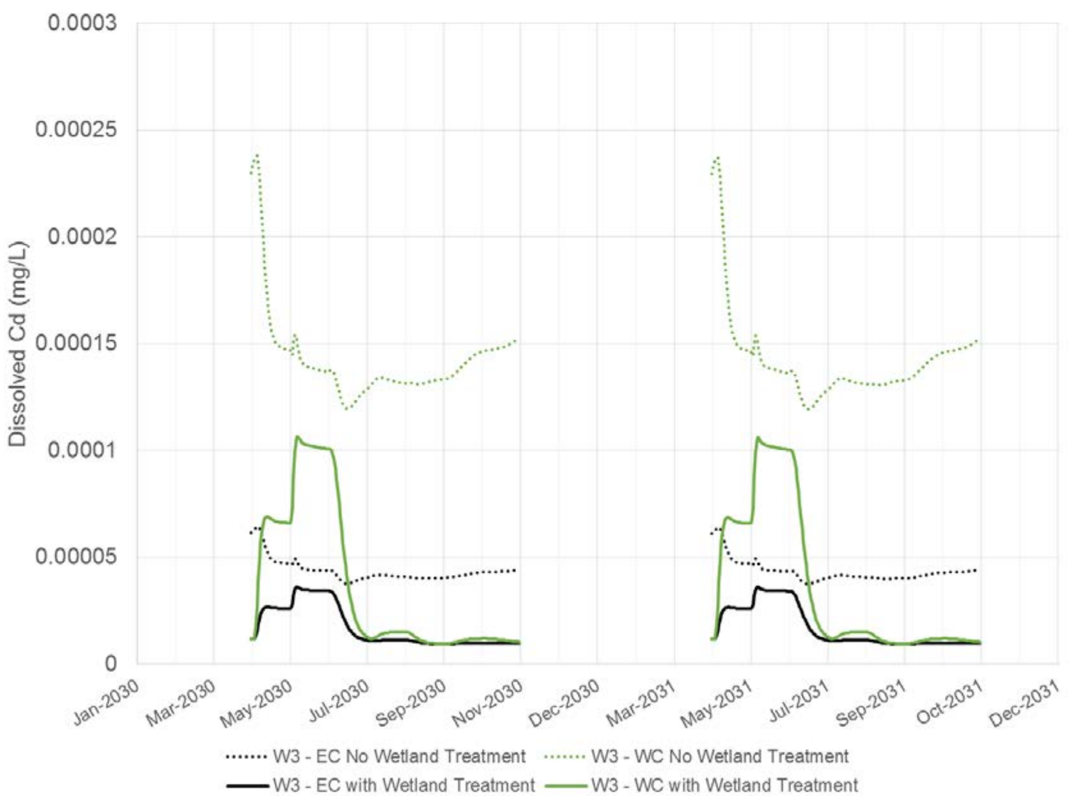


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Figure 5-7 Model Predictions of Dissolved Cadmium Concentrations at W3

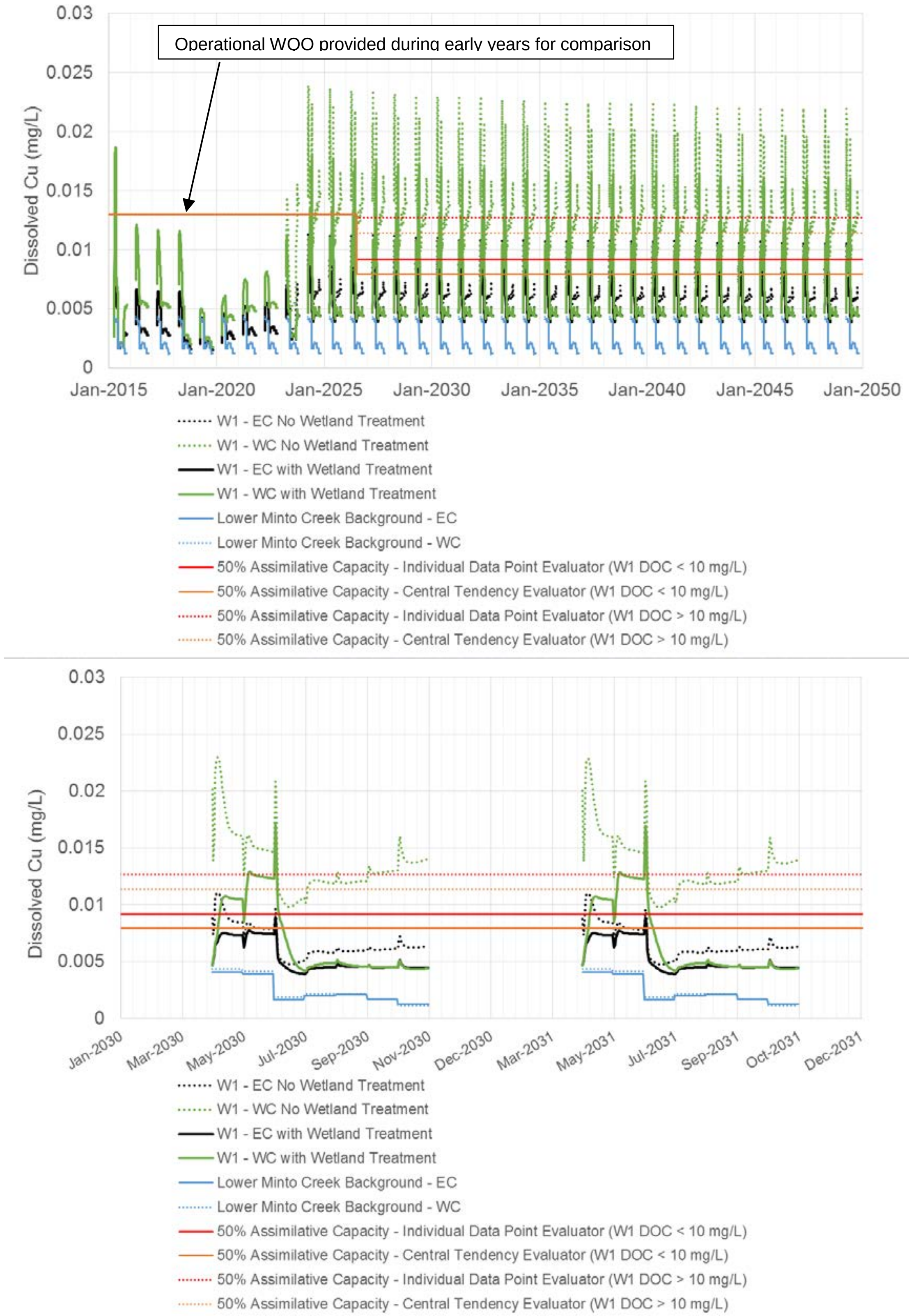

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Figure 5-8 Model Predictions of Dissolved Copper Concentrations in Lower Minto Creek

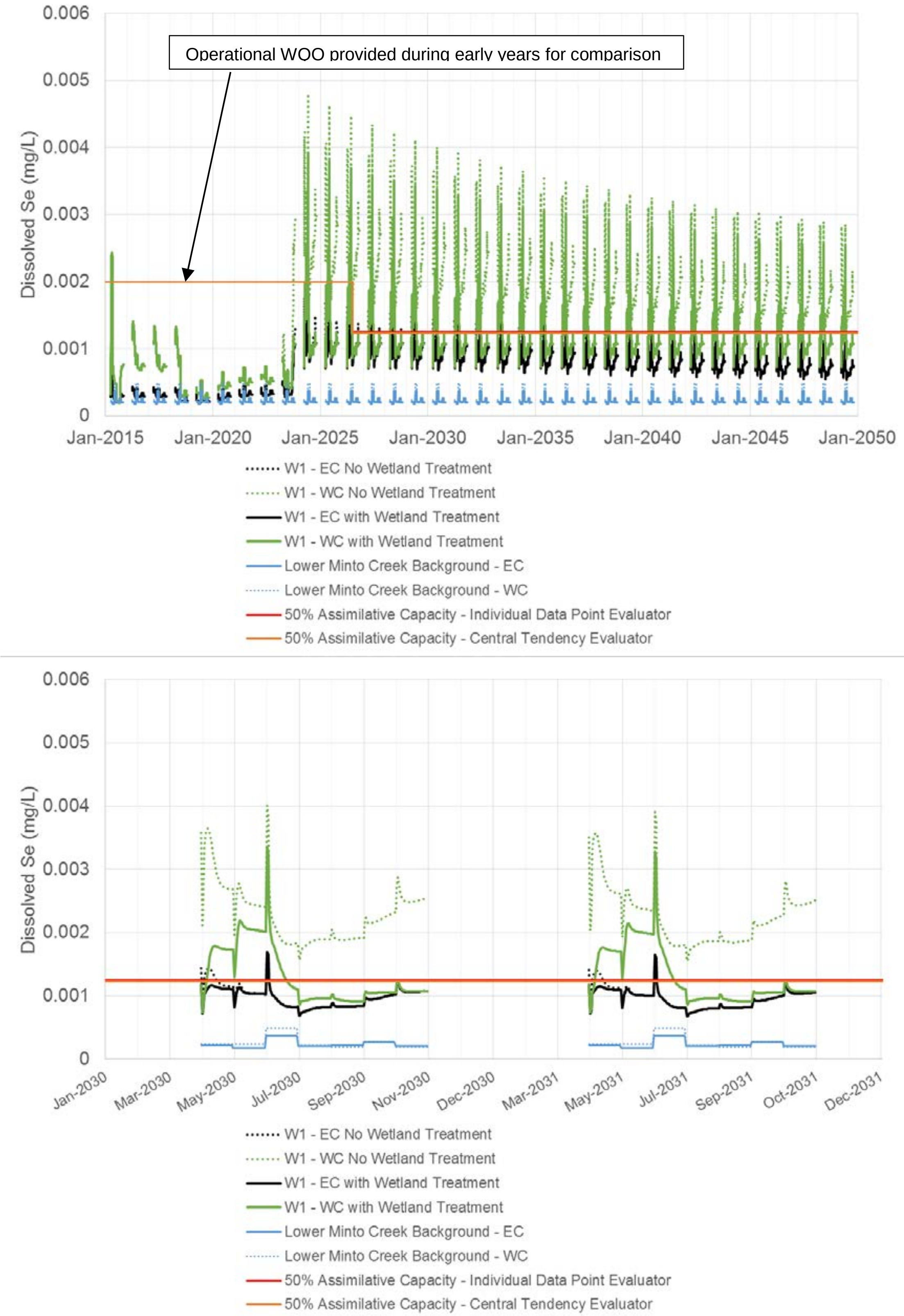

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Figure 5-9 Model Predictions of Dissolved Selenium Concentrations in Lower Minto Creek

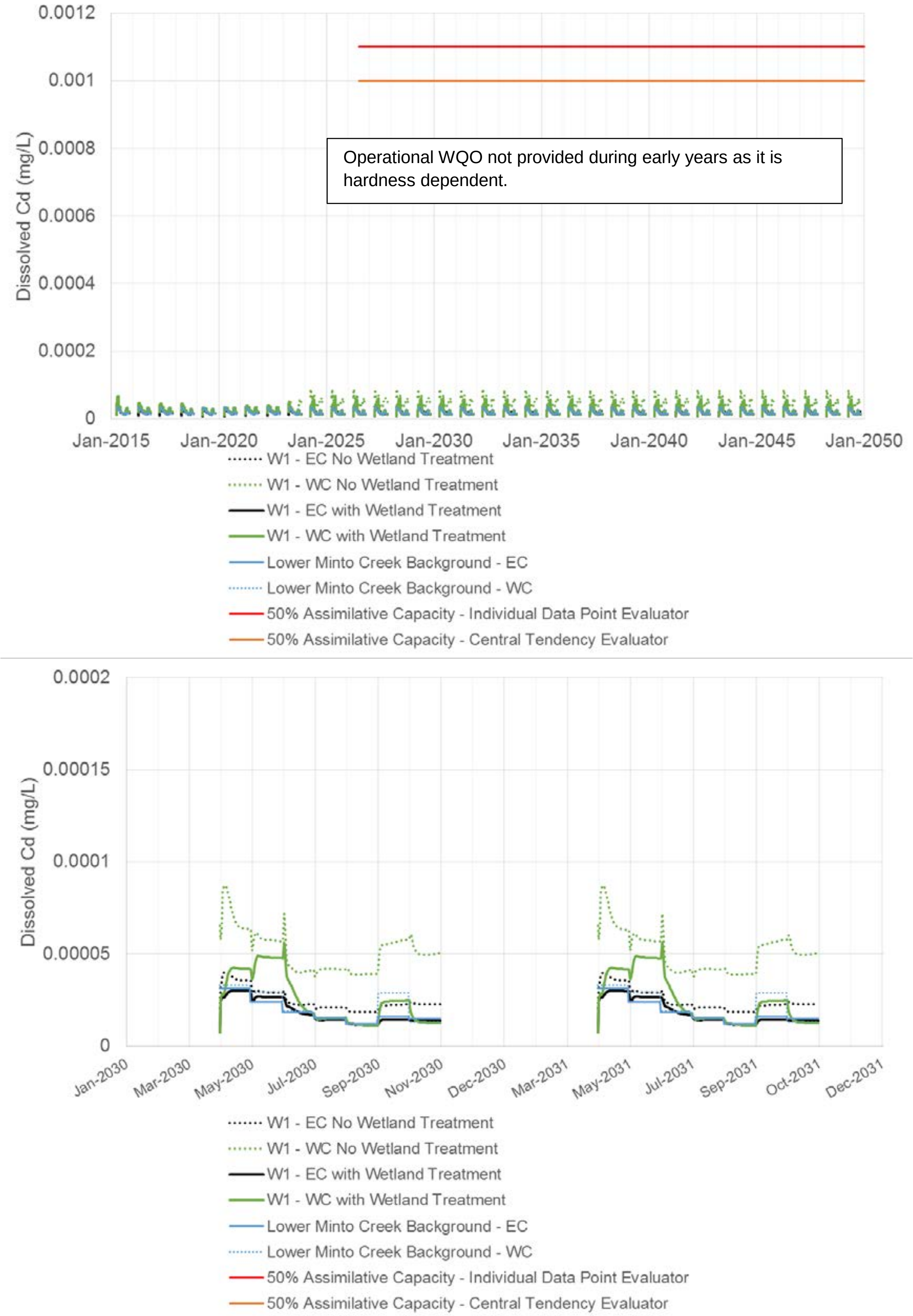

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Figure 5-10 Model Predictions of Dissolved Cadmium Concentrations in Lower Minto Creek

5.2.3 McGinty Creek Water Quality Results

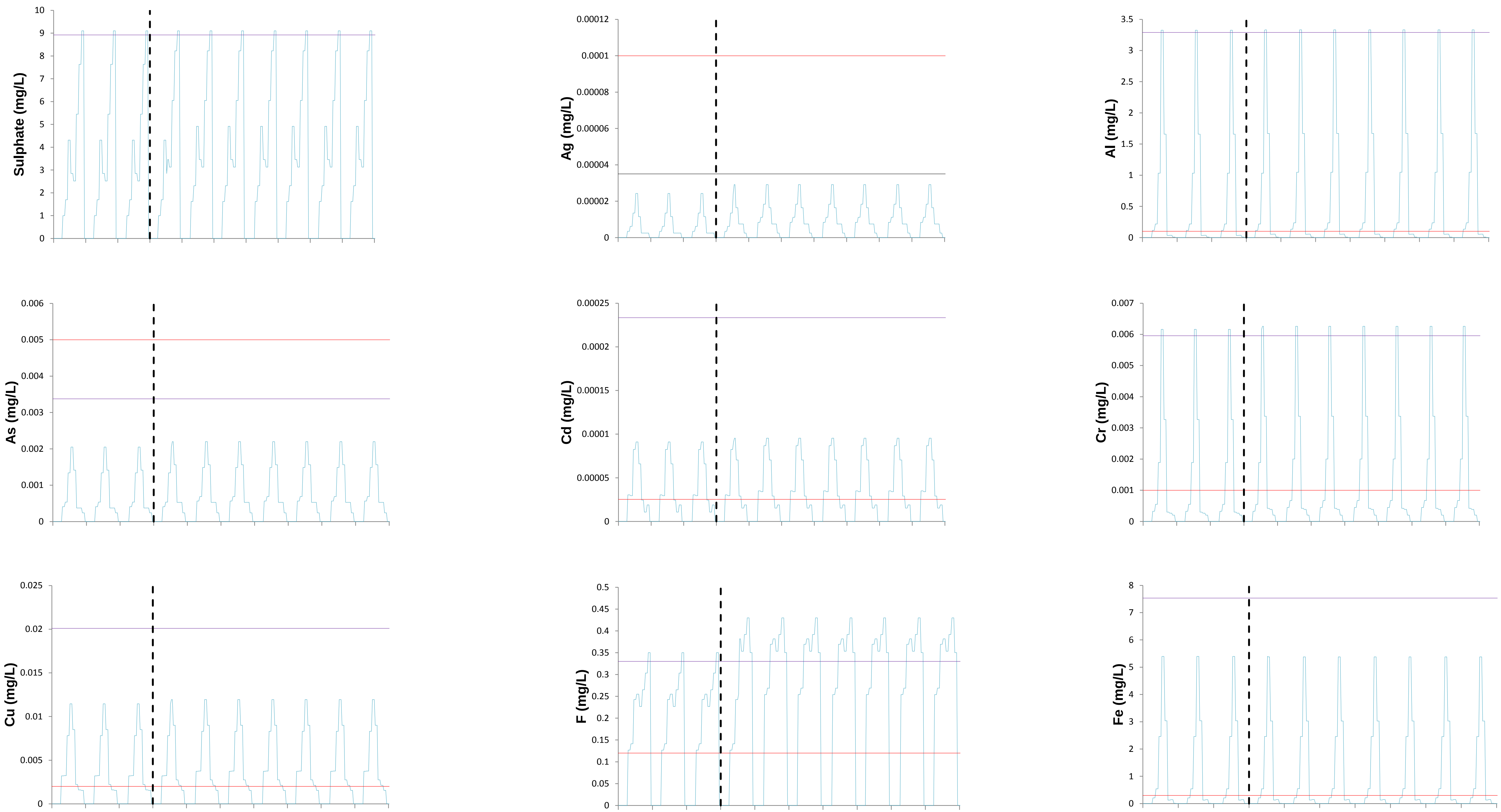
The McGinty Creek water quality modelling was carried out as a scoping exercise for a worst-case scenario that included the following assumptions:

- The magnitude of loadings was set to be equal to the loads determined for the full extent of the pit walls exposed at the end of mining (i.e. there was no gradual decrease in loadings estimates even if the pit was to fill).
- All geochemical loading generated by weathering of the pit walls is both flushed from the weathering sites and reports to water in the Minto North Pit.
- Accumulated loadings would report unattenuated to McGinty Creek by surface discharge and/ or via groundwater pathways.

Under this scenario, Minto North loadings are maximized. This highly conservative approach evaluates the upper limit of the magnitude of potential changes to McGinty Creek water quality from geochemical loadings from the Minto North Pit.

Average and maximum results of the scoping exercise for lower McGinty Creek are presented in Table 5-1, along with average and maximum values in the baseline water quality results. Results for selected parameters are shown in Figure 5-11a and Figure 5-11b, along with indicator values representing the 95th percentile concentrations in the baseline data. CCME Protection of Aquatic Life guidelines (for those parameters with guidelines) and an indicator marking the start of mining at Minto North are also shown. Although the assessment of aquatic effects is addressed elsewhere (Minto 2013 and references therein), inspection of the baseline and worst case post-mining results in Figure 5-11a and 5-11b reveals that the changes in water quality of McGinty Creek from mining Minto North will be minimal.

Table 5-1 indicates that no change from baseline range is expected in the post-mining period for concentrations of nitrogen species. These species are typically derived from soluble blasting residues in mined rock and in pit water. Since the mined rock will be stored in the Minto Creek watershed, and since pit sump water will also be directed to the Minto watershed during operations, it is expected that there will be minimal nitrogen loadings from Minto North to McGinty Creek.

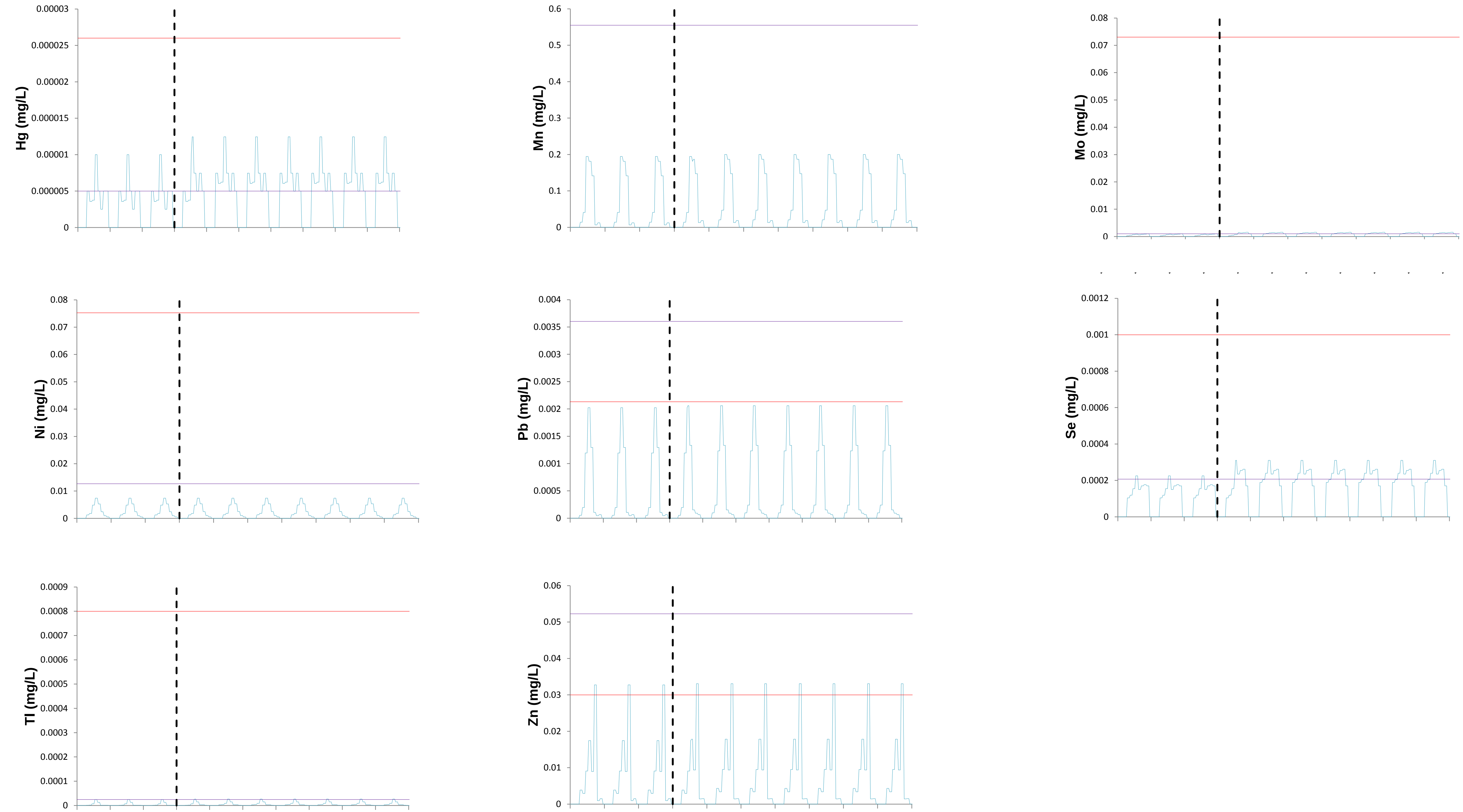


Notes: X-axis tick marks represent a 1-year timeframe

Legend

- McGinty Creek at Mouth
- CCME PAL
- 95th Percentile_MN4.5_baseline
- Minto North Overflows to McGinty Ck

srk consulting	CAPSTONE MINING CORP. MINTO MINE OPERATED BY MINTO EXPLORATIONS LTD.	Water and Load Balance Model Report 2016
Job No: 1CM002.024		**McGinty Creek Water Quality Prediction: Worst Case Results**
Filename: Fig_5-11_McGintyCk_WQ-Prediction_Charts	Minto Mine	Date: July 2016 / Approved: DBM / Figure: **5-11a**



Notes: X-axis tick marks represent a 1-year timeframe

Legend
- McGinty Creek at Mouth
- CCME PAL
- 95th Percentile_MN4.5_baseline
- Minto North Overflows to McGinty Ck

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McGinty Creek Water Quality Prediction: Worst Case Results

Job No: 1CM002.024	Minto Mine	Date: July 2016	Approved: DBM	Figure: 5-11b	
Filename: Fig_5-11_McGintyCk_WQ-Prediction_Charts					

Table 5-1 Water Quality Modelling Results for McGinty Creek at Mouth

Parameter*/ Unit		Baseline Conditions		After Mining at Minto North	
				Worst Case	
		Average	Max	Average	Max
Ammonia	mg/L	0.0355	0.27	not predicted- expect no change	
F	mg/L	0.20	0.43	0.23	0.43
N-NO_2	mg/L	0.0064	0.025	not predicted- expect no change	
N-NO_3	mg/L	0.073	0.3	not predicted- expect no change	
Sulphate	mg/L	3.1	9.1	3.2	9.1
Al	mg/L	0.55	3.3	0.55	3.3
As	mg/L	0.00062	0.0022	0.00065	0.0022
Cd	mg/L	0.000031	0.000095	0.000032	0.000095
Cr	mg/L	0.0011	0.0063	0.0012	0.0063
Cu	mg/L	0.0035	0.012	0.0036	0.012
Fe	mg/L	1.0	5.4	1.00	5.4
Pb	mg/L	0.00043	0.0021	0.00044	0.0021
Mn	mg/L	0.052	0.20	0.053	0.20
Hg	mg/L	0.0000042	0.000012	0.0000047	0.000012
Mo	mg/L	0.00069	0.0016	0.00085	0.0016
Ni	mg/L	0.0021	0.0074	0.0021	0.0074
Se	mg/L	0.00014	0.00031	0.00015	0.00031
Ag	mg/L	0.0000073	0.000029	0.0000084	0.000029
Tl	mg/L	0.0000049	0.000026	0.0000054	0.000026
Zn	mg/L	0.0067	0.033	0.0067	0.033

Source: Source: \\VAN-SVR0\Projects\01_SITES\Minto\!020_Site_Wide_Data\Water_and_Load_Balance_Files\01_Project_Phases\07_Phase_5_6\Results\Minto_North\[1CM002-003_MintoNorth_WQ_Prediction_2013-06-26.xlsx]

Notes:

*: all concentrations are total concentrations

5.2.4 WSP Wetland Performance

The four scenarios that were modelled were selected to provide insight into the range of wetland treatment performance that appears reasonable based on the currently available information. The two model scenarios that do not incorporate passive treatment give a sense of the range of concentrations that may occur based solely on variation in geochemical loading rates from mine-related and background sources and on runoff volumes that vary seasonally with precipitation and melt. The two model scenarios that incorporate passive treatment illustrate the potential improvement in water quality that could be achieved by a constructed wetland treatment system, while showing that the proposed system will not be able to treat the full flow volume expected in higher flow months of the year.

6 Discussion

6.1 Limitations of the Water and Load Balance Model

The model results presented in this report are based on best available input data and are thought to present a reasonably representative example of water quality conditions that will evolve as a result of mine activities (including management of water inventories on site) during the remaining operations periods and through the Active Closure and Post-Closure phases. However, as with any model representation of a complex system there are inherent uncertainties associated with inputs and modelled processes. In most cases, uncertainties are accounted for by incorporating conservative assumptions that are intended to capture the most adverse conditions. One obvious exception to this approach is the water quality results from the “Expected Case” scenarios.

Uncertainties that may affect the accuracy of the model outcome include:

- Geochemical factors that are not reflected in the model. Factors such as attenuation of constituents along surface and subsurface flow paths, removal of chemical load in open pits, and exposure of mine waste materials with geochemical weathering properties that result in substantially higher loadings than previously-mined materials at Minto all may contribute to actual water quality performance being different than the predictions presented here indicate.
- Significant changes to the operations and closure plans used as a basis for the modelling scenarios.
- Amount of precipitation received in a given year. The range of natural variability in the amount of annual precipitation is substantial, and single wet or dry years can have material effects on water inventory and other aspects of site water management.
- Change in local climatic conditions that cause the historical climatic record to inaccurately represent the duration, frequency and intensity of precipitation and runoff events.

6.2 Interpretation of Model Results

As discussed in Section 4.2.1, the stochastic water balance model results produced by the Monte Carlo simulation are probability distributions of water balance outcomes. The average values presented (for example the predicted average water volume in the Area 2 Pit in Figure 5-1) are the most likely outcomes, but there is little doubt that there will be a range of future conditions. During the operational period when water storage is a key element, the average water volumes result from several years of average precipitation or from alternating dry and wet years. Only when several wet years occur in succession, which is relatively improbable, does the model produce results that show greater than average water volumes in the pit. In the results for the post-closure periods (after the Area 2 Pit is full), the range of modelled discharge volumes reflects the range in precipitation as there is no longer any net change in water storage on site.

Evaluation of the effects of the predicted water quality on aquatic resources in Minto Creek and McGinty Creek has been addressed elsewhere (Minto 2013) and is not considered here in detail. The predicted concentrations of water quality parameters include 'Expected Case' values and 'Reasonable Worst Case' values. In the context of actual project performance, the predicted 'expected case' concentrations should be considered to be typical performance values (including the range of variability observed over operations at the Minto Mine). The predictions which represent the 'Reasonable Worst Case' scenario are considered to be highly unlikely to occur, and should be considered to represent the extreme upper end of the range of potential water quality performance of the mine. In the unlikely event that water quality concentrations in the range of the 'Reasonable Worst Case' values occur, it is expected that this condition would be transient and of short duration (as observed with the upper range of water quality concentrations in the site monitoring results to date).

6.3 WSP Wetland

Comparison of model results between 'no treatment' and 'passive treatment' cases shows that the CWTS has the potential to materially reduce dissolved concentrations of copper, selenium, and other parameters in surface water leaving the mine site during low flow summer and fall months when most or all of the surface water can be routed through the CWTS. However, under typical spring conditions and under high flow conditions at other times of the year, a portion of the surface water will bypass the CWTS and will therefore report to lower Minto Creek without the benefit of wetland treatment. A number of other factors will affect the performance of the CWTS, and the reclamation research into constructed wetlands treatment system that has been underway for several years will continue going forward with the intent of refining the understanding of factors that will be most critical to optimizing performance at the full scale. At present, given the range of uncertainty, it is prudent to consider the range of performance that is book-ended by the 'no treatment' and 'passive treatment' scenarios as representative of the range of future surface water quality leaving the mine site.

6.4 Dry Bulk Density of Tailings

For the Minto operations phase, the estimates of the bulk density of tailings to be placed in the TMFs are somewhat uncertain. This uncertainty is important both for the design of the TMFs and for the water and load balance results. When designing a TMF, best practice requires that the capacity of the facility is sized such that it can contain the volume of tailings corresponding to the lower end of the conceivable range of bulk density. This is a conservative approach that ensures adequate storage capacity is available for operations.

However, using the lower end of the estimated density range is not a conservative assumption in developing a water and load balance model. Adopting a lower bulk tailings density value results in storage of more mine water in tailings pores and therefore greater removal of water quality parameter loadings. Furthermore, the volume of water stored in tailings pores is not available for release to the receiving environment. If the volume of tailings porewater is overestimated the volume of water to be released from site is underestimated, which would then lead to an underestimation of water quality parameter concentrations in the receiving environment.

Therefore, selecting a dry bulk density value at the upper range of the expected range (i.e. 1.35 t/m^3) is an appropriately conservative assumption for a water and load balance model.

The water and load balance results presented here are the result of a modelled dry bulk tailings density of 1.35 tonnes/m^3, while the development of the Phase V/VI Tailings Management Plan relied on a density of 1.1 tonnes/m^3 in developing estimates of storage requirements.

This report, "*Water and Load Balance Model Report 2016*", has been prepared by SRK Consulting (Canada) Inc.

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All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

7 References

Clearwater Consultants Ltd., 2010. Memorandum CCL-MC7: Minto Mine – Phase IV Closure Water Balance. Memorandum to Access Consulting Group, 6 August 2010.

Contango Strategies, 2016. Minto Mine Reclamation and Closure Plan – Preliminary Design Report for Treatment We. Report prepared for Minto Explorations Ltd., July 2016.

Minnow Environmental Inc., 2016. Background Water Quality of Lower Minto Creek for Application in the Derivation of Post-Closure Water Quality Objectives. Report to Minto Explorations Ltd., July 2016.

Minto Explorations Ltd. 2013. Minto Mine Phase V/VI Expansion, Project Proposal: Phase V/VI Expansion of Mining and Milling, Minto Mine, Yukon.

Minto Explorations Ltd. 2016. Minto Mine Reclamation and Closure Plan- 2016-01. August 2016.

SRK Consulting, 2013. Minto Mine Expansion- Phase V/VI ML/ARD Assessment and Post-closure Water Quality Predictions. Report prepared for Minto Explorations Ltd. July 2013.

SRK Consulting, 2015a. Minto 2015 Groundwater Model Update. Report prepared for Minto Explorations Ltd. November 2015.

SRK Consulting, 2015b. Minto Mine Closure Covers: Results of Numerical Modelling to Bracket Percolation Predictions. Memo prepared for Minto Explorations Ltd. October 2015.

SRK Consulting (Canada) Inc. 2016. 2015 Water Balance and Water Quality Model Summary for the Minto Mine Site. Memo prepared for Minto Explorations Ltd. Project No.: 1CM002.024. March 2016

YWB (Yukon Water Board). 2015. Minto Mine Type A Water Use Licence Number QZ14-031.Issued to Minto Explorations Ltd. August 2015.

Appendix A: Water and Load Balance Results

Appendix A1: Monthly Water and Load Balance Results – 2030

Scenario 1 - Area 2 Pit 2030 Monthly Water Quality Results

	Al - Dissolved	Ammonia	As - Dissolved	Cd - Dissolved	Cr - Dissolved	Cu - Dissolved	Fe - Dissolved	Pb - Dissolved	Mo - Dissolved	Ni - Dissolved	Nitrate	Nitrite	Se - Dissolved	Ag - Dissolved	Zn - Dissolved
April	0.2	0.51	0.0014	0.000054	0.0017	0.019	0.4	0.00038	0.031	0.0023	0.35	0.35	0.01	0.000041	0.0089
May	0.2	0.5	0.0014	0.000054	0.0017	0.019	0.4	0.00038	0.03	0.0023	0.34	0.34	0.01	0.000041	0.0089
June	0.2	0.5	0.0014	0.000054	0.0017	0.019	0.4	0.00037	0.03	0.0023	0.34	0.34	0.0099	0.00004	0.0089
July	0.2	0.5	0.0014	0.000054	0.0017	0.019	0.4	0.00037	0.03	0.0023	0.34	0.34	0.0099	0.00004	0.0089
August	0.2	0.49	0.0014	0.000054	0.0017	0.019	0.4	0.00037	0.03	0.0023	0.34	0.34	0.0098	0.00004	0.0088
September	0.2	0.49	0.0014	0.000054	0.0017	0.019	0.4	0.00037	0.03	0.0023	0.33	0.33	0.0098	0.00004	0.0088
October	0.2	0.49	0.0014	0.000054	0.0016	0.019	0.4	0.00037	0.03	0.0023	0.33	0.33	0.0098	0.00004	0.0088

Scenario 1 - Main Pit 2030 Monthly Water Quality Results

	Al - Dissolved	Ammonia	As - Dissolved	Cd - Dissolved	Cr - Dissolved	Cu - Dissolved	Fe - Dissolved	Pb - Dissolved	Mo - Dissolved	Ni - Dissolved	Nitrate	Nitrite	Se - Dissolved	Ag - Dissolved	Zn - Dissolved
April	0.14	0.049	0.0014	0.000045	0.0017	0.024	0.54	0.00036	0.0054	0.0021	0.021	0.021	0.0019	0.000038	0.0088
May	0.14	0.048	0.0013	0.000044	0.0016	0.023	0.52	0.00035	0.0052	0.002	0.02	0.02	0.0018	0.000036	0.0085
June	0.14	0.048	0.0013	0.000043	0.0015	0.022	0.51	0.00033	0.005	0.0019	0.018	0.018	0.0017	0.000035	0.0082
July	0.14	0.048	0.0013	0.000043	0.0015	0.022	0.51	0.00033	0.005	0.002	0.018	0.018	0.0017	0.000035	0.0082
August	0.14	0.047	0.0013	0.000043	0.0015	0.022	0.51	0.00033	0.005	0.002	0.018	0.018	0.0017	0.000035	0.0082
September	0.14	0.047	0.0013	0.000043	0.0015	0.022	0.51	0.00033	0.005	0.002	0.018	0.018	0.0017	0.000035	0.0081
October	0.14	0.046	0.0013	0.000043	0.0015	0.022	0.51	0.00034	0.005	0.002	0.017	0.017	0.0017	0.000035	0.0082

Scenario 1 - W3 2030 Monthly Water Quality Results

	Al - Dissolved	Ammonia	As - Dissolved	Cd - Dissolved	Cr - Dissolved	Cu - Dissolved	Fe - Dissolved	Pb - Dissolved	Mo - Dissolved	Ni - Dissolved	Nitrate	Nitrite	Se - Dissolved	Ag - Dissolved	Zn - Dissolved
April	0.16	0.16	0.0014	0.000054	0.0016	0.024	0.45	0.00036	0.012	0.002	0.11	0.11	0.0042	0.000038	0.0087
May	0.13	0.16	0.0011	0.000045	0.0013	0.02	0.44	0.00031	0.01	0.0019	0.095	0.095	0.0036	0.000031	0.0075
June	0.11	0.13	0.001	0.00004	0.0012	0.018	0.38	0.00027	0.0083	0.0017	0.072	0.072	0.0029	0.000027	0.0067
July	0.11	0.11	0.0011	0.000041	0.0013	0.019	0.41	0.00028	0.0078	0.0018	0.063	0.063	0.0028	0.000028	0.0068
August	0.12	0.12	0.0011	0.00004	0.0013	0.019	0.43	0.00029	0.0083	0.0018	0.068	0.068	0.0029	0.00003	0.0068
September	0.12	0.12	0.0012	0.000042	0.0014	0.019	0.44	0.00031	0.0088	0.0019	0.073	0.073	0.0031	0.000032	0.0069
October	0.13	0.14	0.0012	0.000044	0.0014	0.02	0.45	0.00032	0.0097	0.002	0.083	0.083	0.0034	0.000032	0.0071

Scenario 1 - W1 2030 Monthly Water Quality Results

	Al - Dissolved	Ammonia	As - Dissolved	Cd - Dissolved	Cr - Dissolved	Cu - Dissolved	Fe - Dissolved	Pb - Dissolved	Mo - Dissolved	Ni - Dissolved	Nitrate	Nitrite	Se - Dissolved	Ag - Dissolved	Zn - Dissolved
April	0.068	0.051	0.00056	0.000036	0.00085	0.0092	0.22	0.00017	0.0037	0.0011	0.038	0.038	0.0012	0.000016	0.0052
May	0.07	0.085	0.00059	0.00003	0.00071	0.008	0.37	0.00018	0.0031	0.0014	0.027	0.027	0.0011	0.000015	0.0051
June	0.047	0.078	0.00059	0.000023	0.0007	0.0054	0.25	0.00012	0.0028	0.0014	0.028	0.028	0.00096	0.000012	0.0045
July	0.041	0.063	0.00072	0.000021	0.00073	0.0058	0.33	0.00015	0.0025	0.0014	0.021	0.021	0.00079	0.000013	0.004
August	0.042	0.053	0.00074	0.000019	0.00077	0.006	0.37	0.00018	0.0026	0.0015	0.022	0.022	0.00083	0.00002	0.0039
September	0.045	0.049	0.00073	0.000022	0.00096	0.0061	0.38	0.00023	0.0028	0.0017	0.021	0.021	0.00097	0.000015	0.0038
October	0.045	0.061	0.00069	0.000023	0.00073	0.0064	0.33	0.00015	0.0033	0.0014	0.037	0.037	0.0011	0.000015	0.0035

Notes:
All concentration reported in mg/L

Scenario 2 - Area 2 Pit 2030 Monthly Water Quality Results

	Al - Dissolved	Ammonia	As - Dissolved	Cd - Dissolved	Cr - Dissolved	Cu - Dissolved	Fe - Dissolved	Pb - Dissolved	Mo - Dissolved	Ni - Dissolved	Nitrate	Nitrite	Se - Dissolved	Ag - Dissolved	Zn - Dissolved
April	0.41	0.69	0.0029	0.00017	0.0031	0.042	0.8	0.0013	0.044	0.0043	0.48	0.48	0.02	0.000099	0.017
May	0.41	0.68	0.0029	0.00017	0.0031	0.041	0.79	0.0012	0.043	0.0043	0.47	0.47	0.019	0.000098	0.016
June	0.41	0.67	0.0029	0.00017	0.0031	0.041	0.79	0.0012	0.043	0.0042	0.46	0.46	0.019	0.000098	0.016
July	0.41	0.67	0.0029	0.00017	0.0031	0.041	0.79	0.0012	0.043	0.0042	0.46	0.46	0.019	0.000098	0.016
August	0.41	0.66	0.0029	0.00017	0.0031	0.041	0.79	0.0013	0.043	0.0042	0.46	0.46	0.019	0.000098	0.016
September	0.41	0.66	0.0029	0.00017	0.0031	0.041	0.79	0.0013	0.043	0.0042	0.46	0.46	0.019	0.000097	0.016
October	0.41	0.66	0.0029	0.00017	0.0031	0.041	0.79	0.0013	0.043	0.0042	0.46	0.46	0.019	0.000097	0.016

Scenario 2 - Main Pit 2030 Monthly Water Quality Results

	Al - Dissolved	Ammonia	As - Dissolved	Cd - Dissolved	Cr - Dissolved	Cu - Dissolved	Fe - Dissolved	Pb - Dissolved	Mo - Dissolved	Ni - Dissolved	Nitrate	Nitrite	Se - Dissolved	Ag - Dissolved	Zn - Dissolved
April	0.37	0.089	0.0027	0.00018	0.0033	0.061	1.4	0.00097	0.015	0.0045	0.072	0.072	0.0083	0.00013	0.017
May	0.36	0.084	0.0027	0.00018	0.0032	0.058	1.3	0.00095	0.015	0.0044	0.067	0.067	0.0078	0.00013	0.017
June	0.35	0.082	0.0026	0.00017	0.0031	0.056	1.2	0.00094	0.014	0.0042	0.062	0.062	0.0074	0.00012	0.016
July	0.35	0.082	0.0026	0.00017	0.0031	0.055	1.2	0.00094	0.015	0.0042	0.061	0.061	0.0074	0.00012	0.016
August	0.35	0.081	0.0026	0.00017	0.0031	0.055	1.2	0.00094	0.014	0.0042	0.06	0.06	0.0073	0.00012	0.016
September	0.35	0.08	0.0026	0.00017	0.0031	0.055	1.2	0.00094	0.014	0.0042	0.059	0.059	0.0073	0.00012	0.016
October	0.35	0.079	0.0026	0.00017	0.0031	0.055	1.2	0.00094	0.015	0.0042	0.059	0.059	0.0074	0.00012	0.016

Scenario 2 - W3 2030 Monthly Water Quality Results

	Al - Dissolved	Ammonia	As - Dissolved	Cd - Dissolved	Cr - Dissolved	Cu - Dissolved	Fe - Dissolved	Pb - Dissolved	Mo - Dissolved	Ni - Dissolved	Nitrate	Nitrite	Se - Dissolved	Ag - Dissolved	Zn - Dissolved
April	0.38	0.23	0.0028	0.00018	0.0032	0.059	1.1	0.0011	0.023	0.0042	0.17	0.17	0.011	0.00012	0.017
May	0.29	0.22	0.0021	0.00014	0.0025	0.047	0.92	0.00082	0.019	0.0036	0.15	0.15	0.0091	0.000091	0.014
June	0.26	0.18	0.0019	0.00013	0.0022	0.043	0.82	0.00074	0.016	0.0033	0.12	0.12	0.0076	0.000081	0.012
July	0.27	0.16	0.0021	0.00013	0.0023	0.046	0.87	0.00077	0.016	0.0035	0.11	0.11	0.0075	0.000085	0.013
August	0.27	0.17	0.0021	0.00013	0.0024	0.045	0.88	0.00079	0.016	0.0034	0.11	0.11	0.0077	0.000086	0.013
September	0.29	0.17	0.0022	0.00014	0.0025	0.047	0.91	0.00084	0.017	0.0036	0.12	0.12	0.0081	0.00009	0.013
October	0.31	0.19	0.0023	0.00015	0.0026	0.048	0.94	0.00091	0.019	0.0037	0.13	0.13	0.0088	0.000094	0.014

Scenario 2 - W1 2030 Monthly Water Quality Results

	Al - Dissolved	Ammonia	As - Dissolved	Cd - Dissolved	Cr - Dissolved	Cu - Dissolved	Fe - Dissolved	Pb - Dissolved	Mo - Dissolved	Ni - Dissolved	Nitrate	Nitrite	Se - Dissolved	Ag - Dissolved	Zn - Dissolved
April	0.13	0.068	0.00093	0.000071	0.0013	0.018	0.39	0.00038	0.0066	0.0017	0.055	0.055	0.003	0.000036	0.0075
May	0.12	0.11	0.00087	0.000058	0.001	0.015	0.53	0.00031	0.0054	0.002	0.044	0.044	0.0025	0.00003	0.0069
June	0.096	0.12	0.00084	0.000044	0.00092	0.011	0.37	0.00025	0.0045	0.0021	0.041	0.041	0.0021	0.000023	0.0059
July	0.077	0.078	0.00095	0.000041	0.00095	0.012	0.44	0.00027	0.0043	0.0019	0.03	0.03	0.0018	0.000023	0.0053
August	0.078	0.069	0.00094	0.000039	0.00094	0.012	0.45	0.00028	0.0044	0.0019	0.032	0.032	0.0019	0.000028	0.0052
September	0.086	0.062	0.00099	0.000056	0.0012	0.013	0.49	0.00036	0.0049	0.0021	0.033	0.033	0.0022	0.000027	0.0053
October	0.093	0.078	0.00097	0.000051	0.001	0.014	0.44	0.00031	0.0057	0.0018	0.049	0.049	0.0025	0.00003	0.0051

Notes:
All concentration reported in mg/L

Scenario 3 - Area 2 Pit 2030 Monthly Water Quality Results

	Al - Dissolved	Ammonia	As - Dissolved	Cd - Dissolved	Cr - Dissolved	Cu - Dissolved	Fe - Dissolved	Pb - Dissolved	Mo - Dissolved	Ni - Dissolved	Nitrate	Nitrite	Se - Dissolved	Ag - Dissolved	Zn - Dissolved
April	0.2	0.51	0.0014	0.000054	0.0017	0.019	0.4	0.00038	0.031	0.0023	0.35	0.35	0.01	0.000041	0.0089
May	0.2	0.5	0.0014	0.000054	0.0017	0.019	0.4	0.00038	0.03	0.0023	0.34	0.34	0.01	0.000041	0.0089
June	0.2	0.5	0.0014	0.000054	0.0017	0.019	0.4	0.00037	0.03	0.0023	0.34	0.34	0.0099	0.00004	0.0089
July	0.2	0.5	0.0014	0.000054	0.0017	0.019	0.4	0.00037	0.03	0.0023	0.34	0.34	0.0099	0.00004	0.0089
August	0.2	0.49	0.0014	0.000054	0.0017	0.019	0.4	0.00037	0.03	0.0023	0.34	0.34	0.0098	0.00004	0.0088
September	0.2	0.49	0.0014	0.000054	0.0017	0.019	0.4	0.00037	0.03	0.0023	0.33	0.33	0.0098	0.00004	0.0088
October	0.2	0.49	0.0014	0.000054	0.0016	0.019	0.4	0.00037	0.03	0.0023	0.33	0.33	0.0098	0.00004	0.0088

Scenario 3 - Main Pit 2030 Monthly Water Quality Results

	Al - Dissolved	Ammonia	As - Dissolved	Cd - Dissolved	Cr - Dissolved	Cu - Dissolved	Fe - Dissolved	Pb - Dissolved	Mo - Dissolved	Ni - Dissolved	Nitrate	Nitrite	Se - Dissolved	Ag - Dissolved	Zn - Dissolved
April	0.14	0.049	0.0014	0.000045	0.0017	0.024	0.54	0.00036	0.0054	0.0021	0.021	0.021	0.0019	0.000038	0.0088
May	0.14	0.048	0.0013	0.000044	0.0016	0.023	0.52	0.00035	0.0052	0.002	0.02	0.02	0.0018	0.000036	0.0085
June	0.14	0.048	0.0013	0.000043	0.0015	0.022	0.51	0.00033	0.005	0.0019	0.018	0.018	0.0017	0.000035	0.0082
July	0.14	0.048	0.0013	0.000043	0.0015	0.022	0.51	0.00033	0.005	0.002	0.018	0.018	0.0017	0.000035	0.0082
August	0.14	0.047	0.0013	0.000043	0.0015	0.022	0.51	0.00033	0.005	0.002	0.018	0.018	0.0017	0.000035	0.0082
September	0.14	0.047	0.0013	0.000043	0.0015	0.022	0.51	0.00033	0.005	0.002	0.018	0.018	0.0017	0.000035	0.0081
October	0.14	0.046	0.0013	0.000043	0.0015	0.022	0.51	0.00034	0.005	0.002	0.017	0.017	0.0017	0.000035	0.0082

Scenario 3 - W3 2030 Monthly Water Quality Results

	Al - Dissolved	Ammonia	As - Dissolved	Cd - Dissolved	Cr - Dissolved	Cu - Dissolved	Fe - Dissolved	Pb - Dissolved	Mo - Dissolved	Ni - Dissolved	Nitrate	Nitrite	Se - Dissolved	Ag - Dissolved	Zn - Dissolved
April	0.17	0.16	0.0014	0.000023	0.0016	0.016	0.46	0.00037	0.012	0.0021	0.1	0.1	0.0036	0.000039	0.0088
May	0.13	0.16	0.0011	0.000034	0.0013	0.018	0.43	0.00031	0.01	0.0019	0.095	0.095	0.0036	0.000031	0.0075
June	0.11	0.13	0.001	0.000021	0.0012	0.015	0.38	0.00027	0.0084	0.0017	0.073	0.073	0.0029	0.000027	0.0067
July	0.11	0.11	0.0011	0.000011	0.0013	0.013	0.41	0.00028	0.0078	0.0018	0.063	0.063	0.0028	0.000028	0.0068
August	0.12	0.12	0.0011	0.00001	0.0013	0.013	0.43	0.00029	0.0083	0.0018	0.068	0.068	0.0029	0.00003	0.0068
September	0.12	0.12	0.0012	0.0000098	0.0014	0.013	0.44	0.00031	0.0088	0.0019	0.073	0.073	0.0031	0.000032	0.0069
October	0.13	0.13	0.0012	0.0000099	0.0014	0.013	0.45	0.00032	0.0097	0.002	0.082	0.082	0.0034	0.000032	0.0071

Scenario 3 - W1 2030 Monthly Water Quality Results

	Al - Dissolved	Ammonia	As - Dissolved	Cd - Dissolved	Cr - Dissolved	Cu - Dissolved	Fe - Dissolved	Pb - Dissolved	Mo - Dissolved	Ni - Dissolved	Nitrate	Nitrite	Se - Dissolved	Ag - Dissolved	Zn - Dissolved
April	0.07	0.05	0.00057	0.000028	0.00086	0.0071	0.22	0.00017	0.0037	0.0011	0.038	0.038	0.0011	0.000016	0.0052
May	0.07	0.085	0.00059	0.000027	0.00071	0.0074	0.37	0.00018	0.0031	0.0014	0.027	0.027	0.001	0.000015	0.0051
June	0.047	0.078	0.00059	0.00002	0.0007	0.0048	0.25	0.00012	0.0028	0.0014	0.028	0.028	0.00096	0.000012	0.0045
July	0.041	0.063	0.00072	0.000014	0.00073	0.0044	0.33	0.00015	0.0025	0.0014	0.021	0.021	0.00079	0.000013	0.004
August	0.042	0.053	0.00074	0.000012	0.00077	0.0046	0.37	0.00018	0.0026	0.0015	0.022	0.022	0.00083	0.00002	0.0039
September	0.045	0.049	0.00073	0.000014	0.00096	0.0045	0.38	0.00023	0.0028	0.0017	0.021	0.021	0.00097	0.000015	0.0038
October	0.045	0.061	0.00069	0.000014	0.00073	0.0045	0.33	0.00015	0.0033	0.0014	0.037	0.037	0.0011	0.000015	0.0035

Notes:
All concentration reported in mg/L

Scenario 4 - Area 2 Pit 2030 Monthly Water Quality Results

	Al - Dissolved	Ammonia	As - Dissolved	Cd - Dissolved	Cr - Dissolved	Cu - Dissolved	Fe - Dissolved	Pb - Dissolved	Mo - Dissolved	Ni - Dissolved	Nitrate	Nitrite	Se - Dissolved	Ag - Dissolved	Zn - Dissolved
April	0.41	0.69	0.0029	0.00017	0.0031	0.042	0.8	0.0013	0.044	0.0043	0.48	0.48	0.02	0.000099	0.017
May	0.41	0.68	0.0029	0.00017	0.0031	0.041	0.79	0.0012	0.043	0.0043	0.47	0.47	0.019	0.000098	0.016
June	0.41	0.67	0.0029	0.00017	0.0031	0.041	0.79	0.0012	0.043	0.0042	0.46	0.46	0.019	0.000098	0.016
July	0.41	0.67	0.0029	0.00017	0.0031	0.041	0.79	0.0012	0.043	0.0042	0.46	0.46	0.019	0.000098	0.016
August	0.41	0.66	0.0029	0.00017	0.0031	0.041	0.79	0.0013	0.043	0.0042	0.46	0.46	0.019	0.000098	0.016
September	0.41	0.66	0.0029	0.00017	0.0031	0.041	0.79	0.0013	0.043	0.0042	0.46	0.46	0.019	0.000097	0.016
October	0.41	0.66	0.0029	0.00017	0.0031	0.041	0.79	0.0013	0.043	0.0042	0.46	0.46	0.019	0.000097	0.016

Scenario 4 - Main Pit 2030 Monthly Water Quality Results

	Al - Dissolved	Ammonia	As - Dissolved	Cd - Dissolved	Cr - Dissolved	Cu - Dissolved	Fe - Dissolved	Pb - Dissolved	Mo - Dissolved	Ni - Dissolved	Nitrate	Nitrite	Se - Dissolved	Ag - Dissolved	Zn - Dissolved
April	0.37	0.089	0.0027	0.00018	0.0033	0.061	1.4	0.00097	0.015	0.0045	0.072	0.072	0.0083	0.00013	0.017
May	0.36	0.084	0.0027	0.00018	0.0032	0.058	1.3	0.00095	0.015	0.0044	0.067	0.067	0.0078	0.00013	0.017
June	0.35	0.082	0.0026	0.00017	0.0031	0.056	1.2	0.00094	0.014	0.0042	0.062	0.062	0.0074	0.00012	0.016
July	0.35	0.082	0.0026	0.00017	0.0031	0.055	1.2	0.00094	0.015	0.0042	0.061	0.061	0.0074	0.00012	0.016
August	0.35	0.081	0.0026	0.00017	0.0031	0.055	1.2	0.00094	0.014	0.0042	0.06	0.06	0.0073	0.00012	0.016
September	0.35	0.08	0.0026	0.00017	0.0031	0.055	1.2	0.00094	0.014	0.0042	0.059	0.059	0.0073	0.00012	0.016
October	0.35	0.079	0.0026	0.00017	0.0031	0.055	1.2	0.00094	0.015	0.0042	0.059	0.059	0.0074	0.00012	0.016

Scenario 4 - W3 2030 Monthly Water Quality Results

	Al - Dissolved	Ammonia	As - Dissolved	Cd - Dissolved	Cr - Dissolved	Cu - Dissolved	Fe - Dissolved	Pb - Dissolved	Mo - Dissolved	Ni - Dissolved	Nitrate	Nitrite	Se - Dissolved	Ag - Dissolved	Zn - Dissolved
April	0.39	0.23	0.0029	0.000055	0.0033	0.025	1.1	0.0011	0.024	0.0043	0.17	0.17	0.0054	0.00012	0.017
May	0.29	0.22	0.0021	0.000098	0.0025	0.035	0.92	0.00082	0.019	0.0036	0.15	0.15	0.0071	0.000091	0.014
June	0.27	0.18	0.0019	0.000052	0.0022	0.023	0.82	0.00074	0.016	0.0033	0.12	0.12	0.0051	0.000081	0.012
July	0.27	0.16	0.0021	0.000014	0.0023	0.014	0.87	0.00077	0.016	0.0035	0.11	0.11	0.0035	0.000085	0.013
August	0.27	0.17	0.0021	0.000011	0.0024	0.013	0.88	0.00079	0.016	0.0034	0.11	0.11	0.0034	0.000086	0.013
September	0.29	0.17	0.0022	0.000011	0.0025	0.013	0.91	0.00084	0.017	0.0036	0.12	0.12	0.0034	0.00009	0.013
October	0.31	0.19	0.0023	0.000011	0.0026	0.013	0.94	0.0009	0.019	0.0037	0.13	0.13	0.0035	0.000094	0.014

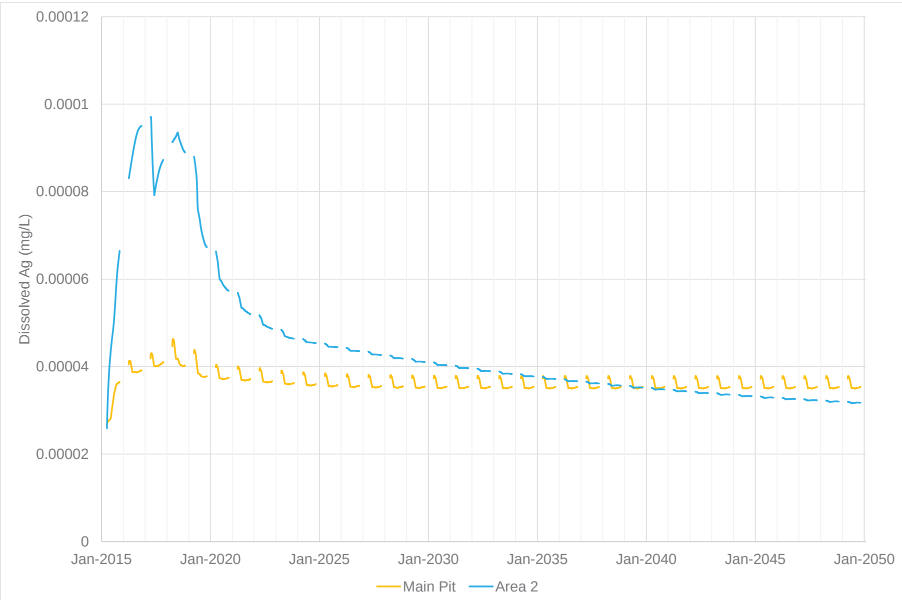
Scenario 4 - W1 2030 Monthly Water Quality Results

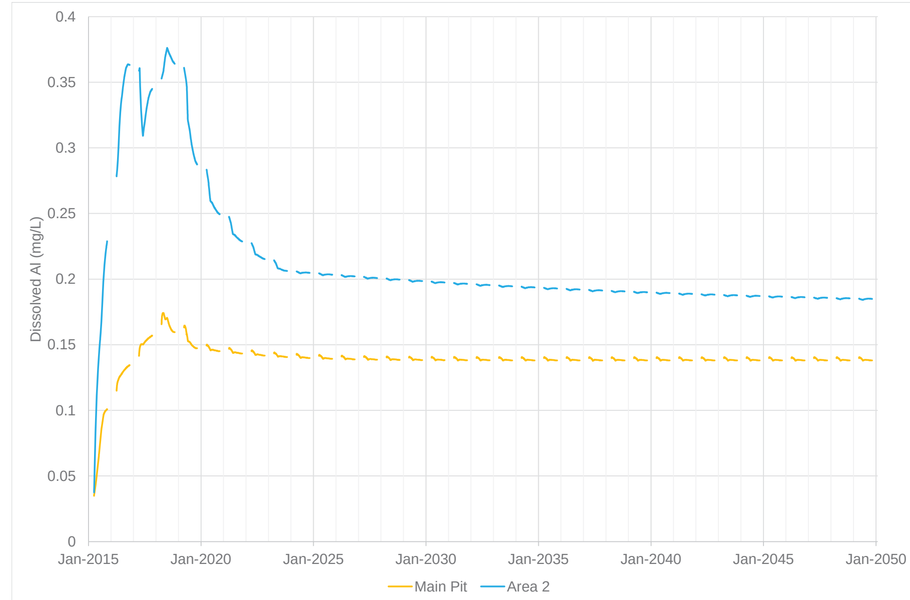
	Al - Dissolved	Ammonia	As - Dissolved	Cd - Dissolved	Cr - Dissolved	Cu - Dissolved	Fe - Dissolved	Pb - Dissolved	Mo - Dissolved	Ni - Dissolved	Nitrate	Nitrite	Se - Dissolved	Ag - Dissolved	Zn - Dissolved
April	0.13	0.068	0.00095	0.000038	0.0013	0.0095	0.39	0.00039	0.0067	0.0017	0.054	0.054	0.0016	0.000037	0.0076
May	0.12	0.11	0.00087	0.000047	0.001	0.012	0.53	0.00031	0.0054	0.002	0.044	0.044	0.002	0.00003	0.0069
June	0.096	0.12	0.00084	0.000028	0.00092	0.0072	0.37	0.00025	0.0046	0.0021	0.041	0.041	0.0016	0.000023	0.0059
July	0.077	0.078	0.00095	0.000015	0.00095	0.0047	0.44	0.00027	0.0043	0.0019	0.03	0.03	0.00095	0.000023	0.0053
August	0.078	0.069	0.00094	0.000012	0.00094	0.0047	0.45	0.00028	0.0044	0.0019	0.032	0.032	0.00093	0.000028	0.0052
September	0.086	0.062	0.00099	0.000024	0.0012	0.0045	0.49	0.00036	0.0049	0.0021	0.033	0.033	0.001	0.000027	0.0053
October	0.092	0.078	0.00097	0.000014	0.001	0.0045	0.44	0.00031	0.0057	0.0018	0.049	0.049	0.0011	0.00003	0.0051

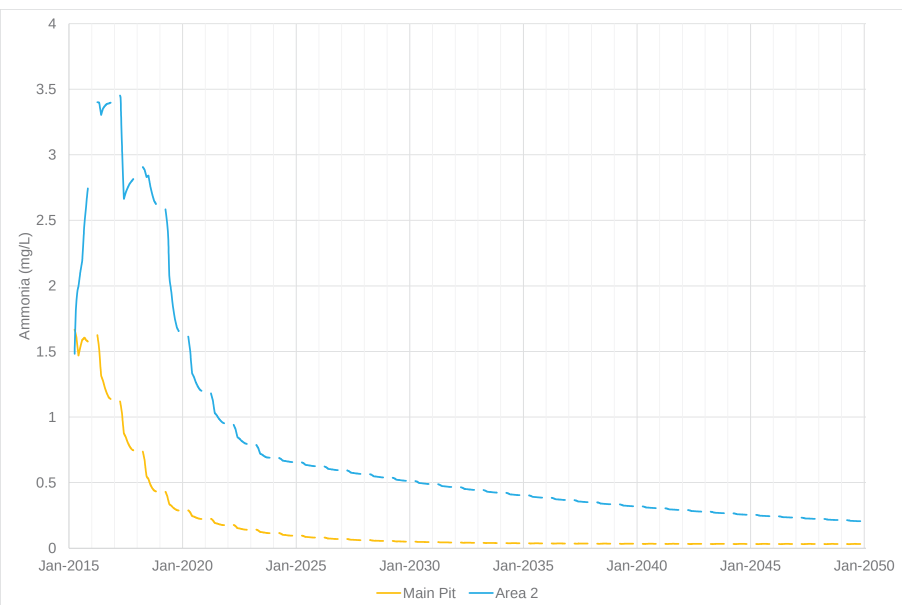
Notes:
All concentration reported in mg/L

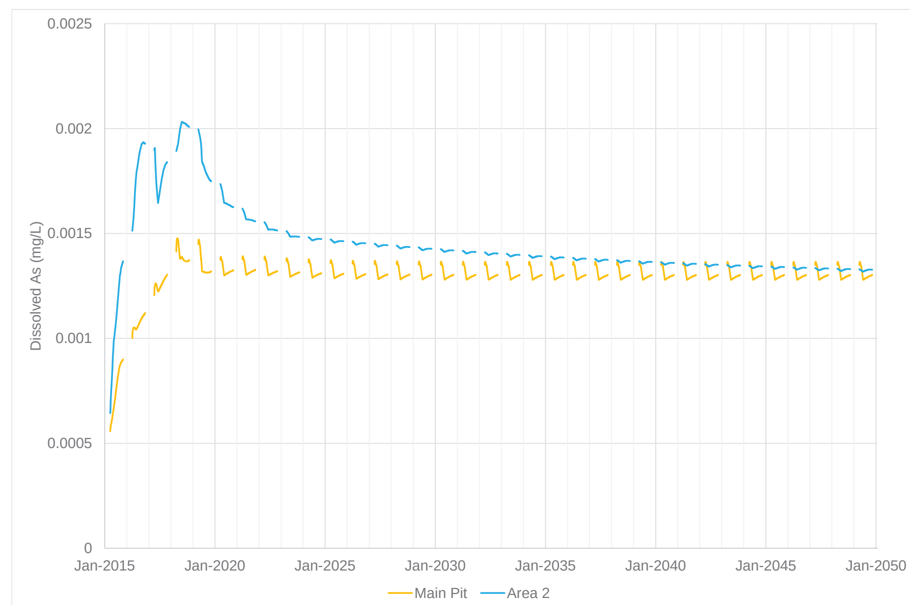
Appendix A2: Water and Load Balance Results Plots

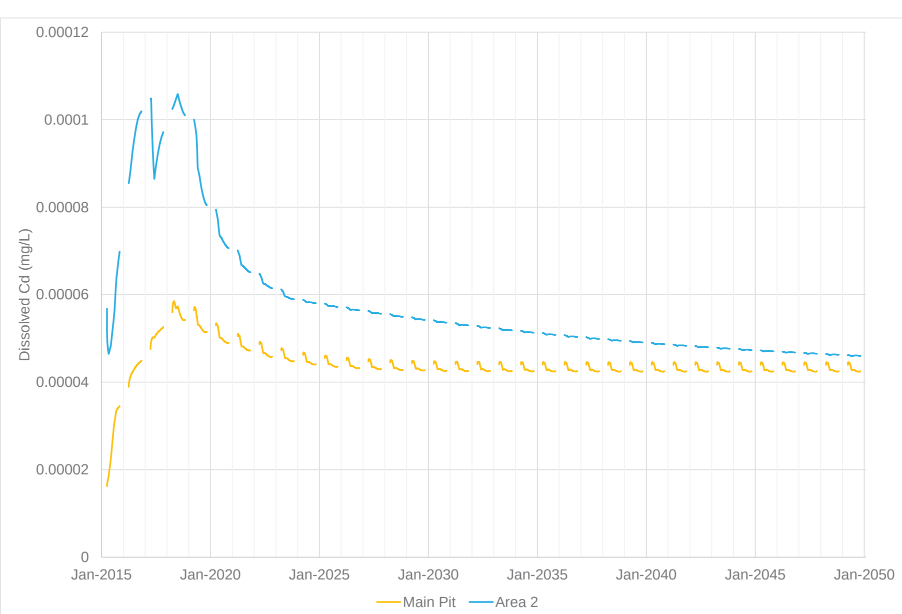
Appendix A2: Water and Load Balance Results
Scenario 1 – Expected Case, No Treatment

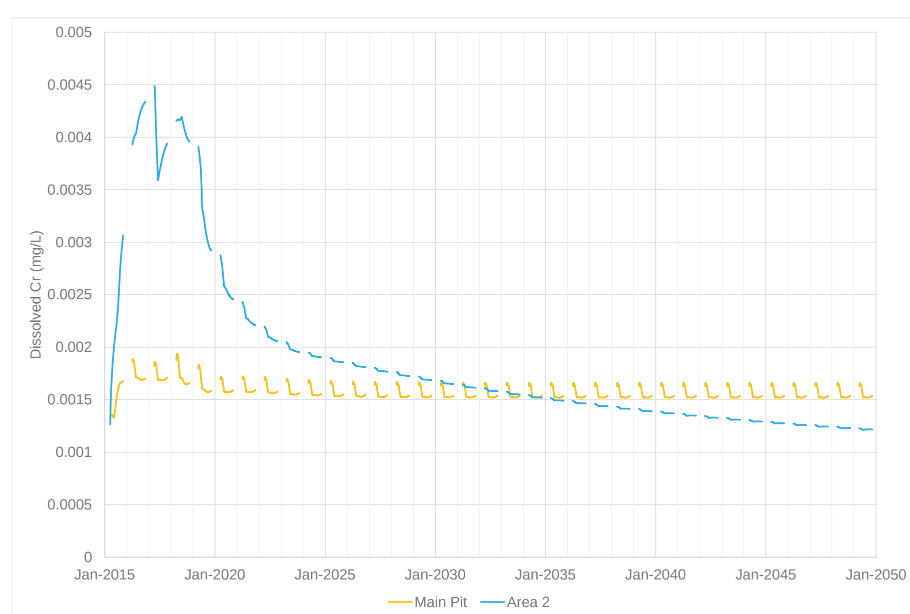


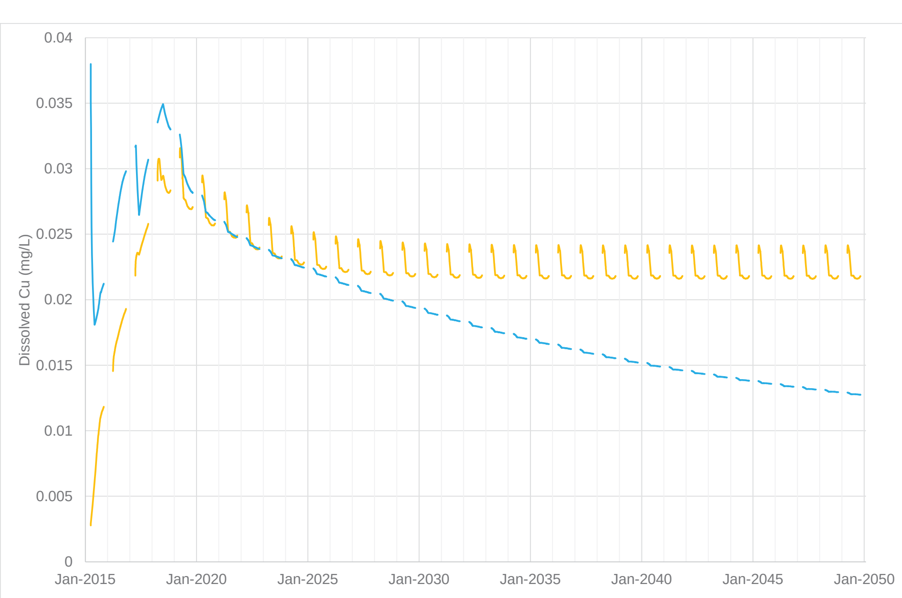


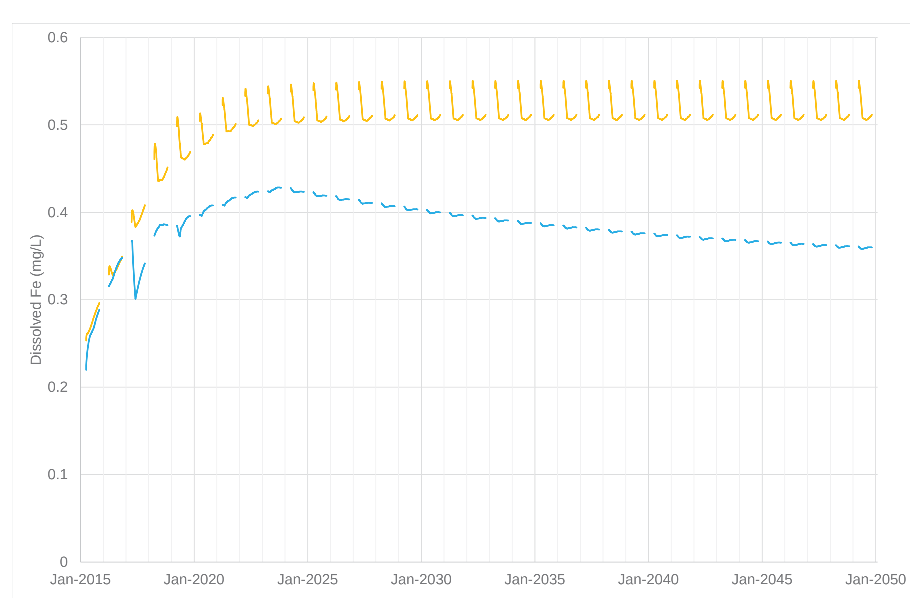












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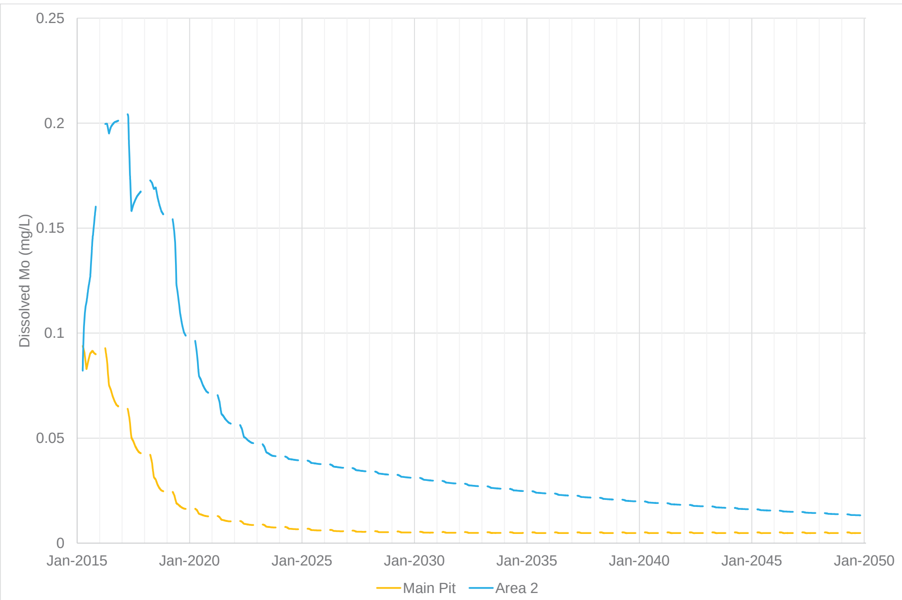
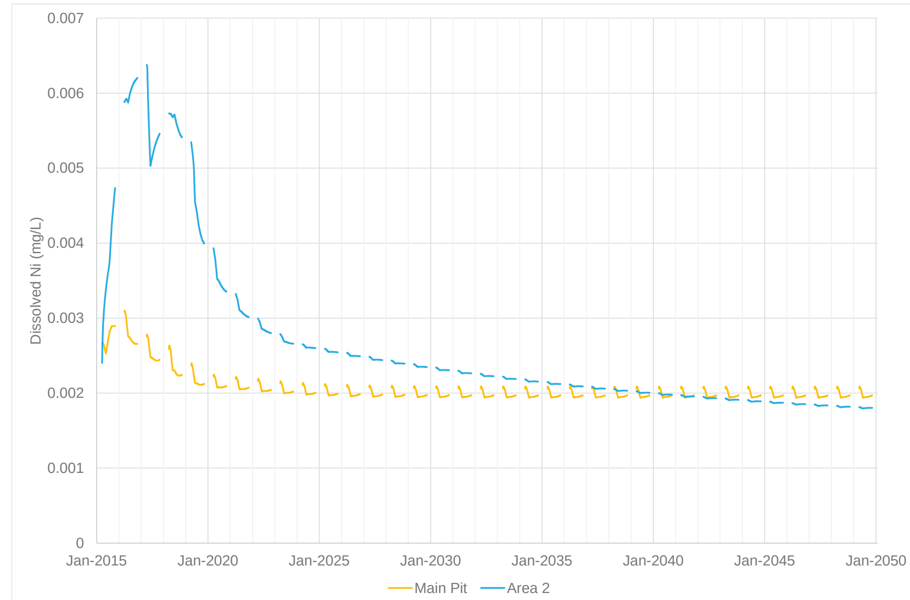
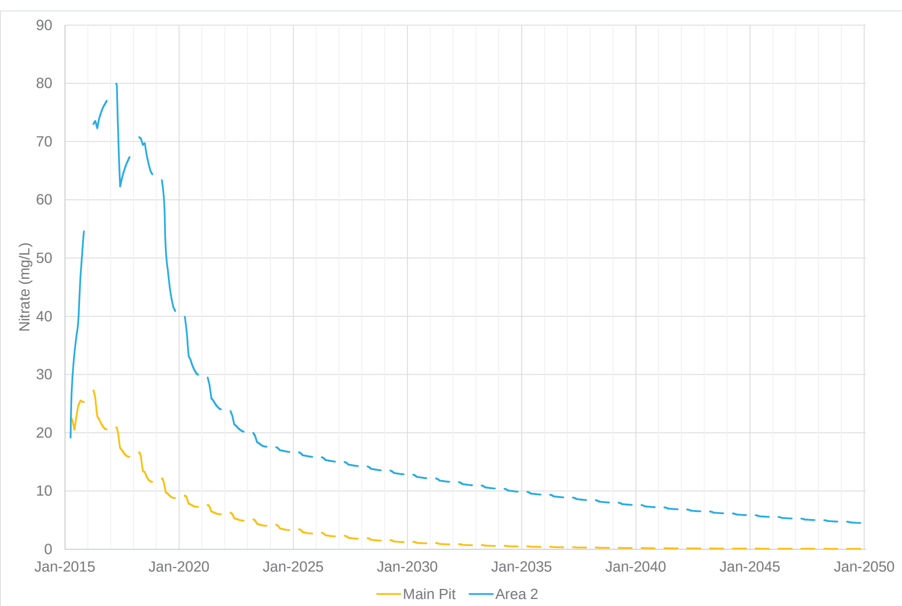
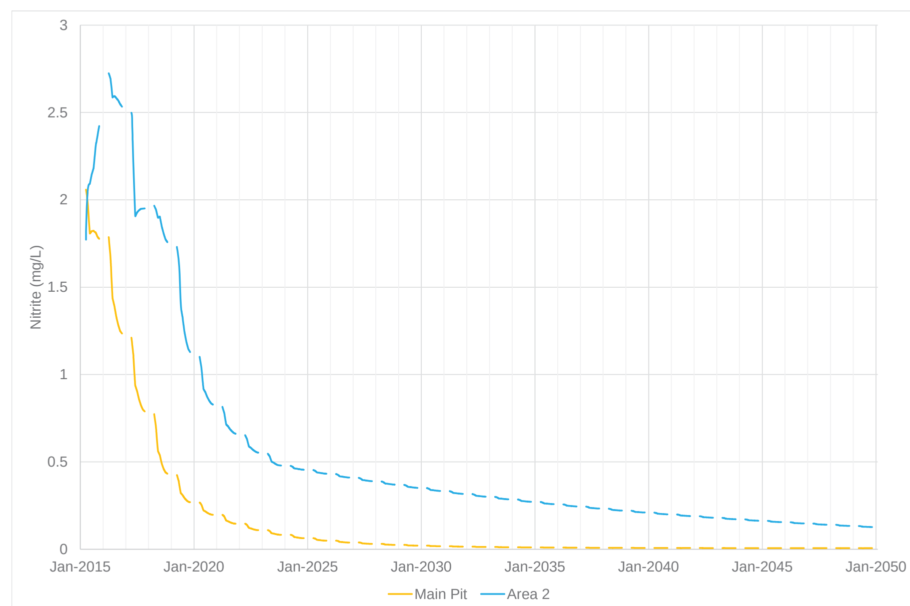
Model: Minto_2016_Annual_Report_1CM002.024_Rev59_SRJ_KNK, 2016/07/25, KNK

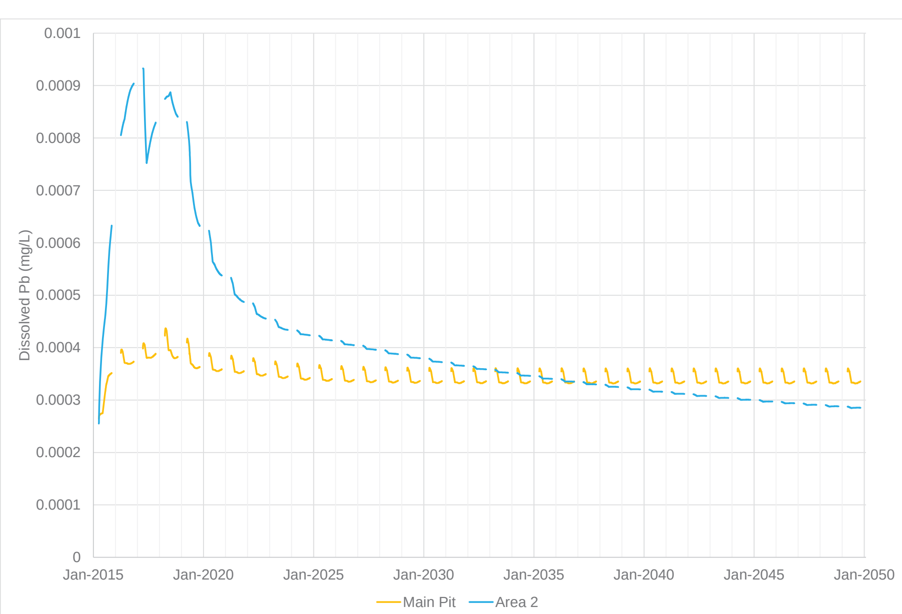
Appendix A2: Water and Load Balance Results
Scenario 1 – Expected Case, No Treatment

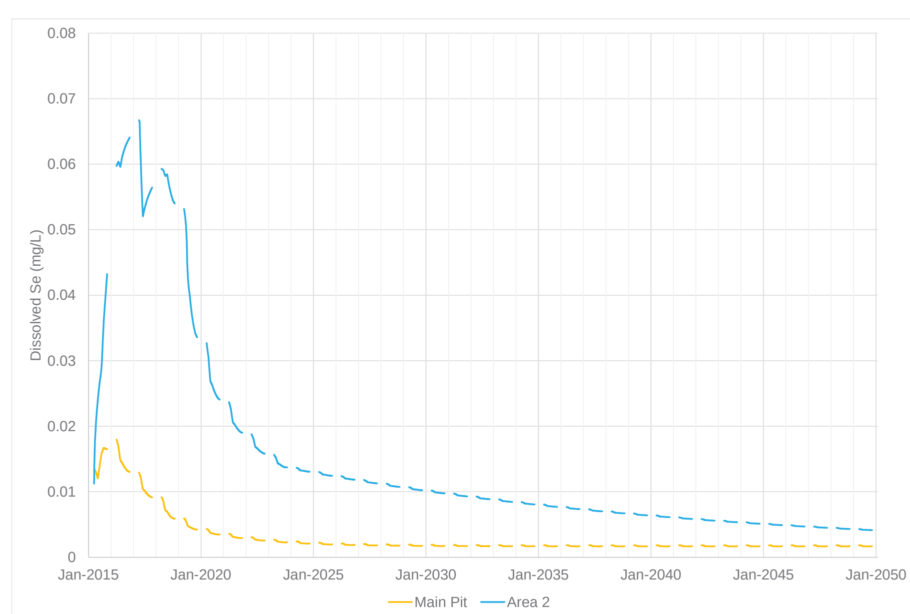


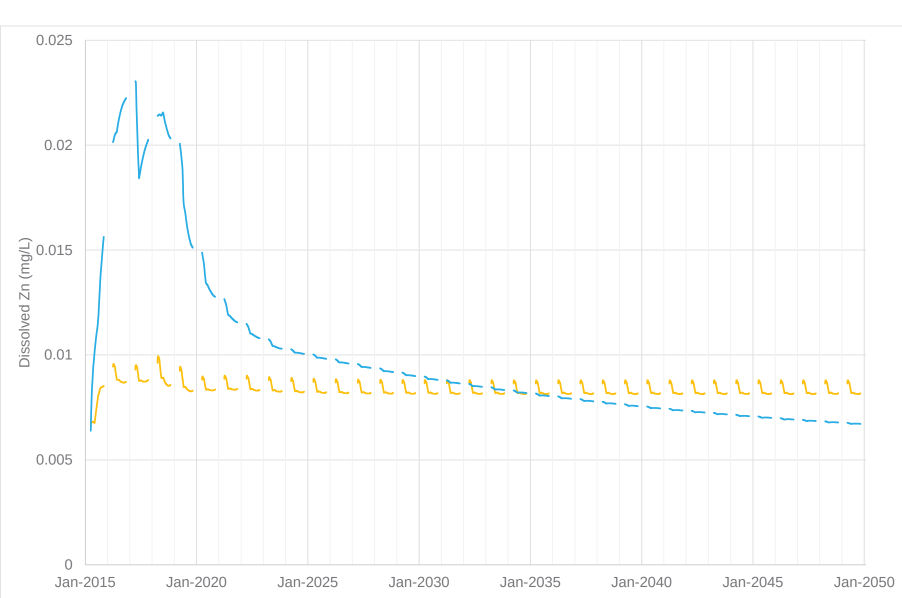












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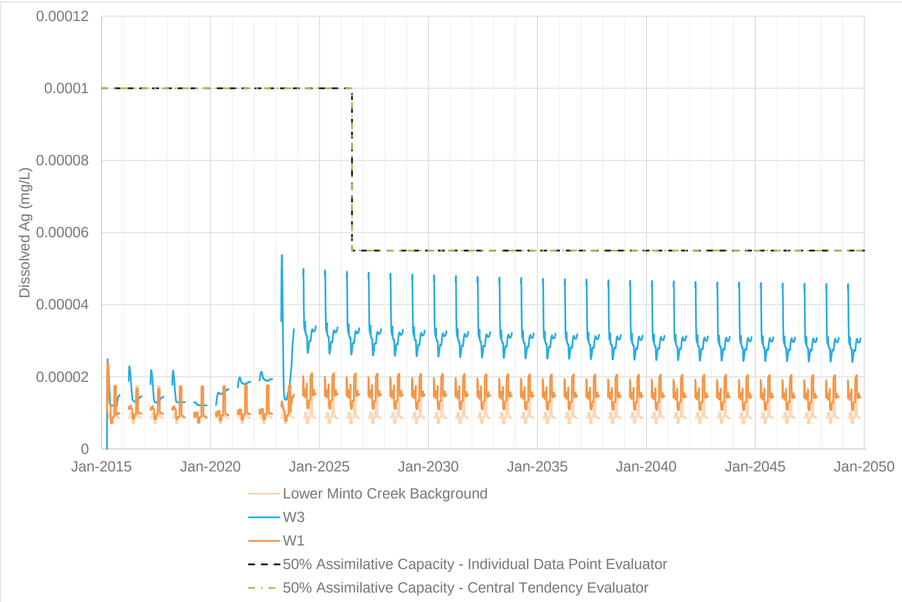
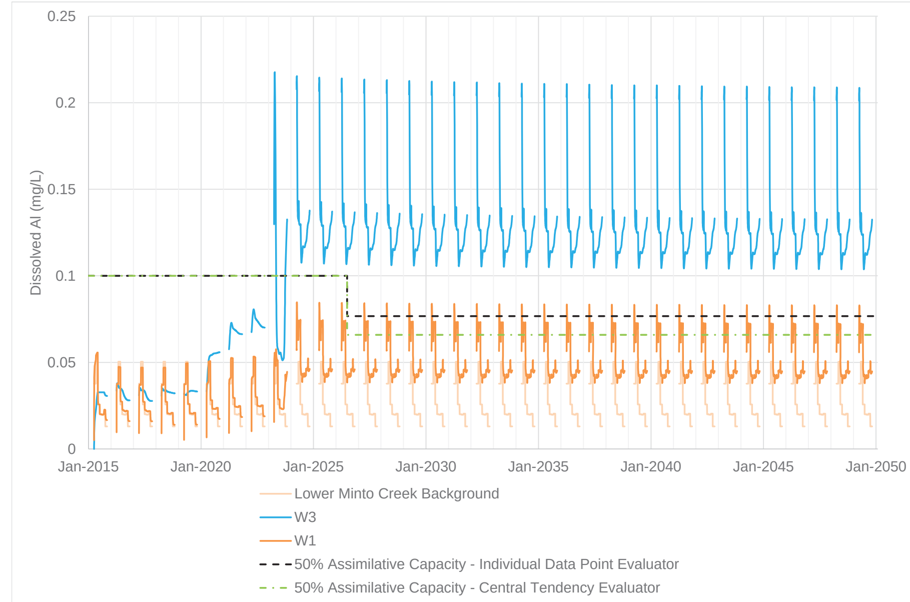
Model: Minto_2016_Annual_Report_1CM002.024_Rev59_SRJ_KNK, 2016/07/25, KNK

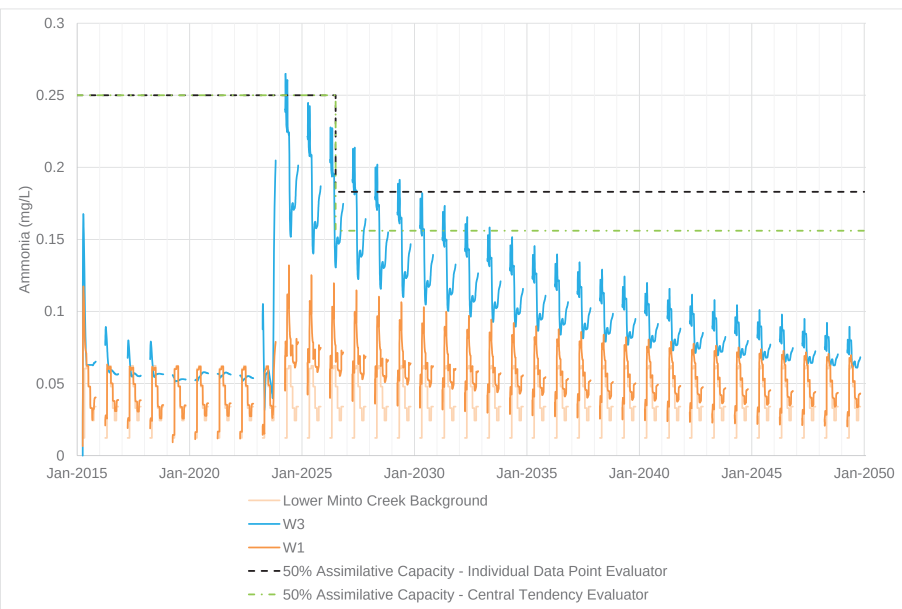
Appendix A2: Water and Load Balance Results
Scenario 1 – Expected Case, No Treatment



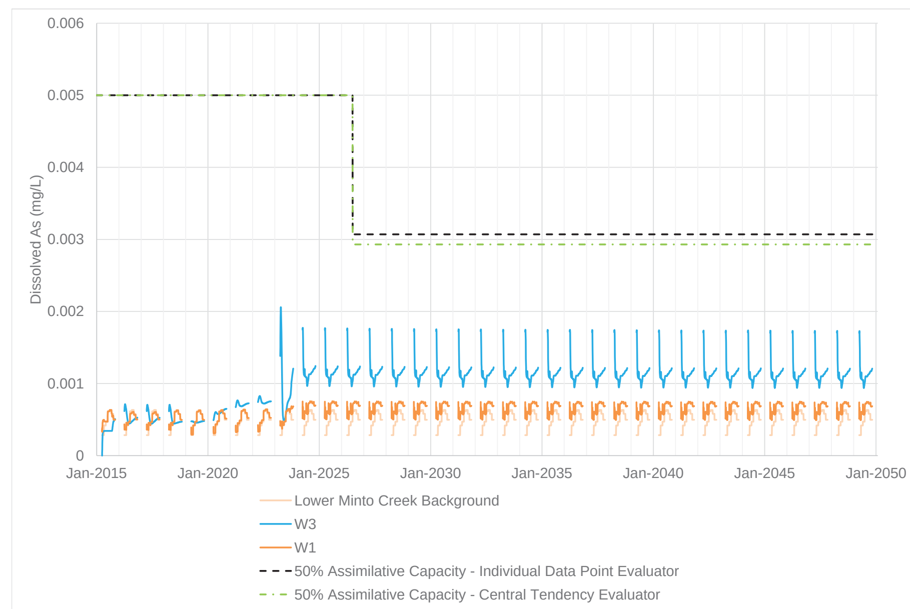
Note: Operational WQO included from 2015 to 2026 for comparison purposes



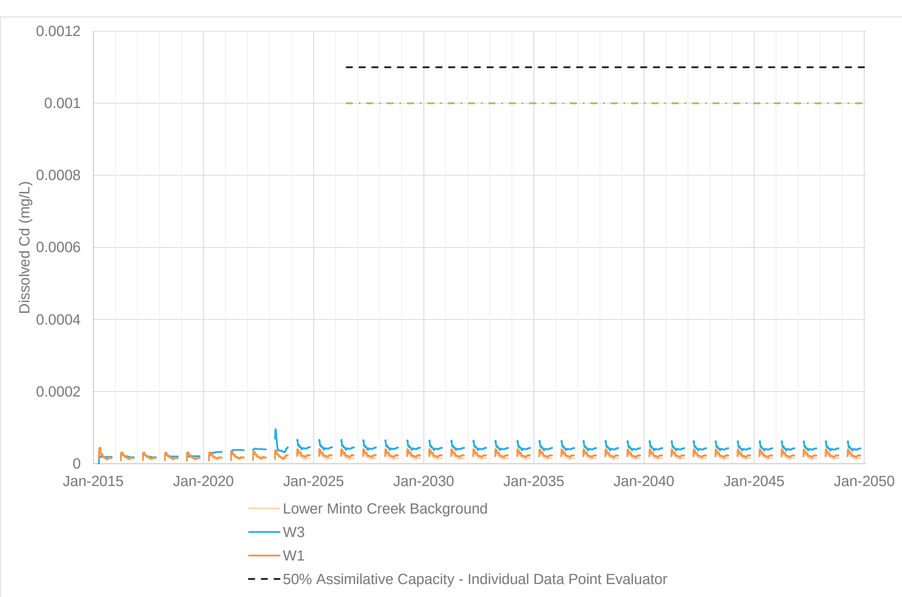
Note: Operational WQO included from 2015 to 2026 for comparison purposes



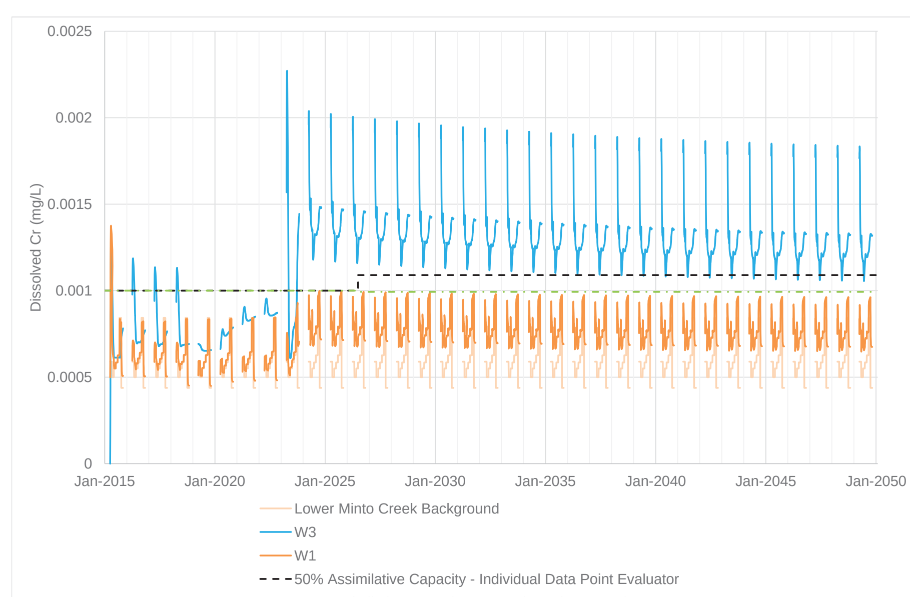
Note: Operational WQO included from 2015 to 2026 for comparison purposes



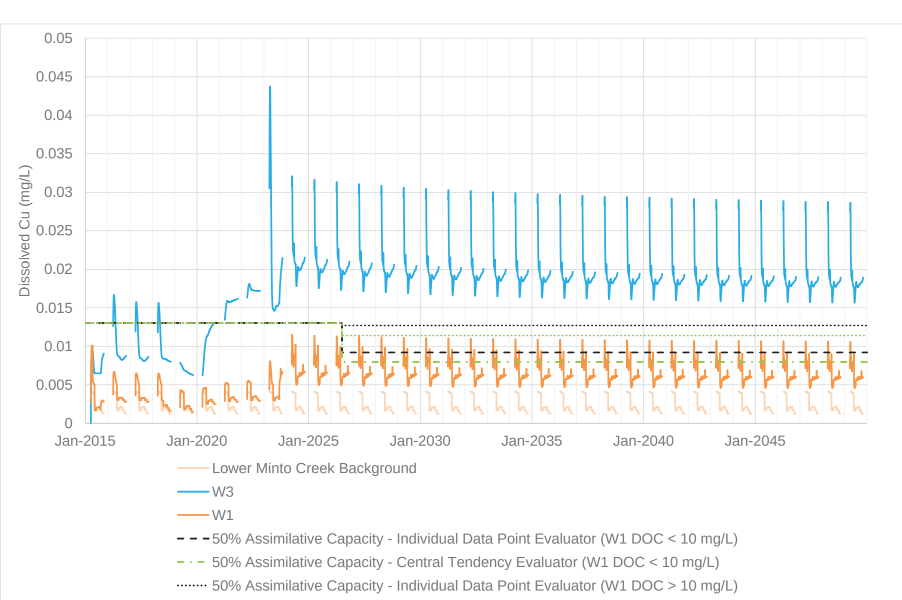
Note: Operational WQO included from 2015 to 2026 for comparison purposes



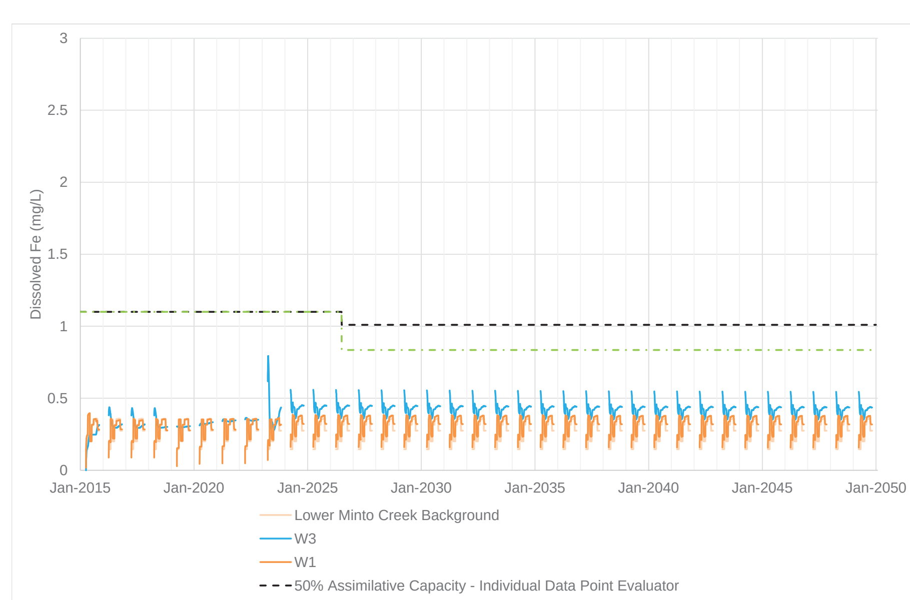
Note: Operational WQO included from 2015 to 2026 for comparison purposes



Note: Operational WQO included from 2015 to 2026 for comparison purposes



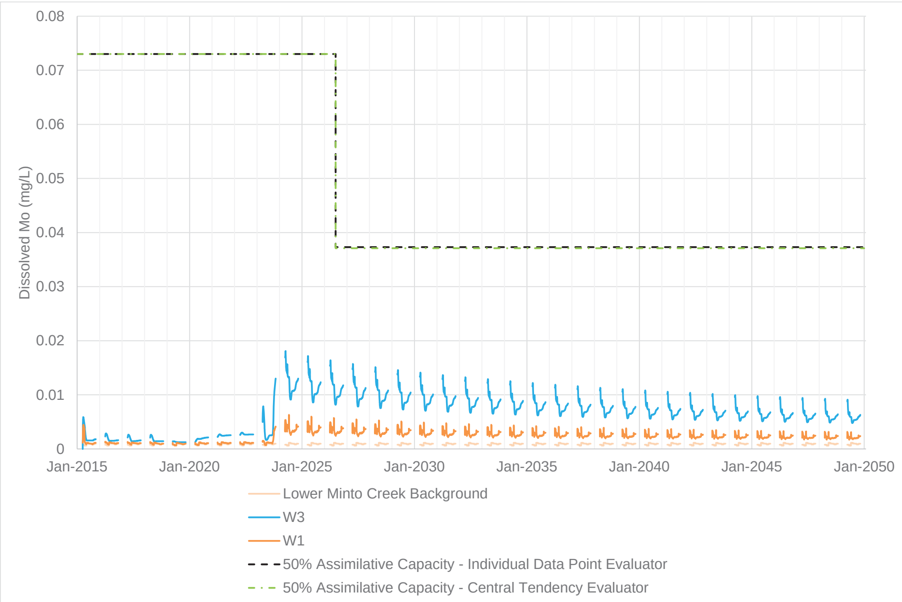
Note: Operational WQO included from 2015 to 2026 for comparison purposes



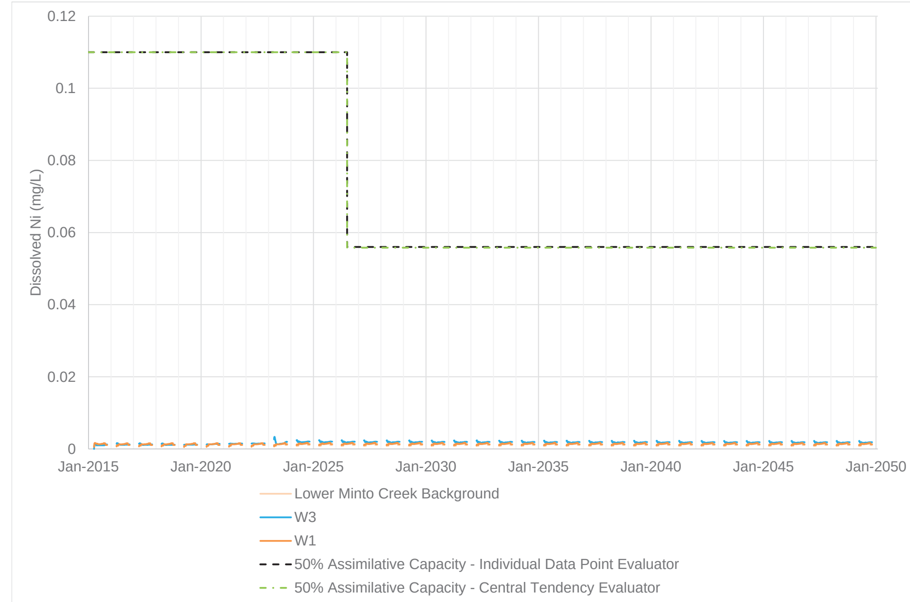
Note: Operational WQO included from 2015 to 2026 for comparison purposes

Source: Z:\01_SITES\Minto\1CM002.024_Water_Balance_Support\2016_RCP_Update\Model_Results\Results 20160725\Model_Results_20160725_Scenario_1_Rev01_KNK.xlsm
Model: Minto_2016_Annual_Report_1CM002.024_Rev59_SRJ_KNK, 2016/07/25, KNK

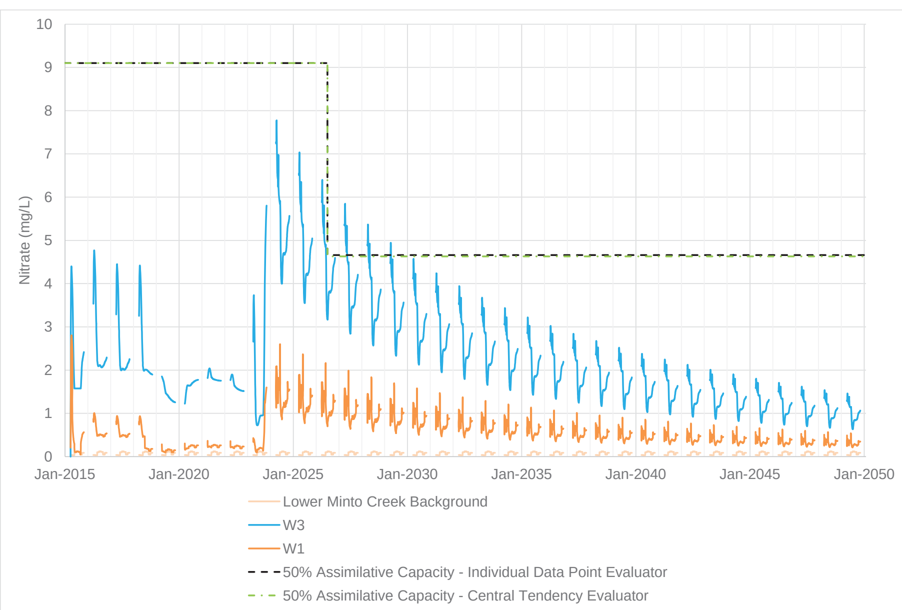
Appendix A2: Water and Load Balance Results
Scenario 1 – Expected Case, No Treatment



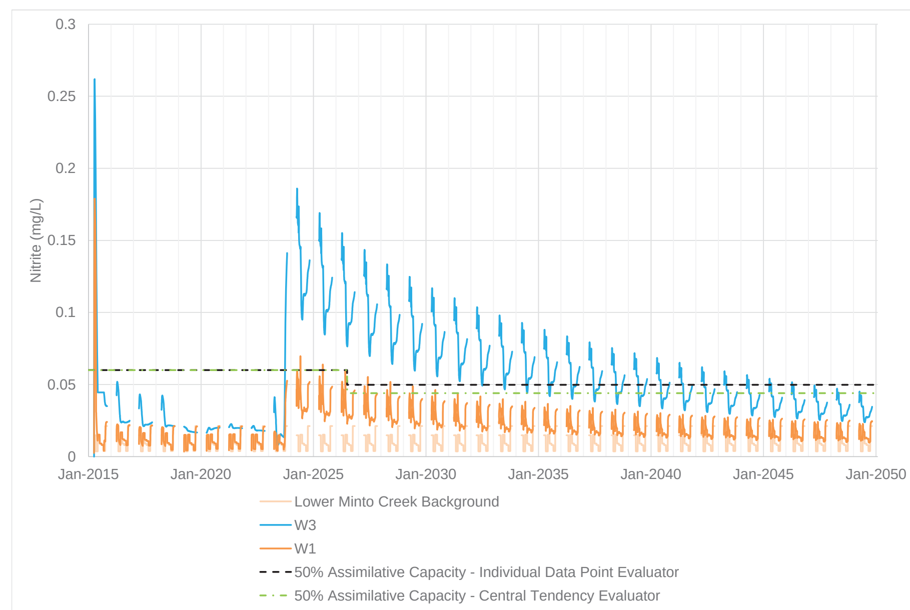
Note: Operational WQO included from 2015 to 2026 for comparison purposes



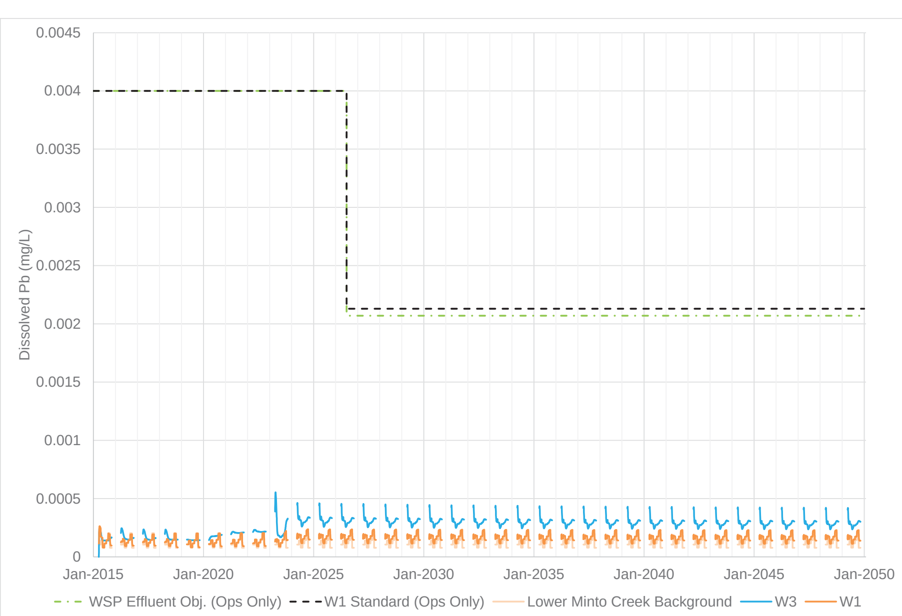
Note: Operational WQO included from 2015 to 2026 for comparison purposes



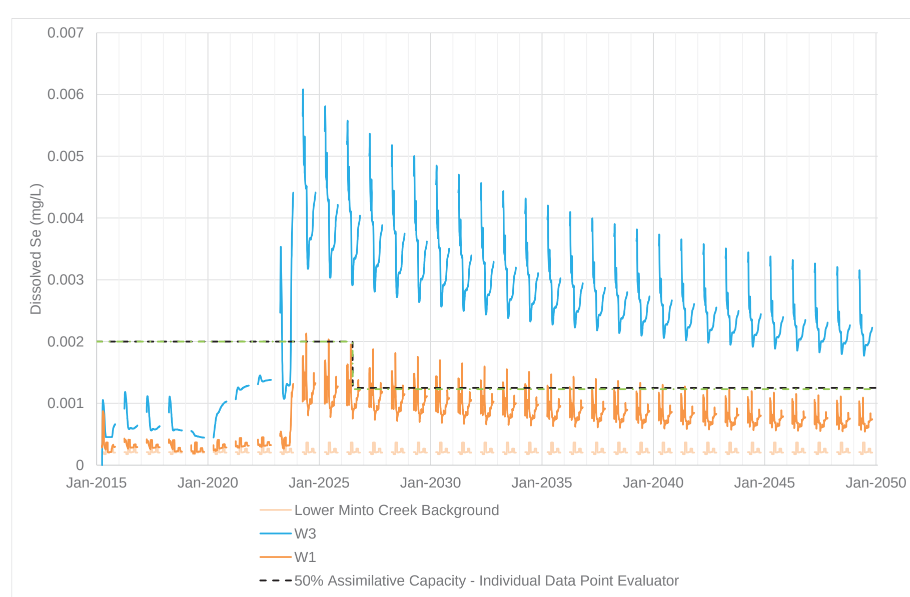
Note: Operational WQO included from 2015 to 2026 for comparison purposes



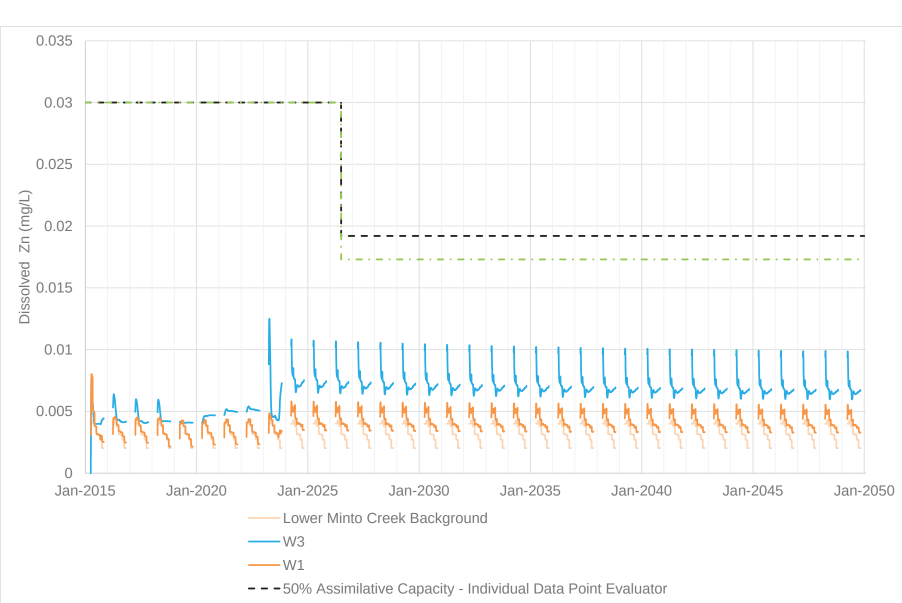
Note: Operational WQO included from 2015 to 2026 for comparison purposes



Note: Operational WQO included from 2015 to 2026 for comparison purposes



Note: Operational WQO included from 2015 to 2026 for comparison purposes



Note: Operational WQO included from 2015 to 2026 for comparison purposes

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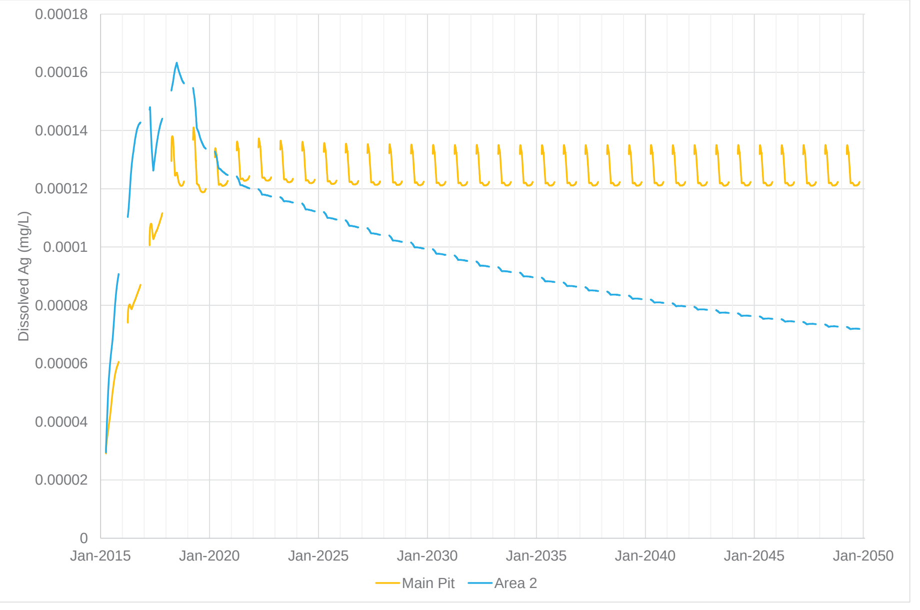
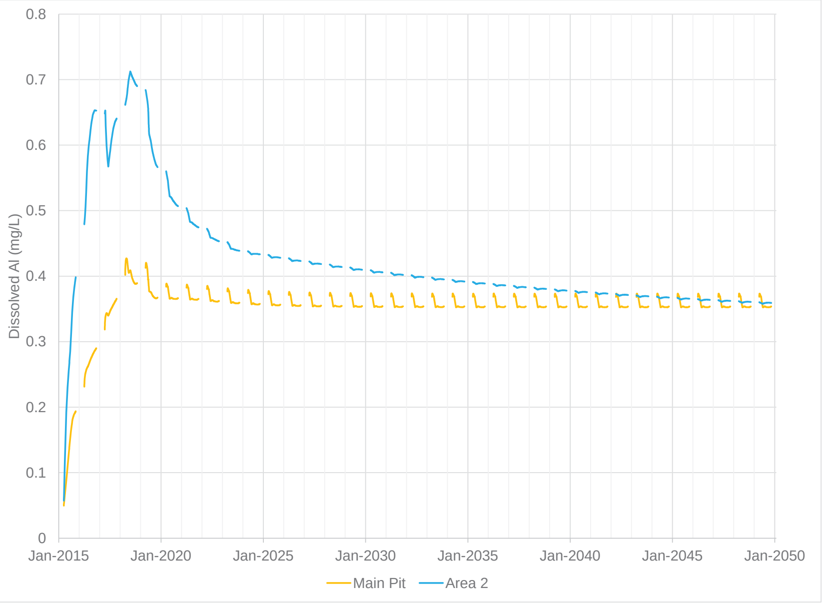
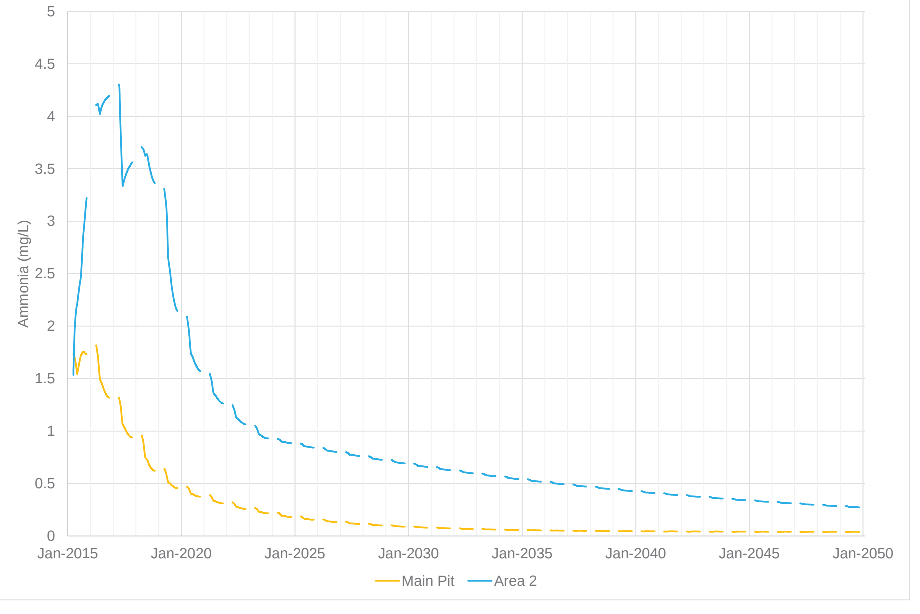
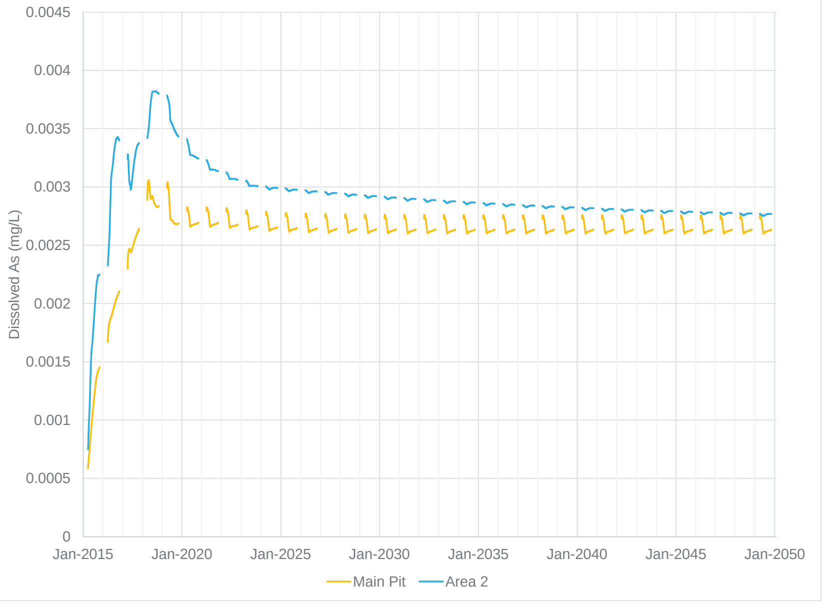
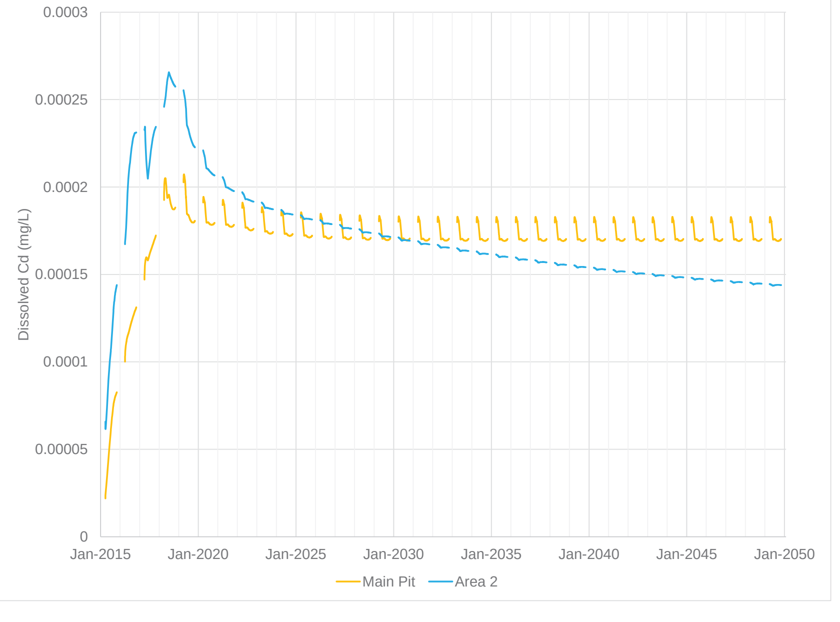
Model: Minto_2016_Annual_Report_1CM002.024_Rev59_SRJ_KNK, 2016/07/25, KNK

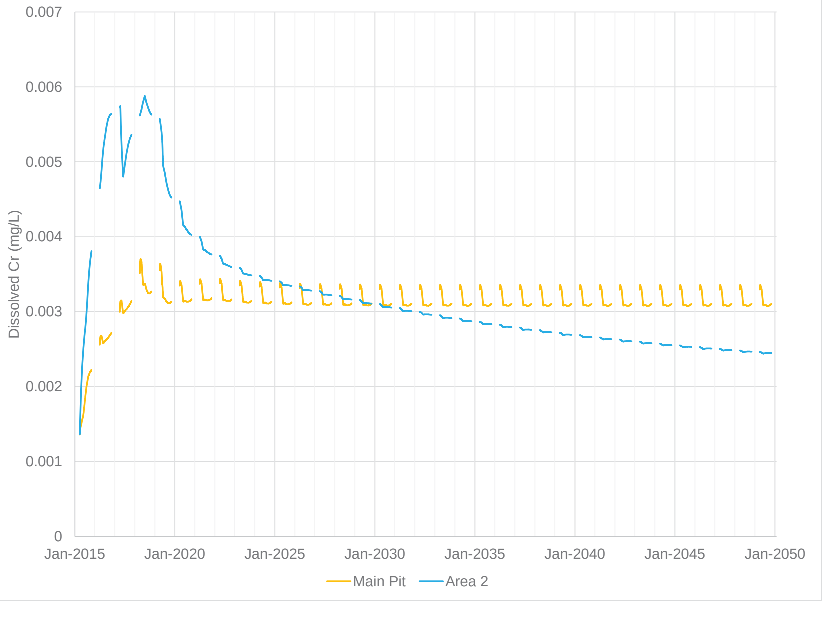


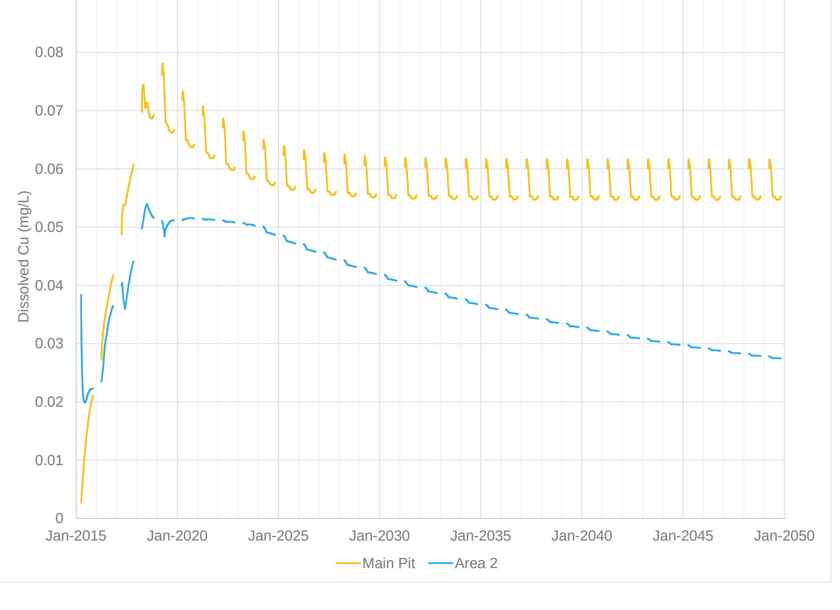


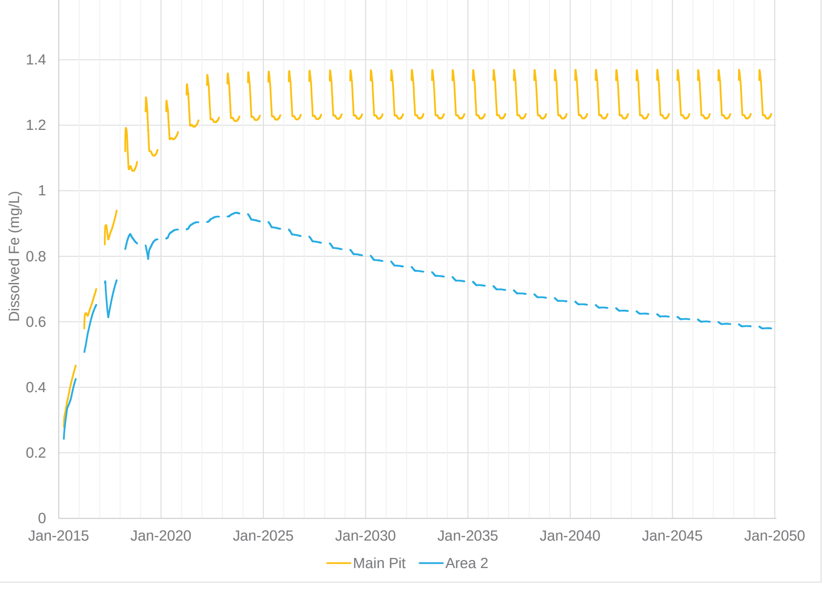












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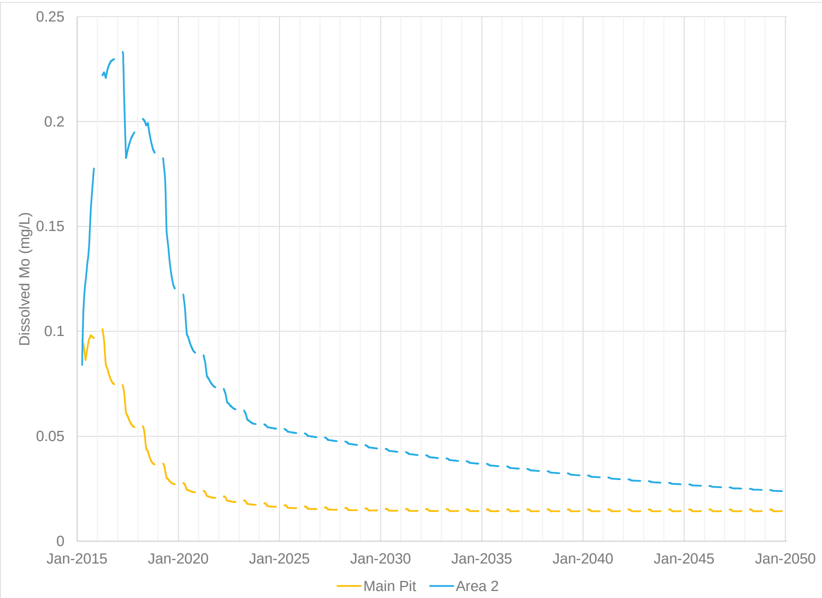
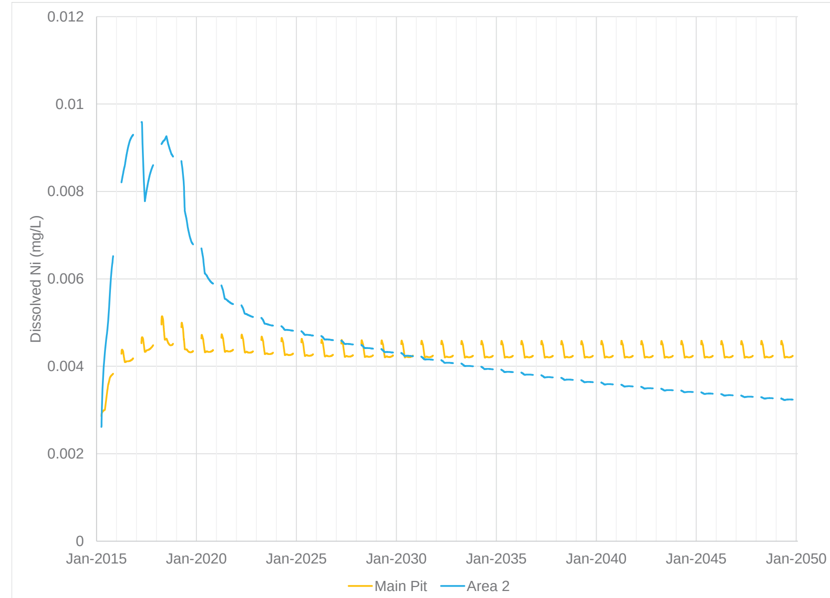
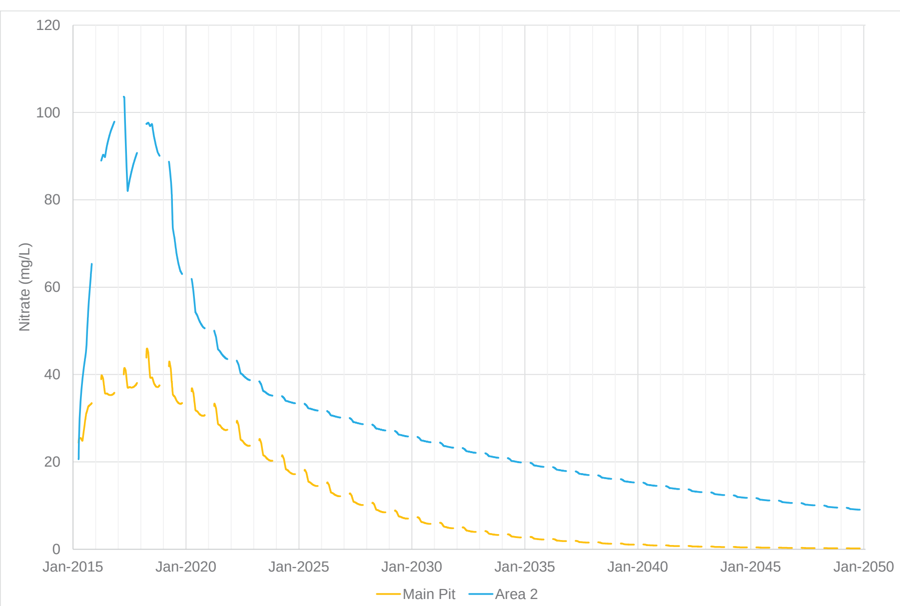
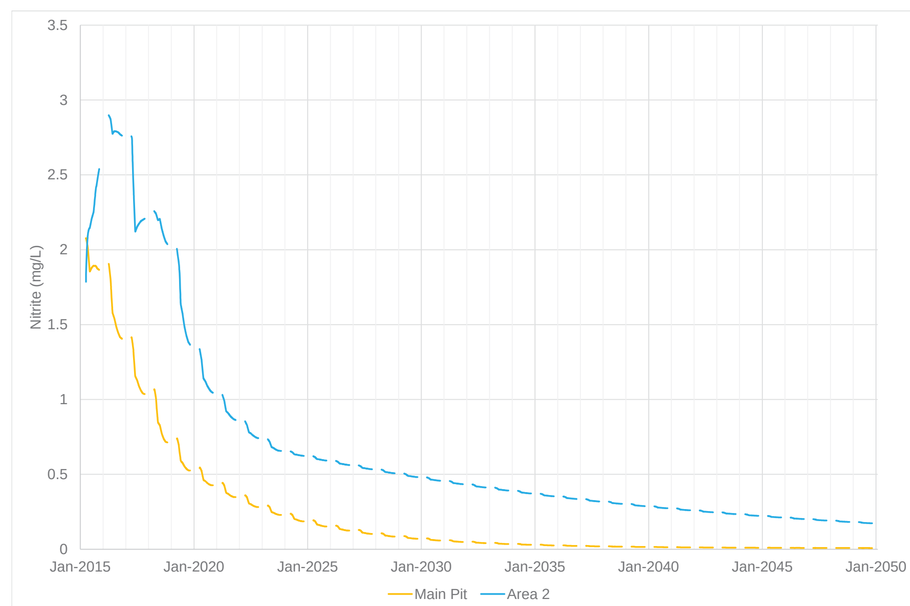
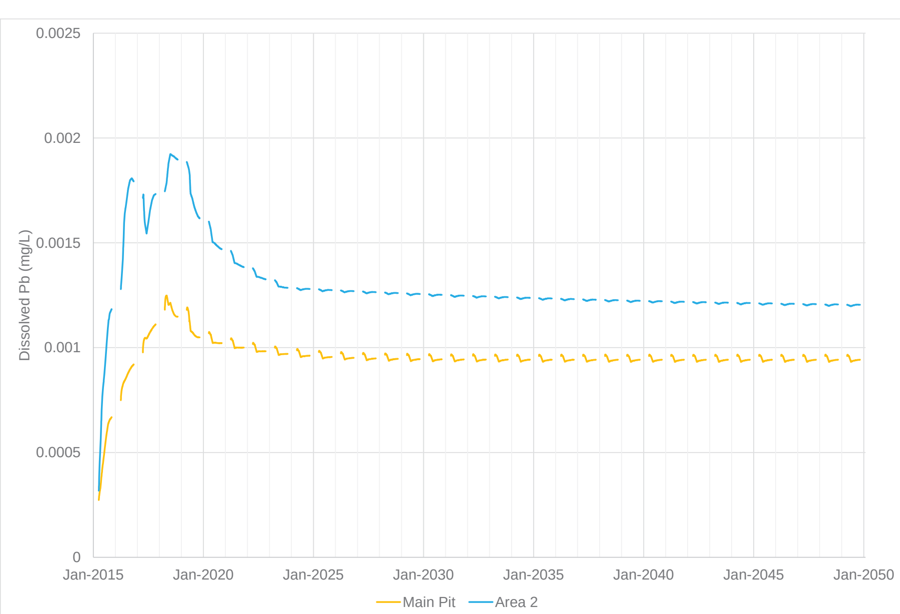
Model: Minto_2016_Annual_Report_1CM002.024_Rev59_SRJ_KNK, 2016/07/25, KNK

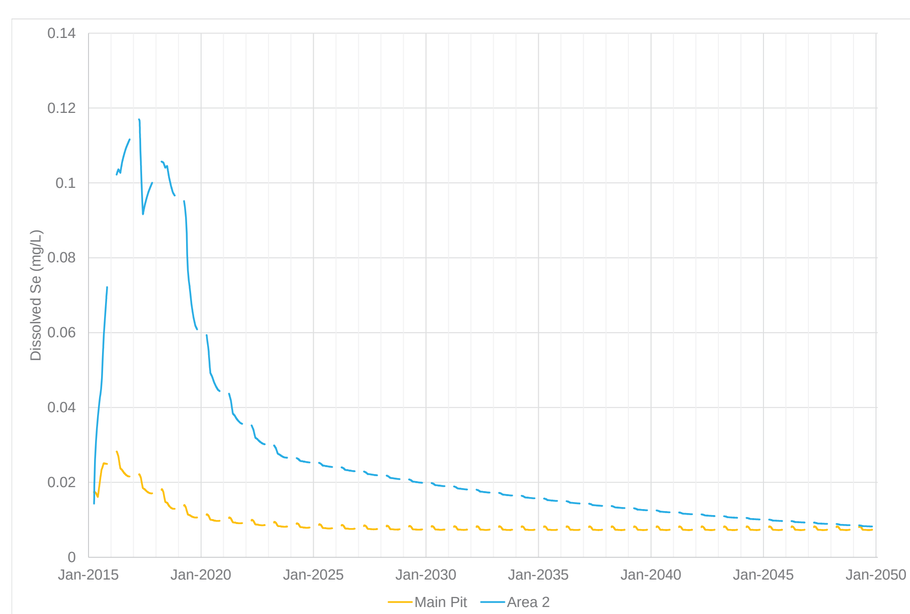


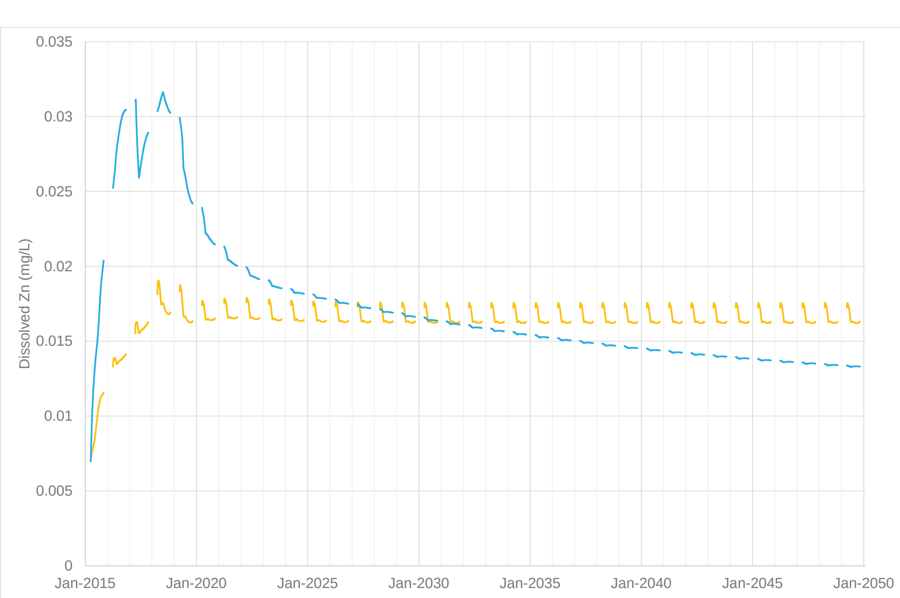












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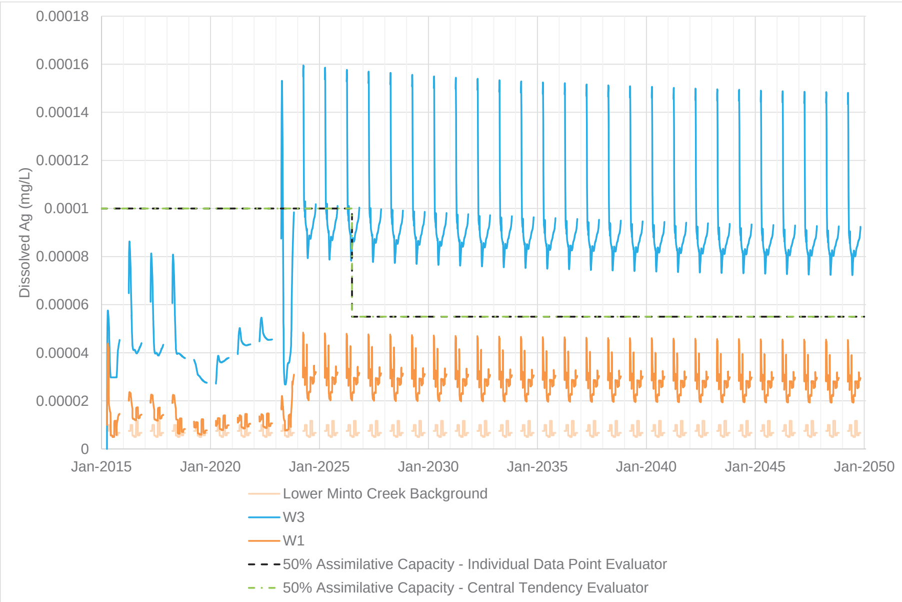
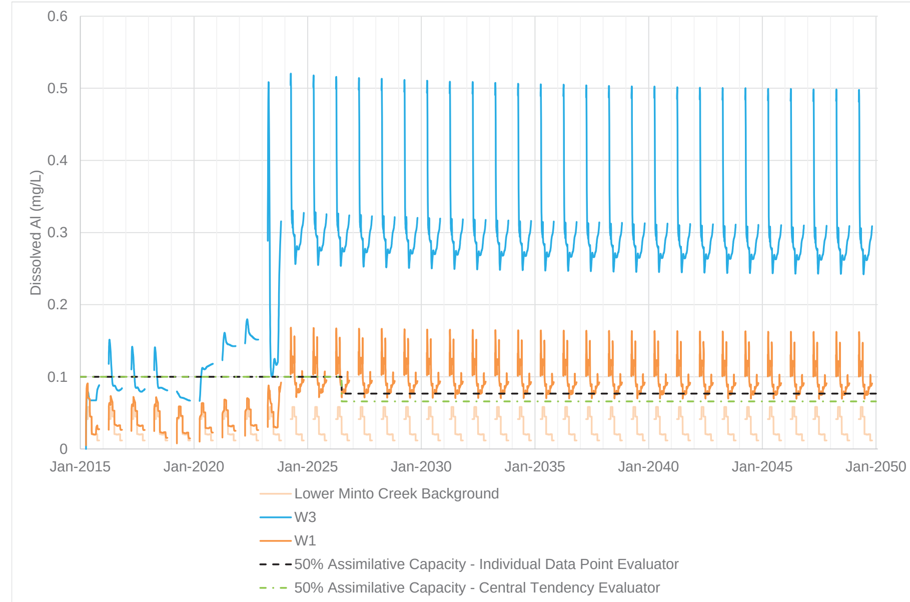
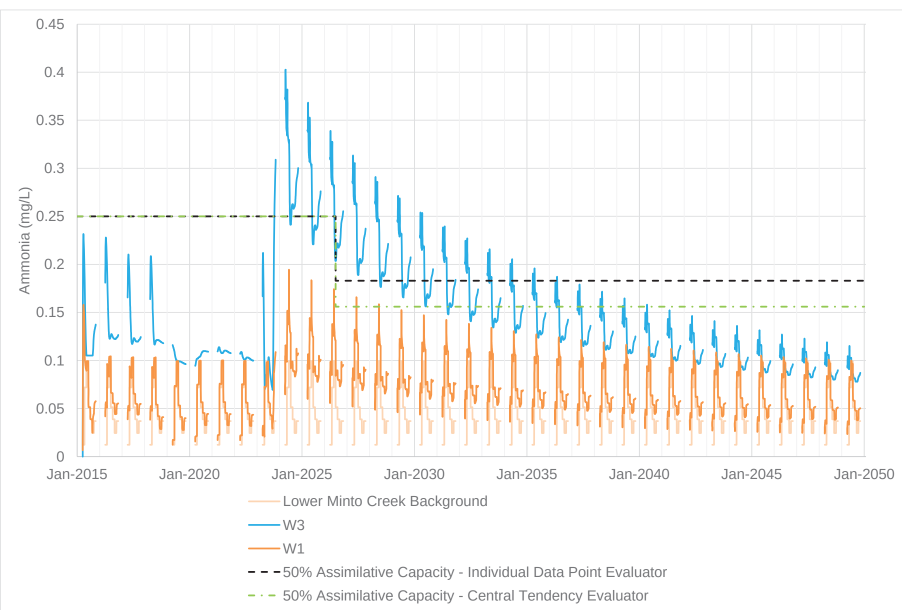
Model: Minto_2016_Annual_Report_1CM002.024_Rev59_SRJ_KNK, 2016/07/25, KNK



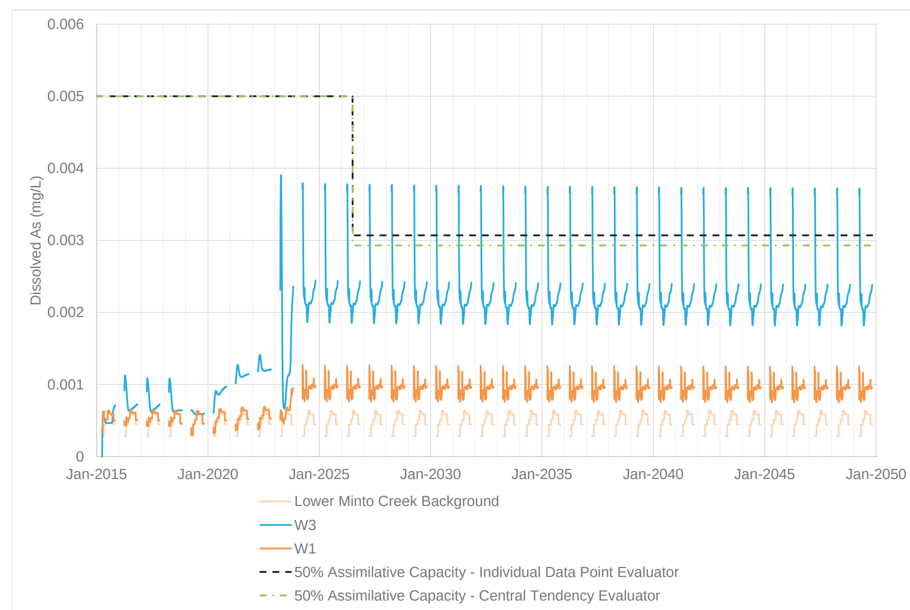
Note: Operational WQO included from 2015 to 2026 for comparison purposes



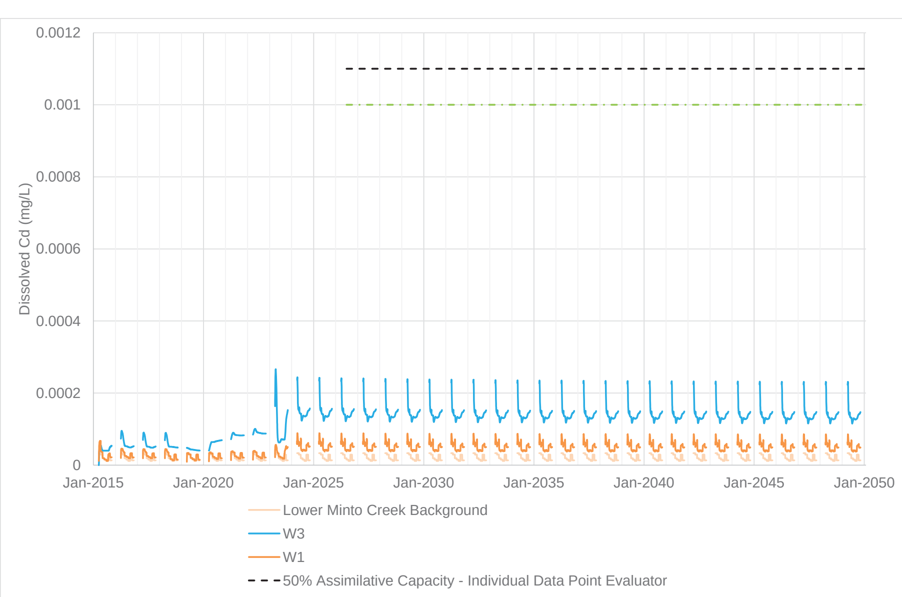
Note: Operational WQO included from 2015 to 2026 for comparison purposes



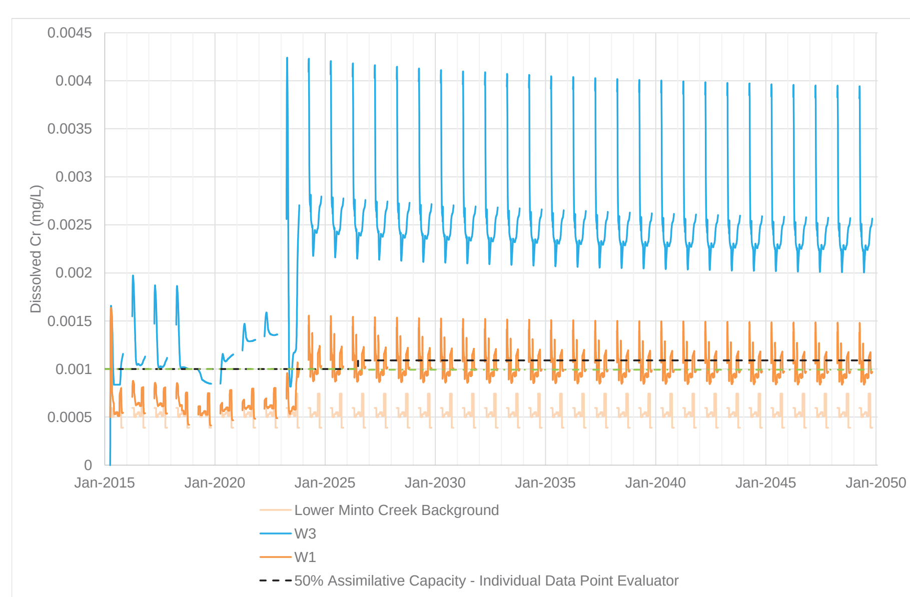
Note: Operational WQO included from 2015 to 2026 for comparison purposes



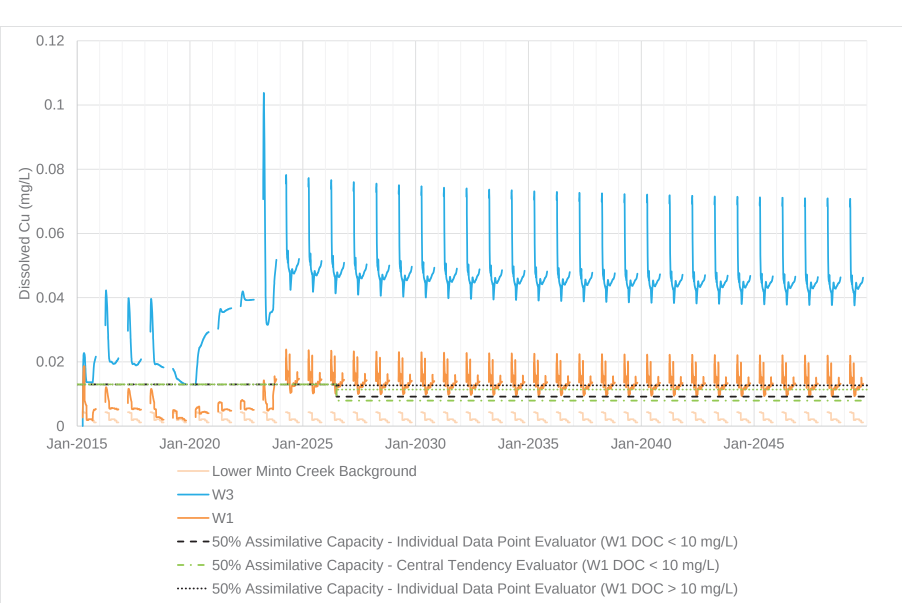
Note: Operational WQO included from 2015 to 2026 for comparison purposes



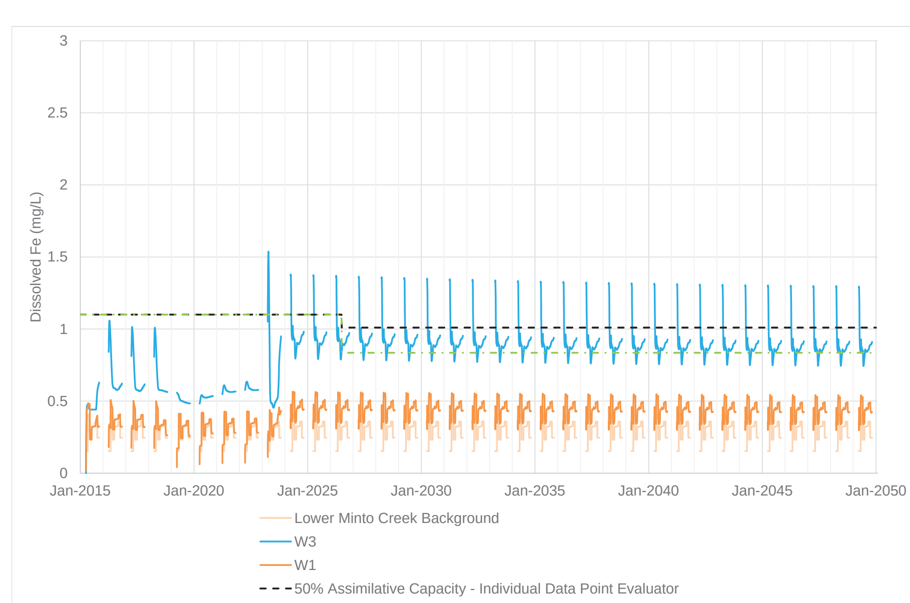
Note: Operational WQO included from 2015 to 2026 for comparison purposes



Note: Operational WQO included from 2015 to 2026 for comparison purposes



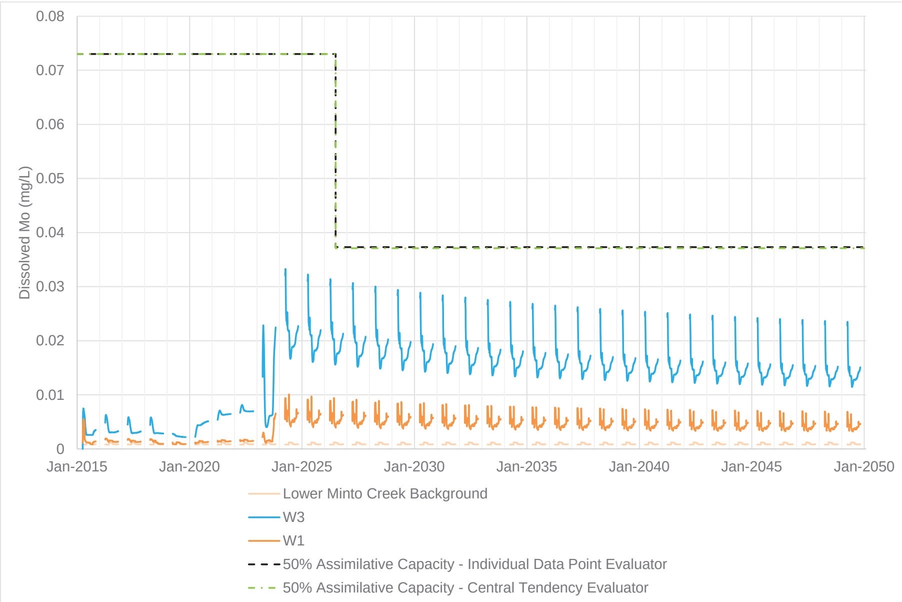
Note: Operational WQO included from 2015 to 2026 for comparison purposes



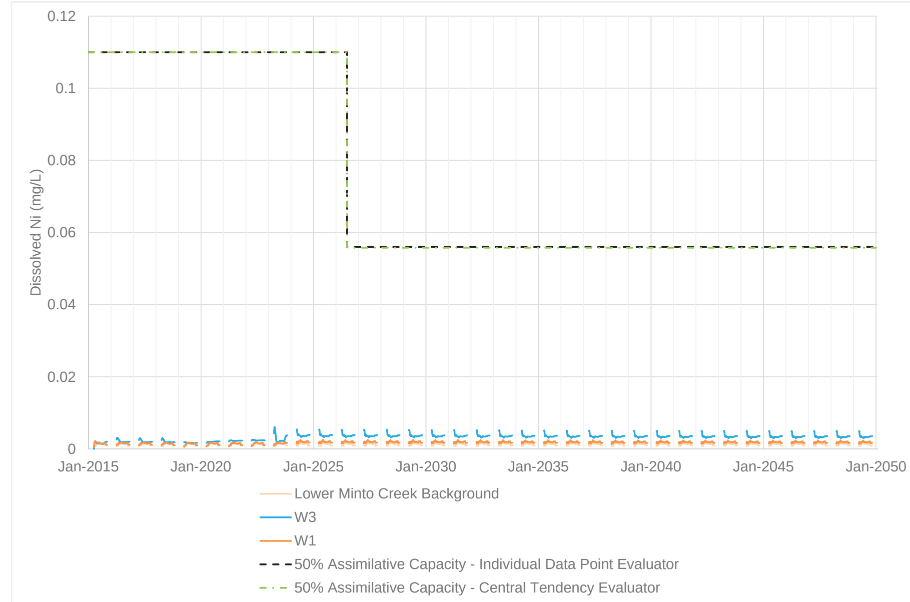
Note: Operational WQO included from 2015 to 2026 for comparison purposes

Source: Z:\01_SITES\Minto\1CM002.024_Water_Balance_Support\2016_RCP_Update\Model_Results\Results 20160725\Model_Results_20160725_Scenario_2_Rev01_KNK.xlsm
Model: Minto_2016_Annual_Report_1CM002.024_Rev59_SRJ_KNK, 2016/07/25, KNK

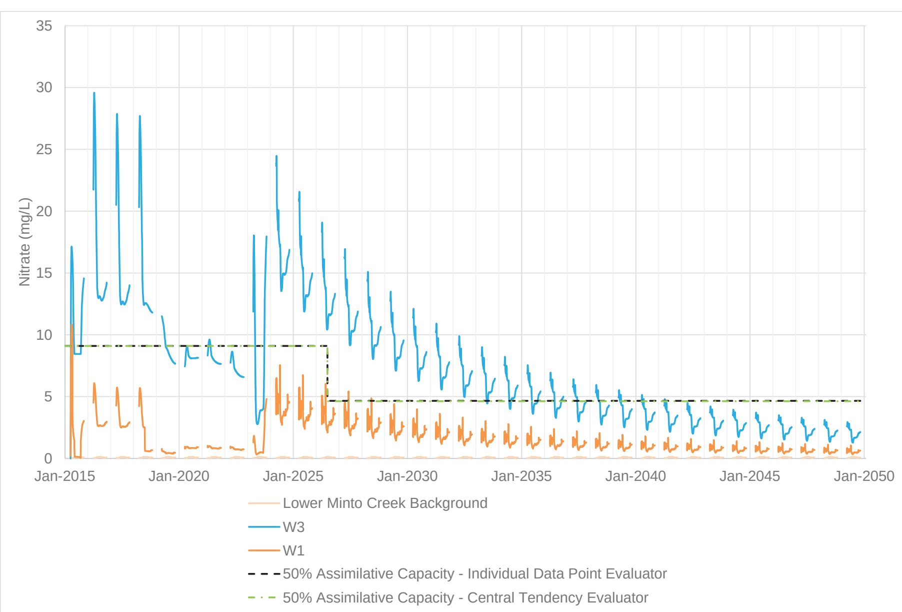
Appendix A2: Water and Load Balance Results
Scenario 2 – Reasonable Worst Case, No Treatment



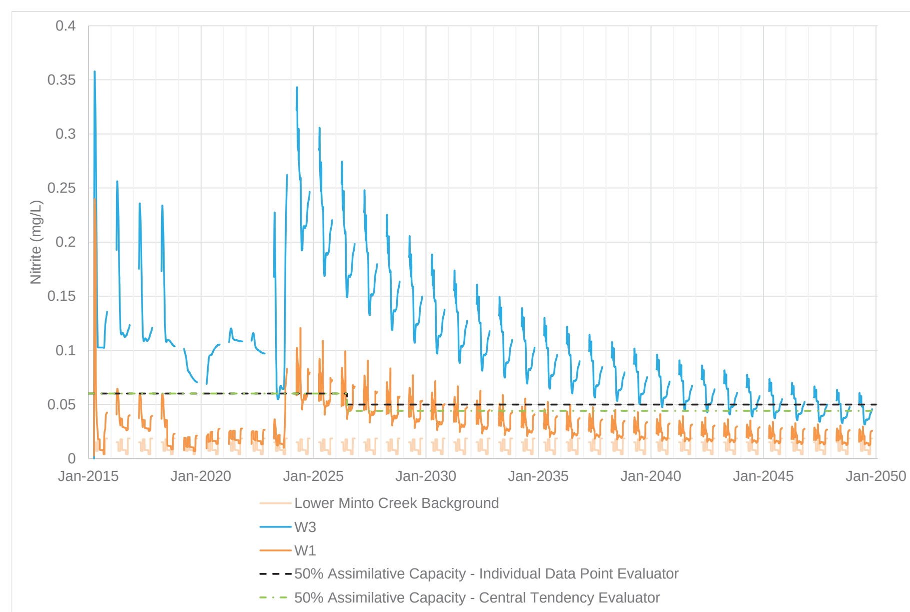
Note: Operational WQO included from 2015 to 2026 for comparison purposes



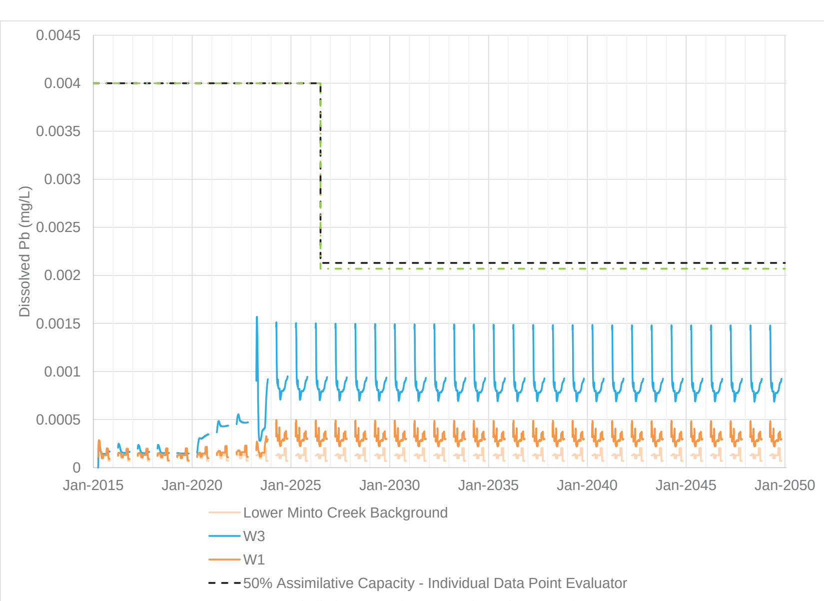
Note: Operational WQO included from 2015 to 2026 for comparison purposes



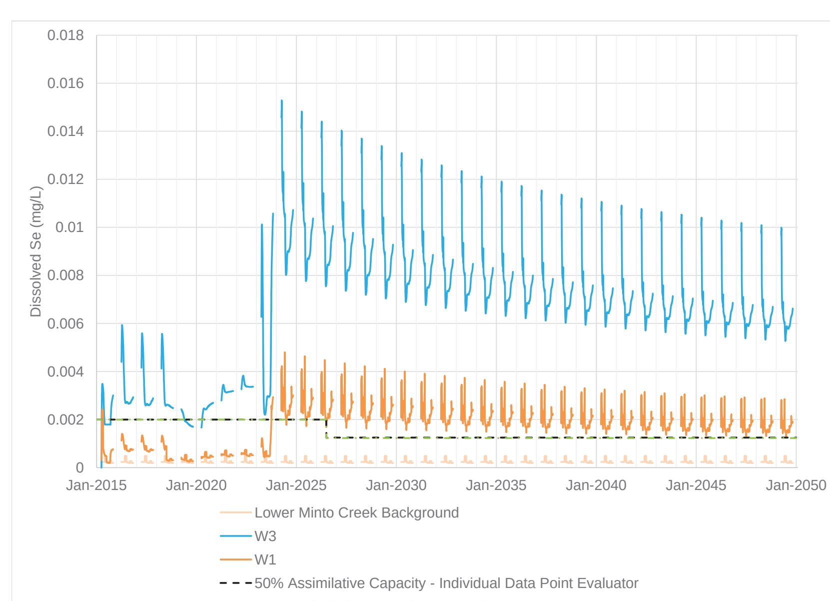
Note: Operational WQO included from 2015 to 2026 for comparison purposes



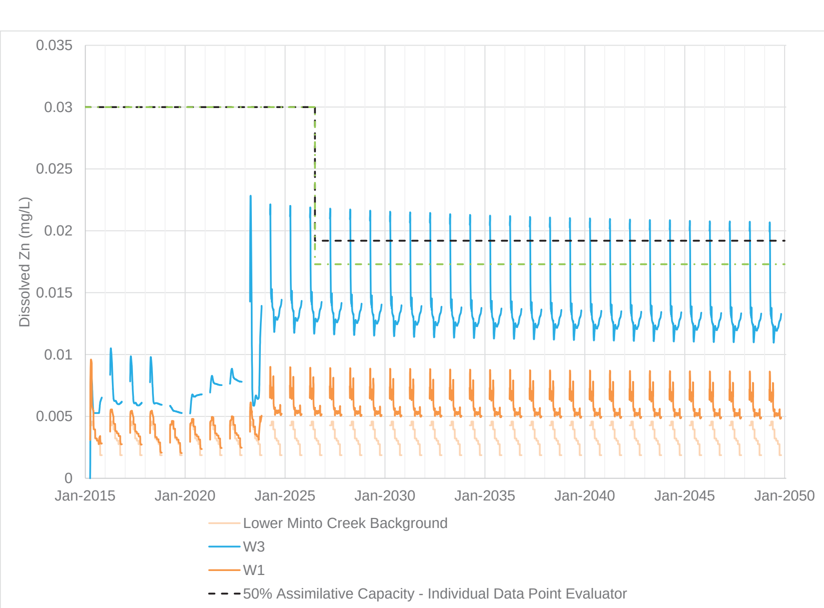
Note: Operational WQO included from 2015 to 2026 for comparison purposes



Note: Operational WQO included from 2015 to 2026 for comparison purposes

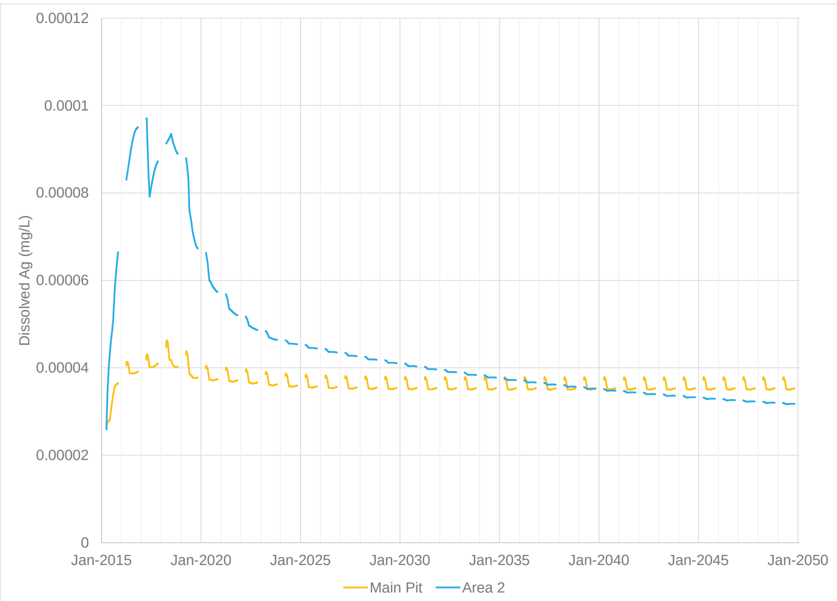


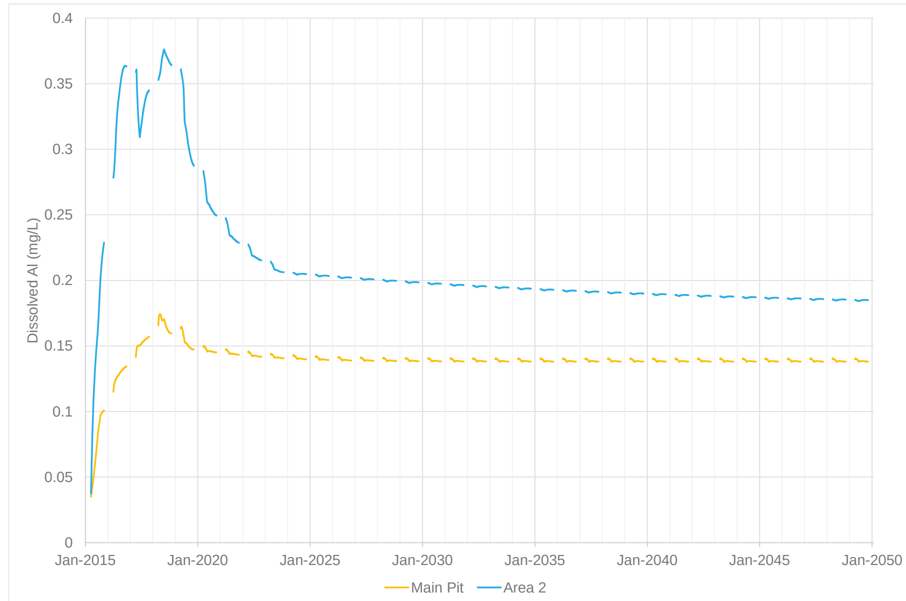
Note: Operational WQO included from 2015 to 2026 for comparison purposes

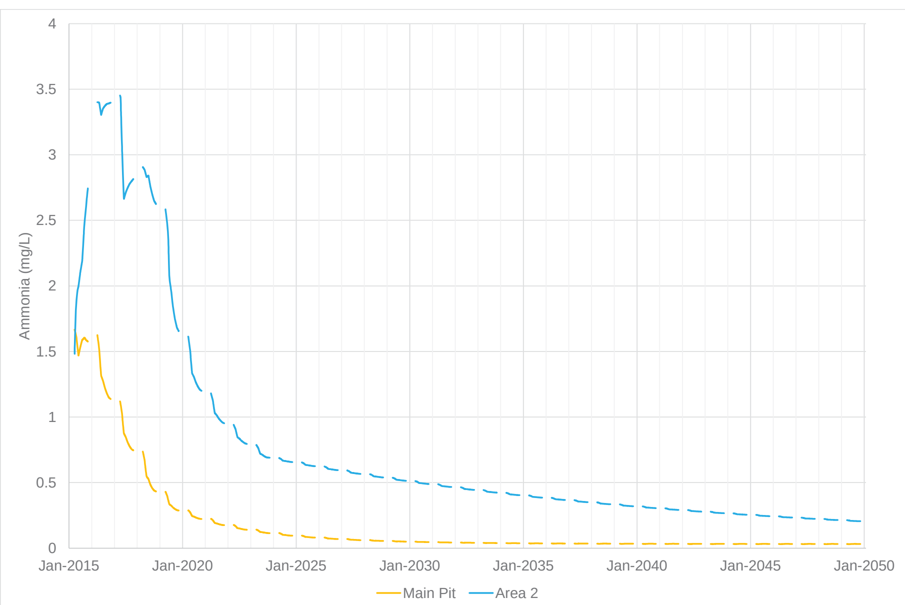


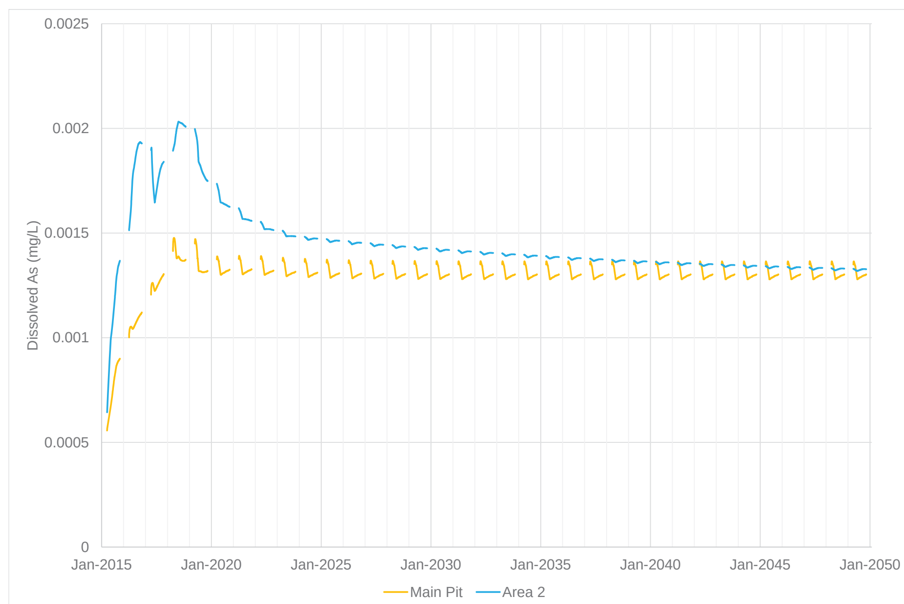
Note: Operational WQO included from 2015 to 2026 for comparison purposes

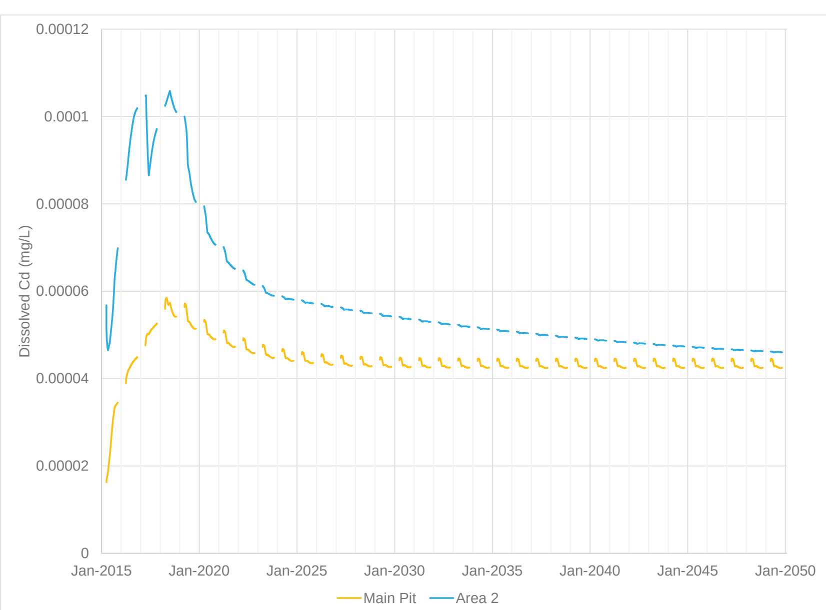
Source: Z:\01_SITES\Minto\1CM002.024_Water_Balance_Support\2016_RCP_Update\Model_Results\Results 20160725\Model_Results_20160725_Scenario_2_Rev01_KNK.xlsm
Model: Minto_2016_Annual_Report_1CM002.024_Rev59_SRJ_KNK, 2016/07/25, KNK

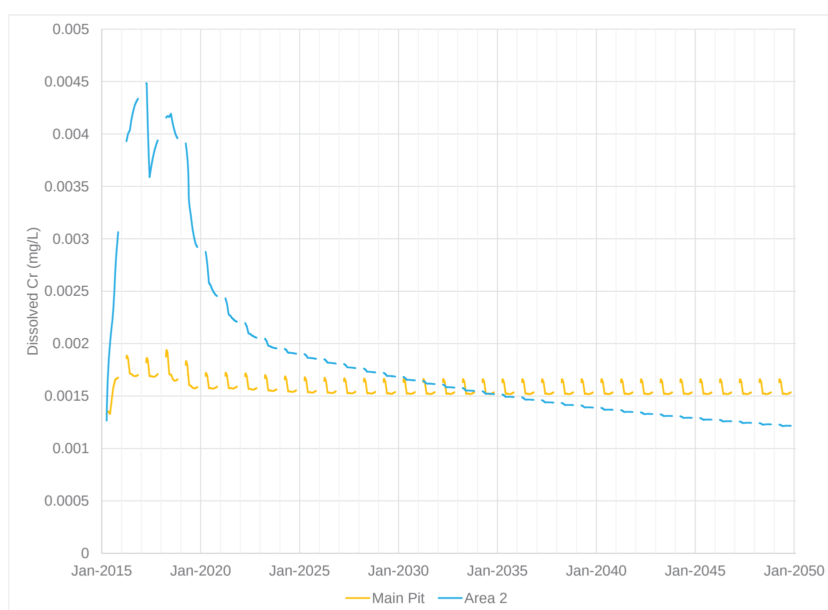


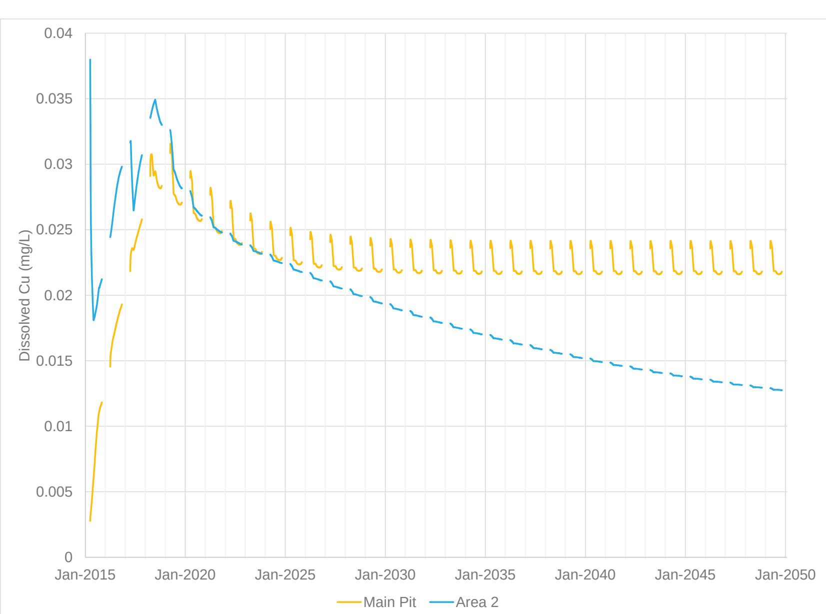


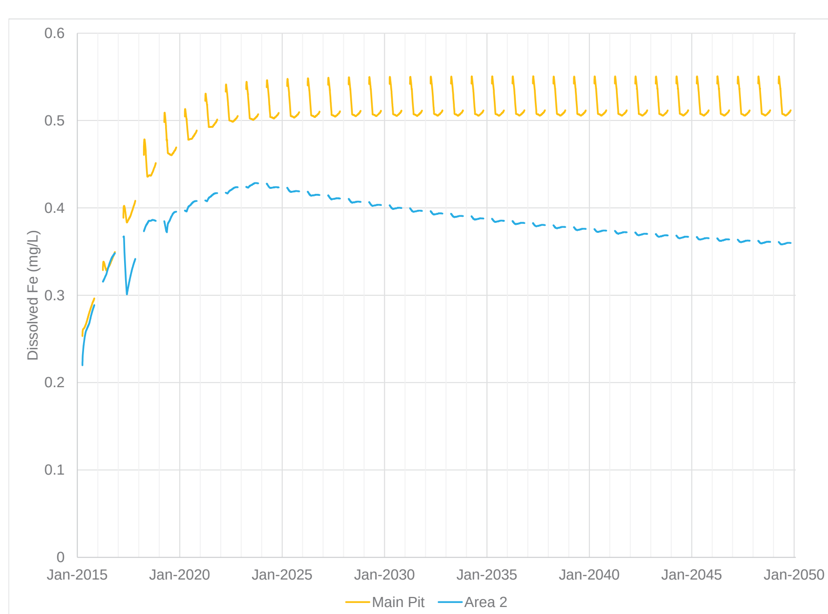






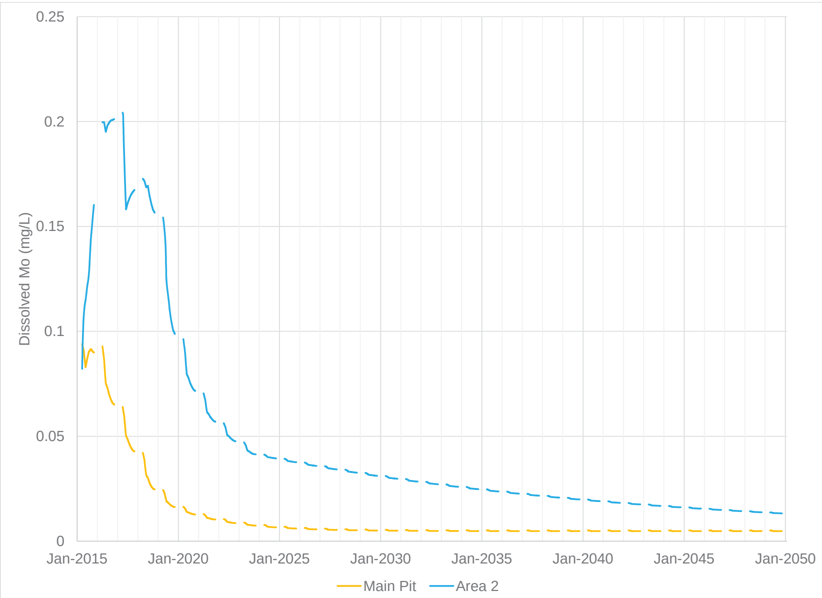


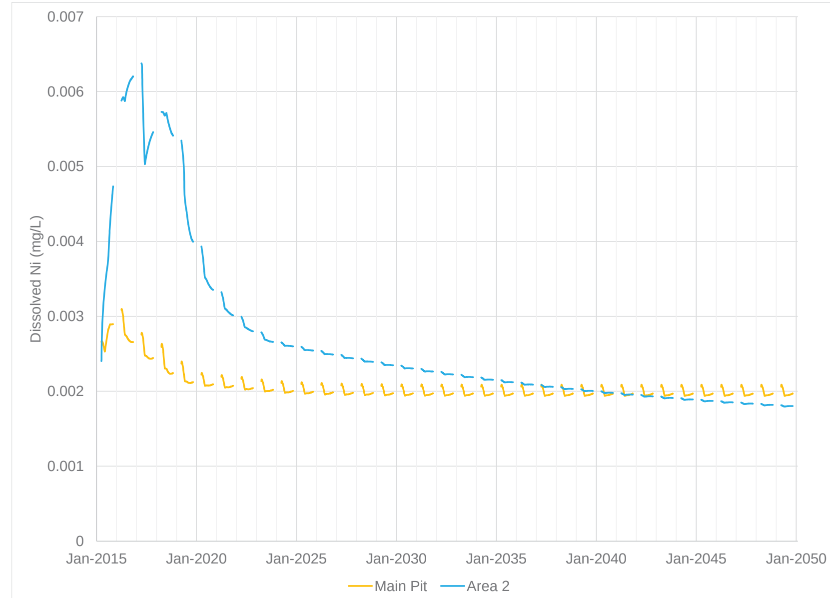


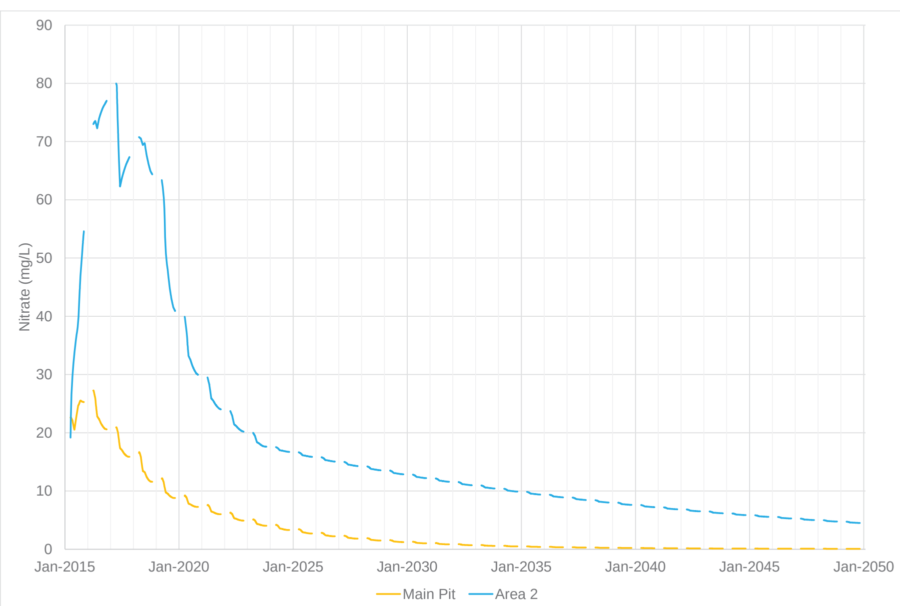


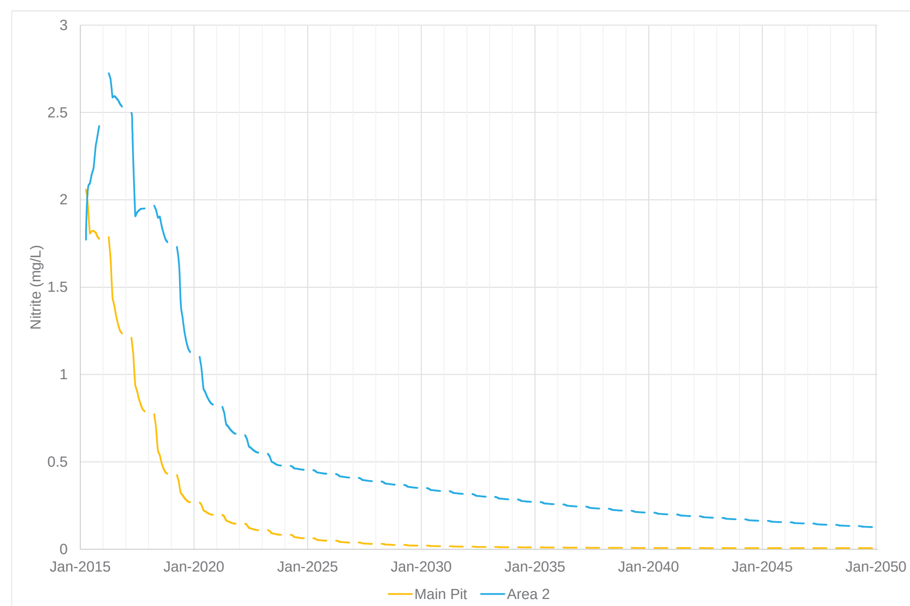
Source: Z:\01_SITES\Minto\1CM002.024_Water_Balance_Support\2016_RCP_Update\Model_Results\Results 20160725\Model_Results_20160725_Scenario_4_Rev01_KNK.xlsm
Model: Minto_2016_Annual_Report_1CM002.024_Rev59_SRJ_KNK, 2016/07/25, KNK

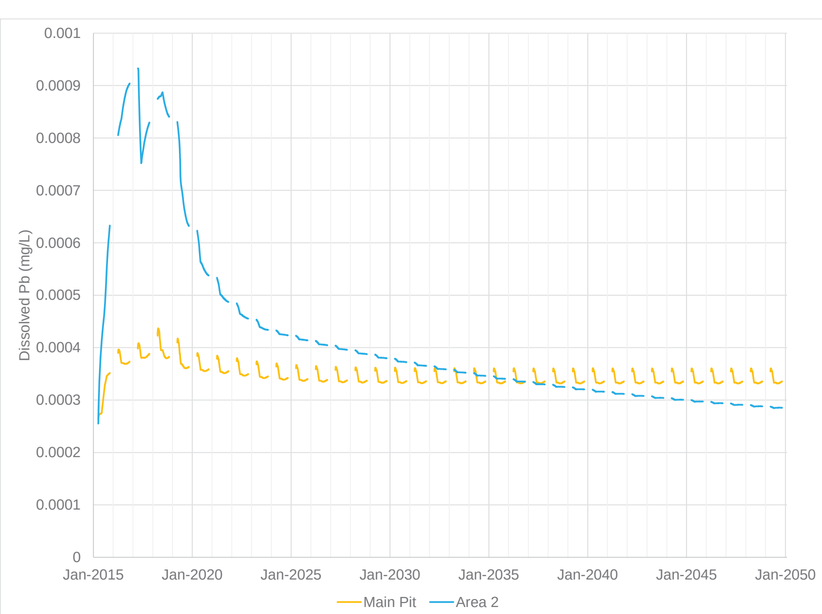
Appendix A2: Water and Load Balance Results
Scenario 3 – Expected Case, With Treatment

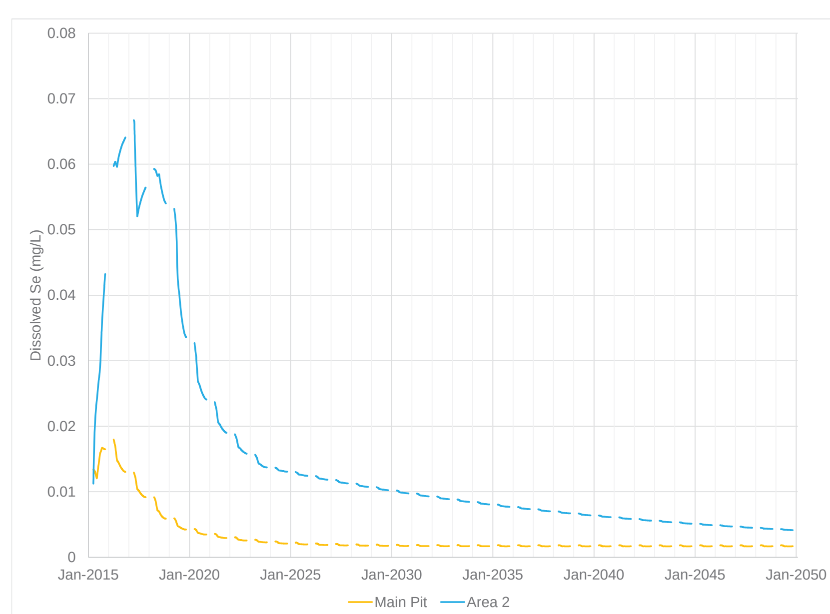


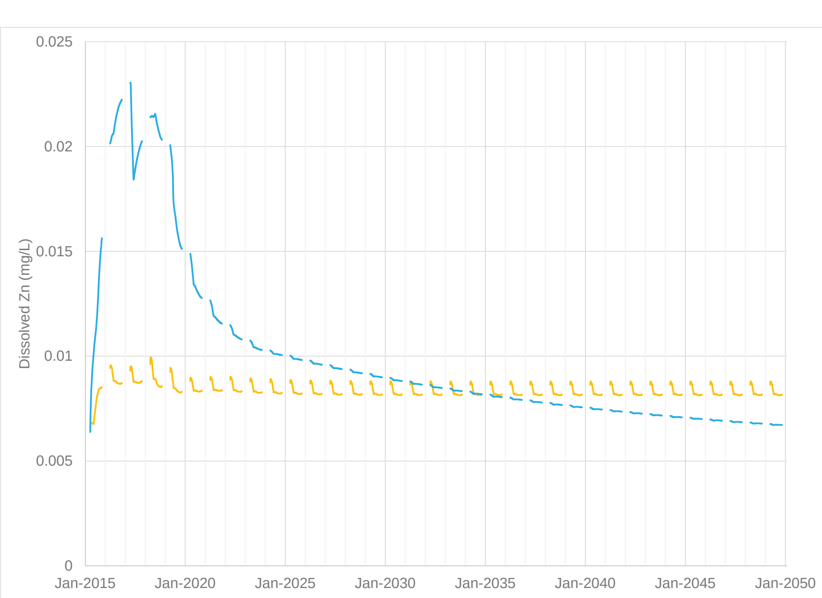












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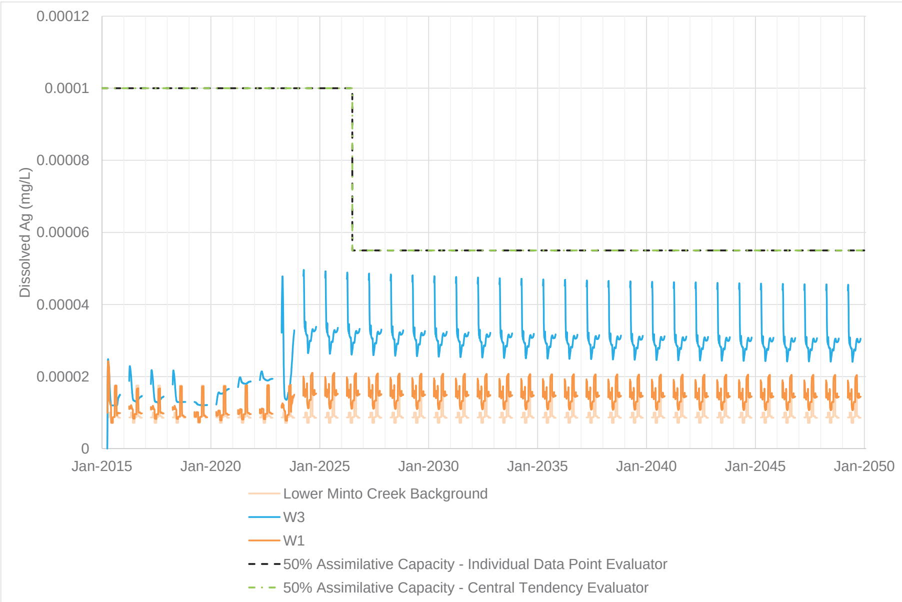
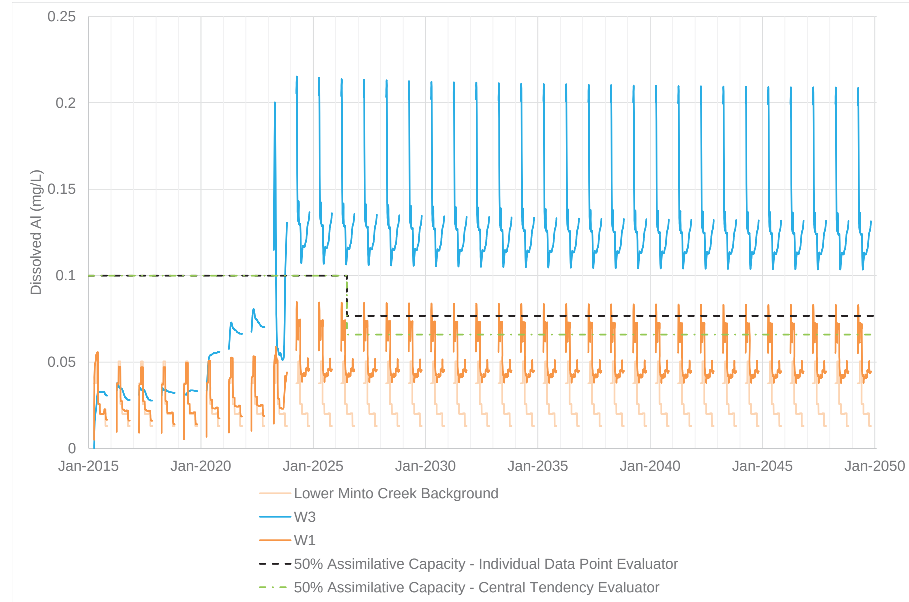
Model: Minto_2016_Annual_Report_1CM002.024_Rev59_SRJ_KNK, 2016/07/25, KNK

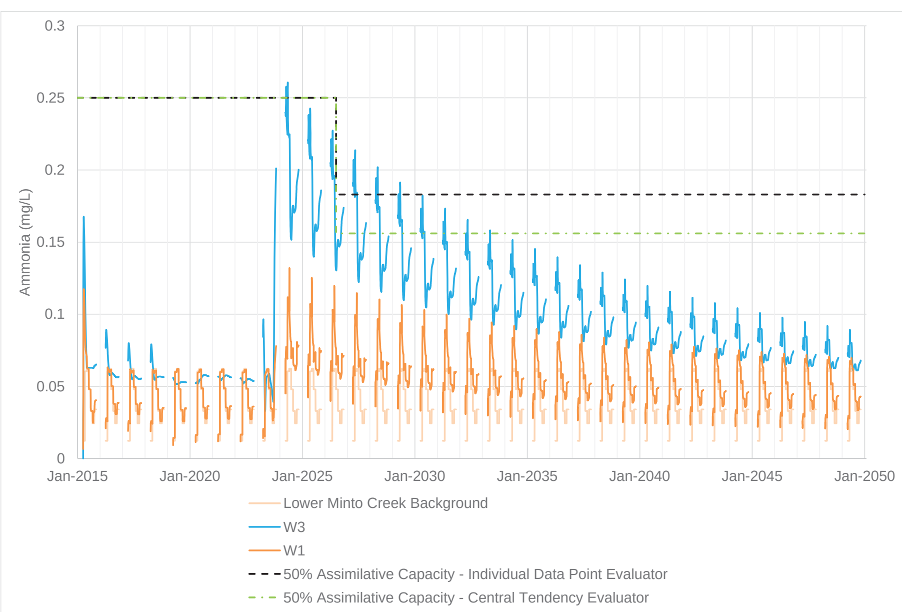
Appendix A2: Water and Load Balance Results
Scenario 3 – Expected Case, With Treatment



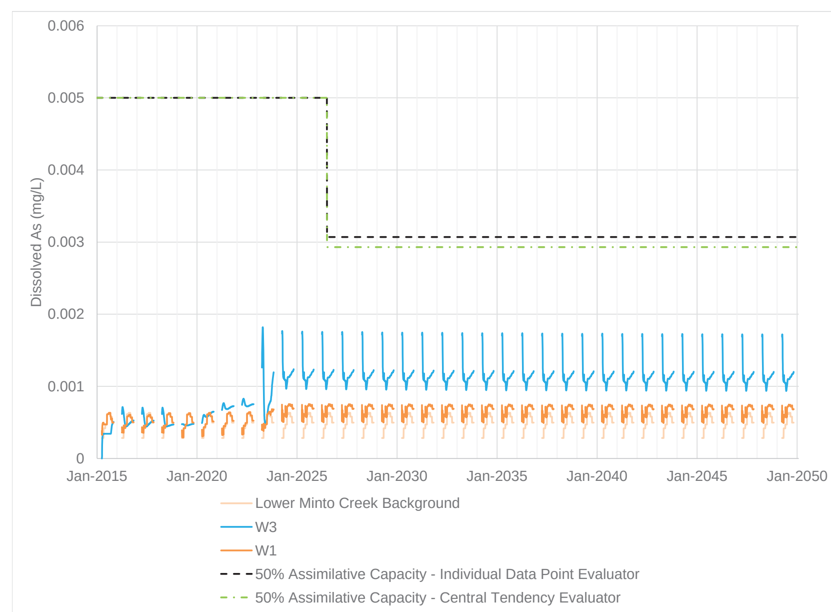
Note: Operational WQO included from 2015 to 2026 for comparison purposes



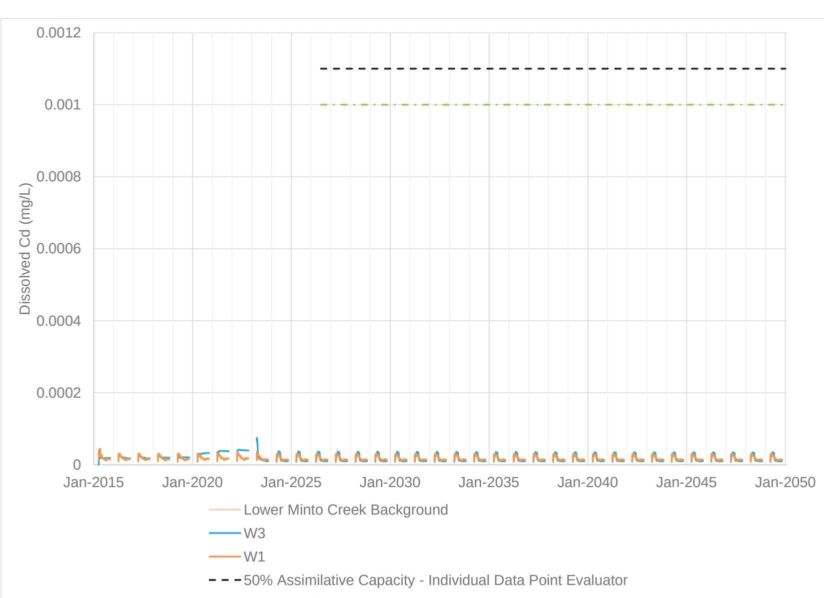
Note: Operational WQO included from 2015 to 2026 for comparison purposes



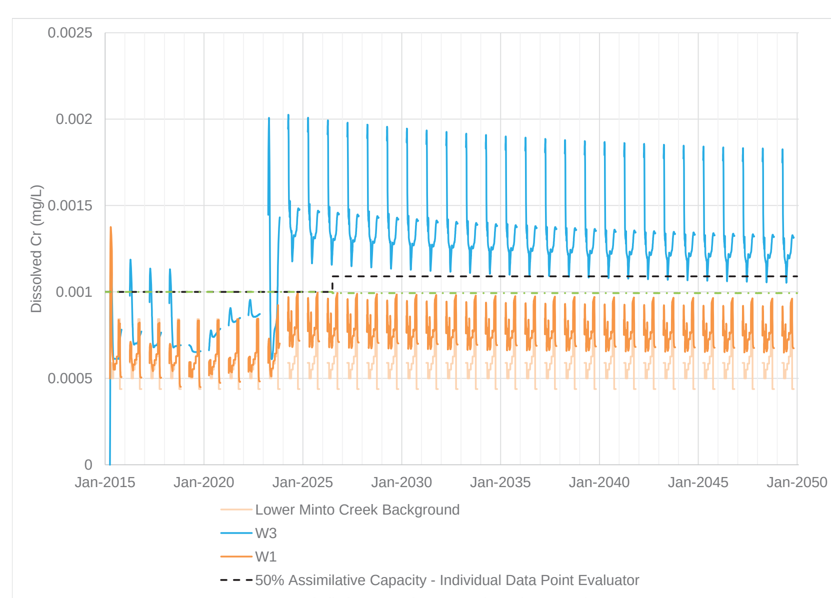
Note: Operational WQO included from 2015 to 2026 for comparison purposes



Note: Operational WQO included from 2015 to 2026 for comparison purposes



Note: Operational WQO included from 2015 to 2026 for comparison purposes



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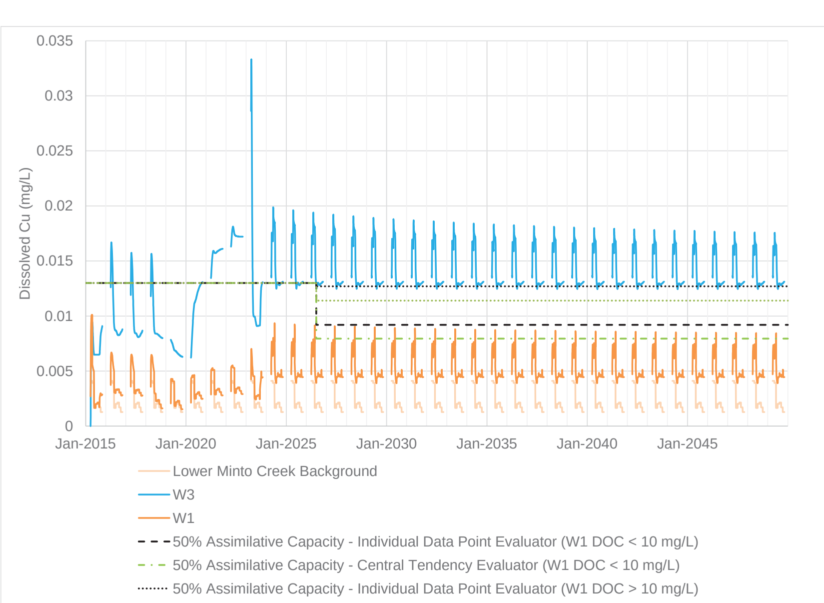
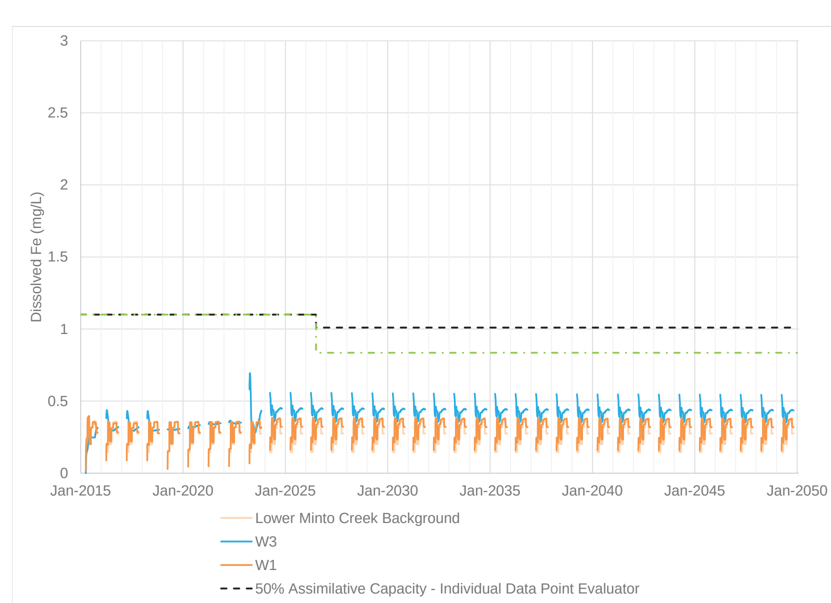


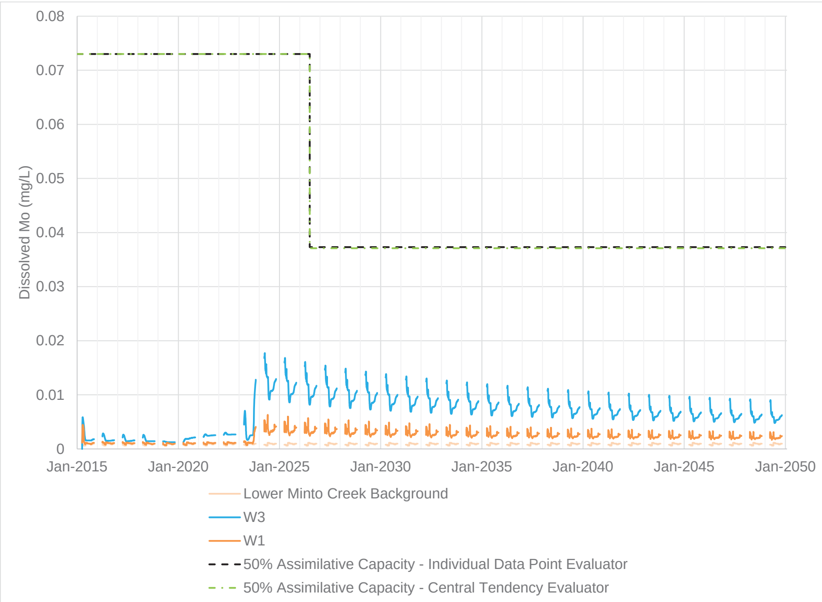
Note: Operational WQO included from 2015 to 2026 for comparison purposes



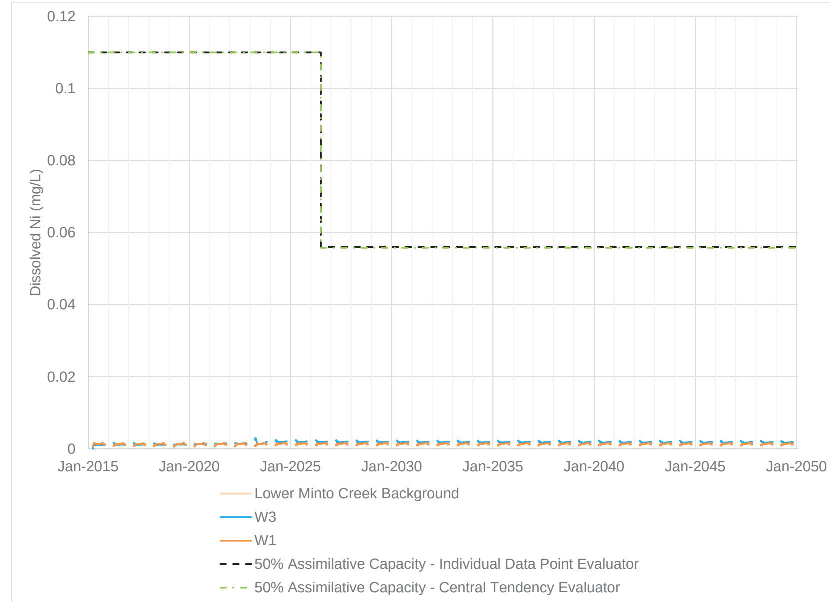
Note: Operational WQO included from 2015 to 2026 for comparison purposes

Source: Z:\01_SITES\Minto\1CM002.024_Water_Balance_Support\2016_RCP_Update\Model_Results\Results 20160725\Model_Results_20160725_Scenario_4_Rev01_KNK.xlsm
Model: Minto_2016_Annual_Report_1CM002.024_Rev59_SRJ_KNK, 2016/07/25, KNK

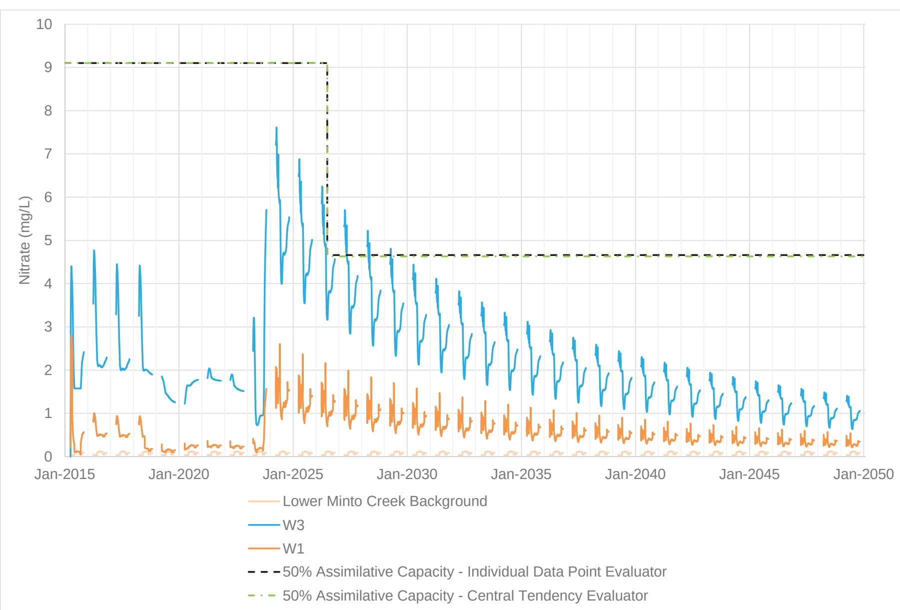
Appendix A2: Water and Load Balance Results
Scenario 3 – Expected Case, With Treatment



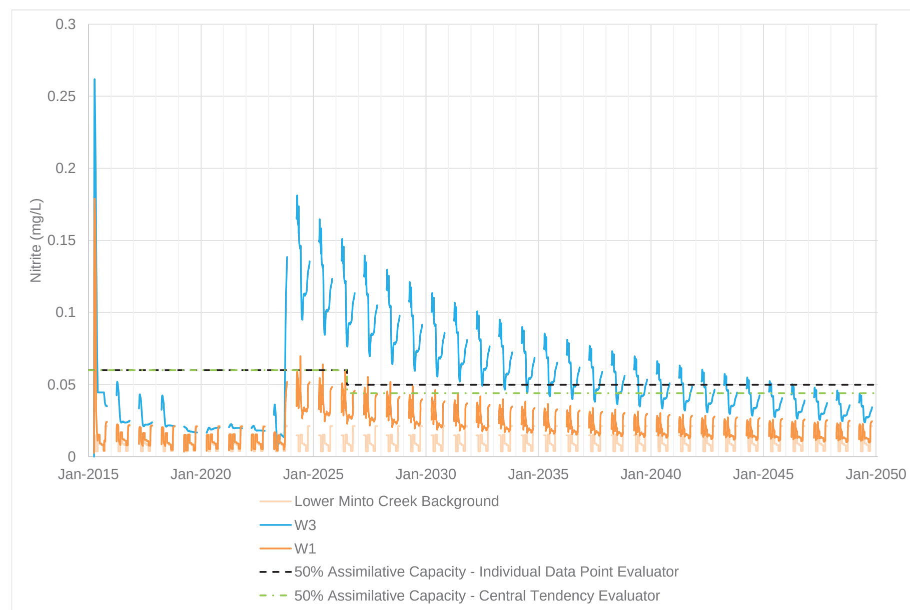
Note: Operational WQO included from 2015 to 2026 for comparison purposes



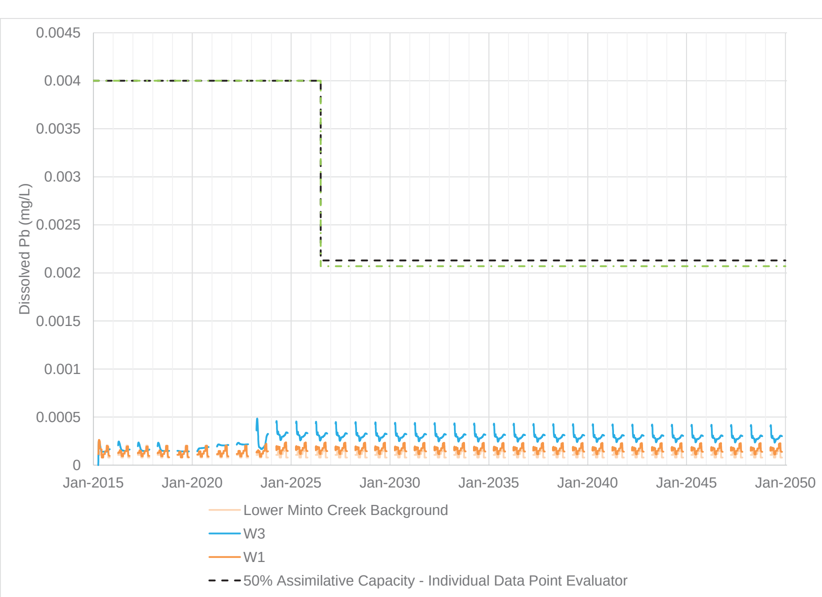
Note: Operational WQO included from 2015 to 2026 for comparison purposes



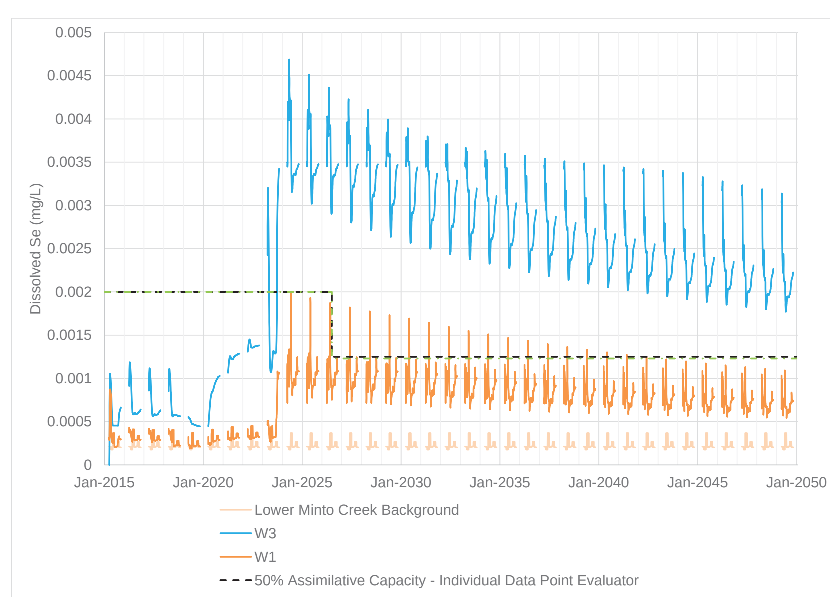
Note: Operational WQO included from 2015 to 2026 for comparison purposes



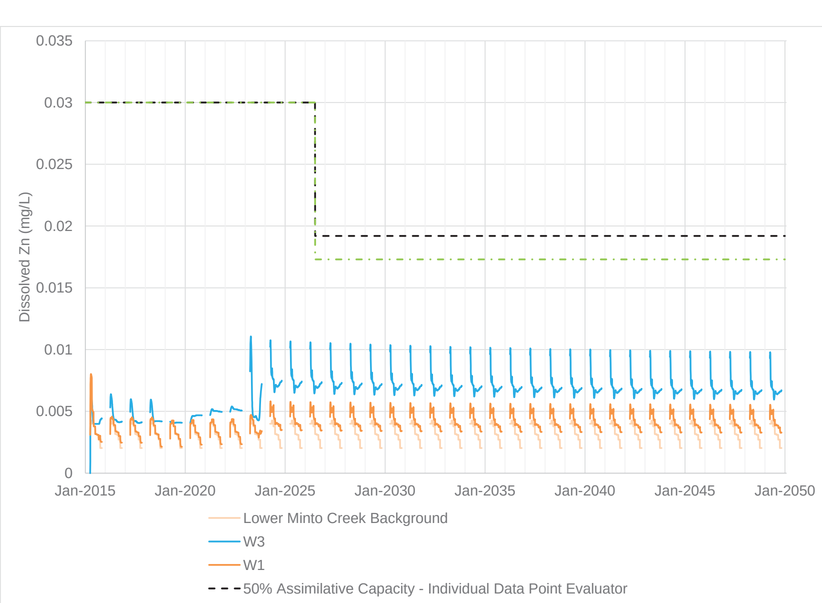
Note: Operational WQO included from 2015 to 2026 for comparison purposes



Note: Operational WQO included from 2015 to 2026 for comparison purposes



Note: Operational WQO included from 2015 to 2026 for comparison purposes



Note: Operational WQO included from 2015 to 2026 for comparison purposes

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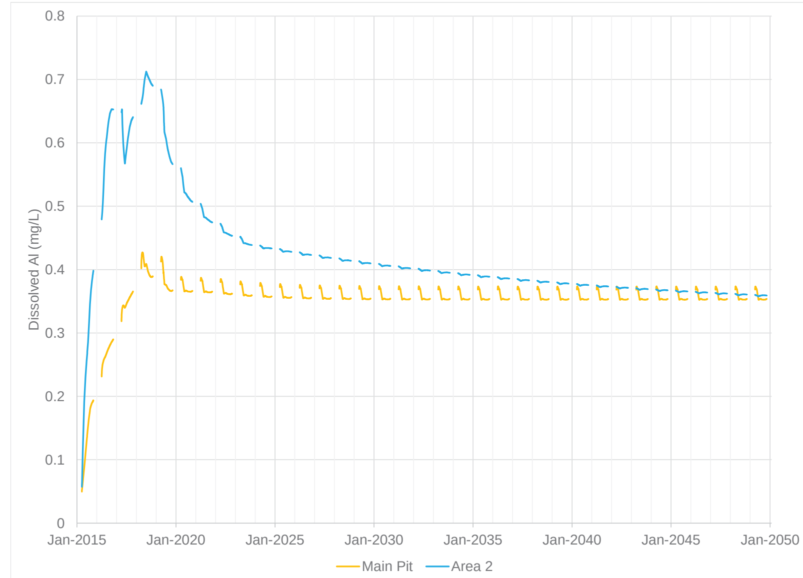
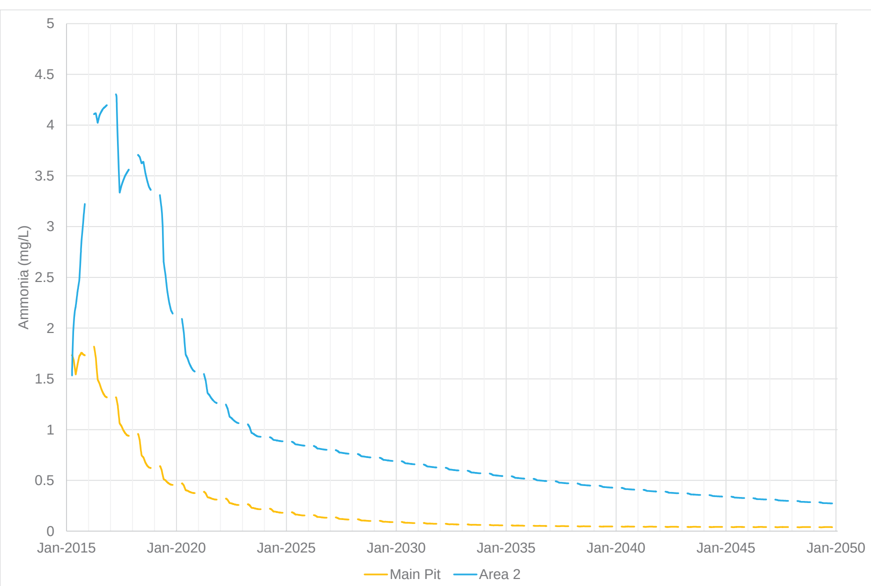
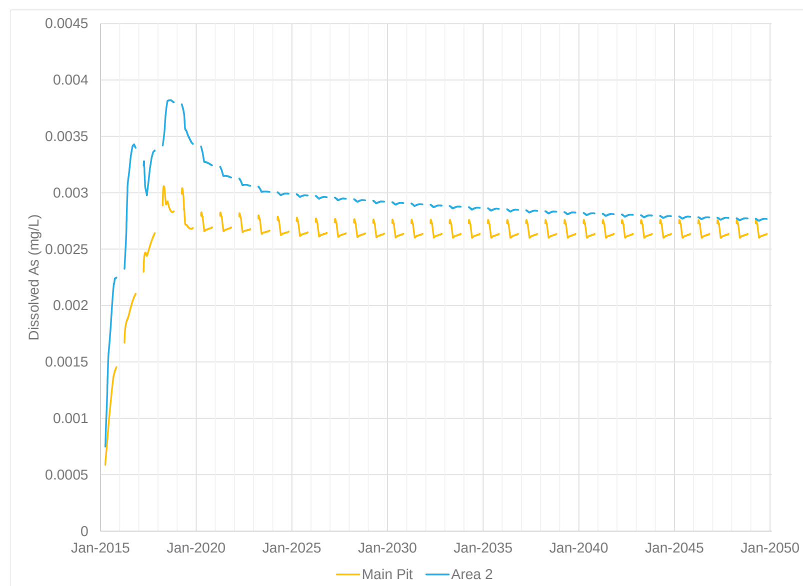
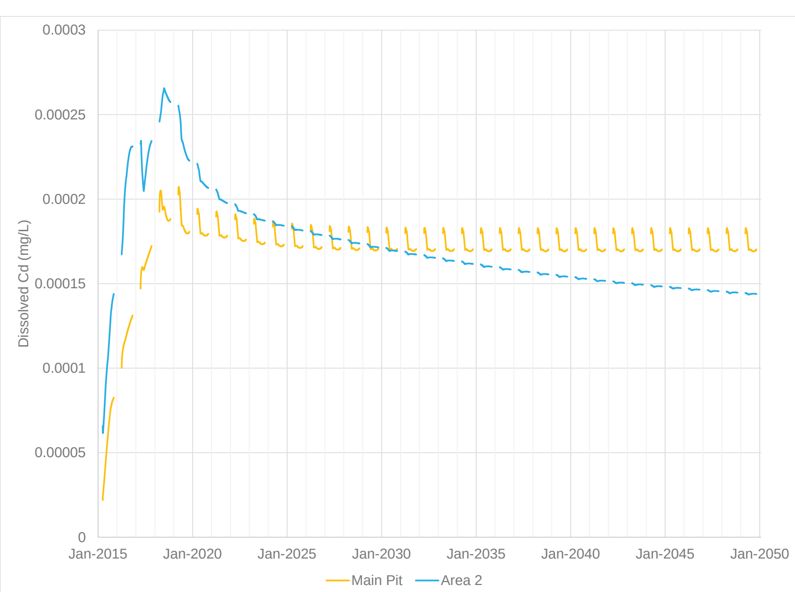
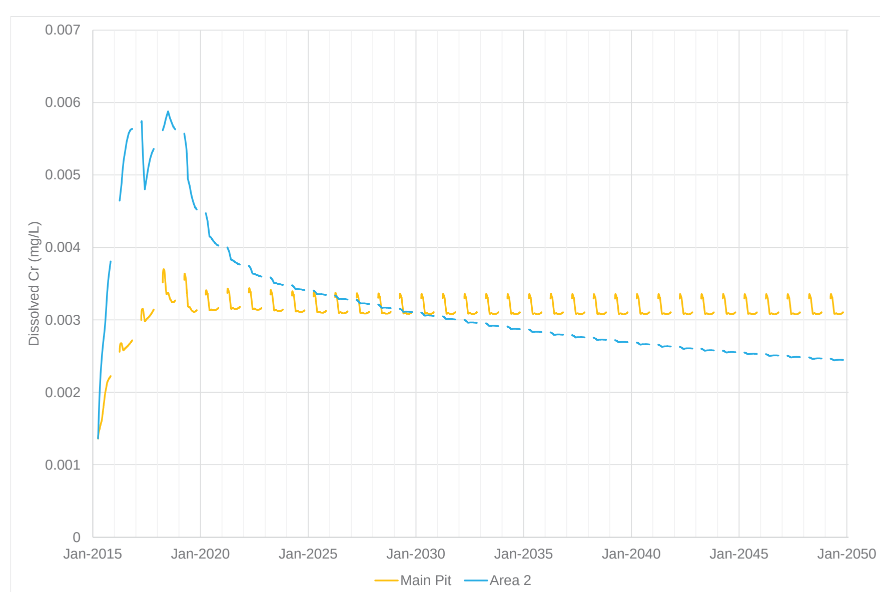
Model: Minto_2016_Annual_Report_1CM002.024_Rev59_SRJ_KNK, 2016/07/25, KNK

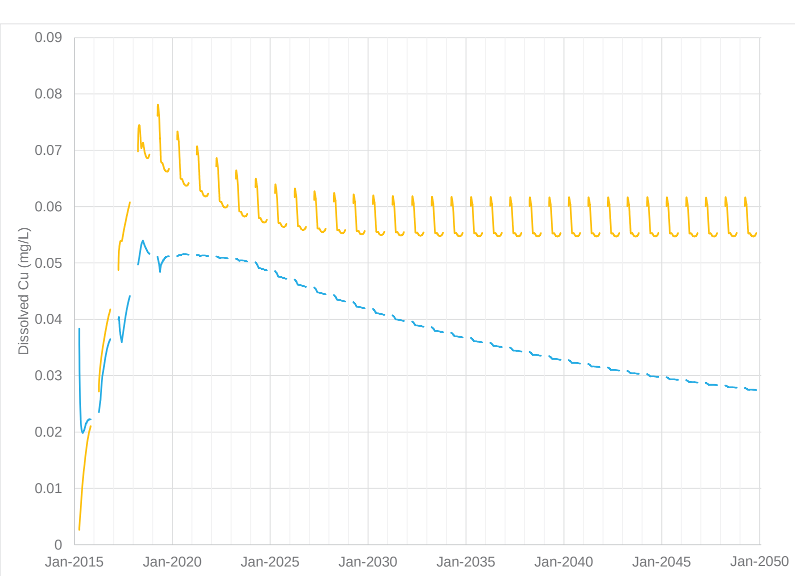


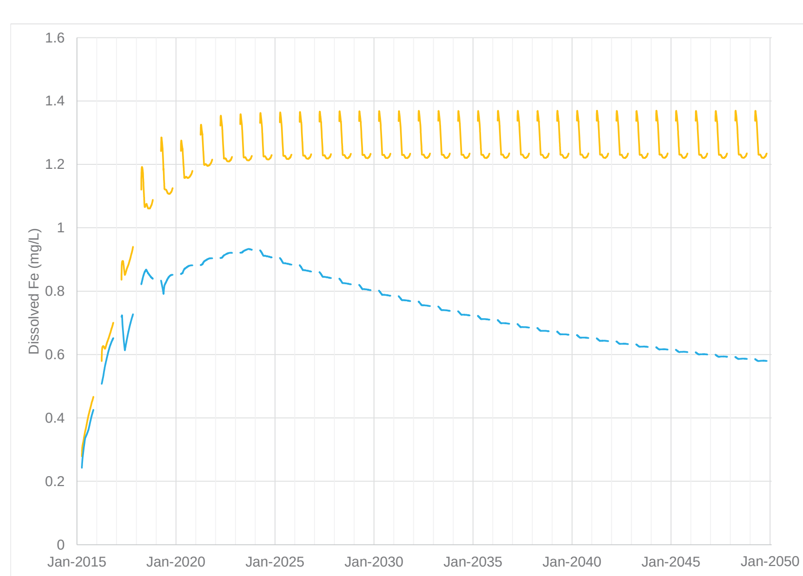












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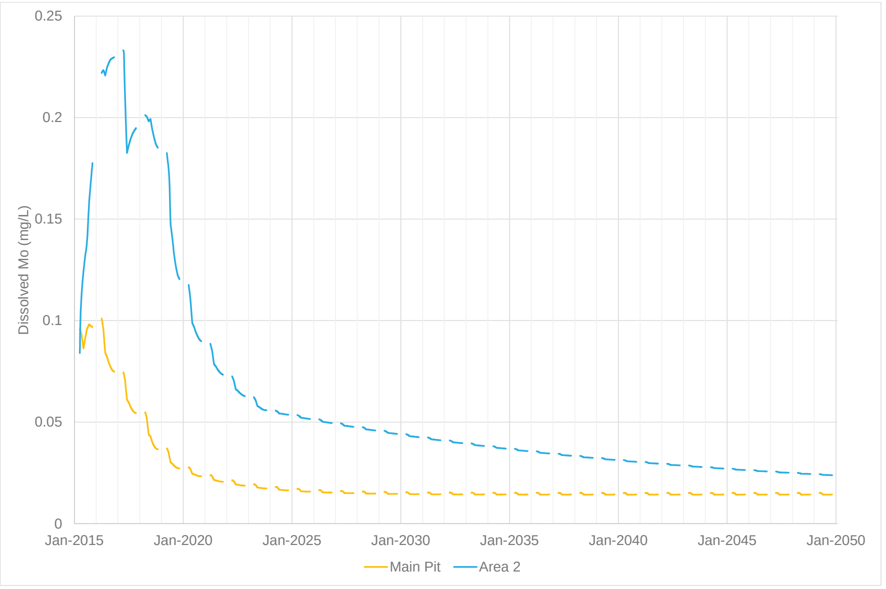
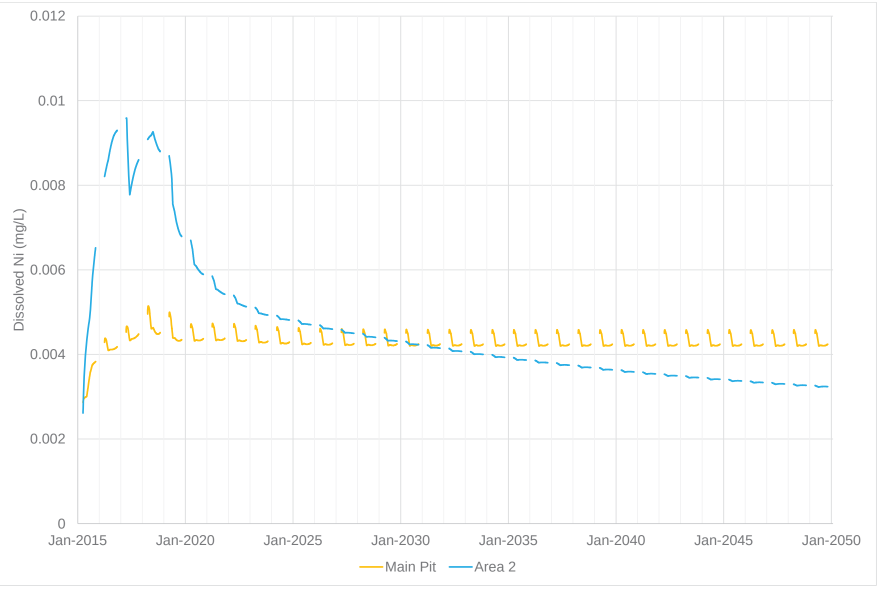
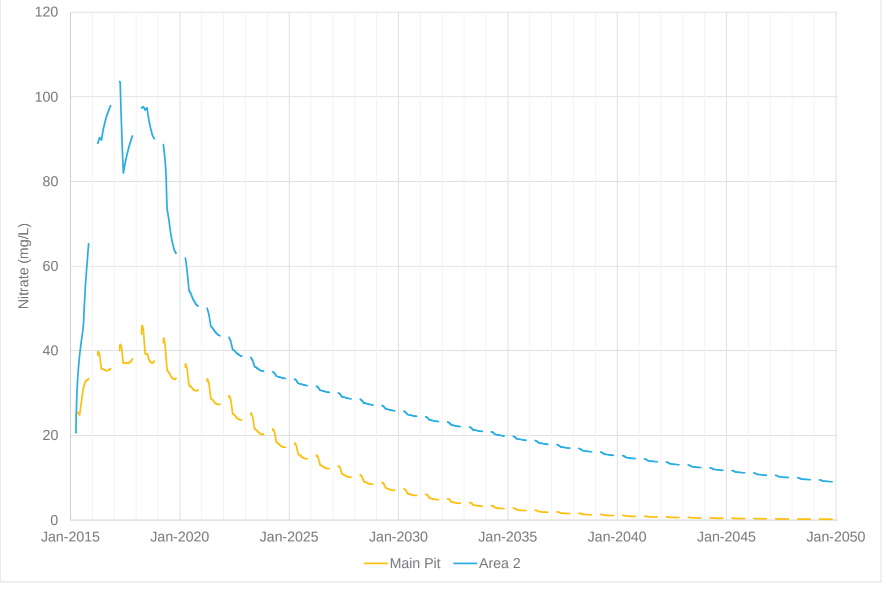
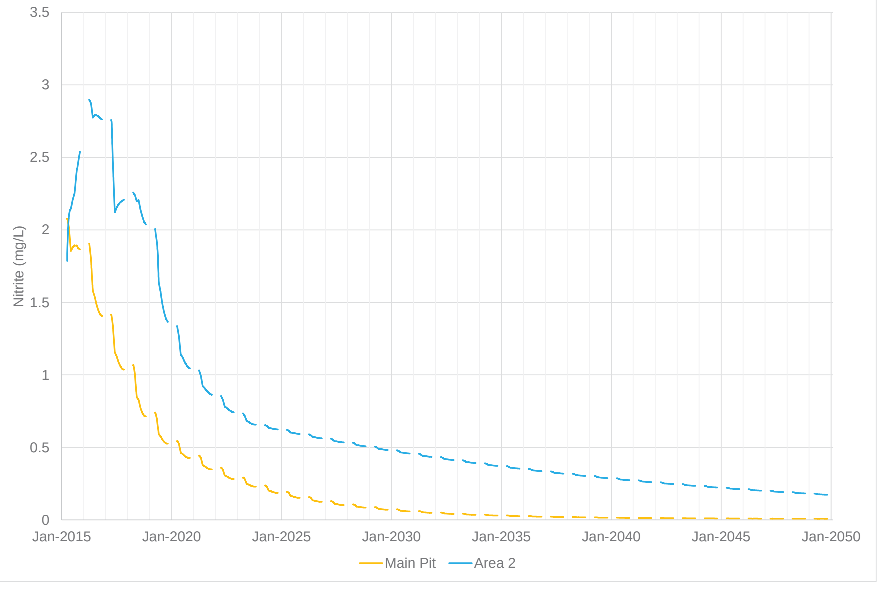
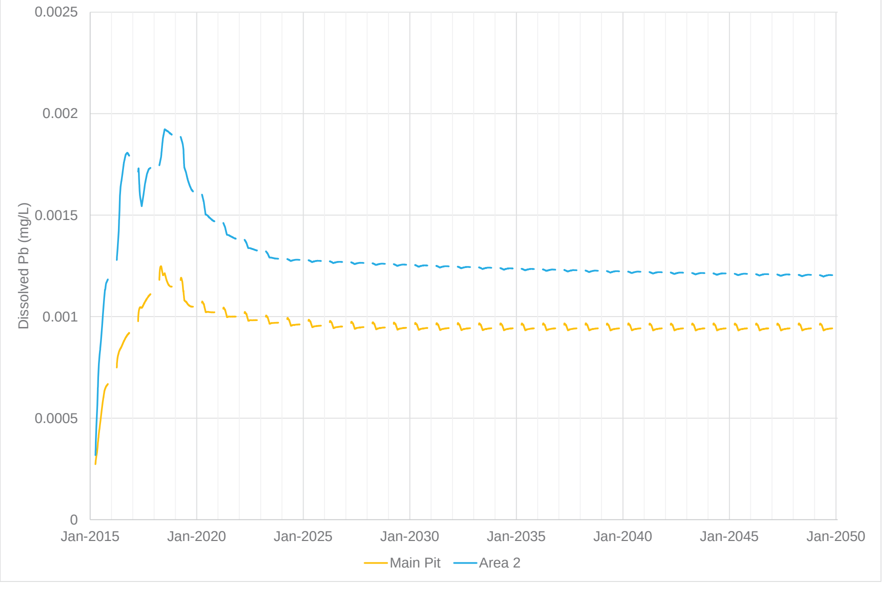
Model: Minto_2016_Annual_Report_1CM002.024_Rev59_SRJ_KNK, 2016/07/25, KNK

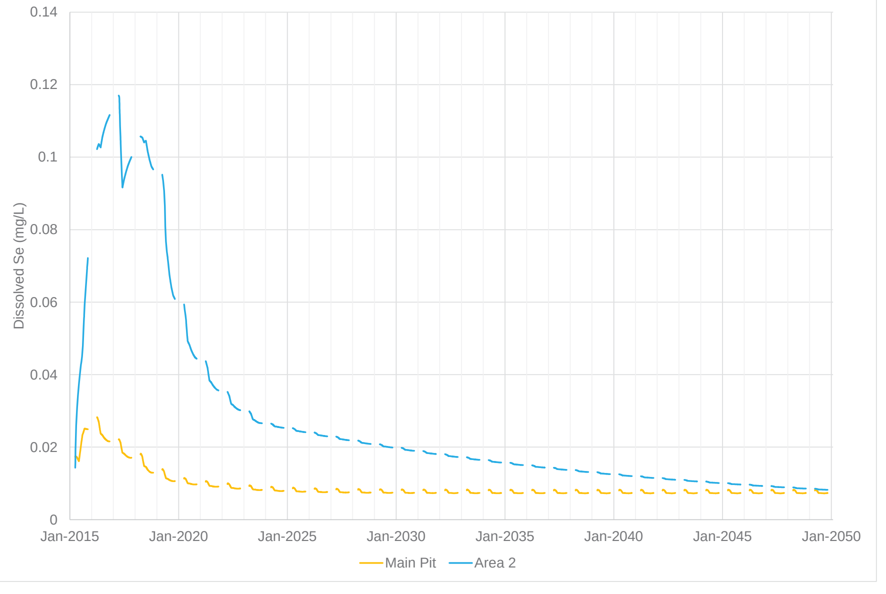


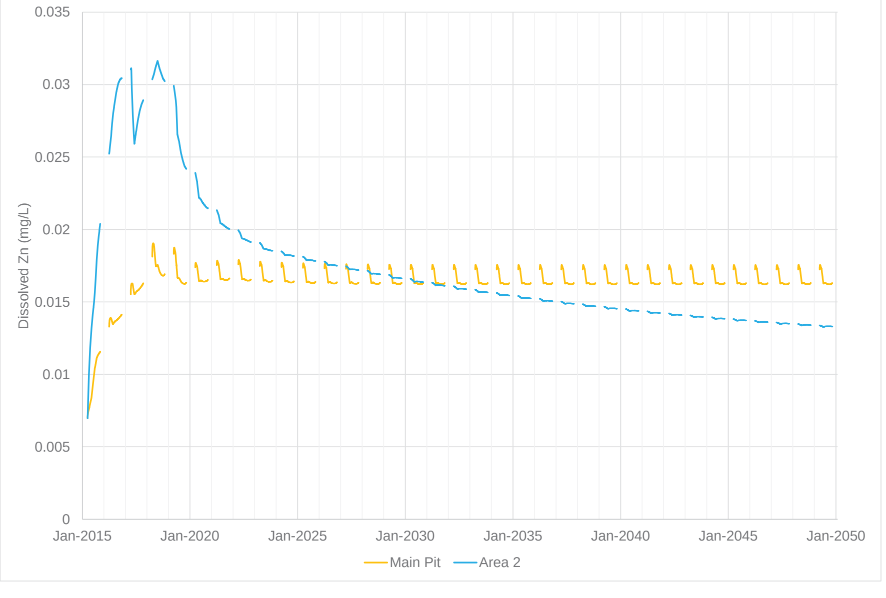












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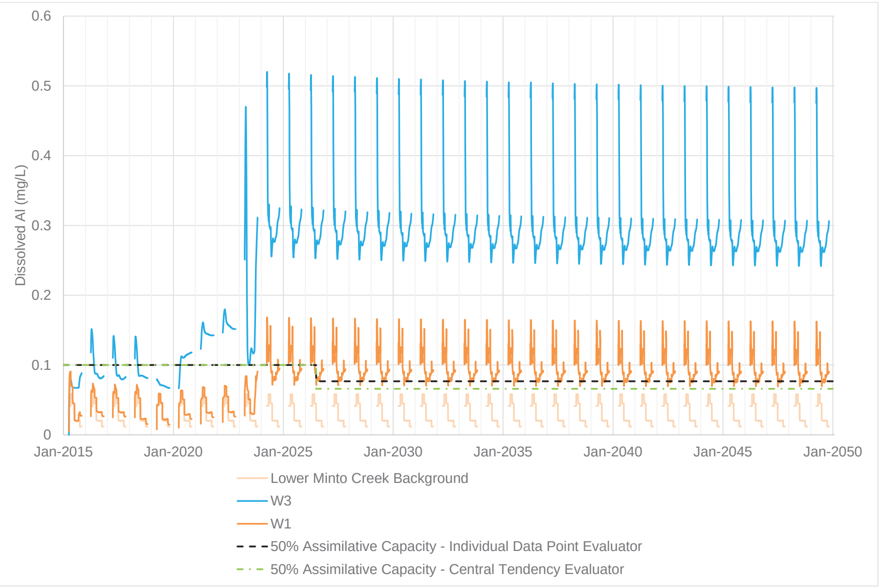
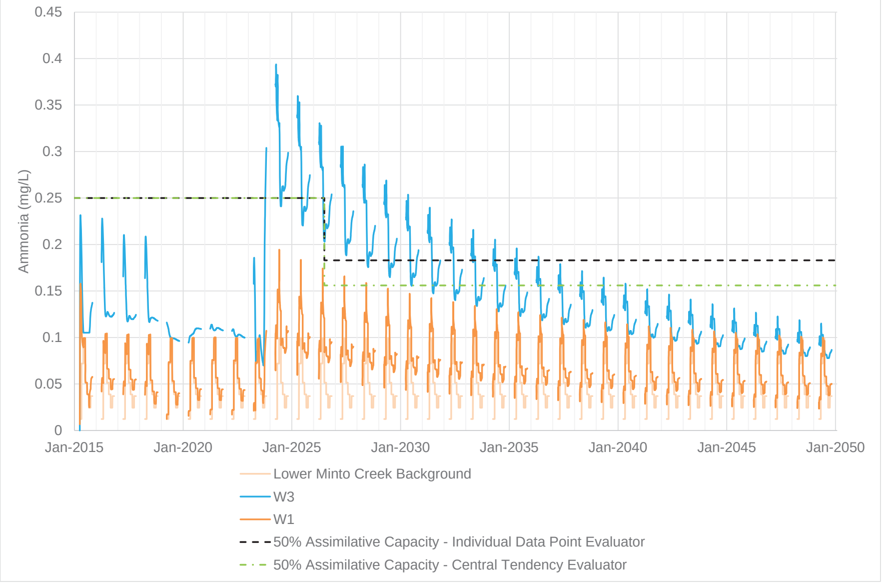
Model: Minto_2016_Annual_Report_1CM002.024_Rev59_SRJ_KNK, 2016/07/25, KNK

Appendix A2: Water and Load Balance Results
Scenario 4 – Reasonable Worst Case, With Treatment

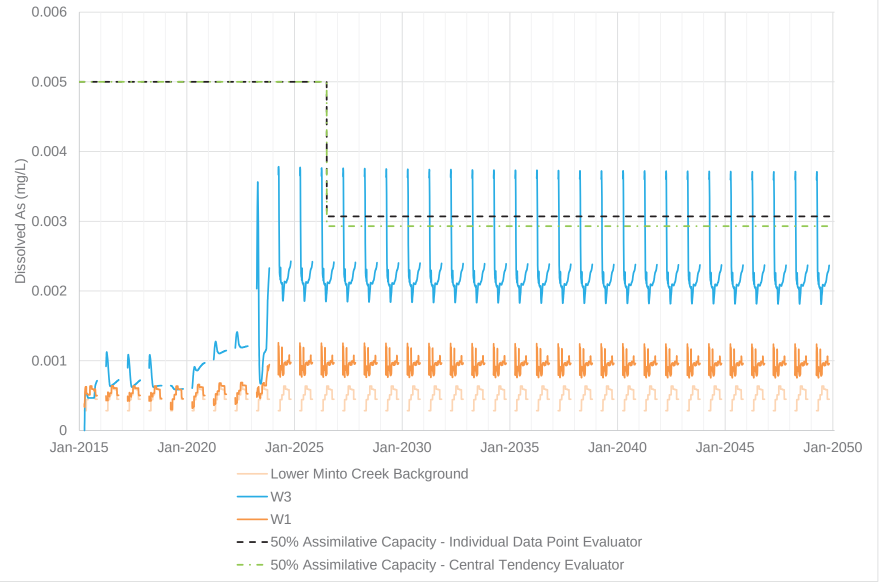
Note: Operational WQO included from 2015 to 2026 for comparison purposes



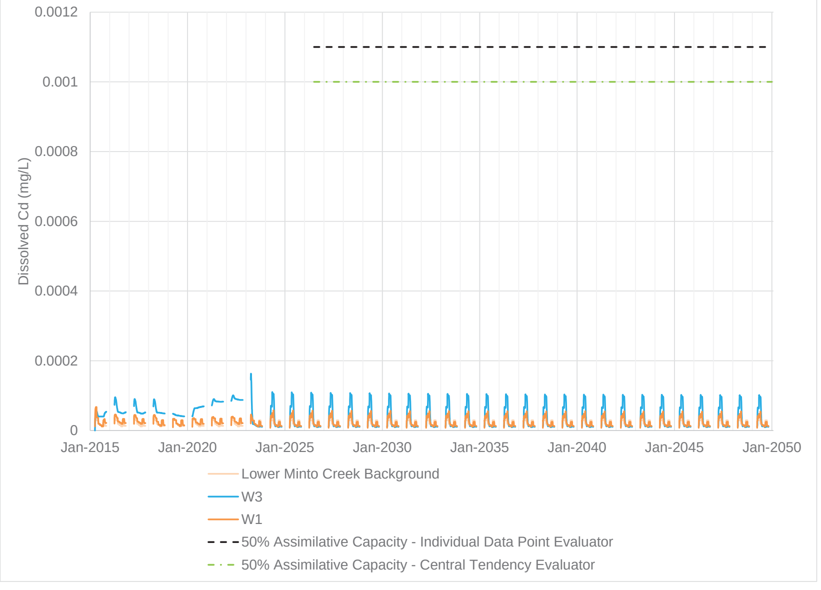
Note: Operational WQO included from 2015 to 2026 for comparison purposes



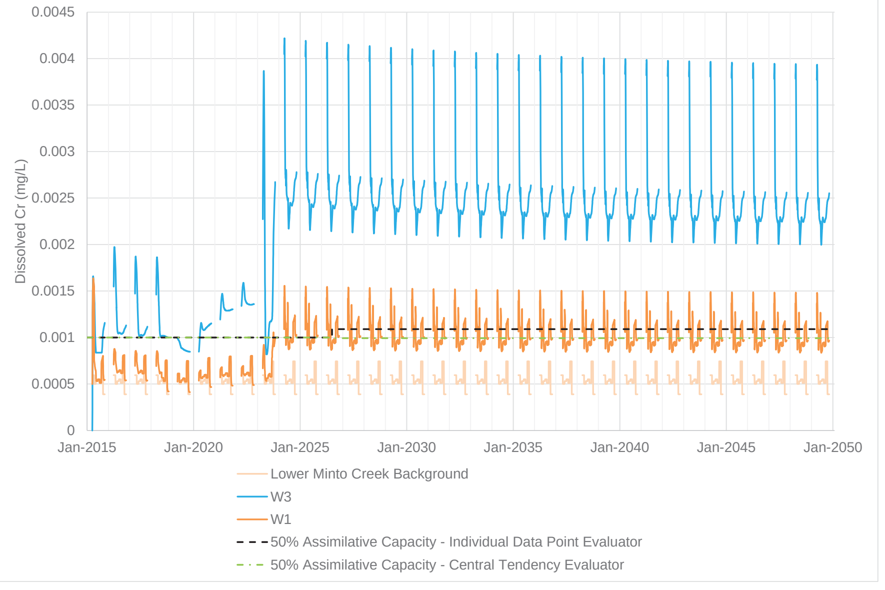
Note: Operational WQO included from 2015 to 2026 for comparison purposes



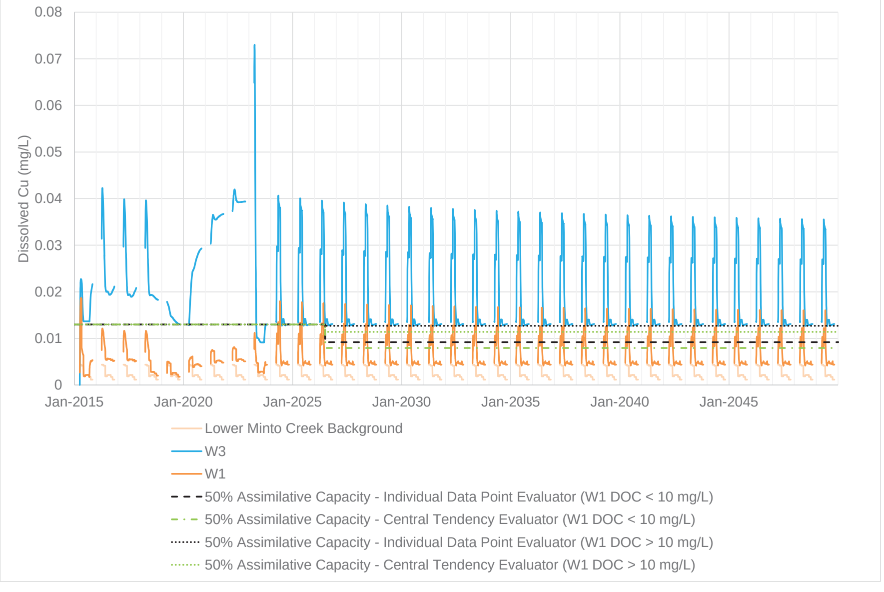
Note: Operational WQO included from 2015 to 2026 for comparison purposes



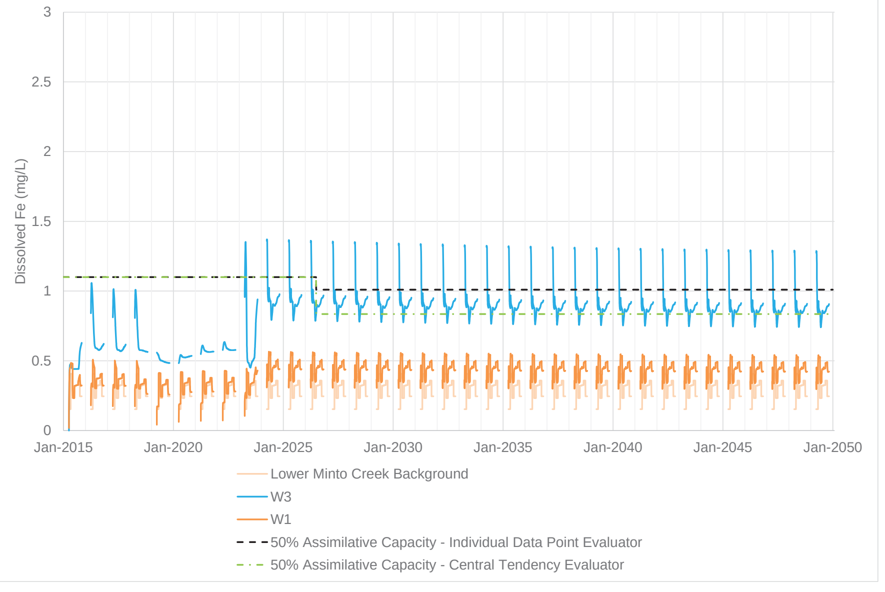
Note: Operational WQO included from 2015 to 2026 for comparison purposes



Note: Operational WQO included from 2015 to 2026 for comparison purposes



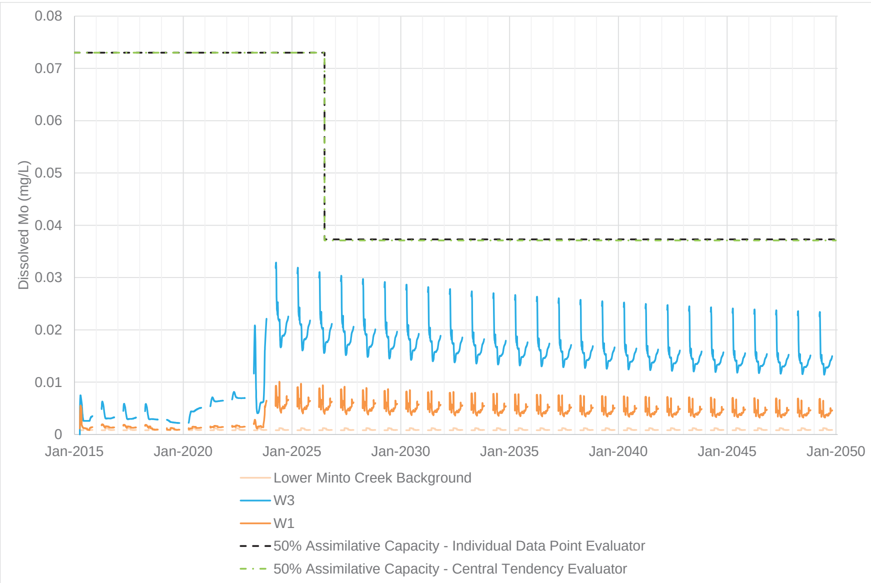
Note: Operational WQO included from 2015 to 2026 for comparison purposes



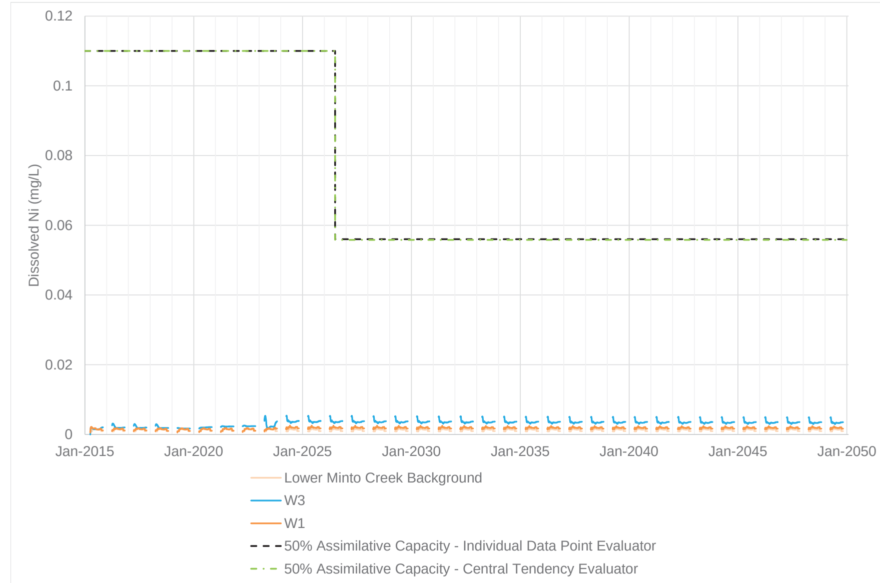
Note: Operational WQO included from 2015 to 2026 for comparison purposes

Source: Z:\01_SITES\Minto\1CM002.024_Water_Balance_Support\2016_RCP_Update\Model_Results\Results 20160725\Model_Results_20160725_Scenario_4_Rev01_KNK.xlsm
Model: Minto_2016_Annual_Report_1CM002.024_Rev59_SRJ_KNK, 2016/07/25, KNK

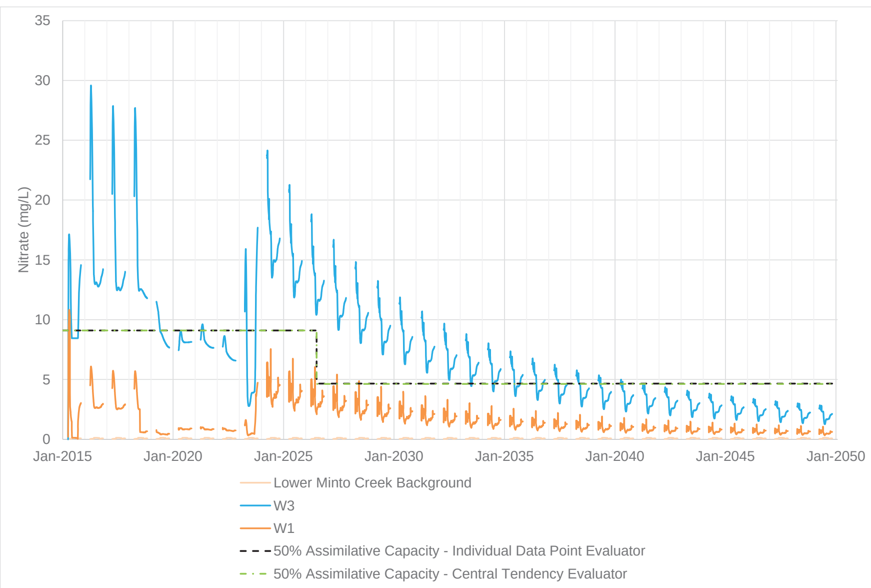
Appendix A2: Water and Load Balance Results
Scenario 4 – Reasonable Worst Case, With Treatment



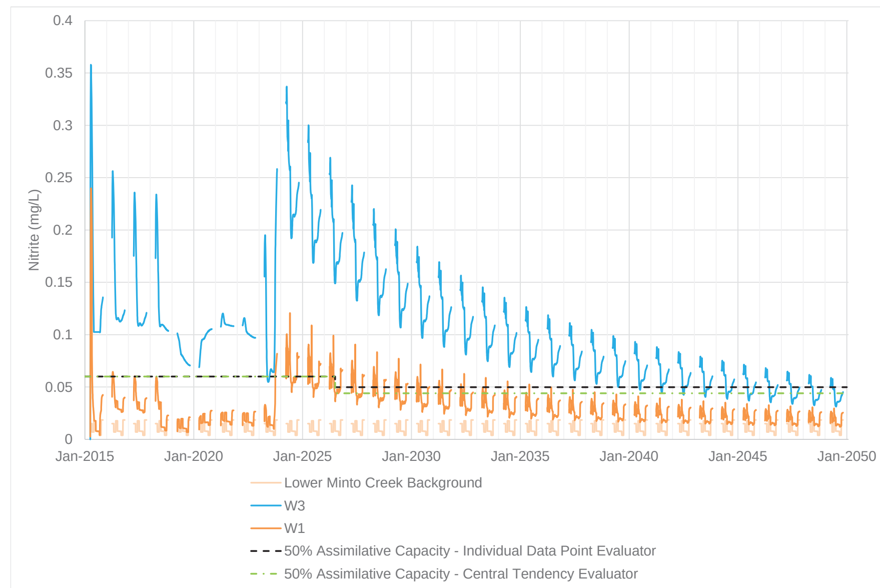
Note: Operational WQO included from 2015 to 2026 for comparison purposes



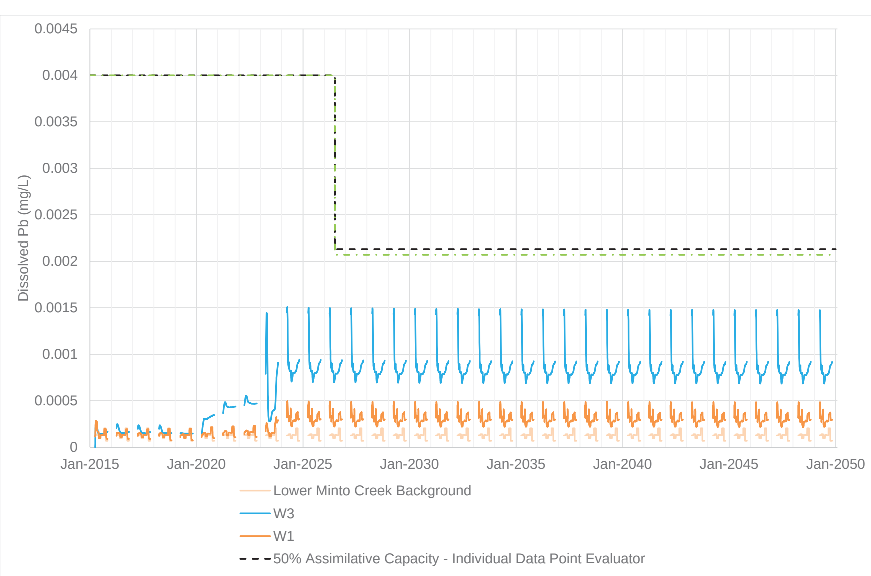
Note: Operational WQO included from 2015 to 2026 for comparison purposes



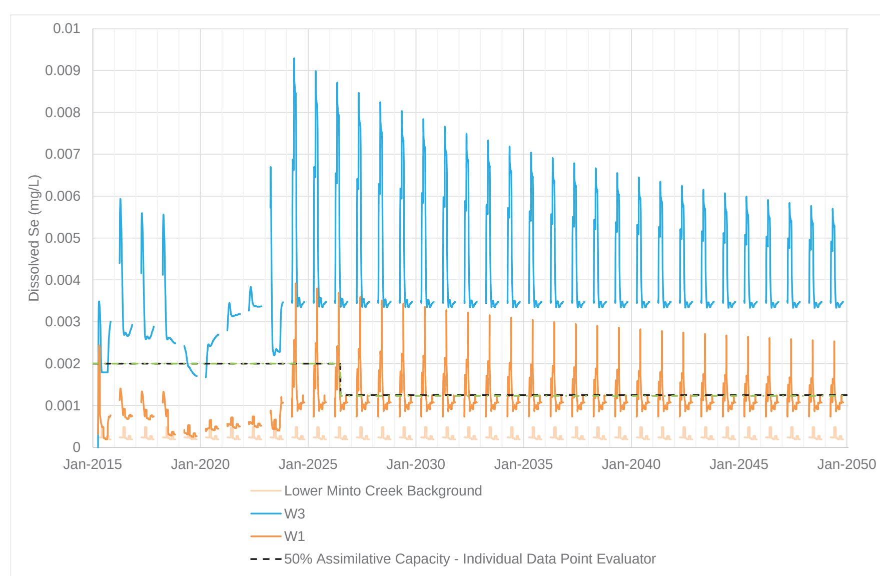
Note: Operational WQO included from 2015 to 2026 for comparison purposes



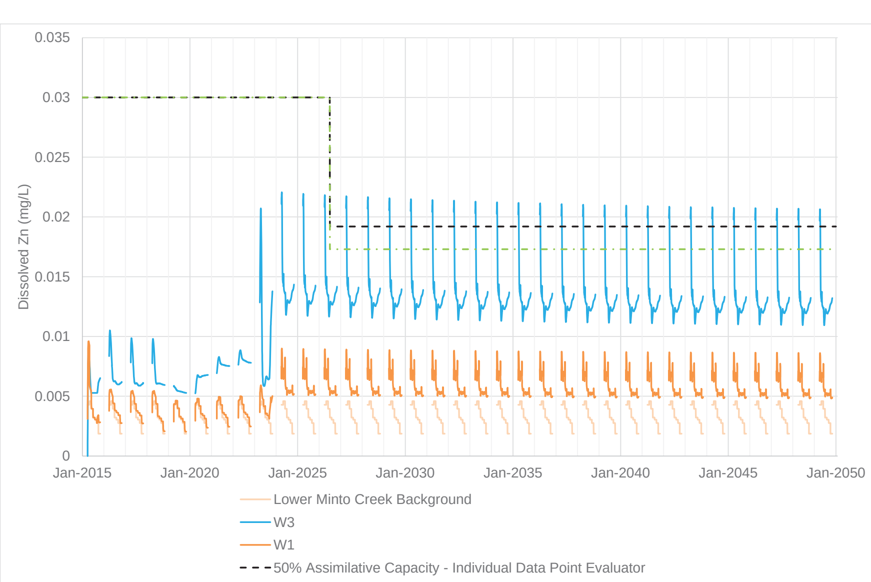
Note: Operational WQO included from 2015 to 2026 for comparison purposes



Note: Operational WQO included from 2015 to 2026 for comparison purposes



Note: Operational WQO included from 2015 to 2026 for comparison purposes



Note: Operational WQO included from 2015 to 2026 for comparison purposes

Source: Z:\01_SITES\Minto\1CM002.024_Water_Balance_Support\2016_RCP_Update\Model_Results\Results 20160725\Model_Results_20160725_Scenario_4_Rev01_KNK.xlsm
Model: Minto_2016_Annual_Report_1CM002.024_Rev59_SRJ_KNK, 2016/07/25, KNK

Appendix B: Water and Load Balance Source Terms

DSTSF Source Terms

	Expected Case	Worst Case
	mg/L	mg/L
Ag-D	0.00002	0.0001
Al-D	0.01	0.069
Sulphate	220	410
Sulphate	0.12	0.98
As-D	0.0005	0.0009
Ba-D	0.12	0.21
B-D	0.062	0.11
Be-D	0.0001	0.00085
Bi-D	0.001	0.001
Ca-D	130	240
Cd-D	0.00011	0.00024
Sulphate	6.9	31
Co-D	0.0006	0.0022
Cr-D	0.001	0.002
Cu-D	0.094	0.32
Fe-D	0.089	0.39
Sulphate	0.32	1.4
Hg-D	0.00002	0.0002
K-D	6.6	18
Li-D	0.005	0.01
Mg-D	31	48
Mn-D	0.6	3.2
Mo-D	0.007	0.038
Na-D	24	46
Ni-D	0.0018	0.005
Sulphate	22	84
Sulphate	0.12	2.5
Pb-D	0.0002	0.00064
Sb-D	0.0005	0.0011
S-D	48	83
Se-D	0.0039	0.014
Si-D	6.6	8
Sn-D	0.005	0.005
Sulphate	120	200
Sr-D	1.5	2.1
Ti-D	0.005	0.01
Tl-D	0.00005	0.0001
U-D	0.002	0.0037
V-D	0.005	0.023
Zn-D	0.005	0.01
Zr-D	0.0005	0.002

Tailings Slurry Source Terms

	Expected Case	Worst Case
	mg/L	mg/L
Ag-D	0.00002	0.00002
Al-D	0.07	0.11
Sulphate	180	180
Sulphate	0.82	1.1
As-D	0.00044	0.00047
Ba-D	0.087	0.1
B-D	0.11	0.12
Be-D	0.0001	0.0001
Bi-D	0.001	0.001
Ca-D	0	52
Cd-D	0.000021	0.000031
Sulphate	13	13
Co-D	0.0005	0.0005
Cr-D	0.001	0.001
Cu-D	0.0047	0
Fe-D	0.01	0.022
Sulphate	1.3	1.5
Hg-D	0.00001	0.00001
K-D	30	35
Li-D	0.02	0.023
Mg-D	0	0
Mn-D	0.038	0.053
Mo-D	0.059	0.067
Na-D	65	69
Ni-D	0.0013	0.0019
Sulphate	22	25
Sulphate	0.42	0.46
Pb-D	0.0002	0.0002
Sb-D	0.00058	0.00075
S-D	50	58
Se-D	0.012	0.021
Si-D	2.2	2.4
Sn-D	0.005	0.005
Sulphate	130	150
Sr-D	3.8	5.2
Ti-D	0.005	0.005
Tl-D	0.00005	0.00005
U-D	0.00045	0.00077
V-D	0.005	0.005
Zn-D	0.0052	0.0057
Zr-D	0.0005	0.0005

Main Pit TMF Source Terms

	Expected Case	Worst Case
	mg/yr	mg/yr
Ag-D	0.00E+00	0.00E+00
Al-D	1.80E+05	6.10E+05
Sulphate	2.40E+09	2.70E+09
Sulphate	7.80E+05	1.40E+06
As-D	4.00E+03	4.60E+03
Ba-D	9.90E+05	1.10E+06
B-D	0.00E+00	0.00E+00
Be-D	0.00E+00	0.00E+00
Bi-D	0.00E+00	0.00E+00
Ca-D	7.30E+08	8.30E+08
Cd-D	5.30E+02	5.90E+02
Sulphate	7.00E+07	7.90E+07
Co-D	0.00E+00	0.00E+00
Cr-D	0.00E+00	0.00E+00
Cu-D	4.90E+05	6.30E+05
Fe-D	6.30E+05	1.50E+06
Sulphate	3.40E+06	4.00E+06
Hg-D	0.00E+00	0.00E+00
K-D	4.40E+07	5.00E+07
Li-D	0.00E+00	0.00E+00
Mg-D	2.50E+08	2.90E+08
Mn-D	3.70E+06	4.20E+06
Mo-D	7.80E+04	1.10E+05
Na-D	1.90E+08	2.20E+08
Ni-D	1.00E+04	1.30E+04
Sulphate	8.60E+07	1.20E+08
Sulphate	7.50E+05	1.80E+06
Pb-D	0.00E+00	0.00E+00
Sb-D	0.00E+00	0.00E+00
S-D	2.30E+08	2.50E+08
Se-D	4.40E+04	5.60E+04
Si-D	5.90E+07	6.50E+07
Sn-D	0.00E+00	0.00E+00
Sulphate	6.80E+08	7.50E+08
Sr-D	9.60E+06	1.10E+07
Ti-D	7.90E+04	7.90E+04
Tl-D	0.00E+00	0.00E+00
U-D	2.10E+04	2.60E+04
V-D	0.00E+00	0.00E+00
Zn-D	4.90E+04	5.30E+04
Zr-D	0.00E+00	0.00E+00

Waste Rock Volume-based Source Terms

	Expected Case	Worst Case
	mg/m3/yr	mg/m3/yr
Ag-D	0.00048	0.0024
Al-D	0.57	3.8
Sulphate	3800	8200
Sulphate	1.7	5.7
As-D	0.012	0.024
Ba-D	2.6	5.3
B-D	1.2	2.4
Be-D	0.0024	0.0048
Bi-D	0.024	0.024
Ca-D	1600	4300
Cd-D	0.00038	0.0024
Sulphate	72	300
Co-D	0.012	0.029
Cr-D	0.024	0.048
Cu-D	0.44	1.2
Fe-D	7.3	25
Sulphate	3.8	6.5
Hg-D	0.00024	0.0048
K-D	64	180
Li-D	0.12	0.24
Mg-D	450	1100
Mn-D	5.8	23
Mo-D	0.064	0.16
Na-D	240	530
Ni-D	0.024	0.067
Sulphate	140	870
Sulphate	1.2	7.2
Pb-D	0.0048	0.0048
Sb-D	0.012	0.012
S-D	580	1800
Se-D	0.03	0.17
Si-D	120	210
Sn-D	0.12	0.12
Sulphate	1300	4600
Sr-D	13	53
Ti-D	0.12	0.24
Tl-D	0.0012	0.0012
U-D	0.026	0.091
V-D	0.12	0.12
Zn-D	0.12	0.24
Zr-D	0.012	0.048

Waste Rock Area-based Source Terms

	Expected Case	Worst Case
	mg/L	mg/L
Ag-D	0.000062	0.00031
Al-D	0.074	0.49
Sulphate	500	1100
Sulphate	0.22	0.73
As-D	0.0015	0.0031
Ba-D	0.33	0.68
B-D	0.15	0.31
Be-D	0.00031	0.00062
Bi-D	0.0031	0.0031
Ca-D	200	550
Cd-D	0.000049	0.00031
Sulphate	9.2	38
Co-D	0.0015	0.0037
Cr-D	0.0031	0.0062
Cu-D	0.057	0.15
Fe-D	0.94	3.3
Sulphate	0.49	0.84
Hg-D	0.000031	0.00062
K-D	8.3	23
Li-D	0.015	0.031
Mg-D	58	140
Mn-D	0.75	3
Mo-D	0.0083	0.021
Na-D	31	68
Ni-D	0.0031	0.0086
Sulphate	18	110
Sulphate	0.15	0.93
Pb-D	0.00062	0.00062
Sb-D	0.0015	0.0015
S-D	75	230
Se-D	0.0039	0.022
Si-D	15	27
Sn-D	0.015	0.015
Sulphate	160	590
Sr-D	1.7	6.8
Ti-D	0.015	0.031
Tl-D	0.00015	0.00015
U-D	0.0034	0.012
V-D	0.015	0.015
Zn-D	0.015	0.031
Zr-D	0.0015	0.0062

Upper and Lower Minto Creek Background Water Quality

	Ag-D	Al-D	Sulphate	Sulphate	As-D	Ba-D	B-D	Be-D	Bi-D	Ca-D	Cd-D	Sulphate	Co-D	Cr-D	Cu-D	Fe-D	Sulphate	Hg-D	K-D	Li-D
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
January	0.00001	0.0053	200	0.005	0.00041	0.1	0.025	0.00005	0.0005	51	0.000035	1.1	0.00025	0.0005	0.0011	0.094	0.52	0.000005	2	0.0025
February	0.00001	0.021	160	0.006	0.00033	0.081	0.025	0.00005	0.0005	43	0.000064	1.4	0.00025	0.0005	0.015	0.049	0.35	0.000005	1.3	0.0025
March	0.00001	0.0031	170	0.0067	0.00039	0.081	0.025	0.00005	0.0005	43	0.000005	0.68	0.00025	0.0005	0.0012	0.012	0.49	0.000005	2	0.0025
April	8.7E-06	0.038	64	0.012	0.00028	0.032	0.023	0.000047	0.00048	17	0.000031	1.8	0.00024	0.00059	0.0041	0.15	0.15	5.6E-06	2	0.0024
May	0.00001	0.05	86	0.06	0.00042	0.059	0.041	0.00037	0.0005	19	0.000024	0.61	0.00074	0.0005	0.0039	0.36	0.17	0.000011	1	0.0027
June	7.1E-06	0.026	110	0.062	0.00047	0.055	0.011	0.00018	0.00033	30	0.000018	1.3	0.0002	0.00055	0.0017	0.2	0.25	0.000009	0.99	0.0025
July	8.8E-06	0.02	120	0.048	0.00061	0.059	0.012	0.00018	0.00034	33	0.000015	0.63	0.00018	0.00059	0.002	0.32	0.26	0.000012	0.92	0.0025
August	0.000018	0.02	120	0.033	0.00063	0.061	0.04	0.00033	0.00049	31	0.000012	0.63	0.00023	0.00063	0.0021	0.36	0.4	9.8E-06	0.94	0.0025
Septembe	0.000009	0.02	110	0.024	0.00058	0.057	0.04	0.00033	0.00047	31	0.000016	0.68	0.00023	0.00084	0.0017	0.36	0.23	9.8E-06	0.94	0.0024
October	8.6E-06	0.013	120	0.034	0.0005	0.052	0.012	0.00018	0.00034	31	0.000015	0.77	0.00019	0.00044	0.0013	0.28	0.22	5.5E-06	0.92	0.0025
November	0.00001	0.01	180	0.051	0.001	0.11	0.025	0.00005	0.0005	51	0.000011	1.5	0.0022	0.00059	0.0013	1.7	0.29	5.4E-06	0.9	0.0025
December	0.00001	0.005	170	0.021	0.00054	0.088	0.025	0.00005	0.0005	51	6.5E-06	3.3	0.00025	0.0005	0.0017	0.046	0.37	0.000005	3	0.0025

	Mg-D	Mn-D	Mo-D	Na-D	Ni-D	Sulphate	Sulphate	Pb-D	Sb-D	S-D	Se-D	Si-D	Sn-D	Sulphate	Sr-D	Ti-D	Tl-D	U-D	V-D	Zn-D	Zr-D
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
January	19	0.034	0.0015	11	0.0005	0.32	0.0025	0.0001	0.00025	8.2	0.00043	8.2	0.0025	24	0.58	0.0025	0.000025	0.0019	0.0025	0.0025	0.00025
February	14	0.0071	0.0014	7.8	0.0005	0.29	0.0025	0.00024	0.0005	4.4	0.00034	8.4	0.0025	12	0.32	0.0025	0.000025	0.0009	0.0025	0.0083	0.00025
March	16	0.0042	0.0011	9.3	0.0005	0.2	0.0025	0.0001	0.00025	7.2	0.00031	6.7	0.0025	23	0.49	0.0025	0.000025	0.0012	0.0025	0.0025	0.00025
April	6	0.041	0.00078	3.5	0.00084	0.035	0.015	0.00011	0.0016	2	0.00021	3.3	0.0023	3.7	0.15	0.0024	0.000023	0.0004	0.0023	0.004	0.00024
May	6.1	0.095	0.00061	3.4	0.0013	0.031	0.0036	0.00014	0.0025	2.3	0.00018	4.9	0.0011	29	0.11	0.0071	0.000072	0.00034	0.012	0.0043	0.00043
June	9.5	0.055	0.0011	6.3	0.0013	0.1	0.015	0.000079	0.0013	3.3	0.00037	5.6	0.00083	14	0.2	0.0041	0.000041	0.00065	0.0012	0.0038	0.00032
July	10	0.068	0.001	6.3	0.0013	0.12	0.0091	0.00011	0.0012	2.9	0.00021	5.9	0.00091	4.4	0.22	0.0041	0.000041	0.00074	0.0012	0.0032	0.00028
August	9.7	0.085	0.00096	5.8	0.0014	0.11	0.008	0.00014	0.0027	2.9	0.00021	6.9	0.001	9.2	0.24	0.004	0.000071	0.00056	0.01	0.0031	0.00032
Septembe	9.7	0.079	0.00083	5.6	0.0016	0.046	0.0038	0.0002	0.0026	3.4	0.00027	6.9	0.00097	9.5	0.25	0.004	0.000071	0.00045	0.01	0.0027	0.0003
October	9.8	0.089	0.00095	5.6	0.0011	0.087	0.021	0.000078	0.0013	2.4	0.0002	6.4	0.0009	8.6	0.2	0.0041	0.000041	0.00046	0.0012	0.002	0.00025
November	15	1.1	0.0011	7.3	0.0017	0.12	0.005	0.00012	0.00075	3.6	0.00016	8.1	0.0025	8.4	0.33	0.0025	0.000025	0.0008	0.0025	0.0025	0.00054
December	17	0.068	0.001	12	0.00095	0.086	0.0025	0.0001	0.00075	13	0.0003	7.1	0.0025	36	0.48	0.0025	0.000025	0.0011	0.0025	0.0025	0.00025

Minto North Pit Source Terms

	Ag-D	Al-D	Sulphate	Sulphate	As-D	Ba-D	B-D	Be-D	Bi-D	Ca-D	Cd-D	Sulphate	Co-D	Cr-D	Cu-D	Fe-D	Sulphate	Hg-D	K-D	Li-D
	mg/mon	mg/mon	mg/mon	mg/mon	mg/mon	mg/mon	mg/mon	mg/mon	mg/mon	mg/mon	mg/mon	mg/mon	mg/mon	mg/mon	mg/mon	mg/mon	mg/mon	mg/mon	mg/mon	mg/mon
January	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
April	4900	18000000	0	0	150000	0	0	0	0	0	4600	0	0	120000	530000	3600000	1.3E+08	2500	0	0
May	4900	18000000	0	0	150000	0	0	0	0	0	4600	0	0	120000	530000	3600000	1.3E+08	2500	0	0
June	1400	5200000	0	0	44000	0	0	0	0	0	1300	0	0	34000	150000	1000000	36000000	700	0	0
July	1400	5200000	0	0	44000	0	0	0	0	0	1300	0	0	34000	150000	1000000	36000000	700	0	0
August	1400	5200000	0	0	44000	0	0	0	0	0	1300	0	0	34000	150000	1000000	36000000	700	0	0
Septembe	1400	5200000	0	0	44000	0	0	0	0	0	1300	0	0	34000	150000	1000000	36000000	700	0	0
October	1400	5200000	0	0	44000	0	0	0	0	0	1300	0	0	34000	150000	1000000	36000000	700	0	0
November	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
December	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Mg-D	Mn-D	Mo-D	Na-D	Ni-D	Sulphate	Sulphate	Pb-D	Sb-D	S-D	Se-D	Si-D	Sn-D	Sulphate	Sr-D	Ti-D	Tl-D	U-D	V-D	Zn-D	Zr-D
	mg/mon	mg/mon	mg/mon	mg/mon	mg/mon	mg/mon	mg/mon	mg/mon	mg/mon	mg/mon	mg/mon	mg/mon	mg/mon	mg/mon	mg/mon	mg/mon	mg/mon	mg/mon	mg/mon	mg/mon	mg/mon
January	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
April	0	6300000	650000	0	36000	0	0	44000	0	0	85000	0	0	6.2E+08	0	0	2100	0	0	450000	0
May	0	6300000	650000	0	36000	0	0	44000	0	0	85000	0	0	6.2E+08	0	0	2100	0	0	450000	0
June	0	1800000	190000	0	10000	0	0	13000	0	0	24000	0	0	1.8E+08	0	0	610	0	0	130000	0
July	0	1800000	190000	0	10000	0	0	13000	0	0	24000	0	0	1.8E+08	0	0	610	0	0	130000	0
August	0	1800000	190000	0	10000	0	0	13000	0	0	24000	0	0	1.8E+08	0	0	610	0	0	130000	0
Septembe	0	1800000	190000	0	10000	0	0	13000	0	0	24000	0	0	1.8E+08	0	0	610	0	0	130000	0
October	0	1800000	190000	0	10000	0	0	13000	0	0	24000	0	0	1.8E+08	0	0	610	0	0	130000	0
November	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
December	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

McGinty Creek Background Water Quality

	Ag-D	Al-D	Sulphate	Sulphate	As-D	Ba-D	B-D	Be-D	Bi-D	Ca-D	Cd-D	Sulphate	Co-D	Cr-D	Cu-D	Fe-D	Sulphate	Hg-D	K-D	Li-D
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
January	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
April	3.4E-06	0.12	0	0	0.00041	0	0	0	0	0	0.00003	0	0	0.00033	0.0032	0.21	0.13	0.000005	0	0
May	6.2E-06	0.22	0	0	0.00053	0	0	0	0	0	0.00003	0	0	0.00055	0.0032	0.54	0.14	3.6E-06	0	0
June	0.000013	1	0	0	0.0013	0	0	0	0	0	0.000082	0	0	0.0019	0.0078	2.5	0.24	3.8E-06	0	0
July	0.000024	3.3	0	0	0.0021	0	0	0	0	0	0.000091	0	0	0.0062	0.011	5.4	0.26	0.00001	0	0
August	0.000012	1.7	0	0	0.0014	0	0	0	0	0	0.000066	0	0	0.0033	0.0085	3	0.23	0.000005	0	0
Septembe	2.5E-06	0.035	0	0	0.00038	0	0	0	0	0	0.000025	0	0	0.0003	0.0022	0.13	0.27	2.5E-06	0	0
October	2.5E-06	0.036	0	0	0.00037	0	0	0	0	0	0.000011	0	0	0.00027	0.0016	0.14	0.3	0.000005	0	0
November	2.5E-06	0.0085	0	0	0.00024	0	0	0	0	0	0.000019	0	0	0.0002	0.0015	0.012	0.35	0.000005	0	0
December	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Mg-D	Mn-D	Mo-D	Na-D	Ni-D	Sulphate	Sulphate	Pb-D	Sb-D	S-D	Se-D	Si-D	Sn-D	Sulphate	Sr-D	Ti-D	Tl-D	U-D	V-D	Zn-D	Zr-D
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
January	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
April	0	0.014	0.00029	0	0.0013	0	0	0.000052	0	0	0.0001	0	0	1	0	0	0.000001	0	0	0.0039	0
May	0	0.041	0.00046	0	0.0018	0	0	0.0002	0	0	0.00012	0	0	1.7	0	0	1.8E-06	0	0	0.0029	0
June	0	0.19	0.00069	0	0.0049	0	0	0.0012	0	0	0.00015	0	0	4.3	0	0	0.000007	0	0	0.0091	0
July	0	0.18	0.00083	0	0.0074	0	0	0.002	0	0	0.00023	0	0	2.8	0	0	0.000024	0	0	0.017	0
August	0	0.14	0.00064	0	0.0053	0	0	0.0013	0	0	0.00015	0	0	2.5	0	0	0.000013	0	0	0.009	0
Septembe	0	0.0067	0.00078	0	0.0025	0	0	0.00011	0	0	0.00017	0	0	5.5	0	0	0.000001	0	0	0.033	0
October	0	0.012	0.0009	0	0.00098	0	0	0.000046	0	0	0.00018	0	0	7.6	0	0	0.000001	0	0	0.00097	0
November	0	0.0005	0.001	0	0.00053	0	0	0.000066	0	0	0.00017	0	0	9.1	0	0	0.000001	0	0	0.0015	0
December	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix C: Minto Mine 2015 Water Balance Update

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Memo

To:	Jasmin Dobson, Ryan Herbert	**Client:**	Minto Explorations Ltd.
From:	Soren Jensen, Kaitlyn Kooy	**Project No:**	1CM002.024
Cc:	Dylan MacGregor (SRK)	**Date:**	March 31, 2016
Subject:	2015 Water Balance and Water Quality Model Summary for the Minto Mine Site		

1 Introduction and Background

This memorandum provides a summary of the 2015 water balance and water quality model updates for the Minto Mine site. The update covers the period January 1, 2015 through December 31, 2015.

The water balance update includes a review and summary of precipitation, flow and water inventory data for the Mine site. The water quality update includes a comparison of water quality data collected in 2015 to updated water quality model predictions for Phase V/VI of the Mine development. Updated water quality predictions for the Main Pit Tailings Management Facility (MPTMF) and the Water Storage Pond (WSP) are provided for the 2017 and for the post-closure period when predicted concentrations are the same from year to year (steady state concentrations).

2 Water Balance Update

2.1 Precipitation

Table 1 shows a summary of monthly precipitation measured at the Mine site in 2014 and 2015 along with precipitation data from the regional station at Pelly Ranch (Climate ID: 2100880)[1]. Approximately 243 mm of precipitation was collected at the Mine site in the 2014 hydrological year. This roughly corresponds to a 1 in 15 dry year.

Minto's Campbell Scientific meteorological station measures total precipitation using a Geonor and a tipping bucket rain gauge. From October through May, the tipping bucket is equipped with a snowfall conversion adaptor, which allows it to measure snowfall as snow water equivalent. The Geonor precipitation gauge collects precipitation in a bucket (Figure 1) and records precipitation by measuring the weight of the bucket. In the winter months, the bucket is partially filled with an antifreeze solution that melts any snow collected. Figure 2 shows a comparison of monthly precipitation recorded by the two gauges. The Geonor gauge is considered to be more reliable.

[1] Pelly Ranch Data: obtained from Meteorological Service of Canada, Environment Canada.

Table 1: Precipitation Records for the Minto Mine Site and Pelly Ranch

		Campbell Scientific Station (Minto Mine)		
Year	**Month**	**Tipping Bucket Gauge**	**Geonor Gauge[A]**	**Pelly Ranch[B] (Climate ID 2100880)**
		mm/month	mm/month	mm/month
2014	Oct	22.0	n/a	32.5
2014	Nov	2.9	n/a	22.0
2014	Dec	19.4	21.0	23.5
2015	Jan	9.1	12.4	17.0
2015	Feb	6.9	0.0	6.0
2015	Mar	3.1	10.9	10
2015	Apr	3.8	8.0	n/a
2015	May	6.3	4.9	n/a
2015	Jun	18.7	20.5	n/a
2015	Jul	35.3	37.7	n/a
2015	Aug	79.7	80.3	n/a
2015	Sept	19.0	16.7	n/a
2015	Oct	14.7	27.7	n/a
2015	Nov	14.3	7.1	n/a
2015	Dec	9.5	11.5	n/a
SUM Hydrological Year, Nov. 2014 to Oct. 2015		204	243	n/a

Source: Minto Site Data: X:\01_SITES\Minto\1CM002.024_Water_Balance_Support\2015_Water_Balance_Update\Minto Water Balance\2016 Met Station Data Summary.xlsx

Notes:

A: Tipping bucket measurement used for month of November.
B: Data obtained from Meteorological Service of Canada, Environment Canada.
n/a – not available at time of publication.

Figure 1: Minto's Geonor Precipitation Gauge

The Pelly Ranch meteorological station is located approximately 25 km north of the Mine site and is the closest regional station with a long-term data record, including total precipitation measurements. Table 1 shows that 2015 data was limited.

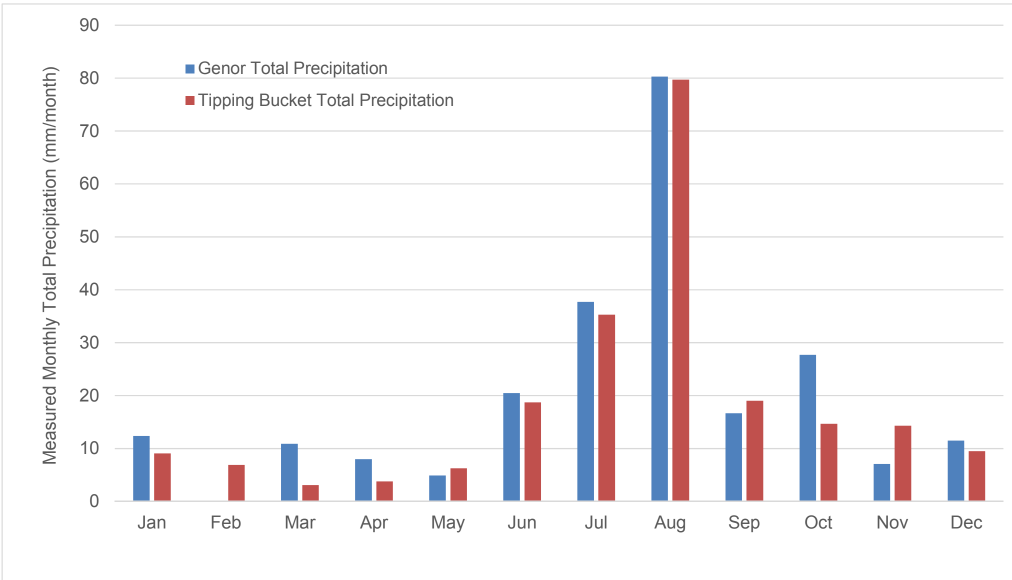

Figure 2: 2015 Monthly Total Precipitation Measurements at Minto by Geonor and Tipping Bucket Gauges

2.2 Snow Course Data

Snow course surveys were completed at the three established snow survey stations at the Mine site in 2015. Table 2 shows a summary of the snow survey data (i.e. an average of the results from the three stations) from 2009 to 2015. The depth and water equivalent of the snow pack provides an indication of the volume of surface runoff that must be managed the following freshet. Between January and late May 2015, approximately 225,000 m^3 of surface runoff was collected from catchments at the Mine site upstream of the Water Storage Dam. This volume corresponds to roughly 22 mm of runoff, or about 30% of the snow pack water equivalent measured in April 2015.

Table 2: Summary of Snow Survey Data for the Minto Mine Site

Year	February			March			April		
	Snow Depth (cm)	Snow Density (%)	Water Equivalent (mm)	Snow Depth (cm)	Snow Density (%)	Water Equivalent (mm)	Snow Depth (cm)	Snow Density (%)	Water Equivalent (mm)
2009	55.6	16.6	92.7	70.2	15.7	110.0	67.4	22.3	150.7
2010	60.5	17.8	107.7	58.1	20.7	120.7	40.4	[A]13.9	56.0
2011	57.2	18.7	106.0	70.3	20.1	141.7	52.3	22.8	111.7
2012	54.7	20.3	111.0	64.6	19.6	127.0	61.3	21.5	132.7
2013	58.7	15.7	91.3	45.8	25.0	106.0	33.7	15.4	62.7
2014	44.3	19.0	84.3	45.8	22.3	99.7	41.0	25.7	67.3
2015	44.3	20.7	90.3	25.3	29.0	76.6	30.0	23	67.8

Source: SRK: X:\01_SITES\Minto\1CM002.024_Water_Balance_Support\2015_Water_Balance_Update\MintoSnowMaster_Clean.xlsx

Notes:

n/a – not available.

[A]zero snow at #3, density is an average of snowpack at #1 and #2, average depth and water-equivalent is average of all three sites.

2.3 Water Management

Water that is suitable for release into Minto Creek is conveyed to the Water Storage Pond (WSP), while water collected from active mine areas is routed to the Main Pit Tailings Management Facility (MPTMF). Since November 2012, the MPTMF has also been used for subaqueous deposition of tailings. Deposition of mine water and tailings (subaqueous) to the Area 2 Pit Tailings Management Facility (A2PTMF) commenced in April 2015. To date, water and tailings are stored in the Stage 2 area of the A2PTMF only.

Other water management features on the Mine site include:

- W15 sump: collects surface runoff and seepage from:
  - The Southwest Waste Dump;
  - Part of the Main Waste Dump; and
  - Adjacent undisturbed catchments.

Water collected at W15 was routed to the Main Pit TMF in 2015.

- W35a sump: collects surface runoff from the minimally disturbed southern catchments. Water collected at W35a in 2015 was piped to the WSP.
- W36 sump (formerly known as W37 sump): collects surface runoff and seepage from the mill valley, including contributions from the Dry Stack Tailings Storage Facility. Water collected at the W36 sump is pumped to the MPTMF.
- South Diversion Ditch: diverts water from minimally disturbed southern catchments to the WSP (can also be routed to the MPTMF).

- WSP: reservoir for water that meets discharge criteria and is destined for discharge to Minto Creek.

2.4 2015 Water Balance

Table 3 summarizes the monthly water and tailings inventory in Minto's MPTMF and A2PTMF as well as water inventory in the WSP. In 2015, the water inventory in the MPTMF was reduced by approximately 250,000 m^3, while the water inventory in A2PTMF increased by roughly 680,000 m^3. The WSP water inventory was reduced by about 100,000 m^3 between January 1 and December 31, 2015. The reduction in the MPTMF water inventory was a result of ongoing deposition of tailings solids (about 150,000 m^3 bank cubic meters (BCM)) and an overall reduction in the MPTMF water level.

Table 4 shows a summary of the 2015 water balance for the Mine site. The total surface runoff collected on site was estimated to be 650,000 m^3 based on the change in the water inventory and the known volume of water released to Minto Creek. Including an estimated inflow of 60,000 m^3 of groundwater, the total site-wide yield was estimated at about 715,000 m^3 for the year. The total catchment upstream of the Water Storage Dam measures approximately 1,040 ha. Therefore, 715,000 m^3 of runoff from 1,040 ha gives a unit yield of approximately 69 mm/year.

The water and load balance model used for forecasting surface runoff volumes uses a site-wide annual average runoff coefficient, which has been derived based on previous years' water balance results. The runoff coefficient is estimated based on the total annual precipitation as follows:

- For dry years with less than 190 mm total precipitation: runoff coefficient = 0.15.
- For average to wet years with more than 309 mm total precipitation: runoff coefficient = 0.30.
- Runoff coefficients for years with total precipitation between 190 mm and 309 mm: interpolated values between 0.15 and 0.30.

In 2015 (hydraulic year) the estimated total precipitation was 243 mm (Table 1), which corresponds to a modelled runoff coefficient of 0.22. The 2015 site-wide runoff coefficient, based on the 2015 water balance (measured flows, water inventory and total precipitation), is:

$$\textit{Annual Yield/ Total Annual Precipitation} = \textit{Runoff Coefficient} \rightarrow \quad 69\ mm/243\ mm = \mathbf{0.28}$$

The calculated value for the annual site-wide runoff coefficient is closer to the value used for average precipitation conditions (0.30) than the interpolated coefficient of 0.22. Overall, the agreement with site-wide runoff coefficients are used for evaluating water management options is good and the model results can be expected to yield reliable estimates of the volume of water that must be managed on site on an annual basis.

Table 3: 2015 Water Inventory and Release to Minto Creek

Month/ Year	MPTMF Volume Occupied (Water + Tailings)[A]	Change in MPTMF Water Inventory	Tailings Solids Deposition in MPTMF	A2PTMF Volume Occupied (Water + Tailings)[A]	Change in A2PTMF Water Inventory	Tailings Solids Deposition in A2PTMF	WSP Volume[A]	Change in WSP Water Inventory
	m^3	m^3/month	BCM/month	m^3	m^3/month	BCM/month	m^3	m^3/month
Jan 2015	4.214.127	-14.268	34.534	0	0	0	179.106	2.335
Feb 2015	4.234.392	-3.196	34.534	0	0	0	181.441	11.411
Mar 2015	4.265.730	-182.640	34.534	0	203.055	0	192.852	6.713
Apr 2015	4.117.625	-175.799	0	203.055	176.166	47.723	199.565	-119.639
May 2015	3.941.826	-194.091	0	426.944	163.331	47.723	79.926	-45.483
Jun 2015	3.747.735	68.992	21.537	637.997	25.850	23.861	34.442	17.071
Jul 2015	3.838.264	97.094	24.640	687.709	-36.508	17.795	51.513	10.208
Aug 2015	3.959.998	128.619	0	668.996	-43.143	45.380	61.721	10.541
Sep 2015	4.088.617	16.142	0	671.233	86.462	40.116	72.262	10.777
Oct 2015	4.104.759	-505	0	797.812	52.003	43.619	83.039	885
Nov 2015	4.104.254	3.409	0	893.433	33.178	37.282	83.924	-822
Dec 2015	4.107.663	126	0	963.893	19.137	41.058	83.102	-1.403
Jan 2016	4.107.790			1.024.08			81.699	
SUM		**-256.116**	**149.779**	**1.024.08**	**679.531**	**344.556**		**-97.406**

Source: X:\01_SITES\Minto\1CM002.024_Water_Balance_Support\2015_Water_Balance_Update\2015 Water Balance Update REV00 SRJ.xlsx

Notes:

[A] – on the first day of the month.

Table 4: Water Balance Summary of the Minto Mine Site, 2015 (Jan to Dec)

	Units	**Main Pit TMF**	**Area 2 Pit TMF**	**WSP**
Volume Change 2015 (water + tailings)	m^3	-106,337	1,024,087	-97,406
Tailings Deposited, total	BCM	149,779	344,556	-
Water Volume Change 2015	m^3	-256,116	679,531	-97,406
Estimated Groundwater Inflow	m^3	0	60,000	0
Total Water Inventory Increase in 2015	m^3	386,000		
Total Water Discharged to Minto Creek	m^3	328,526		
Total Site-Wide Yield in 2015	m^3	**714,534**		

Source: X:\01_SITES\Minto\1CM002.024_Water_Balance_Support\2015_Water_Balance_Update\
2015 Water Balance Update REV00 SRJ

3 Water Quality Model Update

3.1 Solid Phase Geochemistry

The neutralization potential ratio (NPR) and copper content of waste rock and tailings were reviewed in order to identify any new trends in the solid phase geochemistry that may have developed between the last source term update in 2013 and 2015. Significant changes in the solid phase geochemistry would indicate a need for further analysis of the waste rock and tailings to generate new source terms that reflect the observed changes in the geochemistry.

The NPR and copper content of waste rock and tailings are shown in Figure 3 toFigure 6. No significant changes in geochemistry were observed in the properties of the materials produced in 2015 compared to similar materials produced in prior years. Therefore, no further evaluation of 2015 solid phase geochemistry was warranted.

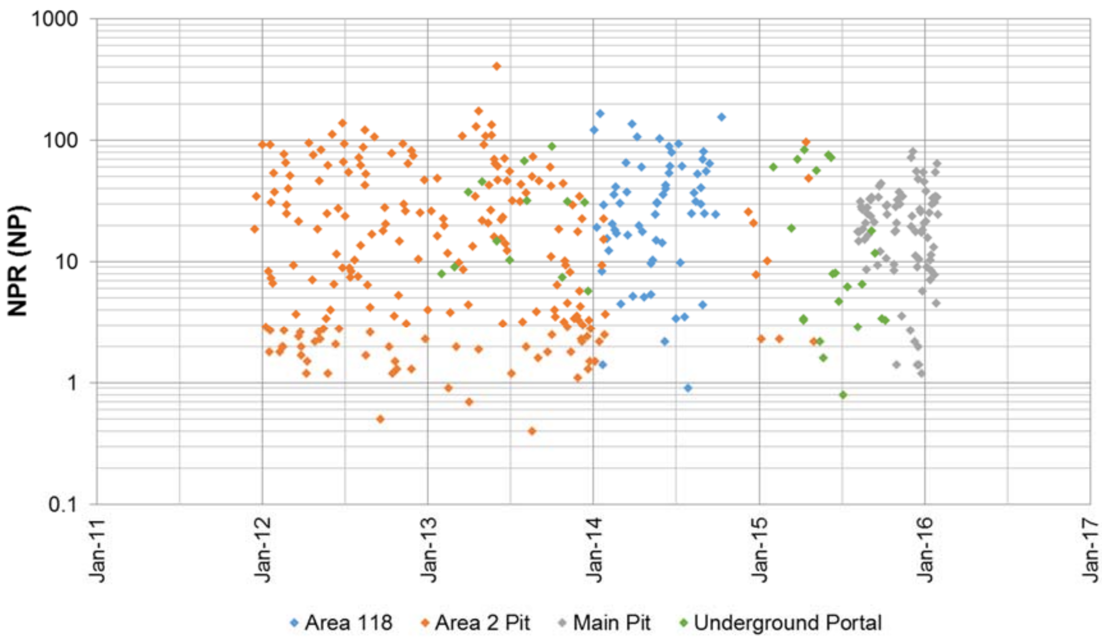

Figure 3: Waste Rock Neutralization Potential Ratio over Time

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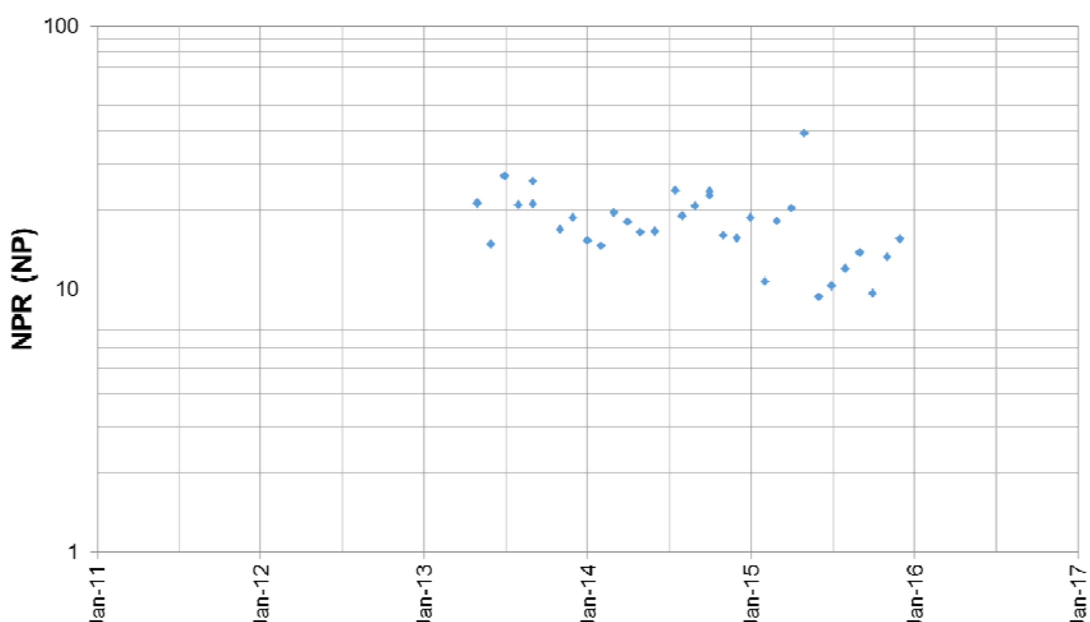

Figure 4: Tailings Neutralization Potential Ratio over Time

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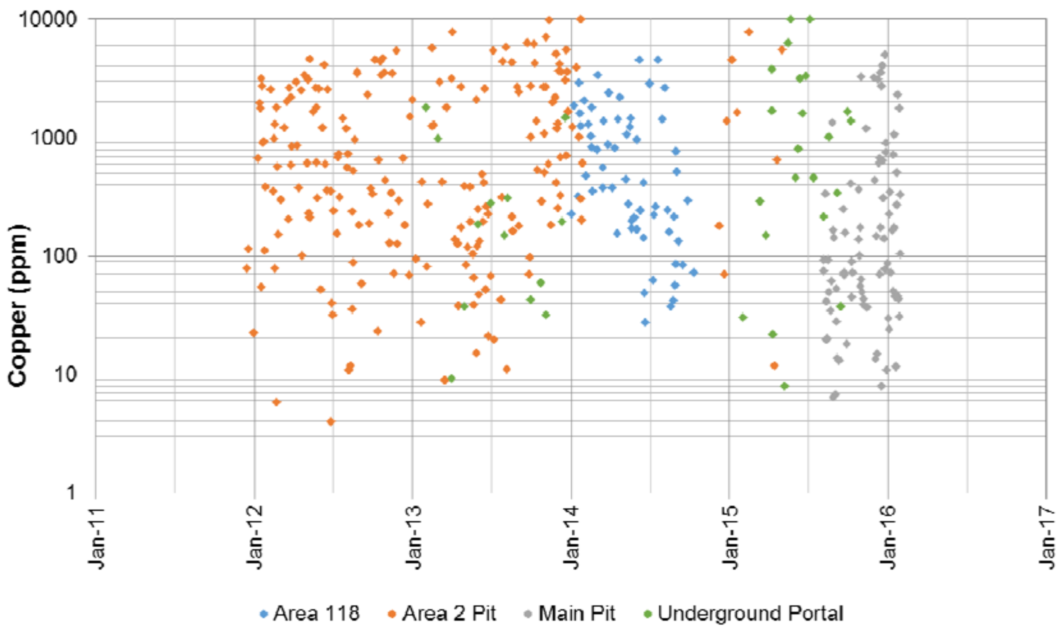

Figure 5: Waste Rock Copper Concentration over Time

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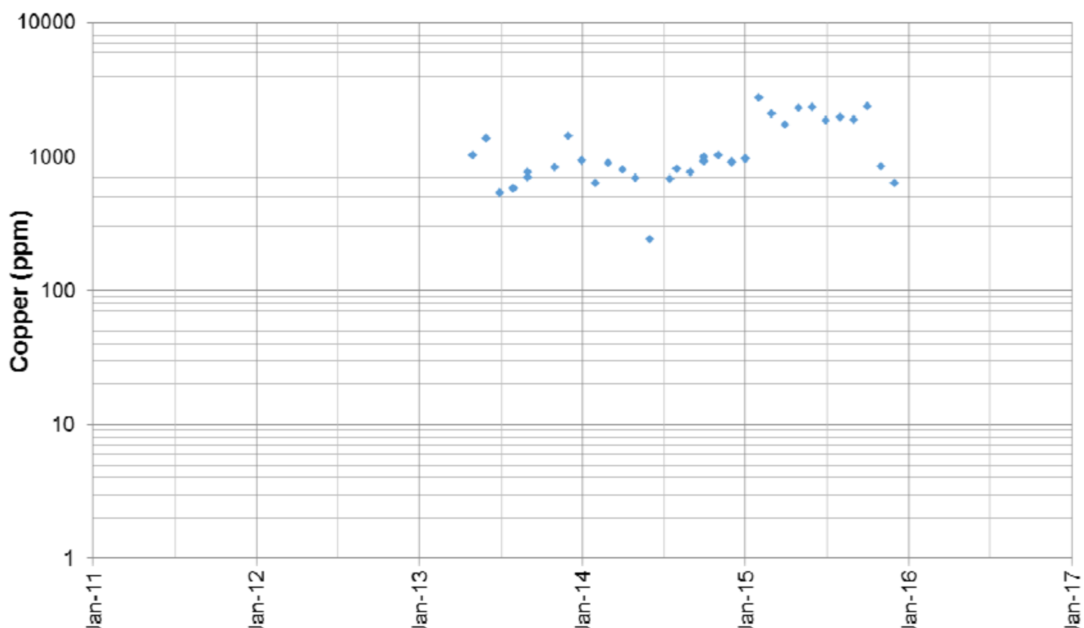

Figure 6: Tailings copper concentration over time

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3.2 Comparison of Measured Water Quality Data to Source Terms

3.2.1 Source Terms – Dry Stack Tailings Storage Facility

The Dry Stack Tailings Storage Facility (DSTSF) source terms used in the 2013 water and load balance model were developed based on the observed water chemistry at station W8. This station was chosen because it had the highest concentrations of copper, cadmium, selenium, and sulphate during the period of record available in 2013. The following points describe the source terms:

- Best Estimate source term: 50th percentile dissolved concentrations from W8 until 2013;
- Reasonable Worst Case source term: 95th percentile dissolved concentrations from W8 until 2013.

A review of the water quality data updated to 2015 from station W8 and as well as from alternate DSTSF monitoring station W8A revealed that the maximum concentrations of key water quality parameters such as copper and selenium prior to 2013 were higher than concentrations measured between 2013 and 2015. The 2013 DSTSF source terms were therefore deemed acceptable and suitably conservative for use in the 2015 Updated Water Balance and Water Quality Model.

3.2.2 Source Terms – Waste Rock

The Main Waste Dump and the Southwest Waste Dump source terms used in the 2013 water and load balance model were defined based on the observed water chemistry at station W15, which collects runoff from the Southwest Waste Dump. Similar to the DSTSF source terms, the Best Estimate waste rock source term was the 50^{th} percentile dissolved concentrations at W15 until 2013 and the Reasonable Worst Case waste rock source term was the 95^{th} percentile dissolved concentrations from W15 until 2013.

Several parameters showed elevated concentrations in March of 2015, possibly due to an early snow melt event. Some concentrations were higher than those used to develop source terms for the 2013 model. Therefore, new waste rock source terms were developed based on the concentrations measured at W15 in 2015, as described in Section 3.3.

3.2.3 Source Term – Tailings Slurry

A survey of water quality in the MPTMF and the A2PTMF indicated that concentrations of certain parameters such as selenium and copper were higher than predicted in 2015. Adjustment of the waste rock source terms were not able to explain the concentration changes. A water quality model sensitivity analyses indicated that a possible explanation could be an increase in loadings assigned to tailings slurry (i.e. loadings released from milled ore), perhaps in response to a subtle change geochemical properties of the ore feed. Alternatively, loadings could originate as “first flush” loadings mobilized when the Area 2 pit and related M-Zone underground workings were inundated.

3.3 Source Term Update

3.3.1 Waste Rock Source Term

Waste rock from the Main Pit was placed in both the Main Waste Dump and in the Southwest Waste Dump, and Area 118 Pit and Area 2 Pit (Stage 1 and 2) waste rock has also been placed in the Southwest Waste Dump. Water chemistry of drainage from these facilities has been monitored at several routine monitoring stations (W15, W30, W31, W32, W38, W39, and W40) since 2007, as well as through semi-annual seepage surveys where a total of 12 seeps have been sampled between 2012 to 2015 (SS1, SS4, SS13, SS21, SS22, SS28, SS29, SS30, SS31, SS44, SS51, and SS52).

All surface drainage from the Main Waste Dump and Southwest Waste Dump catchment areas reports to routine monitoring station W15 and is transferred to the Main Pit by pumping. Pumped volumes are tracked by the mine for water management purposes, and water chemistry at W15 is regularly monitored. These records were used to develop a waste rock volume- based source term as described in the following steps.

1. Water quality records from 2007 through 2015 were compiled, and average and 95th percentile concentrations were calculated.

2. Average and 95th percentile total catchment loadings were estimated using average and 95th percentile concentrations (from step 1) together with flows estimated based on the mean annual runoff (329 mm) and runoff coefficient (0.3) and catchment area of station W15 (253 ha) (SRK 2013b).

3. Loads estimated in step 2 were assumed to be entirely derived from the Southwest Waste Dump and the Main Waste Dump. Estimates of loading rates per volume of waste rock were made by dividing the total step 2 catchment load by the volume of rock that had been placed at end-of-year.

The results of step 3 were then adopted as the expected case and reasonable worst case source terms for volume-based loadings from bulk waste rock. The advantage of source terms based on units of rock volume is that they can be readily applied to existing and proposed new or expanded waste facilities to estimate future loadings. The source term concentrations from step 2 are shown in Table 5.

Table 5: 2015 Waste Rock Source Terms

WQ Parameter	Expected Case	Reasonable Worst Case
	Station W15- 50th Percentile (mg/L)	Station W15- 95th Percentile (mg/L)
Ag-D	0.00002	0.0001
Al-D	0.024	0.1608
Alk-T	161	342
Ammonia	0.072	0.237
As-D	0.0005	0.001
Ba-D	0.108	0.2212
B-D	0.05	0.1
Be-D	0.0001	0.0002
Bi-D	0.001	0.001
Ca-D	66.1	179.7
Cd-D	0.000016	0.0001
Cl-D	3.005	12.45
Co-D	0.0005	0.0012
Cr-D	0.001	0.002
Cu-D	0.0184	0.04998
Fe-D	0.307	1.065
F-D	0.16	0.2735
Hg-D	0.00001	0.0002
K-D	2.69	7.444
Li-D	0.005	0.01
Mg-D	18.9	45.16
Mn-D	0.244	0.9647
Mo-D	0.0027	0.0069
Na-D	9.92	22.19
Ni-D	0.001	0.00279
NO3	5.76	36.48
NO2	0.0488	0.3012
Pb-D	0.0002	0.0002
Sb-D	0.0005	0.0005
S-D	24.25	74.92
Se-D	0.00127	0.007126
Si-D	4.91	8.826
Sn-D	0.005	0.005
SO4-D	52.5	192
Sr-D	0.558	2.224
Ti-D	0.005	0.01
Tl-D	0.00005	0.00005
U-D	0.0011	0.003823
V-D	0.005	0.005
Zn-D	0.005	0.01
Zr-D	0.0005	0.002

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3.3.2 Tailings Slurry Source Term Update

In the current model revision, the tailings slurry term was increased by a factor of 3 to account for the observed increase in selenium loadings to the MPTMF and the A2PTMF. The increase to the tailings source term does not necessarily mean that the additional loadings originate from the milled ore. In that sense, the tailings slurry loading is used as a calibration factor. Monitoring data over the coming year will reveal whether the additional observed loadings indeed are associated with the milled ore or whether the loadings can be attributed to another source.

3.4 Water Quality Model Results

Table 6 and 7 show revised model outputs from the calibrated model of water quality in the Water Storage Pond (WSP) for 2015, 2017 and post-closure (best estimate and worst case) along with concentrations measured in 2015. Table 8 and 9 show revised model predictions of water quality in the MPTMF for 2015, 2017 and post-closure. Predictions for 2017 and post-closure were selected to provide representative short-term and long-term indications of water quality trends. Predictions are for average precipitation conditions. The Water Use Licence (QZ14-031) effluent limits are also listed in the tables. Model runs started on 1 January 2015 and ended on 1 January 2045.

The MPTMF was historically the primary water reservoir on site. In the model, the free water in the MPTMF and A2PTMF are more or less considered to belong to the same reservoir due to the high rate of flow between the two reservoirs. Reclaim water is drawn from the MPTMF and excess free water in the A2PTMF is pumped back to the MPTMF.

Therefore, a comparison of measured MPTMF water quality with concentrations predicted for pit water for the Phase V/VI environmental assessment provides a good measure of actual vs. expected geochemical performance of the site. Water collected in the WSP includes clean (non-contact) runoff and effluent from Minto's water treatment plant.

Median measured concentrations in the WSP in 2015 are comparable to the revised model predictions using best estimate source terms (Table 6). The favorable was agreement indicates that the revised source terms are appropriate for describing the existing geochemical performance and the actual water management practices on site. Best estimate source terms are intended to provide an indication of the general trend in water quality parameter concentrations, but are not intended to capture maximum or outlier concentration values. Therefore, the median values of best estimate model predictions are compared to measured median values.

Revised model predictions using reasonable worst case source terms are generally higher than comparable median and maximum measured values for the WSP (Table 7).

Revised model predictions for water quality in the MPTMF (and by extension the A2PTMF) using the best estimate source terms are in good agreement with median measured concentrations in 2015 (Table 8). Water quality model predictions using reasonable worst case source terms are generally higher than measured median and maximum concentration, with the exception of dissolved copper. Median and maximum measured dissolved copper concentrations were both higher than the concentrations predicted by the reasonable worst case source terms. The increase in dissolved copper concentration is not dramatic and may be caused by the flushing of rock that accompanied the inundation of the Area 2 Pit and related underground workings when deposition of tailings slurry was initiated. The source of the additional copper loadings (or increased copper solubility) will be evaluated based on water quality monitoring results in 2016.

Table 6: WSP Water Quality Model Predictions and Measured Concentrations in 2015, Best Estimate

		WUL Effluent Limits (QZ14-031)	WSP Measured Water Quality (Station W16)	Modelling Predictions of Quality in WSP (Station W16)		
Year			2015	2015	2017	Post-Closure
			Median	Median	Median	Median
Ammonia	mg/L	0.75	0.081	0.14	0.07	0.01
$N\text{-}NO_2$	mg/L	0.18	0.0565	0.11	0.07	0.00
$N\text{-}NO_3$	mg/L	27.3	1.63	3.48	4.56	0.17
Ag-Dissolved	Mg/L	0.0003	0.00002	0.00003	0.00003	0.00003
Al-Dissolved	mg/L	0.3	0.0103	0.09	0.21	0.27
As-Dissolved	mg/L	0.015	0.00031	0.0005	0.0007	0.0011
Cd-Dissolved	mg/L	0.0014[a]	0.00001	0.00002	0.00003	0.00004
Cr-Dissolved	mg/L	0.003	0.001	0.0014	0.0014	0.0012
Cu-Dissolved	mg/L	0.06/0.039[b]	0.0126	0.013	0.018	0.018
Fe-Dissolved	mg/L	3.3	0.0553	0.31	0.65	0.48
Pb-Dissolved	mg/L	0.012	0.0002	0.00029	0.00034	0.00032
Mo-Dissolved	mg/L	0.219	0.0044	0.005	0.003	0.007
Ni-Dissolved	mg/L	0.33	0.001	0.0016	0.0021	0.0017
Se-Dissolved	mg/L	0.006	0.00054	0.0012	0.0013	0.0020
Zn-Dissolved	mg/L	0.09	0.005	0.007	0.007	0.006

Source: SRK, X:\01_SITES\Minto\1CM002.024_Water_Balance_Support\2015_Water_Balance_Update\All_Model_Results_for_WQ_Model_Comparison_for_2015_An_Report_SRJ_Rev00.xlsx

Notes:

Analytical data from Minto's water quality monitoring program.

a) at 50 mg/L hardness.

b) Cu effluent standard is 0.06 when [DOC] @ W2 > 10 mg/L and 0.039 when [DOC] @ W2 ≤ 10 mg/L.

Table 7: WSP Water Quality Model Predictions and Measured Concentrations in 2015, Reasonable Worst Case

		WUL Effluent Limits (QZ14-031)	WSP Measured Water Quality (Station W16)		Modelling Predictions of Quality in WSP (Station W16)					
Year			**2015**		**2015**		**2017**		**Post-Closure**	
			Median	**Max**	**Median**	**Max**	**Median**	**Max**	**Median**	**Max**
Ammonia	mg/L	0.75	0.081	0.29	0.23	0.26	0.20	0.28	0.02	0.03
N-NO_2	mg/L	0.18	0.0565	0.295	0.31	0.32	0.26	0.30	0.01	0.02
N-NO_3	mg/L	27.3	1.63	3.99	6.69	7.89	11.60	11.87	0.43	0.54
Ag-Dissolved	Mg/L	0.0003	0.00002	0.00004	0.00007	0.00009	0.00009	0.00012	0.00008	0.00010
Al-Dissolved	mg/L	0.3	0.0103	0.0531	0.16	0.24	0.32	0.35	0.42	0.47
As-Dissolved	mg/L	0.015	0.00031	0.00054	0.0007	0.0010	0.0011	0.0015	0.0022	0.0026
Cd-Dissolved	mg/L	0.0014[a]	0.00001	0.00009	0.00007	0.00010	0.00009	0.00013	0.00013	0.00015
Cr-Dissolved	mg/L	0.003	0.001	0.001	0.0019	0.0024	0.0022	0.0029	0.0024	0.0027
Cu-Dissolved	mg/L	0.06/0.039[b]	0.0126	0.0246	0.029	0.043	0.042	0.060	0.041	0.046
Fe-Dissolved	mg/L	3.3	0.0553	0.264	0.71	1.07	1.22	1.55	0.84	0.92
Pb-Dissolved	mg/L	0.012	0.0002	0.0002	0.00029	0.00035	0.00034	0.00041	0.00094	0.00110
Mo-Dissolved	mg/L	0.219	0.0044	0.0107	0.007	0.008	0.006	0.009	0.015	0.018
Ni-Dissolved	mg/L	0.33	0.001	0.0012	0.0026	0.0034	0.0034	0.0043	0.0031	0.0035
Se-Dissolved	mg/L	0.006	0.00054	0.00147	0.0042	0.0061	0.0057	0.0083	0.0053	0.0062
Zn-Dissolved	mg/L	0.09	0.005	0.0087	0.009	0.012	0.011	0.014	0.012	0.014

Source: SRK, X:\01_SITES\Minto\1CM002.024_Water_Balance_Support\2015_Water_Balance_Update\All_Model_Results_for_WQ_Model_Comparison_for_2015_An_Report_SRJ_Rev00.xlsx

Notes:

Analytical data from Minto's water quality monitoring program.

a) at 50 mg/L hardness.

b) Cu effluent standard is 0.06 when [DOC] @ W2 > 10 mg/L and 0.039 when [DOC] @ W2 ≤ 10 mg/L.

Table 8: MPTMF Water Quality Model Predictions and Measured Concentrations in 2015, Best Estimate

		WUL Effluent Limits (QZ14-031)	MPTMF Measured Water Quality (Station W12)	Modelling Predictions of Quality in MPTMF (Station W12)		
Year			2015	2015	2017	Post-Closure
			Median	Median	Median	Median
Ammonia	mg/L	0.75	N/A	N/A	N/A	N/A
$N\text{-}NO_2$	mg/L	0.18	N/A	N/A	N/A	N/A
$N\text{-}NO_3$	mg/L	27.3	N/A	N/A	N/A	N/A
Ag-Dissolved	Mg/L	0.0003	0.00002	0.00003	0.00006	0.00004
Al-Dissolved	mg/L	0.3	0.0152	0.09	0.32	0.32
As-Dissolved	mg/L	0.015	0.00044	0.0008	0.0018	0.0013
Cd-Dissolved	mg/L	0.0014[a]	0.00004	0.00003	0.00007	0.00005
Cr-Dissolved	mg/L	0.003	0.001	0.0015	0.0028	0.0015
Cu-Dissolved	mg/L	0.06/0.039[b]	0.0163	0.007	0.026	0.021
Fe-Dissolved	mg/L	3.3	0.0072	0.27	0.42	0.55
Pb-Dissolved	mg/L	0.012	0.0002	0.00032	0.00062	0.00038
Mo-Dissolved	mg/L	0.219	0.0831	0.096	0.113	0.009
Ni-Dissolved	mg/L	0.33	0.0015	0.0028	0.0039	0.0020
Se-Dissolved	mg/L	0.006	0.0105	0.0128	0.0209	0.0024
Zn-Dissolved	mg/L	0.09	0.005	0.008	0.014	0.007

Source: SRK, X:\01_SITES\Minto\1CM002.024_Water_Balance_Support\2015_Water_Balance_Update\All_Model_Results_for_WQ_Model_Comparison_for_2015_An_Report_SRJ_Rev00.xlsx

Notes:

Analytical data from Minto's water quality monitoring program.

a) at 50 mg/L hardness.

b) Cu effluent standard is 0.06 when [DOC] @ W2 > 10 mg/L and 0.039 when [DOC] @ W2 ≤ 10 mg/L.

Table 9: MPTMF Water Quality Model Predictions and Measured Concentrations in 2015, Reasonable Worst Case

Year		WUL Effluent Limits (QZ14-031)	MPTMF Measured Water Quality (Station W12)		Modelling Predictions of Quality in MPTMF (Station W12)					
			2015		2015		2017		Post-Closure	
			Median	**Max**	**Median**	**Max**	**Median**	**Max**	**Median**	**Max**
Ammonia	mg/L	0.75	2.9	4.3	1.04	1.04	1.04	1.04	0.03	0.03
$N\text{-}NO_2$	mg/L	0.18	1.1	2.83	0.64	0.64	0.64	0.64	0.02	0.02
$N\text{-}NO_3$	mg/L	27.3	13.6	26	22.70	22.70	22.70	22.70	0.55	0.61
Ag-Dissolved	Mg/L	0.0003	0.00002	0.00002	0.00005	0.00007	0.00012	0.00014	0.00011	0.00012
Al-Dissolved	mg/L	0.3	0.0152	0.0277	0.15	0.28	0.56	0.60	0.53	0.55
As-Dissolved	mg/L	0.015	0.00044	0.00055	0.0012	0.0019	0.0032	0.0036	0.0029	0.0030
Cd-Dissolved	mg/L	0.0014[a]	0.00004	0.000061	0.00006	0.00010	0.00019	0.00021	0.00017	0.00018
Cr-Dissolved	mg/L	0.003	0.001	0.001	0.0019	0.0027	0.0042	0.0048	0.0031	0.0033
Cu-Dissolved	mg/L	0.06/0.039[b]	**0.0163**	**0.0373**	**0.015**	**0.026**	0.059	0.064	0.048	0.051
Fe-Dissolved	mg/L	3.3	0.0072	0.231	0.36	0.45	0.81	0.89	1.05	1.09
Pb-Dissolved	mg/L	0.012	0.0002	0.0002	0.00051	0.00083	0.00140	0.00156	0.00123	0.00129
Mo-Dissolved	mg/L	0.219	0.0831	0.0972	0.101	0.132	0.133	0.180	0.020	0.021
Ni-Dissolved	mg/L	0.33	0.0015	0.0038	0.0034	0.0047	0.0064	0.0075	0.0039	0.0041
Se-Dissolved	mg/L	0.006	0.0105	0.0207	0.0177	0.0284	0.0370	0.0485	0.0070	0.0075
Zn-Dissolved	mg/L	0.09	0.005	0.0062	0.010	0.014	0.022	0.025	0.015	0.016

Source: SRK, X:\01_SITES\Minto\1CM002.024_Water_Balance_Support\2015_Water_Balance_Update\All_Model_Results_for_WQ_Model_Comparison_for_2015_An_Report_SRJ_Rev00.xlsx

Notes:

Analytical data from Minto's water quality monitoring program.

a) at 50 mg/L hardness.

b) Cu effluent standard is 0.06 when [DOC] @ W2 > 10 mg/L and 0.039 when [DOC] @ W2 ≤ 10 mg/L.