

APPENDIX B

JAY PROJECT – COMPENDIUM OF SUPPLEMENTAL WATER QUALITY MODELLING



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JAY PROJECT

Compendium of Supplemental Water Quality Modelling

Submitted to:
Rick Bargery
Dominion Diamond

REPORT

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Acronyms and Abbreviations

Acronym	Definition
AEMP	Aquatic Effects Monitoring Program
Al	aluminum
As	arsenic
BHP Billiton	BHP Billiton Canada Inc.
Cl	Chloride
DAR	Developer's Assessment Report
DDMI	Diavik Diamond Mines Inc.
Dominion Diamond	Dominion Diamond Ekati Corporation
e.g.	for example
ERM Rescan	ERM Rescan Environmental Services Ltd.
GEMSS	Generalized Environmental Modeling System for Surfacewaters
Golder	Golder Associates Ltd.
MVEIRB	Mackenzie Valley Environmental Impact Review Board
NH ₄	ammonium
NO ₃	nitrate
P	phosphorus
Project	Jay Project
Rescan	Rescan Environmental Services Ltd.)
SNP	Surveillance Network Program
SO ₄	sulphate
TDS	total dissolved solids
WLWB	Wek'èezhii Land and Water Board
WRSA	waste rock storage area



Units of Measure

Unit	Definition
%	percent
>	greater than
µg/L	Micrograms per litre
Km	kilometres
km ²	Square kilometres
m	metre
m ³ /day	cubic metres per day
mg/L	Milligrams per litre
mg-N/L	milligrams as nitrogen per litre
mg-P/L	milligrams as phosphorus per litre
ppb	parts per billion



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APPENDICES

APPENDIX A

Lac du Sauvage Time Series

APPENDIX B

Lac de Gras Time Series

APPENDIX C

Projected Misery Pit Discharge Concentrations



1.0 INTRODUCTION

Dominion Diamond Ekati Corporation (Dominion Diamond) submitted a Developer’s Assessment Report (DAR) (Dominion Diamond 2014) to the Mackenzie Valley Environmental Impact Review Board (MVEIRB) in November 2014. As part of the DAR, water quality models were developed to identify potential Jay Project (Project) effects to surface water quality in Lac du Sauvage and downstream in Lac de Gras. Site discharge water quality was estimated using a mass-balance water quality model (Appendix 8E of the DAR), which was used as an input to the Lac du Sauvage hydrodynamic model (Appendix 8F of the DAR) to assess changes to water quality in Lac du Sauvage. The projected water quality at the outlet of Lac du Sauvage was subsequently used as an input to the Lac de Gras hydrodynamic model. Discharges from the Ekati Mine via Slipper Lake and from the Diavik Mine via a licensed discharge also report to Lac de Gras and were included in the Lac de Gras hydrodynamic model.

Since the submission of the DAR, the following updates have been made to the Lac de Gras hydrodynamic model:

- The model input used to represent the quantity of water discharged from Diavik Mine to Lac de Gras was changed to flow rate estimates provided in the December 2013 Diavik Diamond Mines Inc. Water Management Plan Version 12 (DDMI 2014), which are the most current and appropriate discharge volumes to be used for assessing surface water quality impacts in Lac de Gras; and,
- The model input used to represent the quantity and quality of water discharged from Slipper Lake to Lac de Gras was changed to reflect predictions issued by ERM Rescan in November 2014 based on the most current output of the Koala Watershed water quality model.

The updated water quality projections in Lac de Gras (Golder 2015), considering the above changes, were provided to MVEIRB on January 19, 2015.

As part of the DAR review process, and based on Project information requests submitted to the MVEIRB by interveners, several additional model updates were made to provide supporting results in information request responses. This compendium of supplemental water quality modeling for the Project provides the details of the additional model updates as well as the results for each update that is supplemental to the most recent submission to the MVEIRB on January 19, 2015 (Golder 2015). Table 1-1 provides a brief overview of the model updates that were made and the section number within this compendium that provides the details of the updates:

Table 1-1 Description of Supplemental Model Updates

Model	Section	Description
Updated Assessment Case	2.0	<p>Since submission of the DAR, additional flow information from Diavik Mine has been made publically available as part of annual water licence reporting requirements. The updated flows, which were not previously available, consider the development of the A21 open pit. The Lac de Gras hydrodynamic model was updated to account for these flows.</p> <p>Several information requests were related to the stability of the Jay and Misery Pit lakes at closure. To provide additional confidence that meromixis will remain stable in both pits, input parameters (Appendix 8G) for these models were reviewed and updated to provide additional conservatism in the predictions. The updated assessment case, therefore, also includes an update to the pit lake hydrodynamic model results, as well as the Lac du Sauvage and Lac de Gras hydrodynamic models to account for the update to these inputs.</p>



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Table 1-1 Description of Supplemental Model Updates

Model	Section	Description
No Jay Development Case	3.0	This model scenario provides updated Lac du Sauvage and Lac de Gras water quality predictions for a scenario that does not consider the development of the Jay Project.
Reasonable Estimate Case	4.0	The water quality modelling included in the DAR was based on several conservative assumptions that were used so that actual water quality was not likely to be under-predicted. To provide a more likely but less conservative (i.e., expected) estimate of Project discharge water quality, the models were updated for a reasonable estimate case of the discharge water quality from the Project.
Desteffany Lake Modeling	5.0	On November 28, 2014, MVEIRB provided Dominion Diamond with adequacy review comments on the Project DAR (MVEIRB 2014). Section 9.4 of the adequacy review report requested additional rationale for setting the water quality Effects Study Area equal to the outlet of Lac de Gras. A response was provided to MVEIRB on January 19, 2015 as part of the adequacy response submission as DAR-MVEIRB-20 (Dominion Diamond 2015). As indicated in DAR-MVEIRB-20, Dominion Diamond committed to develop a water quality model downstream of the Lac de Gras outlet in the Coppermine River system. The domain of the model was extended to the outlet of Desteffany Lake

DAR = Developer's Assessment Report; MVEIRB = Mackenzie Valley Environmental Impact Review Board.

Modelling included in the DAR identified the following parameters as constituents of interest: total dissolved solids (TDS), chloride, total phosphorus, ammonium, nitrate, chlorophyll a (lake models only), total aluminum, and total arsenic. The water quality models were updated for the full suite of constituents that were included in the DAR; however, the model updates presented in the following sections focus the results and discussion on the constituents of interest.



2.0 UPDATED ASSESSMENT CASE

The following changes were made for the updated assessment case:

- Wind sheltering coefficients, dynamic shading, and climate record for the pit lake hydrodynamic models were updated (see Section 2.1.1);
- The discharge rate from Diavik Mine to Lac de Gras was updated to reflect the most recent water management plan (Diavik 2014); and,
- Water discharge rates from the B watershed included in the DAR model were overestimated by a factor of two from 2020 to 2060; these were corrected.

The above changes required updates to the following models:

- Misery and Jay Pit lake hydrodynamic models;
- Post-closure site water quality model (to include updated volume transfers from the pit lakes);
- Regional water balance model;
- Lac du Sauvage and Lac de Gras hydrodynamic and water quality models:

The models were only updated for the changes listed above. All other model inputs remained unchanged from those used in the DAR. In addition, the model used the same level of conservatism as was used in the DAR. The reader is referred to Appendix 8E and 8F for additional details on model inputs and conservatism. Details of each of the model updates are provided in the following subsections.

2.1 Model Updates

2.1.1 Pit Lake Models

Pit lake hydrodynamic models were developed for Jay and Misery pits using CE-QUAL-W2, which is a two dimensional, laterally averaged, hydrodynamic and water quality model. The objective of the hydrodynamic modelling was to evaluate the vertical stratification potential within the pits during the first 200 years of the post-closure period (i.e. when the mined-out pits are entirely filled with water). Detailed descriptions of the model set-up, calibration, inputs, and assumptions are provided in Appendix 8G of the DAR.

Consistent with the DAR, the TDS profiles between 200 and 15,000 years for Jay and Misery pits were calculated using a vertical slice, mass-balance model. This simplified model did not account for upward or downward diffusion due to concentration gradients. This model also extrapolated groundwater flows and concentrations beyond the timeframe modelled by the hydrogeological model. Detailed descriptions of the vertical-slice, mass-balance model set-up, inputs, and assumptions used are provided in Appendix 8G of the DAR.

In addition to the assumptions in Appendix 8G of the DAR, the following assumptions and inputs were updated in the Jay and Misery Pits hydrodynamic models:



Table 2-1: Updated Hydrodynamic Model Assumptions and Inputs

Assumptions	DAR Case	Updated Assessment Case
Wind sheltering coefficient	0.5	0.8
Dynamic shading	0.7	1
Meteorological data (years)	4	14

DAR = Developer’s Assessment Report.

Concentrations of TDS in the pits were initialized to create a high density water layer (monimolimnion) overlain by a low density water layer (mixolimnion). In Misery and Jay Pits, the mixolimnion layers were 60 metres (m) and 160 m in depth respectively.

2.1.1.1 Pit Lake Hydrodynamic Model Results and Discussion

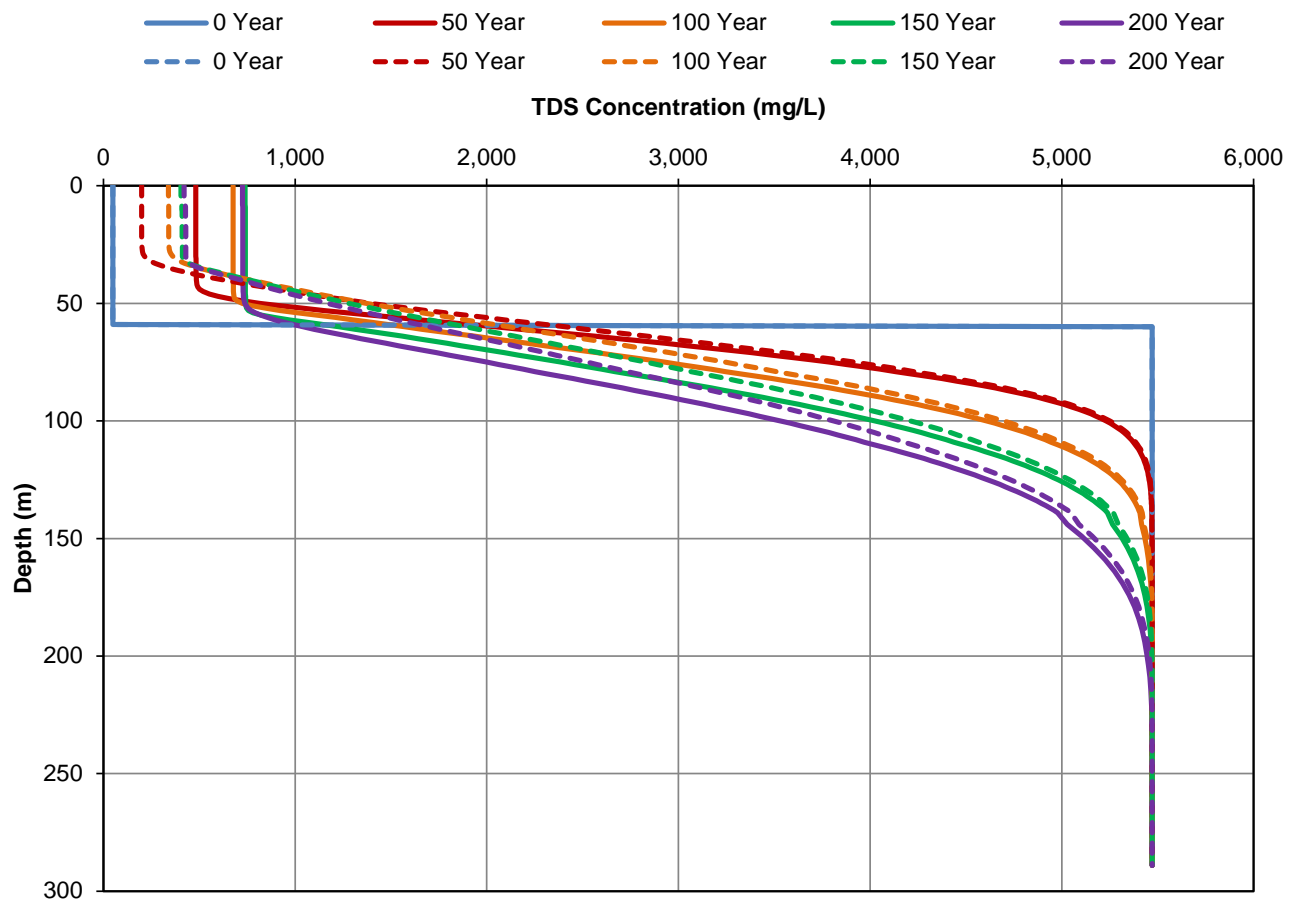
2.1.1.1.1 Misery Pit

Misery Pit was predicted to remain stratified during the entire 200 year simulation period for both the updated assessment and DAR cases (Figure 2-1). The stratification was characterized by a pycnocline that will provide stability to vertical layers within the lake. In the model, wind-driven forces are applied to the water surface and the energy required to generate turbulent mixing increases with depth.

Concentrations of TDS in the mixolimnion were predicted to increase over time until steady-state conditions are reached, approximately 200 years into post-closure. Predicted steady-state TDS concentrations in the mixolimnion for the updated assessment case and the DAR case were 728 milligrams per litre (mg/L) and 429 mg/L, respectively. The increase in the predicted TDS concentration in the mixolimnion for the updated assessment case was attributed to the increased wind sheltering coefficient (Table 2-1). The increase in the wind sheltering coefficient means the water surface is more exposed to wind, which results in an increased upward movement of TDS from the monimolimnion to the mixolimnion over time. The increased upward movement of water results in additional TDS being transport from the monimolimnion to the mixolimnion providing, a more conservative estimate of mixolimnion concentrations, in comparison to the DAR.

Concentrations of TDS at depths below 200 m in the monimolimnion were not predicted to increase over 200 years because the hydrogeological modelling predicted groundwater losses (i.e., outflows from the pit lake).

The model predicted that the pycnocline thickness will increase with time. The elevation of the pycnocline was not predicted to change appreciably, but the gradient was predicted to become less pronounced, reflecting an upward transfer of mass from the bottom of the pit. This upward movement was predicted to occur rapidly after back-flooding, and gradually thereafter. The overall pattern and strength of stratification in the Misery Pit are similar to those predicted for the DAR.



m = metres; mg/L = milligrams per litre; solid lines = updated assessment case; dashed lines = DAR case.

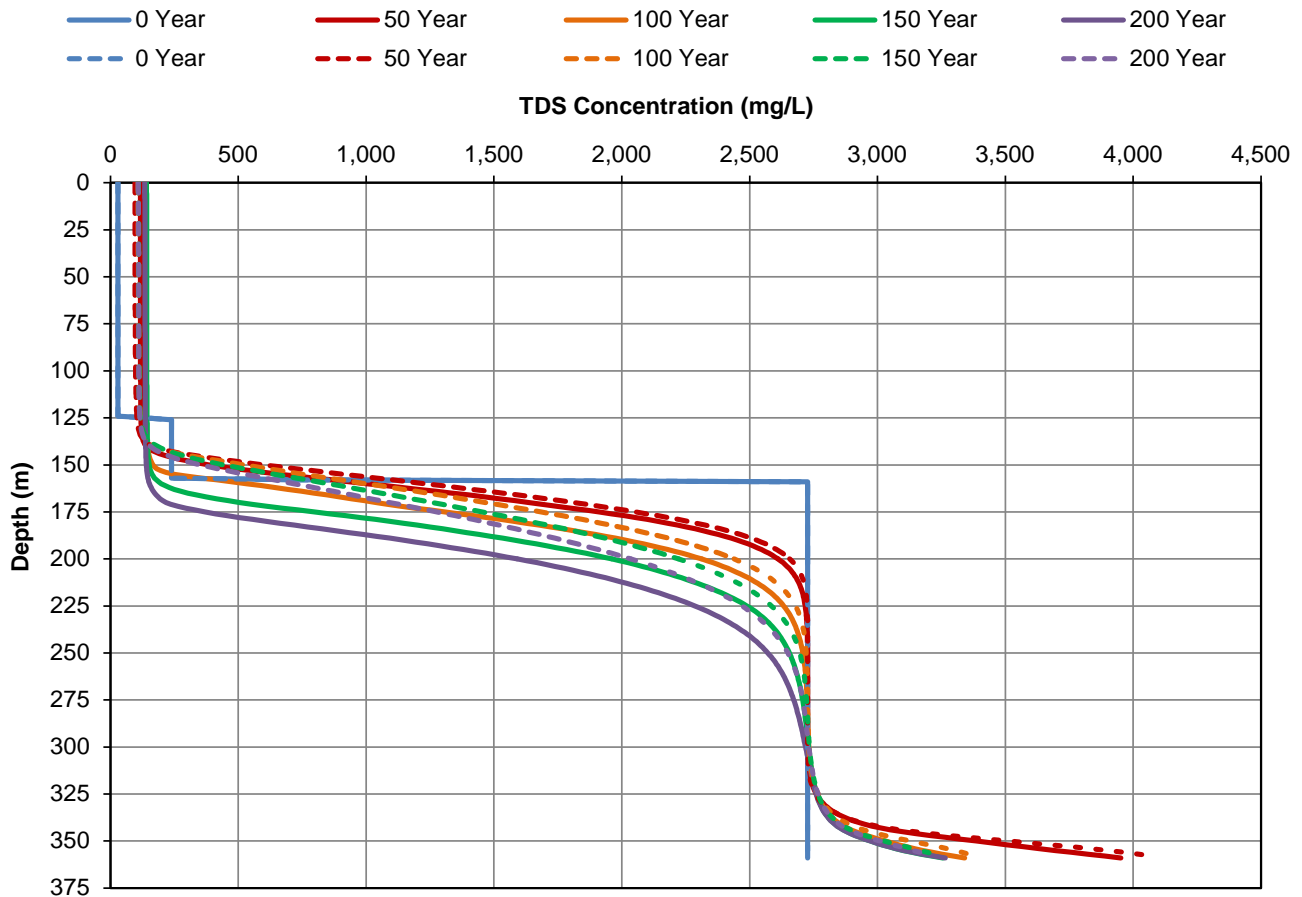
Figure 2-1: Predicted Total Dissolved Solids Profiles over 200-Year Period after Closure of Misery Pit

2.1.1.1.2 Jay Pit

Jay Pit was predicted to remain stratified during the entire 200 year simulation period for both the updated assessment and the DAR cases (Figure 2-2). Similar to the Misery Pit, the pycnocline thickness was predicted to increase with time.

Concentrations of TDS in the mixolimnion were predicted to increase over time until steady-state conditions are reached approximately 200 years into post-closure. Predicted steady-state TDS concentrations in the mixolimnion for the updated assessment and the DAR cases were 136 mg/L and 117 mg/L, respectively. Similar to the results of the Misery Pit, the increase in the predicted TDS concentration in the mixolimnion for the updated assessment case was attributed to the increased wind sheltering coefficient (Table 2-1).

Concentrations of TDS at a depth below 300 m in the monimolimnion were predicted to increase in the first 50 years and then gradually decrease. The increase was attributed to inflows of groundwater with high TDS concentrations compared to groundwater outflows during the first 50 years. The overall pattern and strength of stratification in Jay Pit are similar to those predicted for the DAR.



m = metres; mg/L = milligrams per litre; solid lines = updated assessment case; dashed lines =DAR case.

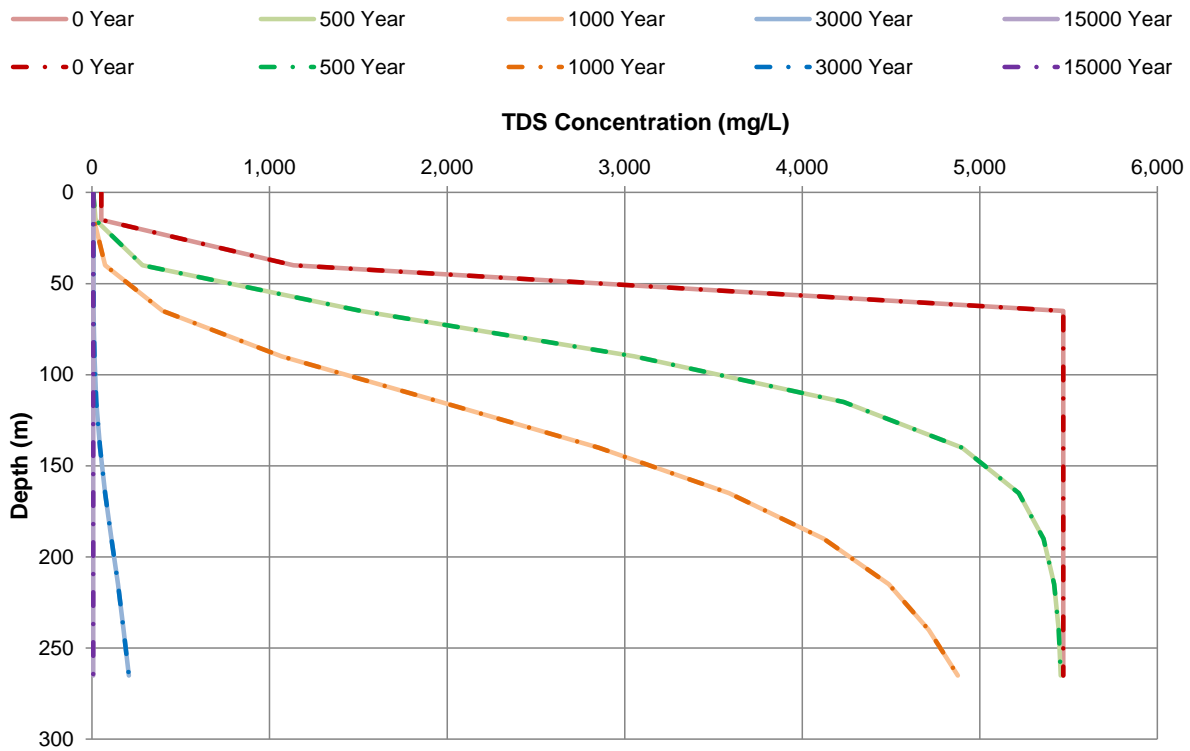
Figure 2-2: Predicted Total Dissolved Solids Profiles over 200-Year Period after Closure of Jay Pit

2.1.1.2 Vertical-Slice, Mass-Balance Model Results and Discussion

The vertical-slice, mass-balance model was updated for the Jay and Misery Pits. Predicted TDS profile concentrations in Misery and Jay Pits for both the updated assessment and the DAR cases were identical because the vertical-slice mass-balance model does not account for wind driven forces (i.e., wind sheltering coefficient) (Figure 2-3 and Figure 2-4). It is likely that after millennia, the lakes will mix more deeply than predicted for the 200-year time frame after the monimolimnion density approaches that of the mixolimnion.

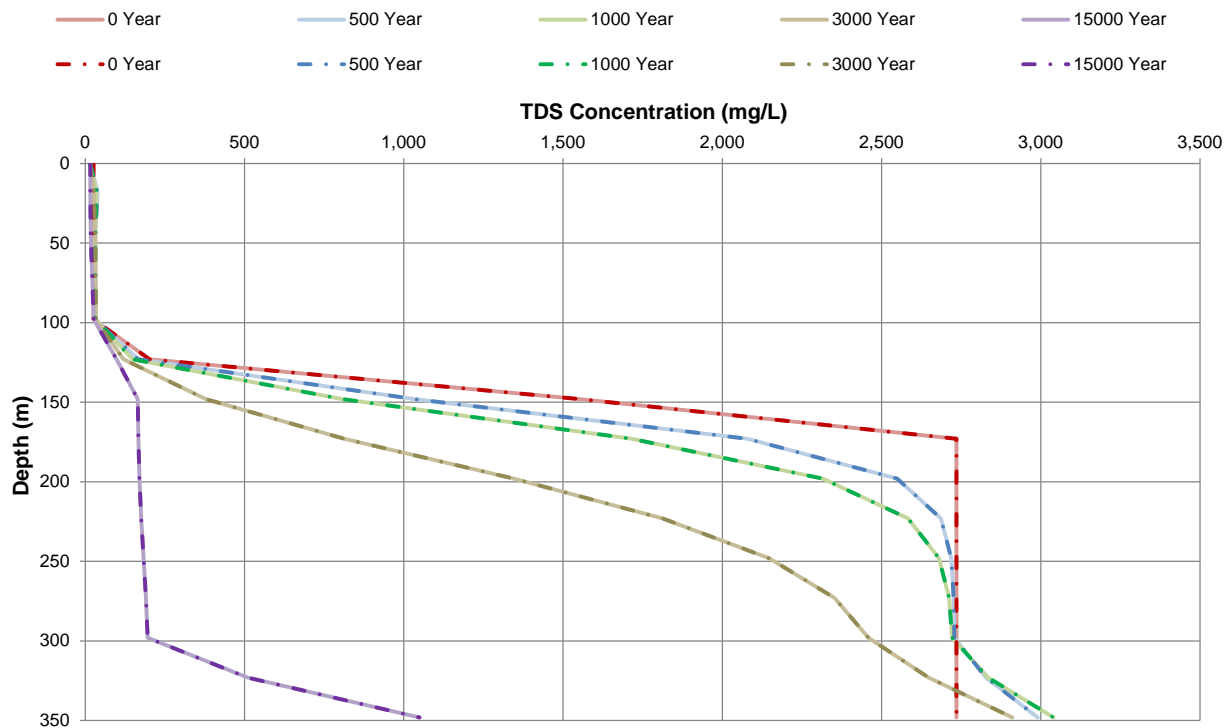


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m = metres; mg/L = milligrams per litre; solid lines = updated assessment case; dashed lines = DAR case.

Figure 2-3: Predicted Total Dissolved Solids Profile over 15,000-Year Period after the Closure of Misery Pit



m = metres; mg/L = milligrams per litre; solid lines – updated assessment case; dashed lines – DAR Case.

Figure 2-4: Predicted Total Dissolved Solids Profile over 15,000-Year Period after the Closure of Jay Pit

2.1.2 Site Water Quality Model

A stochastic site water quality was developed for the Project using GoldSim version 11.1. A detailed description of the model development, inputs, and results is presented in Appendix 8E of the DAR. As presented in Section 8E2.2.2 of Appendix 8E, during post-closure, the Misery and Jay Pits are treated as two-layer systems, composed of a mixolimnion and monimolimnion. The initial composition of the vertical layers in each model is estimated by accounting for all water transfers and inflows (e.g., natural runoff and groundwater inflows) to the pits during the re-filling period. In the site water quality model, the pit models are calibrated to TDS concentrations predicted by the pit lake hydrodynamic models in the mixolimnion by reducing the total capacity of the monimolimnion and increasing the capacity of the mixolimnion at the same rate. In this manner, mass is displaced from the monimolimnion to the mixolimnion. Advective mass transfers related to surface and groundwater inflows, as well as outflows, are also accounted for in the calibration of the site water quality model. As part of the updated assessment case, the site water quality model was re-calibrated to account for the changes made to the pit lake hydrodynamic models as part of the updated assessment case (Section 2.1.1).

The results of the calibrated Misery and Jay Pit lake hydrodynamic models are subsequently used in the Lac du Sauvage and Lac de Gras hydrodynamic models as follows:

- Maximum projected Misery Pit mixolimnion concentrations are advectively transported to Lac de Gras based on predicted outflows;



- Maximum predicted Misery Pit monimolimnion concentrations are directed to Lac de Gras along the base seepage flow pathway; and,
- Maximum Jay Pit monimolimnion concentrations are added to Lac du Sauvage at the same rate as the volume reduction of the monimolimnion.

2.1.2.1 Site Water Quality Model Results and Discussion

Table 2-2 provides the updated maximum concentrations for the Jay Pit monimolimnion and the Misery Pit mixolimnion and monimolimnion. The DAR results are also presented for comparison. In the updated assessment case, the volume of water transferred to the Misery Pit mixolimnion from the monimolimnion increased as a result of the increased wind sheltering coefficient (Section 2.1.1), resulting in increased maximum mixolimnion concentrations in the updated assessment case. For example, concentrations of TDS (435 mg/L) and chloride (235 mg/L) in the DAR increased to 748 mg/l and 437 mg/L, respectively. Sulphate, total aluminum, and total arsenic concentrations were similar between both cases. Projected concentrations in the Misery and Jay Pit monimolimnions were similar between the DAR and updated assessment cases, with a maximum increase in Jay total phosphorus concentrations of 1.5 percent (%) (Table 2-2).

Table 2-2: Projected Pit Lake Water Quality

Parameter	Units	Misery Pit		Jay Monimolimnion
		Mixolimnion	Monimolimnion	
Developer's Assessment Report				
Total Dissolved Solids	mg/L	435	5520	2005
Chloride	mg/L	235	3359	1199
Sulphate	mg/L	21	5.5	3.3
Total Phosphorus	mg/L	0.059	0.19	0.12
Ammonium	mg-N/L	0.37	5.0	2.5
Nitrate	mg-N/L	1.6	22	11
Total Aluminum	mg/L	1.3	1.2	0.018
Total Arsenic	mg/L	0.0017	0.0016	0.0011
Updated Assessment Case				
Total Dissolved Solids	mg/L	748	5520	2024
Chloride	mg/L	437	3359	1211
Sulphate	mg/L	20	5.2	3.3
Total Phosphorus	mg/L	0.067	0.19	0.12
Ammonium	mg-N/L	0.67	5.0	2.5
Nitrate	mg-N/L	2.9	22	11
Total Aluminum	mg/L	1.3	1.2	0.018
Total Arsenic	mg/L	0.0017	0.0016	0.0011

Mg/l milligrams per litre; mg-N/L = milligrams as nitrogen per litre.



2.1.3 Lake Hydrodynamic Models

Hydrodynamic models were developed for Lac du Sauvage and Lac de Gras using the Generalized Environmental Modeling System for Surfacewaters (GEMSS). Details of the development framework, calibration, inputs, and assumptions used in the Lac du Sauvage and Lac de Gras hydrodynamic models are provided in Appendix 8F of the DAR. The purpose of the lake hydrodynamic models is to evaluate changes to surface water quality downstream of Project discharges. The following changes were made to the Lac du Sauvage hydrodynamic model for the updated assessment case:

- The quantity and quality of water transferred from the Jay Pit monimolimnion to Lac du Sauvage were updated using results from the site water quality model described in Section 2.1.2; and,
- Water discharge rates from the B watershed included in the DAR model were overestimated by a factor of two from 2020 to 2060; these were corrected.

The following changes were made to the Lac de Gras hydrodynamic model for the updated assessment case:

- Misery Pit overflow and seepage quantity and quality were updated using results from the site water quality model described in Section 2.1.2;
- The discharge rate from the Diavik Mine to Lac de Gras was updated to reflect the most recent water management plan (DDMI 2014).; and,
- The quantity and quality of water discharged from Slipper Lake to Lac de Gras was updated based on modeling of the Koala Watershed by ERM Rescan (ERM Rescan 2014). This update was presented in January 2015 (Golder 2015).

Water quality data for the Diavik Mine treated effluent were obtained from monitored data at Surveillance Network Program (SNP) stations 1645-18 and 1645-18b for 2009, 2010, 2011, 2012, and 2013 (WLWB 2014). From 2014 to 2023, the Diavik Mine effluent discharge was assigned a water chemistry profile equal to the 95th percentile concentrations of monitored data. The volume of discharge from the Diavik Mine was based on measured discharge rates from 2009 to 2013, and followed predicted discharge rates the most recent water management plan from 2014 to 2023 (DDMI 2014).

Total and dissolved metals concentrations in Lac du Sauvage and Lac de Gras were predicted by adding conservative generic constituents (i.e., tracers) to the inflows from each of the mine discharges at a constant concentration of 100 mg/L. To calculate metals concentrations from the generic tracer concentrations in the lakes, metal concentrations in the mine discharges were assumed to be constant over the period of time that the discharges were active. The maximum metals concentrations for the mine discharges were used to calculate metals concentrations in Lac du Sauvage and Lac de Gras (Appendix 8F, Section 8F2 of the DAR).



2.1.3.1 Lake Hydrodynamic Model Results and Discussion

2.1.3.1.1 Lac du Sauvage

Results of the Lac du Sauvage updated assessment case hydrodynamic model are presented in Tables 2-3 to 2-5. The DAR case results are also presented for comparison. Time series plots for each parameter are presented in Appendix A. Results are presented for the three assessment locations in the lake: LDS-P1 to LDS-P3. LDS-P1 is the location of the proposed Misery Pit discharge diffuser in Lac du Sauvage. LDS-P2 is a location midway between the diffuser and the outlet of Lac du Sauvage, and LDS-P3 is located at the outlet of Lac du Sauvage where the lake discharges to Lac de Gras.

Updated assessment case predictions are similar to the DAR case predictions at all locations for all Project phases. Depth averaged concentrations for the updated assessment case results are within 10% of the DAR case results (Table 2-3). In general, differences in the updated assessment case result in lower concentrations than those predicted in the DAR case. Trends for all parameters are the same under the updated assessment and the DAR cases. For example, TDS concentrations increase in the lake during discharge (2024 – 2029), and decrease throughout closure and post-closure (Appendix A).



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Table 2-3: Predicted Maximum Depth-Averaged Constituent Concentrations in Lac du Sauvage

Parameter	Units	LDS-P1								LDS-P2								LDS-P3							
		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)	
		Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water
Updated Assessment Case																									
Total dissolved solids	mg/L	11	9.9	88	71	88	62	22	19	11	10.0	82	64	84	59	22	18	12	9.4	68	60	70	58	24	17
Chloride	mg/L	0.26	0.23	43	35	43	29	6.6	5.4	0.25	0.23	40	31	41	28	6.4	4.9	0.28	0.22	32	29	33	27	7.0	4.8
Sulphate	mg/L	1.5	1.4	2.0	1.6	1.9	1.5	1.4	1.2	1.5	1.4	1.9	1.5	1.9	1.5	1.4	1.2	1.7	1.3	1.8	1.5	1.8	1.4	1.7	1.1
Total ammonia	mg-N/L	0.031	0.025	0.17	0.13	0.17	0.076	0.057	0.049	0.031	0.025	0.16	0.09	0.16	0.069	0.058	0.05	0.036	0.025	0.13	0.092	0.14	0.064	0.061	0.046
Nitrate	mg-N/L	0.027	0.03	0.6	0.52	0.57	0.38	0.13	0.1	0.027	0.028	0.57	0.47	0.54	0.36	0.13	0.11	0.028	0.027	0.46	0.44	0.45	0.35	0.14	0.096
Total phosphorus (calculated)	mg-P/L	0.0072	0.007	0.012	0.0092	0.012	0.0079	0.0077	0.0074	0.0072	0.007	0.012	0.0078	0.012	0.0075	0.0077	0.0074	0.0073	0.0069	0.011	0.0079	0.011	0.0072	0.008	0.0073
Phytoplankton (as Chlorophyll a)	µg/L	1.8	2.4	11	14	8.1	11	2.1	2.8	1.8	2.3	11	14	8.4	11	2.1	2.8	1.8	2.3	11	14	10	11	2.1	2.8
Total Aluminum	µg/L	4.4	8.8	60	58	58	48	13	16	4.4	8.8	58	53	56	46	13	16	4.4	8.8	51	51	50	45	14	16
Total Arsenic	µg/L	0.35	0.3	0.41	0.36	0.41	0.35	0.36	0.31	0.35	0.3	0.41	0.35	0.41	0.34	0.36	0.31	0.35	0.3	0.4	0.35	0.4	0.34	0.36	0.31
DAR Case																									
Total dissolved solids	mg/L	11	10	97	79	97	72	22	20	11	10	90	70	92	62	21	18	12	9.6	72	63	76	60	22	17
Chloride	mg/L	0.28	0.24	48	40	48	35	6.3	5.6	0.27	0.24	44	34	46	30	6.1	5.0	0.3	0.23	34	30	36	29	6.4	4.8
Sulphate	mg/L	1.8	1.6	2.5	1.9	2.4	2.0	1.4	1.2	1.8	1.5	2.4	1.8	2.3	1.8	1.4	1.2	1.9	1.5	2.2	1.8	2.2	1.7	1.6	1.2
Total ammonia	mg-N/L	0.033	0.027	0.18	0.13	0.18	0.088	0.06	0.055	0.033	0.027	0.17	0.11	0.17	0.068	0.061	0.058	0.037	0.027	0.13	0.093	0.14	0.063	0.066	0.055
Nitrate	mg-N/L	0.045	0.037	0.66	0.6	0.66	0.47	0.13	0.11	0.043	0.036	0.63	0.52	0.62	0.4	0.13	0.12	0.043	0.033	0.51	0.47	0.51	0.38	0.12	0.11
Total phosphorus (calculated)	mg-P/L	0.0072	0.007	0.012	0.0091	0.012	0.0084	0.0077	0.0075	0.0072	0.007	0.012	0.0083	0.012	0.0075	0.0077	0.0075	0.0073	0.0069	0.011	0.0077	0.011	0.0072	0.0079	0.0075
Phytoplankton (as Chlorophyll a)	µg/L	1.9	2.4	11	15	8.6	11	2.7	3.6	1.8	2.3	11	15	8.9	11	2.7	3.6	1.8	2.3	12	15	11	11	2.7	3.5
Total Aluminum	µg/L	4.4	8.8	63	62	62	53	13	16	4.4	8.8	61	56	60	47	12	16	4.4	8.8	53	53	52	46	13	15
Total Arsenic	µg/L	0.35	0.3	0.42	0.35	0.42	0.34	0.36	0.31	0.35	0.3	0.41	0.35	0.41	0.34	0.36	0.31	0.35	0.3	0.41	0.34	0.4	0.34	0.36	0.31

mg/L = milligrams per litre; mg-N/L = milligrams as nitrogen per litre; mg-P/L = milligrams as phosphorus per litre; µg/L = micrograms per litre.



COMPENDIUM OF SUPPLEMENTAL WATER QUALITY MODELLING

Table 2-4: Predicted Maximum Surface Constituent Concentrations in Lac du Sauvage

Parameter	Units	LDS-P1								LDS-P2								LDS-P3							
		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)	
		Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water
Updated Assessment Case																									
Total dissolved solids	mg/L	13	9.5	71	64	72	63	24	18	13	9.5	68	63	70	60	24	18	13	9.4	68	60	70	57	24	17
Chloride	mg/L	0.31	0.22	33	31	34	30	7.2	5.1	0.31	0.22	32	31	33	28	7.0	5.0	0.31	0.22	32	28	33	27	7.1	4.8
Sulphate	mg/L	1.8	1.4	2.0	1.6	1.9	1.5	2.0	1.2	1.8	1.3	1.9	1.6	1.8	1.5	2.0	1.2	1.8	1.3	1.9	1.5	1.8	1.4	2.0	1.2
Total ammonia	mg-N/L	0.038	0.025	0.13	0.12	0.14	0.077	0.073	0.055	0.038	0.025	0.13	0.093	0.14	0.07	0.082	0.051	0.038	0.025	0.13	0.091	0.14	0.064	0.07	0.05
Nitrate	mg-N/L	0.029	0.035	0.45	0.47	0.46	0.39	0.17	0.11	0.029	0.028	0.45	0.46	0.45	0.37	0.19	0.11	0.03	0.027	0.45	0.44	0.45	0.35	0.16	0.1
Total phosphorus (calculated)	mg-P/L	0.0073	0.0069	0.01	0.0083	0.011	0.0079	0.0083	0.0073	0.0073	0.0069	0.01	0.0078	0.011	0.0076	0.0084	0.0074	0.0074	0.0069	0.01	0.0079	0.011	0.0073	0.0083	0.0073
Phytoplankton (as Chlorophyll a)	µg/L	1.8	2.3	11	15	7.7	11	2.1	2.8	1.8	2.3	11	15	7.7	11	2.1	2.8	1.8	2.3	11	15	7.6	11	2.1	2.8
Total Aluminum	µg/L	4.4	8.8	50	54	51	48	14	16	4.4	8.8	50	52	50	47	14	16	4.4	8.8	50	51	50	45	14	16
Total Arsenic	µg/L	0.35	0.3	0.4	0.35	0.4	0.35	0.36	0.31	0.35	0.3	0.4	0.35	0.4	0.34	0.36	0.31	0.35	0.3	0.4	0.35	0.4	0.34	0.36	0.31
DAR Case																									
Total dissolved solids	mg/L	14	9.9	76	70	78	70	23	18	13	9.6	73	70	76	64	22	18	13	9.6	72	63	75	60	22	17
Chloride	mg/L	0.33	0.24	36	35	37	34	6.6	5.0	0.33	0.23	35	34	36	31	6.4	4.9	0.32	0.23	34	30	36	29	6.4	4.8
Sulphate	mg/L	2.2	1.6	2.5	1.8	2.3	1.9	1.9	1.2	2.1	1.5	2.3	1.9	2.2	1.8	1.9	1.2	2.1	1.5	2.3	1.8	2.2	1.7	1.9	1.2
Total ammonia	mg-N/L	0.041	0.027	0.14	0.11	0.15	0.082	0.072	0.055	0.04	0.027	0.14	0.11	0.14	0.071	0.081	0.055	0.041	0.027	0.13	0.092	0.14	0.063	0.07	0.061
Nitrate	mg-N/L	0.053	0.036	0.51	0.53	0.52	0.46	0.16	0.1	0.05	0.033	0.5	0.52	0.51	0.41	0.18	0.11	0.046	0.033	0.49	0.47	0.51	0.38	0.15	0.12
Total phosphorus (calculated)	mg-P/L	0.0074	0.0069	0.011	0.0081	0.011	0.008	0.0083	0.0074	0.0074	0.0069	0.011	0.0084	0.011	0.0074	0.0084	0.0075	0.0074	0.0069	0.011	0.0077	0.011	0.0072	0.0083	0.0075
Phytoplankton (as Chlorophyll a)	µg/L	1.8	2.3	11	15	9.9	11	2.7	3.6	1.8	2.3	11	15	10	11	2.7	3.6	1.8	2.3	11	15	10	11	2.7	3.5
Total Aluminum	µg/L	4.4	8.8	53	57	54	52	13	16	4.4	8.8	52	56	53	48	13	16	4.4	8.8	52	53	52	45	13	15
Total Arsenic	µg/L	0.35	0.3	0.41	0.35	0.41	0.34	0.36	0.31	0.35	0.3	0.4	0.35	0.4	0.34	0.36	0.31	0.35	0.3	0.4	0.34	0.4	0.34	0.36	0.31

mg/L = milligrams per litre; mg-N/L = milligrams as nitrogen per litre; mg-P/L = milligrams as phosphorus per litre; µg/L = micrograms per litre.



COMPENDIUM OF SUPPLEMENTAL WATER QUALITY MODELLING

Table 2-5: Predicted Maximum Constituent Concentrations in Lac du Sauvage

Parameter	Units	LDS-P1								LDS-P2								LDS-P3							
		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)	
		Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water
Updated Assessment Case																									
Total dissolved solids	mg/L	13	11	100	76	103	63	24	19	13	11	94	65	96	60	24	20	13	9.5	68	60	71	58	24	17
Chloride	mg/L	0.31	0.26	51	38	52	30	7.2	5.5	0.31	0.25	47	32	48	28	7.0	5.6	0.31	0.22	32	29	34	27	7.1	4.8
Sulphate	mg/L	1.8	1.5	2.1	1.6	1.9	1.5	2.0	1.3	1.8	1.5	2.0	1.6	1.9	1.5	2.0	1.3	1.8	1.3	1.9	1.5	1.8	1.4	2.0	1.2
Total ammonia	mg-N/L	0.038	0.027	0.19	0.15	0.19	0.077	0.073	0.055	0.038	0.026	0.18	0.095	0.18	0.07	0.082	0.054	0.038	0.025	0.13	0.092	0.14	0.065	0.07	0.05
Nitrate	mg-N/L	0.032	0.035	0.69	0.57	0.67	0.39	0.17	0.12	0.03	0.032	0.65	0.48	0.63	0.37	0.19	0.11	0.03	0.027	0.48	0.44	0.46	0.35	0.16	0.1
Total phosphorus (calculated)	mg-P/L	0.0073	0.0072	0.013	0.01	0.013	0.0083	0.0083	0.0075	0.0073	0.0072	0.013	0.0085	0.012	0.0083	0.0084	0.0075	0.0074	0.0069	0.011	0.0079	0.011	0.0073	0.0083	0.0073
Phytoplankton (as Chlorophyll a)	µg/L	1.9	2.4	11	15	12	11	2.1	2.8	1.8	2.3	12	15	12	11	2.1	2.8	1.8	2.3	12	15	12	11	2.1	2.8
Total Aluminum	µg/L	4.4	8.8	65	67	64	48	14	16	4.4	8.8	63	54	61	47	14	16	4.4	8.8	52	51	50	45	14	16
Total Arsenic	µg/L	0.35	0.3	0.42	0.37	0.42	0.35	0.36	0.31	0.35	0.3	0.42	0.35	0.41	0.34	0.36	0.31	0.35	0.3	0.4	0.35	0.4	0.34	0.36	0.31
DAR Case																									
Total dissolved solids	mg/L	14	11	107	86	110	74	23	21	13	11	99	71	102	64	22	21	13	9.6	72	63	76	60	22	17
Chloride	mg/L	0.33	0.27	54	44	56	36	6.6	5.9	0.33	0.26	50	35	51	31	6.4	5.9	0.32	0.23	34	30	36	29	6.4	4.8
Sulphate	mg/L	2.2	1.8	2.6	1.9	2.4	2.0	1.9	1.3	2.1	1.7	2.5	1.9	2.3	1.8	1.9	1.3	2.1	1.5	2.3	1.8	2.2	1.7	1.9	1.2
Total ammonia	mg-N/L	0.041	0.028	0.2	0.15	0.2	0.092	0.072	0.066	0.04	0.028	0.19	0.13	0.19	0.071	0.081	0.063	0.041	0.027	0.13	0.094	0.14	0.064	0.07	0.061
Nitrate	mg-N/L	0.053	0.043	0.73	0.65	0.74	0.48	0.16	0.13	0.05	0.04	0.71	0.54	0.69	0.41	0.18	0.13	0.046	0.033	0.52	0.47	0.51	0.38	0.15	0.12
Total phosphorus (calculated)	mg-P/L	0.0074	0.0072	0.013	0.01	0.013	0.0087	0.0083	0.0076	0.0074	0.0072	0.013	0.0099	0.012	0.008	0.0084	0.0076	0.0074	0.0069	0.011	0.0077	0.011	0.0072	0.0083	0.0075
Phytoplankton (as Chlorophyll a)	µg/L	1.9	2.4	11	15	12	11	2.7	3.6	1.8	2.4	12	15	12	11	2.7	3.6	1.8	2.3	13	15	12	11	2.7	3.5
Total Aluminum	µg/L	4.4	8.8	68	66	68	54	13	16	4.4	8.8	66	60	64	48	13	16	4.4	8.8	54	53	52	46	13	15
Total Arsenic	µg/L	0.35	0.3	0.42	0.36	0.42	0.34	0.36	0.31	0.35	0.3	0.42	0.35	0.42	0.34	0.36	0.31	0.35	0.3	0.41	0.34	0.4	0.34	0.36	0.31

mg/L = milligrams per litre; mg-N/L = milligrams as nitrogen per litre; mg-P/L = milligrams as phosphorus per litre; µg/L = micrograms per litre.



2.1.3.1.2 Lac de Gras

Results of the Lac de Gras updated assessment case hydrodynamic model are presented in Tables 2-6 to 2-8 compared to the DAR case results. Time series plots for each parameter are presented in Appendix B. Results are presented for the six assessment locations in the lake: LDG-P1 to LDG-P6. LDG-P1 is the location of the FF2-2 Diavik Mine Aquatic Effects Monitoring Program (AEMP) station located between the Diavik Mine discharge and the inflow from Lac du Sauvage. LDG-P2 is the location of the FF1 Diavik Mine AEMP stations where the discharge from Paul Lake enters LDG. LDG-P3 is the location of the FFB Diavik Mine AEMP stations. LDG-P4 is the location of the FFA Diavik Mine AEMP stations. LDG-P5 is the location south of the S2 and S3 Ekati Mine AEMP stations and LDG-P6 is the Lac de Gras outlet.

Updated assessment case predictions for TDS, chloride, and sulphate were similar to the DAR case predictions at all locations for all Project phases. For example, predicted depth averaged TDS concentrations for the updated assessment case results are within 1 mg/L of the DAR case results (Table 2-6). In general, predicted ammonia, total phosphorus, and phytoplankton (as chlorophyll a) concentrations were greater for the updated assessment case by a maximum depth averaged concentration of 0.01 milligrams as nitrogen per litre (mg-N/L), 0.001 milligrams as phosphorus per litre (mg-P/L), and 2 micrograms per litre ($\mu\text{g/L}$), respectively (Table 2-6). Although concentrations of these parameters increased, concentrations are low and the updates to the Lac de Gras hydrodynamic model as part of the updated assessment case do not affect the conclusions presented in the DAR.

The update to the Misery Pit hydrodynamic water quality model was updated as part of the updated assessment case. Based on the updated model parameters, more water is expected to be displaced from the Misery Pit monimolimnion into the mixolimnion. This results in an increase in several parameters in the Misery Pit mixolimnion. The maximum projected concentration in the Misery Pit mixolimnion (Table 2-2) was used as an input to the Lac de Gras water quality model. The maximum projected Misery Pit monimolimnion concentration was applied to seepage from the Misery Pit to Lac de Gras.

Although concentrations of several parameters increased in the Misery Pit mixolimnion (Table 2-2), the total overflow and seepage from the pit to Lac de Gras is small in comparison to all other inflows to the lake. As a result, the Lac de Gras updated assessment results were similar to those presented in the DAR (see Tables 2-6 to 2-8).



COMPENDIUM OF SUPPLEMENTAL WATER QUALITY MODELLING

Table 2-6: Predicted Maximum Depth-Averaged Constituent Concentrations in Lac de Gras
Part A

Parameter	Units	LDG-P1								LDG-P2								LDG-P3							
		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)	
		Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water
Updated Assessment Case																									
Total dissolved solids	mg/L	22	20	22	21	24	24	19	18	21	19	20	19	21	20	20	19	20	19	20	19	20	20	19	18
Chloride	mg/L	3.8	3.4	5.7	5.5	6.5	7.2	4.6	4.3	3.4	3.0	3.8	3.6	4.9	4.7	4.6	4.4	3.4	3.1	3.7	3.4	4.6	4.4	4.4	4.1
Sulphate	mg/L	4.8	4.4	4.2	3.9	2.8	2.6	2.3	2.1	4.3	3.9	4.2	4.0	3.0	2.9	2.5	2.4	4.2	3.8	4.1	3.9	2.9	2.8	2.4	2.3
Total ammonia	mg-N/L	0.043	0.034	0.043	0.035	0.037	0.032	0.021	0.017	0.044	0.033	0.044	0.035	0.029	0.025	0.020	0.017	0.044	0.033	0.043	0.033	0.028	0.024	0.019	0.015
Nitrate	mg-N/L	0.086	0.075	0.059	0.070	0.071	0.078	0.028	0.028	0.047	0.043	0.041	0.036	0.037	0.035	0.023	0.022	0.047	0.042	0.038	0.028	0.034	0.031	0.023	0.022
Total phosphorus (calculated)	mg-P/L	0.0045	0.0040	0.0042	0.0039	0.0035	0.0034	0.0029	0.0028	0.0040	0.0035	0.0042	0.0037	0.0032	0.0031	0.0029	0.0028	0.0039	0.0032	0.0041	0.0031	0.0032	0.0029	0.0029	0.0027
Phytoplankton (as Chlorophyll a)	µg/L	3.4	3.9	3.1	3.7	1.5	1.9	0.7	0.7	3.8	4.8	3.4	5.0	1.6	2.1	0.8	1.0	3.8	5.1	3.5	5.2	1.6	2.2	0.7	1.0
Total Aluminum	µg/L	33	31	27	27	24	25	19	18	27	26	27	27	22	23	20	20	27	26	26	26	22	22	19	19
Total Arsenic	µg/L	0.43	0.4	0.4	0.38	0.33	0.32	0.31	0.3	0.4	0.38	0.39	0.38	0.34	0.33	0.32	0.31	0.39	0.37	0.39	0.38	0.34	0.33	0.32	0.31
DAR Case																									
Total dissolved solids	mg/L	21	20	23	22	23	24	19	19	21	19	21	20	22	21	21	20	20	19	20	19	21	20	20	19
Chloride	mg/L	3.5	3.4	5.8	5.5	6.2	6.9	4.5	4.4	3.4	3.1	4.1	3.7	5.2	5.0	4.9	4.6	3.4	3.1	3.8	3.4	4.9	4.6	4.7	4.3
Sulphate	mg/L	4.5	4.2	4.0	3.9	2.8	2.8	2.3	2.2	4.3	3.9	4.3	4.1	3.2	3.0	2.6	2.5	4.1	3.8	4.2	3.9	3.1	2.9	2.5	2.4
Total ammonia	mg-N/L	0.034	0.028	0.034	0.03	0.034	0.029	0.019	0.016	0.035	0.027	0.034	0.028	0.029	0.024	0.02	0.016	0.034	0.027	0.034	0.028	0.026	0.023	0.018	0.015
Nitrate	mg-N/L	0.073	0.071	0.068	0.078	0.075	0.082	0.028	0.028	0.053	0.048	0.05	0.044	0.048	0.045	0.029	0.027	0.052	0.047	0.047	0.038	0.044	0.039	0.029	0.025
Total phosphorus (calculated)	mg-P/L	0.0036	0.0035	0.0035	0.0035	0.0033	0.0033	0.0028	0.0028	0.0035	0.0032	0.0036	0.0033	0.0032	0.003	0.0029	0.0028	0.0035	0.003	0.0035	0.0029	0.0031	0.0028	0.0029	0.0027
Phytoplankton (as Chlorophyll a)	µg/L	2.0	2.2	1.9	2.1	1.3	1.7	0.61	0.67	2.2	2.8	2.1	3.1	1.3	1.8	0.7	0.9	2.3	3.1	2.2	3.3	1.3	1.9	0.68	0.88
Total Aluminum	µg/L	29	28	25	25	23	24	18	18	26	24	26	25	22	21	19	18	25	23	25	24	22	20	19	18
Total Arsenic	µg/L	0.41	0.39	0.39	0.37	0.33	0.31	0.31	0.29	0.34	0.31	0.34	0.32	0.29	0.26	0.27	0.24	0.34	0.31	0.34	0.31	0.29	0.26	0.27	0.24

mg/L = milligrams per litre; mg-N/L = milligrams as nitrogen per litre; mg-P/L = milligrams as phosphorus per litre; µg/L = micrograms per litre.



COMPENDIUM OF SUPPLEMENTAL WATER QUALITY MODELLING

Table 2-6: Predicted Maximum Depth-Averaged Constituent Concentrations in Lac de Gras Part B

Parameter	Units	LDG-P4								LDG-P5								LDG-P6							
		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)	
		Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water
Updated Assessment Case																									
Total dissolved solids	mg/L	20	19	20	19	20	18	19	18	20	19	20	19	20	19	19	18	23	19	23	19	23	19	23	18
Chloride	mg/L	3.4	3.2	3.4	3.2	4.4	4.1	4.3	4.0	3.5	3.3	3.4	3.3	4.4	4.2	4.4	4.1	4.0	3.3	4.0	3.3	5.1	4.2	5.1	4.1
Sulphate	mg/L	4.1	3.7	4.0	3.8	2.9	2.7	2.4	2.3	4.1	3.8	4.1	3.9	3.0	2.8	2.4	2.3	4.7	3.7	4.8	3.9	3.5	2.8	2.9	2.3
Total ammonia	mg-N/L	0.044	0.033	0.043	0.034	0.027	0.022	0.020	0.015	0.044	0.033	0.044	0.036	0.027	0.023	0.020	0.016	0.050	0.033	0.050	0.034	0.031	0.022	0.023	0.015
Nitrate	mg-N/L	0.047	0.048	0.037	0.027	0.030	0.025	0.024	0.028	0.049	0.056	0.038	0.037	0.029	0.028	0.025	0.031	0.058	0.054	0.044	0.028	0.032	0.025	0.030	0.029
Total phosphorus (calculated)	mg-P/L	0.0037	0.0030	0.0040	0.0028	0.0031	0.0028	0.0028	0.0026	0.0037	0.0035	0.0040	0.0038	0.0031	0.0030	0.0029	0.0028	0.0040	0.0029	0.0042	0.0028	0.0033	0.0027	0.0031	0.0026
Phytoplankton (as Chlorophyll a)	µg/L	3.8	4.7	3.5	5.0	1.6	2.1	0.8	1.0	3.8	4.6	3.6	4.8	1.6	2.1	0.8	1.0	3.8	5.0	4.4	5.3	1.6	2.2	0.8	1.1
Total Aluminum	µg/L	26	25	25	25	21	21	19	20	26	25	26	25	21	22	20	20	29	25	29	26	25	22	22	20
Total Arsenic	µg/L	0.39	0.37	0.39	0.38	0.34	0.33	0.32	0.32	0.39	0.37	0.39	0.38	0.35	0.34	0.33	0.32	0.42	0.37	0.42	0.38	0.37	0.34	0.34	0.32
DAR Case																									
Total dissolved solids	mg/L	20	19	20	19	20	19	19	18	20	19	20	19	20	19	20	19	24	19	23	19	23	19	23	18
Chloride	mg/L	3.4	3.2	3.4	3.2	4.5	4.2	4.4	4.1	3.4	3.3	3.4	3.3	4.5	4.3	4.4	4.2	4.0	3.3	4.0	3.2	5.2	4.2	5.2	4.2
Sulphate	mg/L	4.0	3.8	4.0	3.8	3.0	2.7	2.5	2.3	4.1	3.8	4.0	3.9	3.0	2.9	2.5	2.4	4.8	3.8	4.7	3.8	3.5	2.8	2.9	2.3
Total ammonia	mg-N/L	0.034	0.028	0.034	0.029	0.025	0.022	0.018	0.015	0.035	0.028	0.035	0.029	0.025	0.022	0.019	0.015	0.04	0.027	0.039	0.029	0.029	0.022	0.022	0.015
Nitrate	mg-N/L	0.051	0.052	0.045	0.042	0.038	0.033	0.028	0.029	0.052	0.059	0.046	0.045	0.037	0.036	0.028	0.032	0.062	0.057	0.053	0.039	0.042	0.032	0.033	0.031
Total phosphorus (calculated)	mg-P/L	0.0034	0.0029	0.0035	0.0028	0.003	0.0028	0.0028	0.0026	0.0034	0.0031	0.0035	0.0032	0.003	0.0029	0.0028	0.0027	0.0036	0.0028	0.0037	0.0027	0.0032	0.0026	0.003	0.0026
Phytoplankton (as Chlorophyll a)	µg/L	2.4	3.0	2.2	3.2	1.4	1.8	0.72	0.91	2.4	2.9	2.3	3.1	1.4	1.8	0.73	0.9	2.4	3.3	2.5	3.4	1.4	2.0	0.73	1.0
Total Aluminum	µg/L	24	23	24	22	21	19	19	17	24	22	24	23	21	20	19	18	28	22	27	23	23	19	21	18
Total Arsenic	µg/L	0.33	0.3	0.33	0.3	0.29	0.26	0.27	0.24	0.34	0.3	0.33	0.31	0.29	0.27	0.27	0.25	0.36	0.3	0.36	0.31	0.31	0.26	0.29	0.25

mg/L = milligrams per litre; mg-N/L = milligrams as nitrogen per litre; mg-P/L = milligrams as phosphorus per litre; µg/L = micrograms per litre.



COMPENDIUM OF SUPPLEMENTAL WATER QUALITY MODELLING

Table 2-7: Predicted Maximum Surface Constituent Concentrations in Lac de Gras
Part A

Parameter	Units	LDG-P1								LDG-P2								LDG-P3							
		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)	
		Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water
Updated Assessment Case																									
Total dissolved solids	mg/L	28	21	30	20	29	23	26	18	32	19	30	18	29	19	29	18	30	19	28	19	29	19	28	18
Chloride	mg/L	4.5	3.7	7.4	4.8	7.1	6.5	5.9	4.2	5.2	3.1	5.5	3.6	6.9	4.5	6.4	4.1	5.0	3.1	5.2	3.4	6.6	4.3	6.3	4.1
Sulphate	mg/L	5.7	4.7	5.5	3.8	3.7	2.6	3.1	2.1	6.6	3.9	6.0	3.7	4.0	2.7	3.4	2.2	6.1	3.8	5.7	3.8	3.8	2.7	3.4	2.2
Total ammonia	mg-N/L	0.060	0.034	0.060	0.034	0.045	0.029	0.026	0.016	0.066	0.033	0.061	0.032	0.040	0.025	0.026	0.015	0.063	0.033	0.058	0.033	0.037	0.024	0.025	0.015
Nitrate	mg-N/L	0.069	0.083	0.074	0.051	0.073	0.066	0.042	0.028	0.064	0.041	0.048	0.027	0.048	0.030	0.034	0.021	0.063	0.040	0.043	0.023	0.040	0.028	0.033	0.022
Total phosphorus (calculated)	mg-P/L	0.0048	0.0041	0.0046	0.0034	0.0038	0.0030	0.0033	0.0027	0.0051	0.0030	0.0046	0.0028	0.0036	0.0026	0.0034	0.0026	0.0048	0.0030	0.0045	0.0028	0.0035	0.0027	0.0033	0.0026
Phytoplankton (as Chlorophyll a)	µg/L	3.4	4.0	3.9	3.9	2.4	2.5	0.7	0.7	3.8	5.4	4.7	5.5	1.6	2.6	0.8	1.3	3.8	5.2	4.6	5.2	1.6	2.2	0.7	1.0
Total Aluminum	µg/L	34	33	32	25	29	24	22	19	40	27	36	25	29	22	25	19	37	26	34	26	29	22	25	19
Total Arsenic	µg/L	0.45	0.42	0.43	0.37	0.36	0.32	0.33	0.3	0.49	0.38	0.46	0.37	0.37	0.32	0.35	0.3	0.47	0.37	0.45	0.37	0.37	0.33	0.35	0.31
DAR Case																									
Total dissolved solids	mg/L	27	21	31	21	29	23	27	19	31	18	29	18	30	20	30	18	29	19	27	18	27	19	27	19
Chloride	mg/L	4.3	3.7	7.9	4.9	7.7	6.4	6.1	4.4	5.1	3.0	5.7	3.7	6.9	4.6	6.6	4.1	4.8	3.1	4.9	3.5	6.2	4.4	6.0	4.2
Sulphate	mg/L	5.5	4.6	5.0	3.7	3.6	2.7	3.1	2.2	6.4	3.8	5.9	3.6	3.9	2.7	3.6	2.2	5.9	3.8	5.5	3.7	3.7	2.7	3.3	2.3
Total ammonia	mg-N/L	0.047	0.029	0.049	0.028	0.042	0.027	0.026	0.016	0.051	0.027	0.05	0.027	0.037	0.024	0.024	0.015	0.048	0.027	0.047	0.028	0.034	0.023	0.022	0.015
Nitrate	mg-N/L	0.071	0.078	0.093	0.06	0.091	0.072	0.041	0.028	0.073	0.044	0.057	0.036	0.059	0.039	0.037	0.023	0.066	0.045	0.051	0.034	0.051	0.036	0.034	0.024
Total phosphorus (calculated)	mg-P/L	0.0041	0.0035	0.0039	0.0032	0.0036	0.003	0.0033	0.0027	0.0044	0.0028	0.0041	0.0028	0.0035	0.0026	0.0035	0.0026	0.0041	0.0029	0.0039	0.0027	0.0034	0.0026	0.0032	0.0027
Phytoplankton (as Chlorophyll a)	µg/L	2.0	2.2	1.9	2.2	2.0	1.9	0.62	0.67	2.2	3.2	2.3	3.5	1.4	2.3	0.68	1.1	2.3	3.1	2.5	3.3	1.3	1.9	0.68	0.89
Total Aluminum	µg/L	32	30	30	24	28	23	21	18	37	24	33	22	27	20	24	17	34	23	31	23	26	20	23	17
Total Arsenic	µg/L	0.44	0.4	0.4	0.36	0.35	0.31	0.33	0.29	0.42	0.31	0.4	0.3	0.31	0.25	0.3	0.23	0.41	0.31	0.39	0.3	0.31	0.26	0.29	0.24

mg/L = milligrams per litre; mg-N/L = milligrams as nitrogen per litre; mg-P/L = milligrams as phosphorus per litre; µg/L = micrograms per litre.



COMPENDIUM OF SUPPLEMENTAL WATER QUALITY MODELLING

Table 2-7: Predicted Maximum Surface Constituent Concentrations in Lac de Gras
Part B

Parameter	Units	LDG-P4								LDG-P5								LDG-P6							
		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)	
		Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water
Updated Assessment Case																									
Total dissolved solids	mg/L	31	19	29	19	28	18	29	18	30	19	31	19	29	18	30	18	31	19	32	19	27	18	30	18
Chloride	mg/L	5.3	3.2	4.9	3.3	6.3	4.1	6.3	4.0	5.0	3.5	5.2	3.3	6.5	4.1	6.6	4.1	5.3	3.4	5.4	3.3	6.1	4.1	6.7	4.1
Sulphate	mg/L	6.4	3.7	6.0	3.8	3.8	2.7	3.5	2.3	6.0	3.8	6.3	3.8	3.9	2.7	3.7	2.3	6.3	3.7	6.5	3.8	4.0	2.7	3.7	2.3
Total ammonia	mg-N/L	0.066	0.033	0.062	0.034	0.035	0.023	0.025	0.015	0.062	0.033	0.065	0.034	0.037	0.023	0.025	0.015	0.065	0.033	0.067	0.034	0.036	0.022	0.026	0.015
Nitrate	mg-N/L	0.065	0.051	0.043	0.028	0.036	0.025	0.034	0.029	0.071	0.072	0.044	0.030	0.037	0.027	0.038	0.031	0.067	0.054	0.046	0.027	0.035	0.026	0.038	0.029
Total phosphorus (calculated)	mg-P/L	0.0048	0.0028	0.0046	0.0028	0.0034	0.0026	0.0034	0.0025	0.0046	0.0031	0.0047	0.0032	0.0035	0.0028	0.0034	0.0026	0.0047	0.0029	0.0048	0.0028	0.0035	0.0027	0.0035	0.0026
Phytoplankton (as Chlorophyll a)	µg/L	3.8	4.8	4.4	5.2	1.6	2.1	0.8	1.0	3.8	4.8	4.2	5.1	1.6	2.2	0.8	1.0	3.8	5.0	4.1	5.3	1.6	2.2	0.8	1.1
Total Aluminum	µg/L	38	25	35	25	28	21	25	19	35	25	37	25	29	22	26	20	37	25	38	25	28	22	26	20
Total Arsenic	µg/L	0.48	0.37	0.46	0.38	0.38	0.33	0.36	0.31	0.47	0.37	0.48	0.38	0.38	0.34	0.37	0.32	0.48	0.37	0.49	0.38	0.39	0.34	0.37	0.32
DAR Case																									
Total dissolved solids	mg/L	30	19	30	19	27	19	29	18	32	19	31	19	29	19	30	18	33	19	30	19	30	19	32	18
Chloride	mg/L	5.0	3.3	4.9	3.2	6.1	4.2	6.5	4.1	5.3	3.6	5.1	3.2	6.6	4.2	6.7	4.1	5.6	3.4	5.0	3.2	6.8	4.2	7.1	4.2
Sulphate	mg/L	6.0	3.7	6.0	3.8	3.9	2.7	3.6	2.3	6.4	3.8	6.2	3.8	4.1	2.7	3.8	2.3	6.7	3.8	6.0	3.8	4.1	2.8	4.0	2.3
Total ammonia	mg-N/L	0.05	0.027	0.051	0.029	0.034	0.022	0.024	0.015	0.053	0.028	0.053	0.029	0.035	0.022	0.024	0.015	0.055	0.027	0.051	0.029	0.036	0.022	0.025	0.015
Nitrate	mg-N/L	0.071	0.056	0.053	0.04	0.049	0.032	0.039	0.031	0.076	0.072	0.055	0.043	0.05	0.033	0.042	0.032	0.075	0.057	0.058	0.039	0.049	0.032	0.044	0.03
Total phosphorus (calculated)	mg-P/L	0.0041	0.0028	0.0041	0.0027	0.0034	0.0026	0.0034	0.0026	0.0043	0.0029	0.0042	0.0029	0.0035	0.0026	0.0034	0.0026	0.0044	0.0028	0.0041	0.0027	0.0035	0.0026	0.0035	0.0026
Phytoplankton (as Chlorophyll a)	µg/L	2.3	3.1	2.5	3.3	1.4	1.9	0.72	0.93	2.4	3.1	2.5	3.3	1.4	1.9	0.73	0.97	2.4	3.3	2.5	3.5	1.3	2.0	0.73	1.0
Total Aluminum	µg/L	34	23	34	22	27	19	25	17	36	22	35	22	28	19	25	17	37	22	34	23	29	19	26	18
Total Arsenic	µg/L	0.41	0.3	0.41	0.3	0.33	0.26	0.31	0.24	0.43	0.3	0.42	0.3	0.33	0.26	0.32	0.24	0.44	0.3	0.41	0.31	0.34	0.26	0.32	0.25

mg/L = milligrams per litre; mg-N/L = milligrams as nitrogen per litre; mg-P/L = milligrams as phosphorus per litre; µg/L = micrograms per litre.



COMPENDIUM OF SUPPLEMENTAL WATER QUALITY MODELLING

Table 2-8: Predicted Maximum Constituent Concentrations in Lac de Gras
Part A

Parameter	Units	LDG-P1								LDG-P2								LDG-P3							
		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)	
		Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water
Updated Assessment Case																									
Total dissolved solids	mg/L	28	23	30	24	29	27	26	19	32	21	30	21	29	22	29	21	30	20	28	21	29	22	28	20
Chloride	mg/L	4.5	4.1	7.4	6.9	7.1	9.3	5.9	4.5	5.2	3.4	5.5	3.6	6.9	5.1	6.4	4.8	5.0	3.2	5.2	3.4	6.6	4.9	6.3	4.5
Sulphate	mg/L	5.7	5.3	5.5	4.2	3.7	2.8	3.1	2.2	6.6	4.2	6.0	4.3	4.0	3.1	3.4	2.6	6.1	4.0	5.7	4.2	3.8	3.0	3.4	2.4
Total ammonia	mg-N/L	0.060	0.040	0.060	0.038	0.045	0.035	0.026	0.018	0.066	0.035	0.061	0.039	0.040	0.027	0.026	0.018	0.063	0.033	0.058	0.037	0.037	0.025	0.025	0.017
Nitrate	mg-N/L	0.100	0.101	0.074	0.094	0.075	0.106	0.042	0.034	0.064	0.047	0.048	0.042	0.048	0.038	0.034	0.024	0.063	0.048	0.043	0.036	0.040	0.036	0.033	0.024
Total phosphorus (calculated)	mg-P/L	0.0048	0.0048	0.0046	0.0043	0.0038	0.0036	0.0033	0.0029	0.0051	0.0040	0.0046	0.0043	0.0036	0.0032	0.0034	0.0029	0.0048	0.0037	0.0045	0.0037	0.0035	0.0032	0.0033	0.0028
Phytoplankton (as Chlorophyll a)	µg/L	3.4	4.0	3.9	3.9	2.4	2.5	0.7	0.7	3.8	5.4	5.4	5.5	1.6	2.6	0.8	1.3	3.8	5.2	4.6	5.2	1.6	2.2	0.7	1.0
Total Aluminum	µg/L	36	37	32	29	29	29	22	19	40	28	36	29	29	24	25	21	37	26	34	28	29	24	25	21
Total Arsenic	µg/L	0.45	0.45	0.43	0.39	0.36	0.33	0.33	0.3	0.49	0.39	0.46	0.4	0.37	0.34	0.35	0.32	0.47	0.38	0.45	0.39	0.37	0.34	0.35	0.31
DAR Case																									
Total dissolved solids	mg/L	27	22	31	25	29	28	27	20	31	20	29	21	30	22	30	21	29	21	27	21	27	22	27	21
Chloride	mg/L	4.3	3.8	7.9	7.7	7.7	9.4	6.1	4.7	5.1	3.3	5.7	3.7	6.9	5.3	6.6	4.8	4.8	3.4	4.9	3.5	6.2	5.2	6.0	4.8
Sulphate	mg/L	5.5	4.8	5.0	4.2	3.6	2.9	3.1	2.4	6.4	4.1	5.9	4.3	3.9	3.2	3.6	2.6	5.9	4.2	5.5	4.3	3.7	3.2	3.3	2.6
Total ammonia	mg-N/L	0.047	0.031	0.049	0.034	0.042	0.034	0.026	0.016	0.051	0.028	0.05	0.03	0.037	0.025	0.024	0.017	0.048	0.028	0.047	0.03	0.034	0.025	0.022	0.017
Nitrate	mg-N/L	0.081	0.081	0.093	0.11	0.091	0.12	0.041	0.032	0.073	0.052	0.057	0.049	0.059	0.047	0.037	0.028	0.066	0.054	0.051	0.046	0.051	0.046	0.034	0.029
Total phosphorus (calculated)	mg-P/L	0.0041	0.0037	0.0039	0.0036	0.0036	0.0034	0.0033	0.0029	0.0044	0.0035	0.0041	0.0036	0.0035	0.0032	0.0035	0.0029	0.0041	0.0034	0.0039	0.0034	0.0034	0.0031	0.0032	0.0028
Phytoplankton (as Chlorophyll a)	µg/L	2.0	2.3	1.9	2.5	2.0	1.9	0.62	0.67	2.2	3.2	2.3	3.5	1.4	2.3	0.71	1.1	2.3	3.1	2.5	3.3	1.3	1.9	0.69	0.89
Total Aluminum	µg/L	32	31	30	29	28	29	21	19	37	25	33	26	27	22	24	19	34	25	31	26	26	22	23	19
Total Arsenic	µg/L	0.44	0.41	0.4	0.38	0.35	0.32	0.33	0.3	0.42	0.32	0.4	0.33	0.31	0.27	0.3	0.25	0.41	0.32	0.39	0.33	0.31	0.27	0.29	0.25

mg/L = milligrams per litre; mg-N/L = milligrams as nitrogen per litre; mg-P/L = milligrams as phosphorus per litre; µg/L = micrograms per litre.



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Table 2-8: Predicted Maximum Constituent Concentrations in Lac de Gras
Part B

Parameter	Units	LDG-P4								LDG-P5								LDG-P6							
		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)	
		Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water
Updated Assessment Case																									
Total dissolved solids	mg/L	31	19	29	19	28	20	29	18	30	19	31	20	29	20	30	19	31	19	32	20	27	21	30	19
Chloride	mg/L	5.3	3.2	4.9	3.3	6.3	4.3	6.3	4.0	5.0	3.5	5.2	3.5	6.5	4.5	6.6	4.3	5.3	3.4	5.4	3.5	6.1	4.6	6.7	4.4
Sulphate	mg/L	6.4	3.7	6.0	3.8	3.8	2.8	3.5	2.3	6.0	3.8	6.3	4.1	3.9	3.0	3.7	2.4	6.3	3.8	6.5	4.1	4.0	3.0	3.7	2.5
Total ammonia	mg-N/L	0.066	0.034	0.062	0.035	0.035	0.023	0.025	0.015	0.062	0.033	0.065	0.038	0.037	0.024	0.025	0.016	0.065	0.033	0.067	0.034	0.036	0.022	0.026	0.016
Nitrate	mg-N/L	0.065	0.051	0.043	0.033	0.036	0.028	0.034	0.029	0.071	0.072	0.044	0.041	0.037	0.030	0.038	0.037	0.067	0.054	0.046	0.028	0.035	0.026	0.038	0.030
Total phosphorus (calculated)	mg-P/L	0.0048	0.0036	0.0046	0.0037	0.0034	0.0031	0.0034	0.0027	0.0046	0.0037	0.0047	0.0041	0.0035	0.0031	0.0034	0.0028	0.0047	0.0029	0.0048	0.0029	0.0035	0.0028	0.0035	0.0027
Phytoplankton (as Chlorophyll a)	µg/L	3.8	4.8	4.4	5.2	1.6	2.1	0.8	1.0	3.8	4.8	4.4	5.1	1.6	2.2	0.8	1.0	3.8	5.0	4.7	5.4	1.6	2.2	0.8	1.1
Total Aluminum	µg/L	38	25	35	26	28	22	25	20	35	25	37	26	29	23	26	20	37	25	38	27	28	23	26	21
Total Arsenic	µg/L	0.48	0.37	0.46	0.38	0.38	0.33	0.36	0.32	0.47	0.37	0.48	0.39	0.38	0.35	0.37	0.32	0.48	0.37	0.49	0.39	0.39	0.34	0.37	0.32
DAR Case																									
Total dissolved solids	mg/L	30	19	30	19	27	20	29	19	32	20	31	20	29	20	30	19	33	19	30	20	30	20	32	19
Chloride	mg/L	5.0	3.3	4.9	3.2	6.1	4.4	6.5	4.2	5.3	3.7	5.1	3.6	6.6	4.6	6.7	4.4	5.6	3.4	5.0	3.4	6.8	4.6	7.1	4.4
Sulphate	mg/L	6.0	3.8	6.0	3.8	3.9	2.9	3.6	2.3	6.4	3.9	6.2	4.0	4.1	3.0	3.8	2.5	6.7	3.9	6.0	4.0	4.1	3.0	4.0	2.5
Total ammonia	mg-N/L	0.05	0.028	0.051	0.029	0.034	0.022	0.024	0.015	0.053	0.028	0.053	0.03	0.035	0.022	0.024	0.016	0.055	0.027	0.051	0.029	0.036	0.022	0.025	0.015
Nitrate	mg-N/L	0.071	0.056	0.053	0.042	0.049	0.036	0.039	0.031	0.076	0.073	0.055	0.052	0.05	0.038	0.042	0.044	0.075	0.057	0.058	0.04	0.049	0.035	0.044	0.031
Total phosphorus (calculated)	mg-P/L	0.0041	0.0033	0.0041	0.0035	0.0034	0.003	0.0034	0.0028	0.0043	0.0034	0.0042	0.0035	0.0035	0.003	0.0034	0.0028	0.0044	0.0029	0.0041	0.0029	0.0035	0.0027	0.0035	0.0026
Phytoplankton (as Chlorophyll a)	µg/L	2.4	3.1	2.5	3.3	1.4	1.9	0.73	0.93	2.4	3.1	2.5	3.3	1.4	1.9	0.73	0.98	2.4	3.3	2.6	3.5	1.4	2.0	0.74	1.0
Total Aluminum	µg/L	34	23	34	23	27	20	25	18	36	23	35	25	28	21	25	19	37	23	34	24	29	20	26	18
Total Arsenic	µg/L	0.41	0.3	0.41	0.31	0.33	0.27	0.31	0.24	0.43	0.32	0.42	0.32	0.33	0.28	0.32	0.26	0.44	0.3	0.41	0.31	0.34	0.27	0.32	0.25

mg/L = milligrams per litre; mg-N/L = milligrams as nitrogen per litre; mg-P/L = milligrams as phosphorus per litre; µg/L = micrograms per litre.



3.0 NO JAY DEVELOPMENT CASE

The no Jay development case was developed for inclusion in this compendium. This is a scenario that does not consider the development of the Jay Project, but includes existing and approved developments (i.e., Base Case) through the modelling timeframe. The following changes to existing models were made for the no Jay development case:

- The Lac du Sauvage hydrodynamic model used in the DAR assessment (Appendix 8F of the DAR) was extended to 2060 to predict future conditions in the lake without the development of the Project. In this case, inputs applied during the calibration period were extended throughout the entire simulation period to reflect “No Jay Development”;
- Input water quantity and quality from the Slipper Lake discharge and Misery Pit overflow to Lac de Gras were revised based on updated modelling completed by ERM Rescan of the Koala watershed and King-Cujo watershed without the development of the Project (Forster 2015a);
- The discharge rate from Diavik Mine to Lac de Gras was updated to reflect the most recent water management plan (DDMI 2014); and,
- Water discharge rates from the B watershed included in the DAR model were overestimated by a factor of two from 2020 to 2060; these were corrected.

The above changes required updates to the following models:

- Regional water balance model; and,
- Lac du Sauvage and Lac de Gras hydrodynamic models.

Details of each of the model updates are provided in the following subsections.

3.1 Model Updates

3.1.1 Lake Hydrodynamic Models

The no Jay development case Lac du Sauvage hydrodynamic model was developed as an extension of the model presented in the DAR (Appendix 8F of the DAR). For this update, the inputs used for the calibration period were extended for the entire simulation period and Project inputs to the Lac du Sauvage hydrodynamic model were omitted. The omitted Project inputs included:

- dewatering flow from the diked area in Lac du Sauvage;
- discharge from the Misery Pit;
- runoff from the Jay waste rock storage area (WRSA); and,
- load from the Jay Pit monimolimnion.

Additionally, Project related withdrawals from Lac du Sauvage were removed from the model, including pumping to the Misery Pit and pumping to the Jay Pit and diked area during back-flooding at closure. Time series of predicted concentrations at the Lac du Sauvage outlet from 2009 to 2060 were used as an input to the Lac de Gras hydrodynamic model.



To derive input watershed flows for the no Jay development case to Lac de Gras, the regional water balance model was updated. The update involved adding revised predictions of inflows from Slipper Lake to Lac de Gras to the regional water balance model from modelling completed by ERM Rescan (Attachment 8F3 of the DAR) of the Koala Watershed without the development of the Project (Forster 2015a).

The Misery Pit was assumed to fill and overflow to Lac de Gras beginning in 2030. Overflow volumes from the Misery Pit were based on modelling of the Misery Pit (without the Project) (Rescan 2013). Predicted surface water quality for the Misery Pit was provided by ERM Rescan (Forster 2015b). Due to the small watershed area of this pit lake, the overflow was predicted to be approximately 9,000 cubic metres per year ($m^3/year$) and to only occur in June (ERM Rescan 2014). No seepage through the groundwater from the Misery Pit to Lac de Gras was predicted under the no Jay development case.

Inflow water quality from Slipper Lake was based on modelling of the Ekati Mine (Rescan 2012) that does not include the Project. Water quality in the discharge from Slipper Lake to Lac de Gras has been changed by Ekati Mine operations in the Koala watershed, which discharges to Lac de Gras via Slipper Lake (BHP Billiton 2013). Water quality data for inflows from Slipper Lake to Lac de Gras were obtained from data presented in the 2010, 2011, and 2012 Ekati Mine AEMPs for Slipper Lake, the Slipper Lake discharge stream, and sampling stations in Lac de Gras (BHP Billiton 2011, 2012, 2013). From 2009 to 2012, the available Slipper Lake outlet water quality was used to generate a time series to represent outlet water quality to Lac de Gras. For future water quality projections, predicted water quality concentrations from Slipper Lake to Lac de Gras were provided by ERM Rescan (Forster 2015a).

Water quality data for the Diavik Mine treated effluent were obtained from monitored data at SNP stations 1645-18 and 1645-18b for 2009, 2010, 2011, 2012, and 2013 (WLWB 2014). From 2014 to 2023, the Diavik Mine effluent discharge was assigned a water chemistry profile equal to the 95th percentile concentrations of monitored data. The volume of discharge from the Diavik Mine was based on measured discharge rates from 2009 – 2013, and followed projected discharge rates from the most recent water management plan starting in 2014 (DDMI 2014).

Similar to the DAR model, a tracer constituent was used to estimate the metals concentrations in Lac du Sauvage and Lac de Gras.



3.1.1.1 Lake Hydrodynamic Model Results and Discussion

3.1.1.1.1 Lac du Sauvage

Results of the Lac du Sauvage no Jay development case hydrodynamic model are presented in Tables 3-1 to 3-3. The updated assessment case results (Section 2.0) are also presented for comparison. Time series plots for each parameter are presented in Appendix A. Results are presented for the three assessment locations in the lake: LDS-P1, LDS-P2, and LDS-P3.

In the no Jay development case, predicted constituent concentrations in Lac du Sauvage are similar to the baseline concentrations presented in early operations for the updated assessment case (prior to Project related discharges to Lac du Sauvage) for the duration of the model. Trends in predicted concentrations for most constituents show little to no variation over time from the initial, baseline concentrations (Appendix A). Some parameters, e.g., sulphate, show slight increases until 2030. These increases are related to the Christine Lake discharge to Lac du Sauvage. Water quality from Christine Lake to Lac du Sauvage has been influenced by the Misery site, which discharges minewater via the King Pond Settling Facility into Cujo Lake and then through Christine Lake. The influence of this discharge is also accounted for in the updated assessment case.



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Table 3-1: Predicted Maximum Depth-Averaged Constituent Concentrations in Lac du Sauvage

Parameter	Units	LDS-P1								LDS-P2								LDS-P3							
		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)	
		Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water
No Jay Development Case																									
Total dissolved solids	mg/L	11	10.0	11	9.4	11	9.8	11	9.8	11	10	11	9.4	11	9.8	10	9.7	12	9.4	12	9.4	13	9.3	12	9.3
Chloride	mg/L	0.26	0.23	0.26	0.22	0.26	0.23	0.24	0.22	0.26	0.24	0.26	0.22	0.26	0.23	0.24	0.22	0.29	0.22	0.29	0.22	0.29	0.22	0.28	0.21
Sulphate	mg/L	1.5	1.4	1.5	1.3	1.5	1.2	1.2	1.1	1.5	1.4	1.5	1.3	1.5	1.2	1.2	1.1	1.7	1.3	1.6	1.3	1.6	1.2	1.4	1.0
Total ammonia	mg-N/L	0.03	0.024	0.031	0.025	0.029	0.023	0.026	0.021	0.03	0.024	0.031	0.025	0.029	0.023	0.026	0.022	0.036	0.024	0.035	0.025	0.034	0.023	0.031	0.021
Nitrate	mg-N/L	0.028	0.025	0.028	0.027	0.028	0.022	0.015	0.013	0.028	0.026	0.028	0.027	0.027	0.022	0.015	0.012	0.028	0.023	0.028	0.023	0.027	0.022	0.015	0.012
Total phosphorus (calculated)	mg-P/L	0.0072	0.007	0.0072	0.0069	0.0072	0.007	0.0072	0.0071	0.0072	0.007	0.0072	0.0069	0.0072	0.007	0.0072	0.0071	0.0073	0.0068	0.0072	0.0069	0.0073	0.0069	0.0073	0.007
Phytoplankton (as Chlorophyll a)	µg/L	1.7	2.2	1.6	2.2	1.6	2.1	1.7	2.2	1.7	2.2	1.6	2.2	1.6	2.1	1.7	2.1	1.7	2.2	1.6	2.3	1.6	2.1	1.7	2.1
Total Aluminum	µg/L	4.4	8.8	4.4	8.8	4.4	8.8	4.4	8.8	4.4	8.8	4.4	8.8	4.4	8.8	4.4	8.8	4.4	8.8	4.4	8.8	4.4	8.8	4.4	8.8
Total Arsenic	µg/L	0.35	0.3	0.35	0.3	0.35	0.3	0.35	0.3	0.35	0.3	0.35	0.3	0.35	0.3	0.35	0.3	0.35	0.3	0.35	0.3	0.35	0.3	0.35	0.3
Updated Assessment Case																									
Total dissolved solids	mg/L	11	9.9	88	71	88	62	22	19	11	10.0	82	64	84	59	22	18	12	9.4	68	60	70	58	24	17
Chloride	mg/L	0.26	0.23	43	35	43	29	6.6	5.4	0.25	0.23	40	31	41	28	6.4	4.9	0.28	0.22	32	29	33	27	7.0	4.8
Sulphate	mg/L	1.5	1.4	2.0	1.6	1.9	1.5	1.4	1.2	1.5	1.4	1.9	1.5	1.9	1.5	1.4	1.2	1.7	1.3	1.8	1.5	1.8	1.4	1.7	1.1
Total ammonia	mg-N/L	0.031	0.025	0.17	0.13	0.17	0.076	0.057	0.049	0.031	0.025	0.16	0.09	0.16	0.069	0.058	0.05	0.036	0.025	0.13	0.092	0.14	0.064	0.061	0.046
Nitrate	mg-N/L	0.027	0.03	0.6	0.52	0.57	0.38	0.13	0.1	0.027	0.028	0.57	0.47	0.54	0.36	0.13	0.11	0.028	0.027	0.46	0.44	0.45	0.35	0.14	0.096
Total phosphorus (calculated)	mg-P/L	0.0072	0.007	0.012	0.0092	0.012	0.0079	0.0077	0.0074	0.0072	0.007	0.012	0.0078	0.012	0.0075	0.0077	0.0074	0.0073	0.0069	0.011	0.0079	0.011	0.0072	0.008	0.0073
Phytoplankton (as Chlorophyll a)	µg/L	1.8	2.4	11	14	8.1	11	2.1	2.8	1.8	2.3	11	14	8.4	11	2.1	2.8	1.8	2.3	11	14	10	11	2.1	2.8
Total Aluminum	µg/L	4.4	8.8	60	58	58	48	13	16	4.4	8.8	58	53	56	46	13	16	4.4	8.8	51	51	50	45	14	16
Total Arsenic	µg/L	0.35	0.3	0.41	0.36	0.41	0.35	0.36	0.31	0.35	0.3	0.41	0.35	0.41	0.34	0.36	0.31	0.35	0.3	0.4	0.35	0.4	0.34	0.36	0.31

mg/L = milligrams per litre; mg-N/L = milligrams as nitrogen per litre; mg-P/L = milligrams as phosphorus per litre; µg/L = micrograms per litre.



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Table 3-2: Predicted Maximum Surface Constituent Concentrations in Lac du Sauvage

Parameter	Units	LDS-P1								LDS-P2								LDS-P3							
		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)	
		Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water
No Jay Development Case																									
Total dissolved solids	mg/L	13	9.4	14	9.4	13	9.3	18	12	14	9.4	14	9.4	13	9.3	18	12	14	9.4	14	9.5	13	9.3	18	12
Chloride	mg/L	0.3	0.22	0.32	0.22	0.31	0.22	2.3	1.5	0.33	0.22	0.32	0.22	0.3	0.22	2.3	1.5	0.34	0.22	0.33	0.22	0.31	0.22	2.3	1.5
Sulphate	mg/L	1.8	1.3	1.9	1.3	1.8	1.2	1.7	1.2	1.9	1.3	1.8	1.3	1.7	1.2	1.7	1.2	2.0	1.3	1.9	1.3	1.7	1.2	1.7	1.2
Total ammonia	mg-N/L	0.037	0.024	0.038	0.025	0.035	0.023	0.056	0.032	0.04	0.024	0.039	0.025	0.034	0.023	0.056	0.032	0.041	0.024	0.04	0.025	0.036	0.023	0.056	0.032
Nitrate	mg-N/L	0.03	0.027	0.031	0.028	0.029	0.022	0.043	0.023	0.029	0.024	0.03	0.03	0.028	0.022	0.043	0.023	0.029	0.024	0.03	0.023	0.027	0.022	0.043	0.023
Total phosphorus (calculated)	mg-P/L	0.0073	0.0069	0.0073	0.0069	0.0073	0.0069	0.0079	0.007	0.0074	0.0069	0.0073	0.0069	0.0073	0.0069	0.0079	0.007	0.0074	0.0068	0.0073	0.0069	0.0073	0.0069	0.0079	0.007
Phytoplankton (as Chlorophyll a)	µg/L	1.7	2.2	1.6	2.2	1.6	2.1	3.3	4.9	1.7	2.2	1.6	2.2	1.6	2.1	3.3	4.9	1.7	2.2	1.6	2.3	1.6	2.1	3.3	4.9
Total Aluminum	µg/L	4.4	8.8	4.4	8.8	4.4	8.8	4.4	8.8	4.4	8.8	4.4	8.8	4.4	8.8	4.4	8.8	4.4	8.8	4.4	8.8	4.4	8.8	4.4	8.8
Total Arsenic	µg/L	0.35	0.3	0.35	0.3	0.35	0.3	0.35	0.3	0.35	0.3	0.35	0.3	0.35	0.3	0.35	0.3	0.35	0.3	0.35	0.3	0.35	0.3	0.35	0.3
Updated Assessment Case																									
Total dissolved solids	mg/L	13	9.5	71	64	72	63	24	18	13	9.5	68	63	70	60	24	18	13	9.4	68	60	70	57	24	17
Chloride	mg/L	0.31	0.22	33	31	34	30	7.2	5.1	0.31	0.22	32	31	33	28	7.0	5.0	0.31	0.22	32	28	33	27	7.1	4.8
Sulphate	mg/L	1.8	1.4	2.0	1.6	1.9	1.5	2.0	1.2	1.8	1.3	1.9	1.6	1.8	1.5	2.0	1.2	1.8	1.3	1.9	1.5	1.8	1.4	2.0	1.2
Total ammonia	mg-N/L	0.038	0.025	0.13	0.12	0.14	0.077	0.073	0.055	0.038	0.025	0.13	0.093	0.14	0.07	0.082	0.051	0.038	0.025	0.13	0.091	0.14	0.064	0.07	0.05
Nitrate	mg-N/L	0.029	0.035	0.45	0.47	0.46	0.39	0.17	0.11	0.029	0.028	0.45	0.46	0.45	0.37	0.19	0.11	0.03	0.027	0.45	0.44	0.45	0.35	0.16	0.1
Total phosphorus (calculated)	mg-P/L	0.0073	0.0069	0.01	0.0083	0.011	0.0079	0.0083	0.0073	0.0073	0.0069	0.01	0.0078	0.011	0.0076	0.0084	0.0074	0.0074	0.0069	0.01	0.0079	0.011	0.0073	0.0083	0.0073
Phytoplankton (as Chlorophyll a)	µg/L	1.8	2.3	11	15	7.7	11	2.1	2.8	1.8	2.3	11	15	7.7	11	2.1	2.8	1.8	2.3	11	15	7.6	11	2.1	2.8
Total Aluminum	µg/L	4.4	8.8	50	54	51	48	14	16	4.4	8.8	50	52	50	47	14	16	4.4	8.8	50	51	50	45	14	16
Total Arsenic	µg/L	0.35	0.3	0.4	0.35	0.4	0.35	0.36	0.31	0.35	0.3	0.4	0.35	0.4	0.34	0.36	0.31	0.35	0.3	0.4	0.35	0.4	0.34	0.36	0.31

mg/L = milligrams per litre; mg-N/L = milligrams as nitrogen per litre; mg-P/L = milligrams as phosphorus per litre; µg/L = micrograms per litre.



COMPENDIUM OF SUPPLEMENTAL WATER QUALITY MODELLING

Table 3-3: Predicted Maximum Constituent Concentrations in Lac du Sauvage

Parameter	Units	LDS-P1								LDS-P2								LDS-P3							
		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)	
		Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water
No Jay Development Case																									
Total dissolved solids	mg/L	13	11	14	9.4	13	10	12	10	14	11	14	9.5	13	10	12	10	14	9.4	14	9.5	13	9.5	13	9.6
Chloride	mg/L	0.3	0.26	0.32	0.22	0.31	0.24	0.28	0.23	0.33	0.25	0.32	0.22	0.3	0.24	0.28	0.23	0.34	0.22	0.33	0.22	0.31	0.22	0.3	0.22
Sulphate	mg/L	1.8	1.5	1.9	1.3	1.8	1.2	1.4	1.1	1.9	1.5	1.8	1.3	1.7	1.2	1.4	1.1	2.0	1.3	1.9	1.3	1.7	1.2	1.5	1.0
Total ammonia	mg-N/L	0.037	0.026	0.038	0.025	0.035	0.025	0.03	0.023	0.04	0.026	0.039	0.025	0.034	0.025	0.031	0.023	0.041	0.024	0.04	0.025	0.036	0.023	0.033	0.021
Nitrate	mg-N/L	0.03	0.029	0.031	0.028	0.029	0.022	0.016	0.014	0.029	0.028	0.03	0.03	0.028	0.022	0.016	0.014	0.029	0.024	0.03	0.023	0.027	0.022	0.015	0.012
Total phosphorus (calculated)	mg-P/L	0.0073	0.0072	0.0073	0.0069	0.0073	0.0072	0.0073	0.0072	0.0074	0.0072	0.0073	0.0069	0.0073	0.0071	0.0073	0.0072	0.0074	0.0068	0.0073	0.0069	0.0073	0.0069	0.0074	0.007
Phytoplankton (as Chlorophyll a)	µg/L	1.7	2.3	1.6	2.2	1.6	2.1	1.7	2.2	1.7	2.2	1.6	2.2	1.6	2.1	1.7	2.1	1.7	2.2	1.6	2.3	1.6	2.1	1.7	2.1
Total Aluminum	µg/L	4.4	8.8	4.4	8.8	4.4	8.8	4.4	8.8	4.4	8.8	4.4	8.8	4.4	8.8	4.4	8.8	4.4	8.8	4.4	8.8	4.4	8.8	4.4	8.8
Total Arsenic	µg/L	0.35	0.3	0.35	0.3	0.35	0.3	0.35	0.3	0.35	0.3	0.35	0.3	0.35	0.3	0.35	0.3	0.35	0.3	0.35	0.3	0.35	0.3	0.35	0.3
Updated Assessment Case																									
Total dissolved solids	mg/L	13	11	100	76	103	63	24	19	13	11	94	65	96	60	24	20	13	9.5	68	60	71	58	24	17
Chloride	mg/L	0.31	0.26	51	38	52	30	7.2	5.5	0.31	0.25	47	32	48	28	7.0	5.6	0.31	0.22	32	29	34	27	7.1	4.8
Sulphate	mg/L	1.8	1.5	2.1	1.6	1.9	1.5	2.0	1.3	1.8	1.5	2.0	1.6	1.9	1.5	2.0	1.3	1.8	1.3	1.9	1.5	1.8	1.4	2.0	1.2
Total ammonia	mg-N/L	0.038	0.027	0.19	0.15	0.19	0.077	0.073	0.055	0.038	0.026	0.18	0.095	0.18	0.07	0.082	0.054	0.038	0.025	0.13	0.092	0.14	0.065	0.07	0.05
Nitrate	mg-N/L	0.032	0.035	0.69	0.57	0.67	0.39	0.17	0.12	0.03	0.032	0.65	0.48	0.63	0.37	0.19	0.11	0.03	0.027	0.48	0.44	0.46	0.35	0.16	0.1
Total phosphorus (calculated)	mg-P/L	0.0073	0.0072	0.013	0.01	0.013	0.0083	0.0083	0.0075	0.0073	0.0072	0.013	0.0085	0.012	0.0083	0.0084	0.0075	0.0074	0.0069	0.011	0.0079	0.011	0.0073	0.0083	0.0073
Phytoplankton (as Chlorophyll a)	µg/L	1.9	2.4	11	15	12	11	2.1	2.8	1.8	2.3	12	15	12	11	2.1	2.8	1.8	2.3	12	15	12	11	2.1	2.8
Total Aluminum	µg/L	4.4	8.8	65	67	64	48	14	16	4.4	8.8	63	54	61	47	14	16	4.4	8.8	52	51	50	45	14	16
Total Arsenic	µg/L	0.35	0.3	0.42	0.37	0.42	0.35	0.36	0.31	0.35	0.3	0.42	0.35	0.41	0.34	0.36	0.31	0.35	0.3	0.4	0.35	0.4	0.34	0.36	0.31

mg/L = milligrams per litre; mg-N/L = milligrams as nitrogen per litre; mg-P/L = milligrams as phosphorus per litre; µg/L = micrograms per litre.



3.1.1.1.2 Lac de Gras

Results of the Lac de Gras no Jay development case hydrodynamic model are presented in Tables 3-4 to 3-6. Updated assessment case results are also presented for comparison. Time series plots for each parameter are presented in Appendix B. Results are presented for the six assessment locations in the lake: LDG-P1, LDG-P2, LDG-P3, LDG-P4, LDG-P5, and LDG-P6.

Constituent concentrations are predicted to increase until 2024 in Lac de Gras and then decrease to steady-state concentrations prior to 2060 (Appendix B). A comparison of the updated assessment case and the no Jay development case constituent concentrations in Lac de Gras indicates that predicted concentrations are similar from 2014 to 2024, but are greater post-2024 in the updated assessment case. In the updated assessment case, the Project is not projected to discharge until 2024. Therefore, the predicted increases in constituent concentrations in Lac de Gras prior to 2024 are related to discharges from the existing Diavik and Ekati operations. Predicted increases in constituent concentrations in Lac de Gras post-2024 in the updated assessment case are related to discharges from the Project.



COMPENDIUM OF SUPPLEMENTAL WATER QUALITY MODELLING

Table 3-4: Predicted Maximum Depth-Averaged Constituent Concentrations in Lac de Gras
Part A

Parameter	Units	LDG-P1								LDG-P2								LDG-P3							
		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)	
		Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water
No Jay Development Case																									
Total dissolved solids	mg/L	22	20	20	18	15	14	14	13	20	19	20	19	16	16	14	14	20	18	20	19	16	15	14	13
Chloride	mg/L	3.8	3.4	3.2	3.0	1.9	1.7	1.3	1.2	3.3	3.0	3.3	3.1	2.1	2.0	1.5	1.4	3.3	3.0	3.3	3.1	2.1	2.0	1.5	1.4
Sulphate	mg/L	4.8	4.4	4.1	3.9	2.7	2.6	2.2	2.0	4.2	3.8	4.2	4.0	3.0	2.9	2.4	2.3	4.2	3.8	4.1	3.9	2.9	2.8	2.3	2.2
Total ammonia	mg-N/L	0.043	0.034	0.043	0.034	0.018	0.015	0.012	0.010	0.044	0.033	0.043	0.034	0.017	0.015	0.011	0.009	0.043	0.033	0.043	0.032	0.017	0.014	0.011	0.009
Nitrate	mg-N/L	0.085	0.074	0.049	0.044	0.013	0.013	0.012	0.011	0.047	0.043	0.040	0.035	0.012	0.011	0.011	0.011	0.047	0.042	0.037	0.026	0.012	0.011	0.012	0.011
Total phosphorus (calculated)	mg-P/L	0.0045	0.0040	0.0042	0.0038	0.0029	0.0028	0.0026	0.0025	0.0039	0.0035	0.0042	0.0037	0.0029	0.0028	0.0027	0.0026	0.0039	0.0032	0.0041	0.0031	0.0029	0.0027	0.0027	0.0026
Phytoplankton (as Chlorophyll a)	µg/L	3.3	3.8	3.0	3.7	0.7	0.8	0.4	0.5	3.8	4.7	3.4	4.9	0.8	1.2	0.5	0.7	3.8	5.1	3.5	5.2	0.8	1.2	0.5	0.6
Total Aluminum	µg/L	32	30	27	26	16	16	12	13	27	26	27	27	17	18	13	14	26	26	26	26	17	18	13	14
Total Arsenic	µg/L	0.44	0.41	0.40	0.38	0.33	0.31	0.30	0.29	0.40	0.38	0.40	0.39	0.34	0.33	0.31	0.30	0.40	0.38	0.40	0.38	0.34	0.33	0.31	0.30
Updated Assessment Case																									
Total dissolved solids	mg/L	22	20	22	21	24	24	19	18	21	19	20	19	21	20	20	19	20	19	20	19	20	20	19	18
Chloride	mg/L	3.8	3.4	5.7	5.5	6.5	7.2	4.6	4.3	3.4	3.0	3.8	3.6	4.9	4.7	4.6	4.4	3.4	3.1	3.7	3.4	4.6	4.4	4.4	4.1
Sulphate	mg/L	4.8	4.4	4.2	3.9	2.8	2.6	2.3	2.1	4.3	3.9	4.2	4.0	3.0	2.9	2.5	2.4	4.2	3.8	4.1	3.9	2.9	2.8	2.4	2.3
Total ammonia	mg-N/L	0.043	0.034	0.043	0.035	0.037	0.032	0.021	0.017	0.044	0.033	0.044	0.035	0.029	0.025	0.02	0.017	0.044	0.033	0.043	0.033	0.028	0.024	0.019	0.015
Nitrate	mg-N/L	0.086	0.075	0.059	0.07	0.071	0.078	0.028	0.028	0.047	0.043	0.041	0.036	0.037	0.035	0.023	0.022	0.047	0.042	0.038	0.028	0.034	0.031	0.023	0.022
Total phosphorus (calculated)	mg-P/L	0.0045	0.004	0.0042	0.0039	0.0035	0.0034	0.0029	0.0028	0.0040	0.0035	0.0042	0.0037	0.0032	0.0031	0.0029	0.0028	0.0039	0.0032	0.0041	0.0031	0.0032	0.0029	0.0029	0.0027
Phytoplankton (as Chlorophyll a)	µg/L	3.4	3.9	3.1	3.7	1.5	1.9	0.65	0.71	3.8	4.8	3.4	5.0	1.6	2.1	0.76	1.02	3.8	5.1	3.5	5.2	1.6	2.2	0.74	1.0
Total Aluminum	µg/L	33	31	27	27	24	25	19	18	27	26	27	27	22	23	20	20	27	26	26	26	22	22	19	19
Total Arsenic	µg/L	0.43	0.40	0.40	0.38	0.33	0.32	0.31	0.30	0.40	0.38	0.39	0.38	0.34	0.33	0.32	0.31	0.39	0.37	0.39	0.38	0.34	0.33	0.32	0.31

mg/L = milligrams per litre; mg-N/L = milligrams as nitrogen per litre; mg-P/L = milligrams as phosphorus per litre; µg/L = micrograms per litre.



COMPENDIUM OF SUPPLEMENTAL WATER QUALITY MODELLING

Table 3-4: Predicted Maximum Depth-Averaged Constituent Concentrations in Lac de Gras
Part B

Parameter	Units	LDG-P4								LDG-P5								LDG-P6							
		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)	
		Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water
No Jay Development Case																									
Total dissolved solids	mg/L	20	18	20	19	16	15	14	13	20	18	20	19	16	16	14	14	23	18	23	19	19	15	17	13
Chloride	mg/L	3.3	3.1	3.2	3.1	2.1	1.9	1.5	1.4	3.4	3.2	3.3	3.2	2.1	2.0	1.5	1.4	3.8	3.3	3.9	3.1	2.5	2.0	1.8	1.4
Sulphate	mg/L	4.1	3.7	4.0	3.7	2.9	2.7	2.4	2.2	4.1	3.7	4.0	3.8	2.9	2.8	2.4	2.3	4.7	3.7	4.7	3.8	3.5	2.8	2.8	2.2
Total ammonia	mg-N/L	0.043	0.033	0.043	0.033	0.018	0.014	0.011	0.009	0.044	0.033	0.043	0.036	0.018	0.015	0.011	0.009	0.049	0.032	0.050	0.033	0.021	0.014	0.013	0.009
Nitrate	mg-N/L	0.047	0.048	0.035	0.025	0.013	0.014	0.013	0.013	0.049	0.056	0.035	0.034	0.013	0.015	0.013	0.014	0.058	0.055	0.039	0.026	0.015	0.015	0.015	0.015
Total phosphorus (calculated)	mg-P/L	0.0037	0.0030	0.0040	0.0028	0.0029	0.0027	0.0027	0.0025	0.0037	0.0035	0.0040	0.0038	0.0029	0.0028	0.0027	0.0026	0.0039	0.0029	0.0042	0.0028	0.0031	0.0026	0.0029	0.0025
Phytoplankton (as Chlorophyll a)	µg/L	3.7	4.7	3.5	5.0	0.8	1.1	0.5	0.6	3.8	4.6	3.5	4.8	0.8	1.1	0.5	0.6	3.8	5.0	4.4	5.3	0.8	1.3	0.5	0.7
Total Aluminum	µg/L	26	25	25	25	18	18	14	15	26	25	25	25	18	19	14	15	29	25	29	25	20	18	16	15
Total Arsenic	µg/L	0.40	0.38	0.39	0.38	0.34	0.33	0.32	0.31	0.40	0.38	0.40	0.39	0.35	0.34	0.32	0.32	0.42	0.38	0.42	0.38	0.37	0.34	0.34	0.32
Updated Assessment Case																									
Total dissolved solids	mg/L	20	19	20	19	20	18	19	18	20	19	20	19	20	19	19	18	23	19	23	19	23	19	23	18
Chloride	mg/L	3.4	3.2	3.4	3.2	4.4	4.1	4.3	4.0	3.5	3.3	3.4	3.3	4.4	4.2	4.4	4.1	4.0	3.3	4.0	3.3	5.1	4.2	5.1	4.1
Sulphate	mg/L	4.1	3.7	4.0	3.8	2.9	2.7	2.4	2.3	4.1	3.8	4.1	3.9	3.0	2.8	2.4	2.3	4.7	3.7	4.8	3.9	3.5	2.8	2.9	2.3
Total ammonia	mg-N/L	0.044	0.033	0.043	0.034	0.027	0.022	0.02	0.015	0.044	0.033	0.044	0.036	0.027	0.023	0.02	0.016	0.05	0.033	0.05	0.034	0.031	0.022	0.023	0.015
Nitrate	mg-N/L	0.047	0.048	0.037	0.027	0.03	0.025	0.024	0.028	0.049	0.056	0.038	0.037	0.029	0.028	0.025	0.031	0.058	0.054	0.044	0.028	0.032	0.025	0.03	0.029
Total phosphorus (calculated)	mg-P/L	0.0037	0.0030	0.0040	0.0028	0.0031	0.0028	0.0028	0.0026	0.0037	0.0035	0.0040	0.0038	0.0031	0.0030	0.0029	0.0028	0.0040	0.0029	0.0042	0.0028	0.0033	0.0027	0.0031	0.0026
Phytoplankton (as Chlorophyll a)	µg/L	3.8	4.7	3.5	5.0	1.6	2.1	0.77	0.97	3.8	4.6	3.6	4.8	1.6	2.1	0.78	1.0	3.8	5.0	4.4	5.3	1.6	2.2	0.78	1.1
Total Aluminum	µg/L	26	25	25	25	21	21	19	20	26	25	26	25	21	22	20	20	29	25	29	26	25	22	22	20
Total Arsenic	µg/L	0.39	0.37	0.39	0.38	0.34	0.33	0.32	0.32	0.39	0.37	0.39	0.38	0.35	0.34	0.33	0.32	0.42	0.37	0.42	0.38	0.37	0.34	0.34	0.32

mg/L = milligrams per litre; mg-N/L = milligrams as nitrogen per litre; mg-P/L = milligrams as phosphorus per litre; µg/L = micrograms per litre.



COMPENDIUM OF SUPPLEMENTAL WATER QUALITY MODELLING

Table 3-5: Predicted Maximum Surface Constituent Concentrations in Lac de Gras
Part A

Parameter	Units	LDG-P1								LDG-P2								LDG-P3							
		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)	
		Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water
No Jay Development Case																									
Total dissolved solids	mg/L	27	21	27	18	21	14	19	13	31	19	29	18	23	14	22	13	29	18	28	18	22	15	21	13
Chloride	mg/L	4.2	3.7	4.1	2.9	2.4	1.7	1.8	1.3	5.1	3.1	4.6	2.9	2.6	1.8	2.1	1.3	4.7	3.0	4.5	3.0	2.6	1.9	2.0	1.4
Sulphate	mg/L	5.4	4.7	5.4	3.7	3.5	2.5	3.1	2.1	6.4	3.9	5.9	3.7	3.8	2.6	3.5	2.1	5.9	3.8	5.7	3.8	3.8	2.6	3.4	2.1
Total ammonia	mg-N/L	0.057	0.034	0.058	0.033	0.023	0.014	0.016	0.009	0.065	0.032	0.060	0.031	0.022	0.013	0.016	0.009	0.060	0.033	0.058	0.032	0.021	0.013	0.015	0.009
Nitrate	mg-N/L	0.068	0.083	0.043	0.038	0.017	0.012	0.017	0.011	0.065	0.041	0.047	0.020	0.017	0.009	0.016	0.010	0.062	0.040	0.041	0.022	0.016	0.010	0.017	0.011
Total phosphorus (calculated)	mg-P/L	0.0047	0.0041	0.0046	0.0034	0.0033	0.0027	0.0032	0.0025	0.0051	0.0030	0.0046	0.0028	0.0034	0.0025	0.0033	0.0025	0.0046	0.0030	0.0045	0.0028	0.0033	0.0026	0.0033	0.0025
Phytoplankton (as Chlorophyll a)	µg/L	3.4	4.0	3.9	3.9	0.7	0.8	0.4	0.5	3.7	5.4	4.7	5.4	0.8	1.5	0.5	0.9	3.8	5.2	4.6	5.2	0.8	1.2	0.5	0.6
Total Aluminum	µg/L	33	33	32	25	19	16	15	13	39	27	35	25	21	17	17	14	36	26	34	26	21	17	17	14
Total Arsenic	µg/L	0.45	0.43	0.44	0.37	0.35	0.31	0.33	0.3	0.49	0.38	0.47	0.37	0.37	0.32	0.35	0.3	0.47	0.38	0.46	0.38	0.37	0.33	0.35	0.3
Updated Assessment Case																									
Total dissolved solids	mg/L	28	21	30	20	29	23	26	18	32	19	30	18	29	19	29	18	30	19	28	19	29	19	28	18
Chloride	mg/L	4.5	3.7	7.4	4.8	7.1	6.5	5.9	4.2	5.2	3.1	5.5	3.6	6.9	4.5	6.4	4.1	5.0	3.1	5.2	3.4	6.6	4.3	6.3	4.1
Sulphate	mg/L	5.7	4.7	5.5	3.8	3.7	2.6	3.1	2.1	6.6	3.9	6.0	3.7	4.0	2.7	3.4	2.2	6.1	3.8	5.7	3.8	3.8	2.7	3.4	2.2
Total ammonia	mg-N/L	0.060	0.034	0.060	0.034	0.045	0.029	0.026	0.016	0.066	0.033	0.061	0.032	0.040	0.025	0.026	0.015	0.063	0.033	0.058	0.033	0.037	0.024	0.025	0.015
Nitrate	mg-N/L	0.069	0.083	0.074	0.051	0.073	0.066	0.042	0.028	0.064	0.041	0.048	0.027	0.048	0.030	0.034	0.021	0.063	0.040	0.043	0.023	0.040	0.028	0.033	0.022
Total phosphorus (calculated)	mg-P/L	0.0048	0.0041	0.0046	0.0034	0.0038	0.0030	0.0033	0.0027	0.0051	0.0030	0.0046	0.0028	0.0036	0.0026	0.0034	0.0026	0.0048	0.0030	0.0045	0.0028	0.0035	0.0027	0.0033	0.0026
Phytoplankton (as Chlorophyll a)	µg/L	3.4	4.0	3.9	3.9	2.4	2.5	0.7	0.7	3.8	5.4	4.7	5.5	1.6	2.6	0.8	1.3	3.8	5.2	4.6	5.2	1.6	2.2	0.7	1.0
Total Aluminum	µg/L	34	33	32	25	29	24	22	19	40	27	36	25	29	22	25	19	37	26	34	26	29	22	25	19
Total Arsenic	µg/L	0.45	0.42	0.43	0.37	0.36	0.32	0.33	0.30	0.49	0.38	0.46	0.37	0.37	0.32	0.35	0.30	0.47	0.37	0.45	0.37	0.37	0.33	0.35	0.31

mg/L = milligrams per litre; mg-N/L = milligrams as nitrogen per litre; mg-P/L = milligrams as phosphorus per litre; µg/L = micrograms per litre.



COMPENDIUM OF SUPPLEMENTAL WATER QUALITY MODELLING

Table 3-5: Predicted Maximum Surface Constituent Concentrations in Lac de Gras Part B

Parameter	Units	LDG-P4								LDG-P5								LDG-P6							
		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)	
		Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water
No Jay Development Case																									
Total dissolved solids	mg/L	31	18	29	19	23	15	21	13	31	18	31	19	23	15	22	13	30	18	28	19	22	15	23	13
Chloride	mg/L	5.2	3.1	4.7	3.1	2.7	1.9	2.1	1.4	5.2	3.5	5.0	3.1	2.8	1.9	2.1	1.4	5.0	3.3	4.7	3.1	2.9	2.0	2.2	1.4
Sulphate	mg/L	6.3	3.7	5.9	3.8	3.9	2.7	3.4	2.2	6.3	3.7	6.2	3.8	3.9	2.7	3.5	2.2	6.1	3.7	5.8	3.8	4.0	2.7	3.6	2.2
Total ammonia	mg-N/L	0.066	0.033	0.061	0.033	0.023	0.014	0.015	0.009	0.066	0.033	0.064	0.033	0.023	0.014	0.016	0.009	0.063	0.032	0.060	0.033	0.024	0.014	0.017	0.009
Nitrate	mg-N/L	0.065	0.052	0.040	0.025	0.019	0.014	0.019	0.015	0.070	0.072	0.040	0.028	0.020	0.019	0.020	0.019	0.072	0.055	0.042	0.025	0.017	0.016	0.020	0.015
Total phosphorus (calculated)	mg-P/L	0.0049	0.0028	0.0046	0.0028	0.0034	0.0026	0.0032	0.0025	0.0048	0.0031	0.0047	0.0032	0.0034	0.0026	0.0033	0.0025	0.0047	0.0029	0.0045	0.0028	0.0033	0.0026	0.0034	0.0025
Phytoplankton (as Chlorophyll a)	µg/L	3.8	4.8	4.4	5.2	0.8	1.2	0.5	0.6	3.8	4.8	4.2	5.0	0.8	1.2	0.5	0.7	3.8	5.0	4.1	5.3	0.8	1.3	0.5	0.7
Total Aluminum	µg/L	38	25	35	25	22	18	18	14	38	25	37	25	22	18	18	15	36	25	35	25	23	18	18	15
Total Arsenic	µg/L	0.49	0.38	0.47	0.38	0.38	0.34	0.36	0.31	0.49	0.38	0.48	0.39	0.38	0.34	0.36	0.32	0.48	0.38	0.47	0.38	0.39	0.34	0.37	0.32
Updated Assessment Case																									
Total dissolved solids	mg/L	31	19	29	19	28	18	29	18	30	19	31	19	29	18	30	18	31	19	32	19	27	18	30	18
Chloride	mg/L	5.3	3.2	4.9	3.3	6.3	4.1	6.3	4.0	5.0	3.5	5.2	3.3	6.5	4.1	6.6	4.1	5.3	3.4	5.4	3.3	6.1	4.1	6.7	4.1
Sulphate	mg/L	6.4	3.7	6.0	3.8	3.8	2.7	3.5	2.3	6.0	3.8	6.3	3.8	3.9	2.7	3.7	2.3	6.3	3.7	6.5	3.8	4.0	2.7	3.7	2.3
Total ammonia	mg-N/L	0.066	0.033	0.062	0.034	0.035	0.023	0.025	0.015	0.062	0.033	0.065	0.034	0.037	0.023	0.025	0.015	0.065	0.033	0.067	0.034	0.036	0.022	0.026	0.015
Nitrate	mg-N/L	0.065	0.051	0.043	0.028	0.036	0.025	0.034	0.029	0.071	0.072	0.044	0.030	0.037	0.027	0.038	0.031	0.067	0.054	0.046	0.027	0.035	0.026	0.038	0.029
Total phosphorus (calculated)	mg-P/L	0.0048	0.0028	0.0046	0.0028	0.0034	0.0026	0.0034	0.0025	0.0046	0.0031	0.0047	0.0032	0.0035	0.0028	0.0034	0.0026	0.0047	0.0029	0.0048	0.0028	0.0035	0.0027	0.0035	0.0026
Phytoplankton (as Chlorophyll a)	µg/L	3.8	4.8	4.4	5.2	1.6	2.1	0.8	1.0	3.8	4.8	4.2	5.1	1.6	2.2	0.8	1.0	3.8	5.0	4.1	5.3	1.6	2.2	0.8	1.1
Total Aluminum	µg/L	38	25	35	25	28	21	25	19	35	25	37	25	29	22	26	20	37	25	38	25	28	22	26	20
Total Arsenic	µg/L	0.48	0.37	0.46	0.38	0.38	0.33	0.36	0.31	0.47	0.37	0.48	0.38	0.38	0.34	0.37	0.32	0.48	0.37	0.49	0.38	0.39	0.34	0.37	0.32

mg/L = milligrams per litre; mg-N/L = milligrams as nitrogen per litre; mg-P/L = milligrams as phosphorus per litre; µg/L = micrograms per litre.



COMPENDIUM OF SUPPLEMENTAL WATER QUALITY MODELLING

Table 3-6: Predicted Maximum Constituent Concentrations in Lac de Gras
Part A

Parameter	Units	LDG-P1								LDG-P2								LDG-P3							
		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)	
		Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water
No Jay Development Case																									
Total dissolved solids	mg/L	27	23	27	20	21	15	19	13	31	21	29	21	23	17	22	15	29	20	28	20	22	17	21	14
Chloride	mg/L	4.2	4.1	4.1	3.2	2.4	1.8	1.8	1.3	5.1	3.3	4.6	3.4	2.6	2.2	2.1	1.6	4.7	3.2	4.5	3.4	2.6	2.1	2.0	1.5
Sulphate	mg/L	5.4	5.2	5.4	4.1	3.5	2.7	3.1	2.1	6.4	4.2	5.9	4.3	3.8	3.1	3.5	2.5	5.9	4.0	5.7	4.2	3.8	3.0	3.4	2.4
Total ammonia	mg-N/L	0.057	0.039	0.058	0.038	0.023	0.015	0.016	0.011	0.065	0.035	0.06	0.038	0.022	0.016	0.016	0.01	0.06	0.033	0.058	0.036	0.021	0.015	0.015	0.009
Nitrate	mg-N/L	0.099	0.099	0.053	0.051	0.0171	0.0139	0.0167	0.0122	0.065	0.047	0.047	0.041	0.0166	0.0123	0.0165	0.0119	0.062	0.0481	0.0411	0.0343	0.0161	0.0131	0.017	0.0124
Total phosphorus (calculated)	mg-P/L	0.0048	0.0048	0.0046	0.0043	0.0033	0.0029	0.0032	0.0026	0.0051	0.0040	0.0046	0.0043	0.0034	0.0030	0.0033	0.0027	0.0046	0.0037	0.0045	0.0037	0.0033	0.0029	0.0033	0.0027
Phytoplankton (as Chlorophyll a)	µg/L	3.4	4.0	3.9	3.9	0.7	0.8	0.4	0.5	3.8	5.4	5.4	5.4	0.8	1.5	0.5	0.9	3.8	5.2	4.6	5.2	0.8	1.2	0.5	0.6
Total Aluminum	µg/L	35	37	32	28	19	17	15	13	39	27	35	29	21	19	17	15	36	26	34	28	21	19	17	15
Total Arsenic	µg/L	0.46	0.45	0.44	0.40	0.35	0.32	0.33	0.30	0.49	0.39	0.47	0.40	0.37	0.34	0.35	0.31	0.47	0.38	0.46	0.40	0.37	0.34	0.35	0.31
Updated Assessment Case																									
Total dissolved solids	mg/L	28	23	30	24	29	27	26	19	32	21	30	21	29	22	29	21	30	20	28	21	29	22	28	20
Chloride	mg/L	4.5	4.1	7.4	6.9	7.1	9.3	5.9	4.5	5.2	3.4	5.5	3.6	6.9	5.1	6.4	4.8	5.0	3.2	5.2	3.4	6.6	4.9	6.3	4.5
Sulphate	mg/L	5.7	5.3	5.5	4.2	3.7	2.8	3.1	2.2	6.6	4.2	6.0	4.3	4.0	3.1	3.4	2.6	6.1	4.0	5.7	4.2	3.8	3.0	3.4	2.4
Total ammonia	mg-N/L	0.060	0.040	0.060	0.038	0.045	0.035	0.026	0.018	0.066	0.035	0.061	0.039	0.040	0.027	0.026	0.018	0.063	0.033	0.058	0.037	0.037	0.025	0.025	0.017
Nitrate	mg-N/L	0.100	0.101	0.074	0.094	0.075	0.106	0.042	0.034	0.064	0.047	0.048	0.042	0.048	0.038	0.034	0.024	0.063	0.048	0.043	0.036	0.040	0.036	0.033	0.024
Total phosphorus (calculated)	mg-P/L	0.0048	0.0048	0.0046	0.0043	0.0038	0.0036	0.0033	0.0029	0.0051	0.0040	0.0046	0.0043	0.0036	0.0032	0.0034	0.0029	0.0048	0.0037	0.0045	0.0037	0.0035	0.0032	0.0033	0.0028
Phytoplankton (as Chlorophyll a)	µg/L	3.4	4.0	3.9	3.9	2.4	2.5	0.7	0.7	3.8	5.4	5.4	5.5	1.6	2.6	0.8	1.3	3.8	5.2	4.6	5.2	1.6	2.2	0.7	1.0
Total Aluminum	µg/L	36	37	32	29	29	29	22	19	40	28	36	29	29	24	25	21	37	26	34	28	29	24	25	21
Total Arsenic	µg/L	0.45	0.45	0.43	0.39	0.36	0.33	0.33	0.30	0.49	0.39	0.46	0.40	0.37	0.34	0.35	0.32	0.47	0.38	0.45	0.39	0.37	0.34	0.35	0.31

mg/L = milligrams per litre; mg-N/L = milligrams as nitrogen per litre; mg-P/L = milligrams as phosphorus per litre; µg/L = micrograms per litre.



COMPENDIUM OF SUPPLEMENTAL WATER QUALITY MODELLING

Table 3-6: Predicted Maximum Constituent Concentrations in Lac de Gras
Part B

Parameter	Units	LDG-P4								LDG-P5								LDG-P6							
		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)	
		Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water
No Jay Development Case																									
Total dissolved solids	mg/L	31	18	29	19	23	15	21	13	31	19	31	20	23	16	22	14	30	19	28	20	22	16	23	14
Chloride	mg/L	5.2	3.1	4.7	3.1	2.7	2.0	2.1	1.4	5.2	3.5	5.0	3.4	2.8	2.1	2.1	1.5	5.0	3.3	4.7	3.3	2.9	2.2	2.2	1.5
Sulphate	mg/L	6.3	3.7	5.9	3.8	3.9	2.8	3.4	2.2	6.3	3.7	6.2	4.0	3.9	3.0	3.5	2.3	6.1	3.7	5.8	4.1	4.0	3.0	3.6	2.4
Total ammonia	mg-N/L	0.066	0.033	0.061	0.035	0.023	0.015	0.015	0.009	0.066	0.033	0.064	0.038	0.023	0.016	0.016	0.009	0.063	0.032	0.06	0.033	0.024	0.0144	0.017	0.0094
Nitrate	mg-N/L	0.065	0.052	0.0404	0.0312	0.0194	0.0141	0.0186	0.0151	0.07	0.072	0.0399	0.039	0.0201	0.0193	0.020	0.0187	0.072	0.055	0.0416	0.0261	0.0172	0.0157	0.0197	0.0147
Total phosphorus (calculated)	mg-P/L	0.0049	0.0036	0.0046	0.0037	0.0034	0.0029	0.0032	0.0026	0.0048	0.0037	0.0047	0.0041	0.0034	0.0029	0.0033	0.0026	0.0047	0.0029	0.0045	0.0029	0.0033	0.0027	0.0034	0.0026
Phytoplankton (as Chlorophyll a)	µg/L	3.8	4.8	4.4	5.2	0.8	1.2	0.5	0.6	3.8	4.8	4.4	5.0	0.8	1.2	0.5	0.7	3.8	5.0	4.7	5.3	0.8	1.3	0.5	0.7
Total Aluminum	µg/L	38	25	35	25	22	18	18	15	38	25	37	26	22	20	18	15	36	25	35	27	23	19	18	15
Total Arsenic	µg/L	0.49	0.38	0.47	0.39	0.38	0.34	0.36	0.32	0.49	0.38	0.48	0.40	0.38	0.35	0.36	0.32	0.48	0.38	0.47	0.39	0.39	0.34	0.37	0.32
Updated Assessment Case																									
Total dissolved solids	mg/L	31	19	29	19	28	20	29	18	30	19	31	20	29	20	30	19	31	19	32	20	27	21	30	19
Chloride	mg/L	5.3	3.2	4.9	3.3	6.3	4.3	6.3	4.0	5.0	3.5	5.2	3.5	6.5	4.5	6.6	4.3	5.3	3.4	5.4	3.5	6.1	4.6	6.7	4.4
Sulphate	mg/L	6.4	3.7	6.0	3.8	3.8	2.8	3.5	2.3	6.0	3.8	6.3	4.1	3.9	3.0	3.7	2.4	6.3	3.8	6.5	4.1	4.0	3.0	3.7	2.5
Total ammonia	mg-N/L	0.066	0.034	0.062	0.035	0.035	0.023	0.025	0.015	0.062	0.033	0.065	0.038	0.037	0.024	0.025	0.016	0.065	0.033	0.067	0.034	0.036	0.022	0.026	0.016
Nitrate	mg-N/L	0.065	0.051	0.043	0.033	0.036	0.028	0.034	0.029	0.071	0.072	0.044	0.041	0.037	0.030	0.038	0.037	0.067	0.054	0.046	0.028	0.035	0.026	0.038	0.030
Total phosphorus (calculated)	mg-P/L	0.0048	0.0036	0.0046	0.0037	0.0034	0.0031	0.0034	0.0027	0.0046	0.0037	0.0047	0.0041	0.0035	0.0031	0.0034	0.0028	0.0047	0.0029	0.0048	0.0029	0.0035	0.0028	0.0035	0.0027
Phytoplankton (as Chlorophyll a)	µg/L	3.8	4.8	4.4	5.2	1.6	2.1	0.8	1.0	3.8	4.8	4.4	5.1	1.6	2.2	0.8	1.0	3.8	5.0	4.7	5.4	1.6	2.2	0.8	1.1
Total Aluminum	µg/L	38	25	35	26	28	22	25	20	35	25	37	26	29	23	26	20	37	25	38	27	28	23	26	21
Total Arsenic	µg/L	0.48	0.37	0.46	0.38	0.38	0.33	0.36	0.32	0.47	0.37	0.48	0.39	0.38	0.35	0.37	0.32	0.48	0.37	0.49	0.39	0.39	0.34	0.37	0.32

mg/L = milligrams per litre; mg-N/L = milligrams as nitrogen per litre; mg-P/L = milligrams as phosphorus per litre; µg/L = micrograms per litre.



4.0 REASONABLE ESTIMATE CASE

To provide a more likely but less conservative (i.e., expected) estimate of Project discharge water quality, the models were updated for a reasonable estimate case of the discharge water quality from the Project. The following model inputs and assumptions to existing models were modified as part of the reasonable estimate case water quality model:

- Expected groundwater inflows to the Jay Pit were estimated and incorporated into the site mass-balance water quality model;
- Attenuation of nitrogen species in the Jay WRSA drainage during post-closure was included; and,
- Average observed discharge concentrations were used to represent the effluent quality from the Diavik Mine to Lac de Gras.

The updated inputs and assumptions required all models developed as part of the DAR to be updated. Incorporation of the above changes into the Project water quality models is discussed in the following subsections. For the reasonable estimate case water quality model, only changes to model inputs were evaluated and the conceptual water quality model for the Project remains the same. A detailed description of the conceptual water quality model is provided in Section 8E2.2 of Appendix 8E2.2 of the DAR.

4.1 Model Updates

4.1.1 Hydrogeological Model

Details of the development framework, calibration, inputs, and assumptions used in the hydrogeological models are provided in Appendix 8A, 8B, and 8C of the DAR. The objective of the hydrogeologic models is to evaluate hydrogeologic conditions that will develop during mining and post-closure, and to predict the quantity and quality of groundwater discharge to the mine.

In Appendix 8A of the DAR, two scenarios for model input parameters are presented:

- The reasonable estimate case (referred to as the “Reference Case” in Appendix 8A, Section 8A3.3 of the DAR), which reflects the most likely estimate of hydrogeological conditions that are expected to be encountered during mining; and,
- The “Environmental Assessment Conservative Scenario” (Appendix 8A, Section 8A4 of the DAR), which reflects a more conservative scenario with greater predicted groundwater discharge to the mine.

The predicted inflow quantity and quality to the Jay Pit for the reasonable estimate case are presented in the DAR (i.e., the Reference Case in Appendix 8A); therefore, there were no updates to the hydrogeological model for the reasonable estimate case. The hydrogeological model outputs were extracted for input to the site water quality model and the hydrodynamic models as required for the reasonable estimate case.

Appendix 8B of the DAR presents an assessment of the post-closure groundwater regime near the Jay Pit. The purpose of the assessment is to evaluate the effects of water with higher TDS concentrations beneath the open pit on the groundwater flow regime after closure of the mine, and to evaluate the influence of solute transport by groundwater flow on the movement of solutes from the bedrock into the back-flooded Jay Pit (Appendix 8B, Section 8B1.2). The results presented in Appendix 8B of the DAR are for the “Environmental Assessment Conservative Scenario”; therefore, for the present study, the model was updated with parameters



corresponding to the reasonable estimate case scenario described in Appendix 8A, Section 8A3.3 of the DAR, and model outputs from this scenario were extracted for input to the hydrodynamic models.

Appendix 8C of the DAR presents the results of an assessment to predict the long-term (100s of years) groundwater conditions near the Misery Pit after back-flooding of the pit to its ultimate elevation (post-closure period). The results presented in Appendix 8C of the DAR are for the “Environmental Assessment Conservative Scenario”; therefore, for the present study, this model was updated with the pit lake TDS-depth profile corresponding to the reasonable estimate case and model outputs from this scenario were extracted for input to the hydrodynamic models.

4.1.1.1 *Hydrogeological Model Results and Discussion*

The Jay Pit hydrogeology model results for the reasonable estimate and DAR cases are presented in Table 4-1. The following statements can be made based on a comparison of the reasonable estimate and DAR case hydrogeological model results (Table 4-1):

- Groundwater inflows to the Jay Pit are lower in the reasonable estimate case in comparison to the DAR case. For example, peak operational inflows were predicted to be lower in the reasonable estimate case compared to the DAR during the last year of operational mining (21,300 cubic metres per day [m^3/day] in the DAR case compared to 13,700 m^3/day in the reasonable estimate case).
- Total dissolved solids concentrations were also projected to be lower in the reasonable estimate case with concentrations decreasing by up to 16%.
- The percentage of lake water recharging groundwater flowing to the Jay Pit also was predicted to be lower in the reasonable estimate case by up to 7%.



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Table 4-1: Jay Pit Groundwater Inflows

Period	Phase	Year	Duration (Days)	Reasonable Case ^(a)				Environmental Assessment Conservative Scenario ^(b)			
				Groundwater Inflow (m ³ /day)		Groundwater Quality (mg/L)	Lakewater (%) in Total Inflow	Groundwater Inflow (m ³ /day)		Groundwater Quality (mg/L)	Lakewater (%) in Total Inflow
				Jay Pit	Diked Area around Jay Pit	Jay Pit		Jay Pit	Diked Area around Jay Pit	Jay Pit	
1	Dewatering	2019	180	800	5,000	300	0%	900	5,400	300	0%
2	Stripping	2019	90	10,000	200	400	0%	10,400	300	400	0%
3	OP Mining	2020	365	5,900	0	1,100	2%	7,700	0	1,200	1%
4	OP Mining	2021	365	6,500	0	1,700	14%	9,500	0	2,000	16%
5	OP Mining	2022	365	7,100	0	2,100	28%	10,700	0	2,500	29%
6	OP Mining	2023	365	8,000	0	2,600	35%	12,100	0	3,000	37%
7	OP Mining	2024	365	9,400	0	3,100	39%	14,300	0	3,600	42%
8	OP Mining	2025	365	10,200	0	3,600	47%	15,700	0	4,200	48%
9	OP Mining	2026	365	10,300	0	4,100	50%	16,000	0	4,600	54%
10	OP Mining	2027	365	10,800	0	4,700	51%	17,000	0	5,000	58%
11	OP Mining	2028	365	11,400	0	5,500	53%	18,000	0	5,800	59%
12	OP Mining	2029	365	13,700	0	7,100	48%	21,300	0	7,300	56%
13	Closure (OP Flooding)	2030-2033	1018	6,300	0	2,300	72%	6,300	0	2,600	74%
14	Closure (Sump Flooding)	2033	332	-900	-11,000	NA	NA	-2,300	-11,000	NA	NA

Notes:

Positive values indicate predicted net groundwater inflow into mine openings.

Negative values indicate net water outflow to the subsurface from the mine openings. During these stages, water level in the pit is higher than surrounding rock and flow is to fill the pores in the rock around the pit.

a) The Reasonable Case corresponds to the Reference Case described in Appendix 8A Section 8A3.3 of the DAR.

b) The Environmental Assessment Conservative is described in Appendix 8A, Section 8A4 of the DAR, and was carried through the DAR and updated assessment case water quality models.

m³/day = cubic metres per day; mg/L = milligrams per litre; % = percent; OP = Open Pit; NA = not applicable.



4.1.2 Pit Lake Models

Consistent with the DAR, pit lake hydrodynamic models were developed for Jay and Misery pits using CE-QUAL-W2. The purpose of the hydrodynamic modelling was to evaluate the vertical stratification potential within the pits during the first 200 years of the post-closure period (i.e., when the mined-out pits are entirely filled with water). The TDS profiles between 200 and 15,000 years for Jay and Misery pits were calculated using a vertical slice, mass-balance model. Concentrations of TDS in the pits were initialized to create a high density water layer (monimolimnion) overlain by a low density water layer (mixolimnion). In Misery and Jay pits, the mixolimnion layers were 60 m and 160 m in depth respectively.

The following updates were made to the Jay and Misery Pit lake models for the reasonable estimate case:

- Predicted groundwater inflows and TDS concentrations, and predicted groundwater outflows to Jay and Misery pits were updated based on hydrogeological model results presented in Section 4.1.1.1; and,
- Initial TDS concentrations in Jay and Misery pits were updated based on site water quality mode results presented in Section 4.1.3.1.

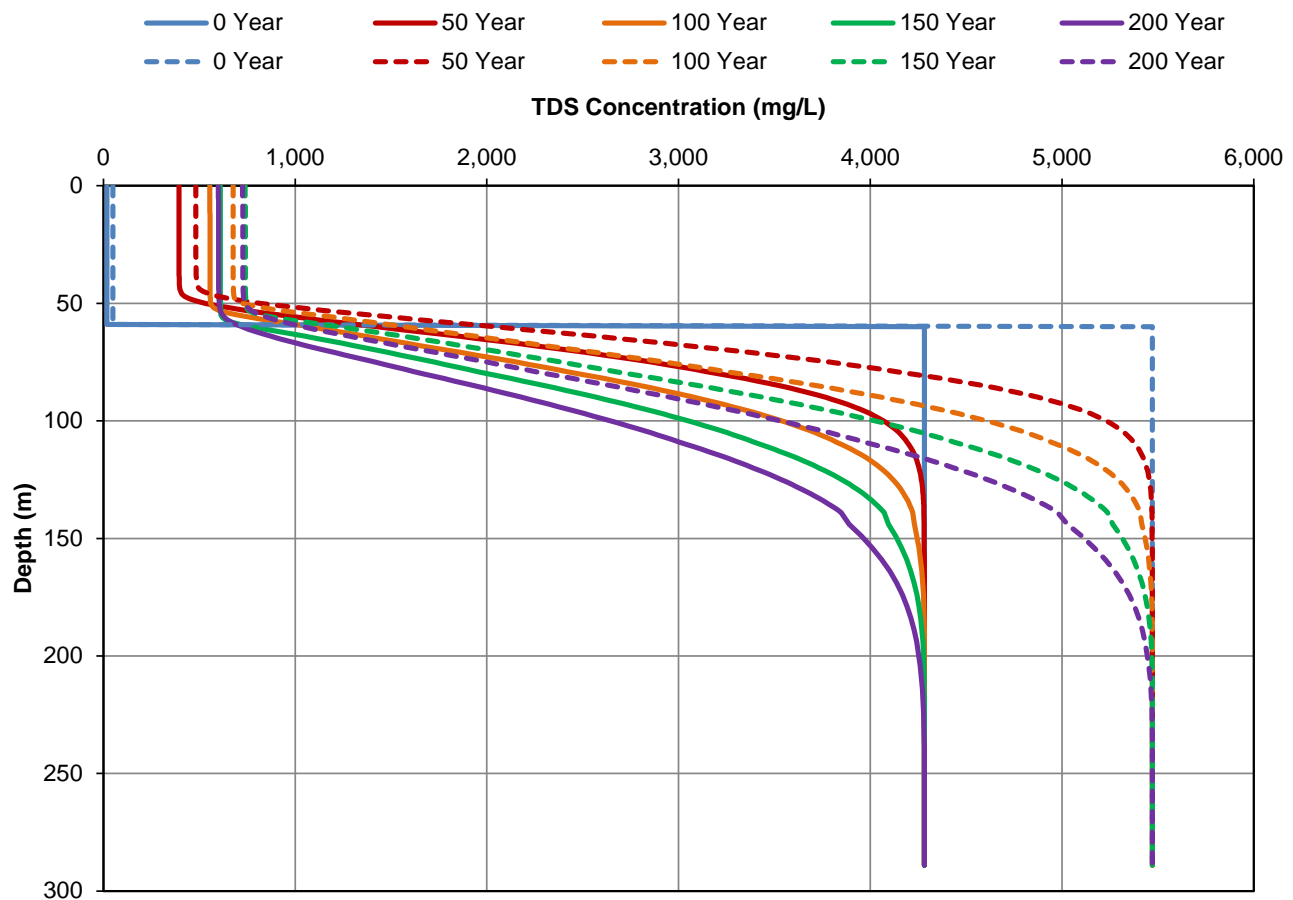
4.1.2.1 Pit Lake Hydrodynamic Model Results and Discussion

4.1.2.1.1 Misery Pit

Misery Pit was predicted to remain stratified during the entire 200 year simulation period for both the reasonable estimate and updated assessment cases (Figure 4-1). Predicted TDS profile concentrations for the reasonable estimate case were lower compared to the updated assessment case because the initial TDS concentrations in the mixolimnion and monimolimnion decreased from 50 mg/L to 18 mg/L and from 5,471 mg/L to 4,282 mg/L, respectively. The stratification was characterized by a pycnocline that will provide stability to vertical layers within the lake. In the model, wind-driven forces are applied to the water surface and the energy required to generate turbulent mixing increases with depth.

Concentrations of TDS in the mixolimnion of Misery Pit were predicted to increase over time until steady-state conditions are reached approximately 200 years into post-closure. Concentrations of TDS in the monimolimnion were predicted to decrease over time. The decrease in predicted TDS concentrations in the monimolimnion was attributed to natural runoff (i.e., freshwater) entering the pit lake over time. Concentrations of TDS at depths below 200 m were not predicted to increase over 200 years because the hydrogeological modelling predicted groundwater losses (i.e., outflows) at a depth higher than 100 m and negligible inflows.

Concentrations of TDS at depths below 200 m in the monimolimnion of Misery Pit were not predicted to increase over 200 years because the hydrogeological modelling predicted groundwater losses (i.e., outflows). The model predicted that the pycnocline thickness will increase with time. The elevation of the pycnocline was not predicted to change appreciably, but the gradient was predicted to become less pronounced, reflecting an upward transfer of mass from the bottom of the pit. This upward movement was predicted to occur rapidly after back-flooding, and gradually thereafter.



m = metres; mg/L = milligrams per litre; solid lines = reasonable estimate case predictions; dashed lines = updated assessment case predictions.

Figure 4-1: Predicted Total Dissolved Solids Profiles over 200-Year Period after Closure of Misery Pit

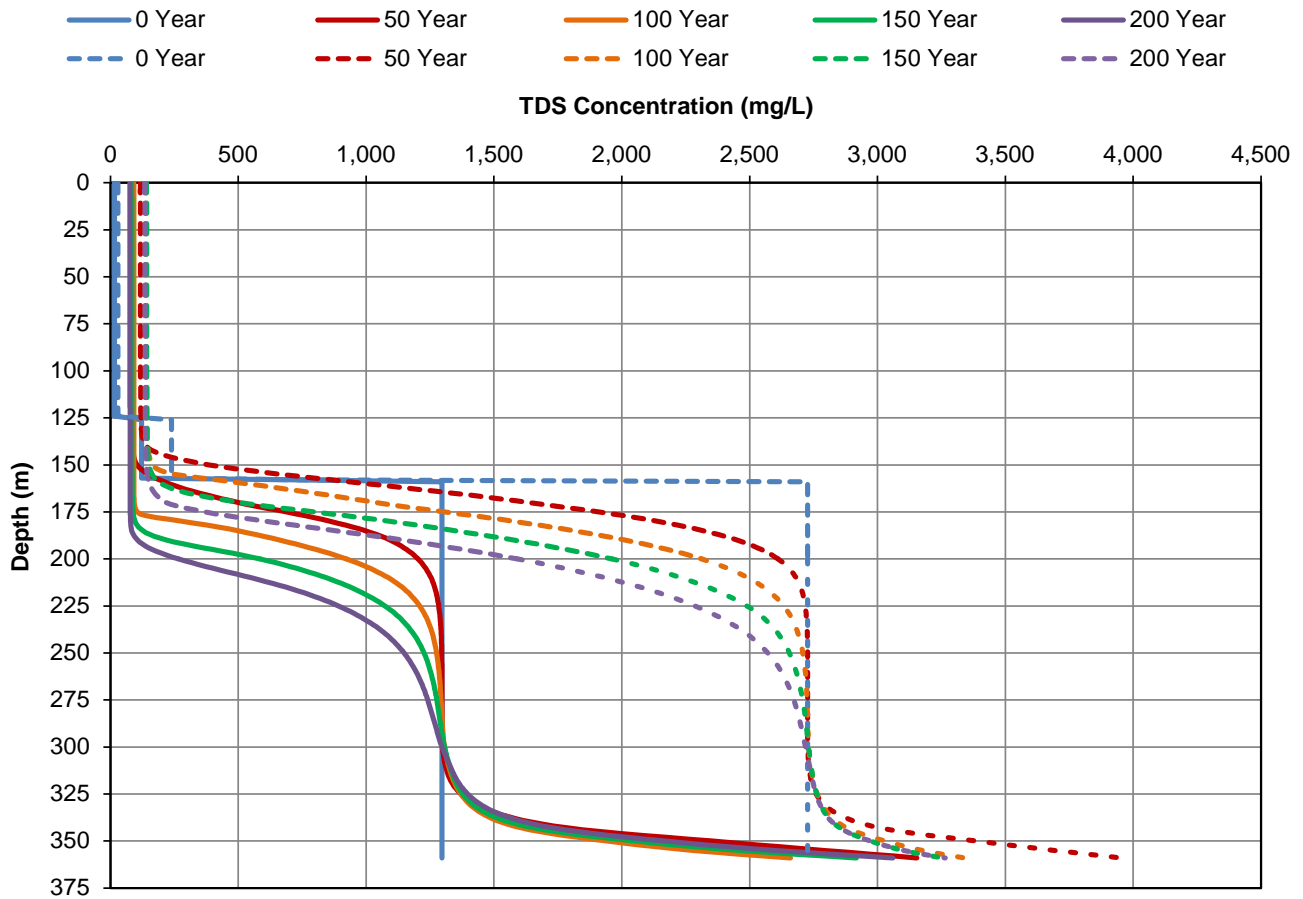
4.1.2.1.2 Jay Pit

Similar to the updated assessment case results (Section 2.1.1), the Jay Pit was predicted to remain stratified during the entire 200 year simulation period (Figure 4-2). Similar to the results for the Misery Pit hydrodynamic model, the pycnocline thickness was predicted to increase with time. Predicted TDS profile concentrations for the reasonable estimate case were lower compared to the updated assessment case because the initial TDS concentrations decreased from 29 mg/L to 16 mg/L in the mixolimnion and from 2,727 mg/L to 1,297 mg/L in the monimolimnion, respectively, and the initial TDS concentration in runoff from the WRSA decreased from 350 mg/L to 199 mg/L.

Concentrations of TDS in the mixolimnion of the Jay Pit were predicted to increase over time until steady-state conditions are reached approximately 200 years into post-closure. Concentrations of TDS at a depth below 300 m in the monimolimnion were predicted to increase in the first 50 years and then gradually decrease. The increase was attributed to inflows of groundwater with high TDS concentrations compared to groundwater outflows during the first 50 years.



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m = metres; mg/L = milligrams per litre; solid lines = reasonable estimate case predictions; dashed lines = updated assessment case predictions.

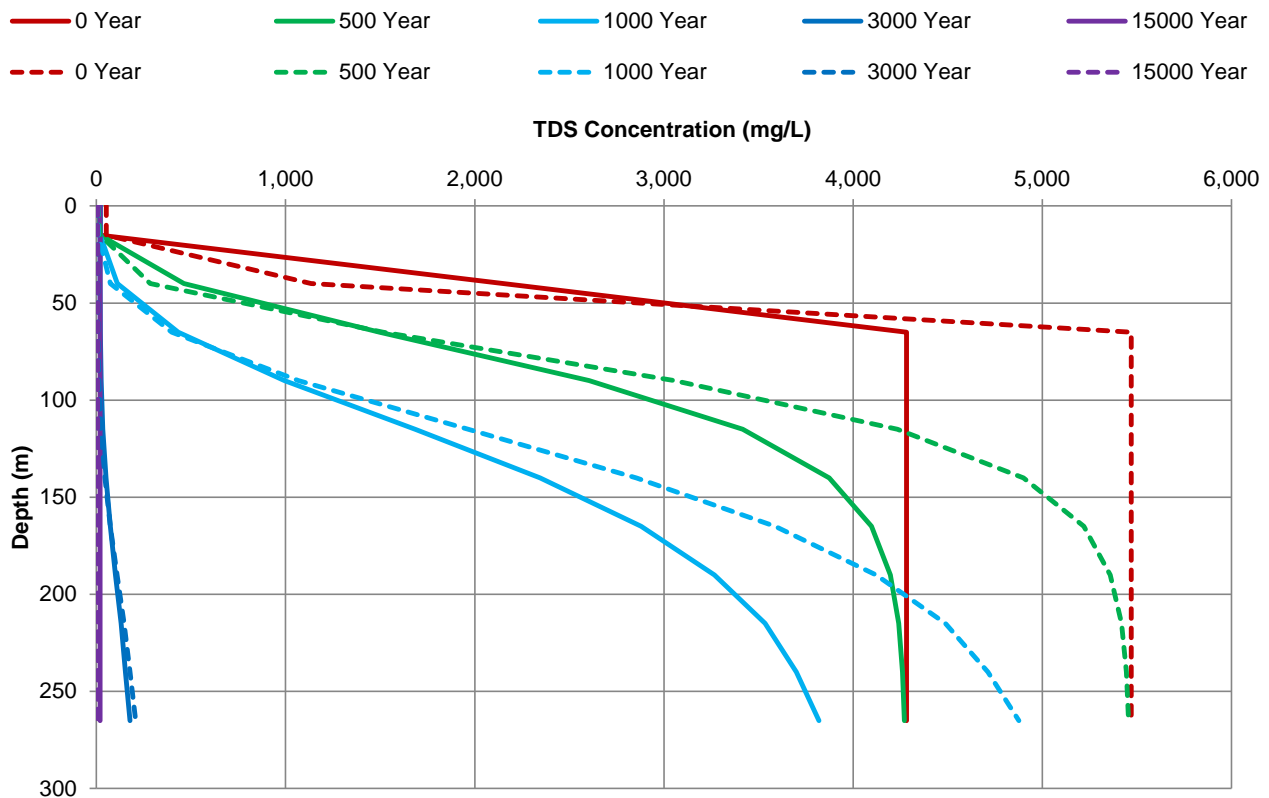
Figure 4-2: Predicted Total Dissolved Solids Profiles over 200-Year Period after Closure of Jay Pit



4.1.2.2 Vertical-Slice, Mass-Balance Model Results and Discussion

4.1.2.2.1 Misery Pit

Although the hydrodynamic model results indicated little change in TDS in the monimolimnion in the first 200 years, the vertical-slice, mass-balance model indicated that TDS concentrations would gradually decrease in the first 1,000 years, because groundwater outflow rates (losses) are higher than groundwater inflow rates (which were zero below a depth of 100 m). Similar to the updated assessment case results, after 3,000 years, the model indicated that the concentrations in the monimolimnion would approach natural surface water concentrations. It is likely, therefore, that after millennia, the lake will mix more deeply than predicted for the 200-year time frame after the monimolimnion density approaches that of the mixolimnion (Figure 4-3).



m = metres; mg/L = milligrams per litre; solid lines = updated assessment case; dashed lines = DAR case.

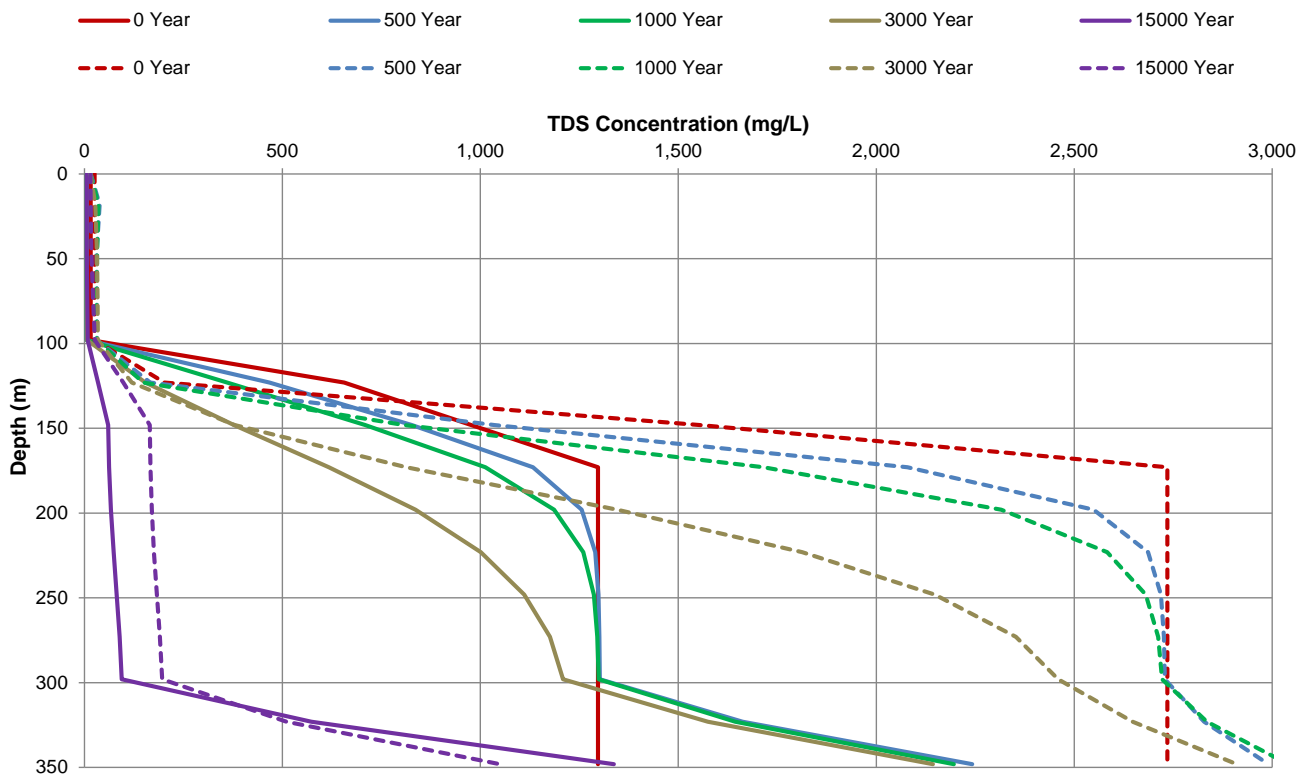
Figure 4-3: Predicted Total Dissolved Solids Profile over 15,000-Year Period after the Closure of Misery Pit



4.1.2.2.2 Jay Pit

Similar to the hydrodynamic model results for the Jay Pit, concentrations of TDS in the monimolimnion of the Jay Pit were predicted to increase over the first 50 years because of groundwater inflows with high TDS concentrations and then to gradually decrease over time.

The vertical-slice, mass-balance model for Jay Pit predicted that concentrations of TDS in the monimolimnion would decrease from approximately 2,200 mg/L to 1,300 mg/L over a 15,000 year period (Figure 4-4). The pit was predicted to remain stratified over the first few thousand years, but the stratification was predicted to weaken over time. The weakening stratification was attributed to a decrease in groundwater inflows compared to seepage from the pit resulting in lower concentrations of TDS in the pit lake.



m = metres; mg/L = milligrams per litre; solid lines – updated assessment case; dashed lines – DAR Case.

Figure 4-4: Predicted Total Dissolved Solids Profile over 15,000-Year Period after the Closure of Jay Pit



4.1.3 Site Water Quality Model

As presented in Section 8E2.2 of the Appendix 8E of the DAR, each flow that could influence site discharge water quality for the Project was itemized and assigned a source term chemical profile based on geochemical testing of waste rock materials, observed mine site facility drainage at the Ekati Mine operations, and baseline surface and groundwater quality monitoring data. The chemical inputs used to represent site facility drainage during operations were not changed as part of the reasonable estimate case water quality model and the reader is referred to Section 8E3 of Appendix 8E of the DAR for a detailed discussion of the chemical profiles selected to represent the quality of the drainage. The site water quality model was updated to incorporate changes made to the hydrogeological (Section 4.1.1) and the pit lake (Section 4.1.2) models for the reasonable estimate case.

During post-closure, the Jay WRSA will drain directly to Lac du Sauvage. A chemical profile was assigned to this drainage (see Appendix 8E of the DAR) during post-closure. As part of the reasonable estimate case, the source term input for this drainage was also updated to account for attenuation of residual ammonia and nitrate, originating from explosives usage, to Lac du Sauvage during post-closure.

Water will be discharged from the following locations during the life of the Project:

- Operations:
 - Misery Pit discharge to Lac du Sauvage.
- Post-closure:
 - Misery Pit overflow to Lac de Gras;
 - Misery Pit seepage to Lac de Gras;
 - Water displacement from the Jay Pit monimolimnion to Lac du Sauvage; and,
 - Jay WRSA runoff and seepage.

The closure phase of the Project is included in the water quality model; however, this period is defined as the back-flooding of the Misery Pit and Jay Pit and diked area and no discharge occurs from the Project during this time.

As discussed in Section 8E2.2 of the DAR, the site water quality model was designed to project the composition of site discharges on a daily time step during operations, closure, and post-closure of the Jay Project. The model is calculated based on randomly selected values for each of the stochastic inputs 200 times. Following the model run, average discharge concentrations were calculated from the 200 values calculated at each timestep. To facilitate results presentation, maximum daily average values were calculated for each of the following model snap-shots:

- Operations – Post-Diavik Shutdown (2023 – 2030); and,
- Post-Closure (>July 1, 2032).

The following subsections present the projected water chemistry of the Project discharges listed above.



4.1.3.1 Site Water Quality Model Results and Discussion

4.1.3.1.1 Operations: Misery Pit Discharge to Lac du Sauvage

The conceptual model for the reasonable estimate case is the same as the DAR conceptual model, and therefore, all water will be managed through the Misery Pit during operations. A key change in the reasonable estimate case is the groundwater inflows to the Jay Pit (Section 4.1.1) are lower in comparison to the updated assessment case. Therefore, water quantity predictions indicate an additional year of storage is available prior to water being discharged from Misery Pit to Lac du Sauvage.

Maximum predicted Misery Pit discharge concentrations for the reasonable estimate case are presented in Table 4-2 and time series results are presented in Appendix C. For discussion, the updated assessment case predictions are also included. Simulated discharge concentrations to Lac du Sauvage from the Misery Pit are seasonal for all constituents (Appendix C). For example, peak discharge concentrations occur during the winter months as a result of ice formation concentrating constituent concentrations in the upper layer of the Misery Pit (Table 4-2). During freshet, concentrations decrease as a result of ice melt and are further reduced during the open water season.

It was noted in the DAR that the Misery Pit discharge water quality is most sensitive to groundwater inflows. Therefore, the reduced groundwater inflows used in the reasonable estimate case generally result in constituent concentrations that are lower in comparison to the projections included in the DAR (Table 4-2). For example, peak under ice TDS (1,150 mg/L) and chloride (605 mg/L) concentrations are approximately one-third of the peak DAR concentrations of 2,925 mg/L and 1,712 mg/L, respectively.

Ammonium concentrations were projected to be similar in the reasonable estimate case in comparison to the DAR case (Table 4-2). Water balance modelling indicates the upper layer of water stored in the Misery Pit is primarily composed of water pumped from the diked area in Lac du Sauvage and minewater pumped from the Jay Pit. Projected ammonium concentrations in the diked area, which include runoff from the Jay WRSA, range between approximately 5.0 and 6.0 mg-N/L, similar to the input source term concentration applied to water pumped from the Jay Pit (i.e., 5.5 mg-N/L). Therefore, without reducing conservatism in the Jay WRSA source term, projected ammonium concentrations are less sensitive to the model updates made as part of the reasonable estimate case.

Total aluminum concentrations in the operational Misery Pit discharge water quality were not sensitive to the changes made as part of the reasonable estimate case and maximum under ice and open water concentrations were similar between the two model cases (Table 4-2). In the reasonable estimate case, groundwater inflows are lower in comparison to the DAR case. As a result, the Misery Pit is projected to require an additional year prior to discharge being required from the facility. The longer filling time results in the Misery Pit wall rock accounting for a higher proportion of the total runoff reporting to the pit during the filling period. Therefore, parameters that are greater in the wall rock runoff, in comparison to the groundwater chemical profile can increase.

Wall rock runoff was assigned the maximum of the humidity cell input results or the stochastic seepage source term assigned to the Jay WRSA. Total aluminum concentrations in the Jay WRSA were greater in comparison to the humidity cell inputs (Section 8E3.4 and 8E3.5 of the DAR) and were therefore carried forward as the source term concentration for Misery Pit wall runoff. Average aluminum concentrations, based on the stochastic input distribution for this constituent, were 0.35 mg/L. Aluminum concentrations in the groundwater inflow to the



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Jay Pit were 0.004 mg/L. Therefore, the reduced groundwater inflows used in the reasonable estimate case resulted in less reduction of wall rock runoff concentrations in comparison to the DAR case.

Table 4-2: Simulated Maximum Misery Pit Discharge Concentrations

Constituent	Units	Maximum Concentrations in Misery Discharge-Mean Daily Values			
		Late Operations		Post-Closure	
		Under Ice	Open Water	Under Ice	Open Water
Assessment Case/Updated Assessment Case ^a					
Total Dissolved Solids (TDS)	mg/L	2,925	2,091	748	728
Chloride (Cl)	mg/L	1,712	1,196	437	426
Sulphate (SO ₄)	mg/L	18	15	21	20
Nitrate as N (NO ₃)	mg/L N	20	16	2.9	2.8
Ammonium as N (NH ₄)	mg/L N	5.4	4.6	0.67	0.66
Phosphorus, dissolved (P)	mg/L	0.21	0.16	0.059	0.058
Phosphorus, total (P)	mg/L	0.22	0.16	0.067	0.065
Total Aluminum (Al)	mg/L	1.3	1.3	1.3	1.3
Total Arsenic (As)	mg/L	0.0018	0.0015	0.0017	0.0016
Reasonable Estimate Case					
Total Dissolved Solids (TDS)	mg/L	1,150	804	615	599
Chloride (Cl)	mg/L	605	395	353	269
Sulphate (SO ₄)	mg/L	20	17	20	19
Nitrate as N (NO ₃)	mg-N/L	13	11	2.9	2.8
Ammonium as N (NH ₄)	mg-N/L	4.9	4.1	0.67	0.65
Phosphorus, dissolved (P)	mg/L	0.15	0.11	0.062	0.061
Phosphorus, total (P)	mg/L	0.15	0.12	0.07	0.068
Total Aluminum (Al)	mg/L	1.3	1.3	1.3	1.3
Total Arsenic (As)	mg/L	0.0015	0.0013	0.0017	0.0016

a) Changes to the updated assessment case only result in changes to Misery pit post-closure results.

Note:

Mg/L = milligrams per litre; mg-N/L = milligrams as nitrogen per litre.



4.1.3.1.2 Post-Closure: Misery Pit Overflow and Seepage to Lac de Gras

Hydrogeological modelling predicted that a small amount of seepage will drain from the bottom of Misery Pit to Lac de Gras during post-closure. This seepage was assigned the maximum predicted constituent concentrations in the Misery Pit monimolimnion. Maximum predicted Misery Pit monimolimnion concentrations for the reasonable estimate case and the updated assessment case are provided in Table 4-3.

As a result of the lower groundwater inflows requiring management through the Misery Pit during operations, in general, projected concentrations of the constituent concentrations in the Misery Pit monimolimnion were lower in the reasonable estimate case in comparison to the updated assessment case. For example, projected updated assessment case TDS (5,520 mg/L) and chloride (3,359 mg/L) decreased to 4,329 mg/L and 2,601 mg/L, respectively in the reasonable estimate case.

Maximum total phosphorus and arsenic concentrations increased in the Misery Pit monimolimnion in the reasonable estimate case (Table 4-3). Although the reasonable estimate case has lower groundwater inflows to the Jay Pit, the lake water percentages decrease in comparison to the DAR model (Table 4-1). Lake water percentages in groundwater inflows vary as much as seven percent, and the variation increases towards the end of mine life when groundwater flows are greater. As a result, the Jay sump phosphorus and arsenic concentrations (i.e., pumped to the bottom of the Misery Pit) are marginally higher in the reasonable estimate case in comparison to the DAR case.

Similar to the projected operational Misery Pit discharge concentrations, total aluminium was not sensitive to the changes made to the model as part of the reasonable estimate case and predicted concentrations were similar to those projected in the updated assessment scenario (Table 4-3).

During post-closure, the Misery Pit mixolimnion (upper layer) will overflow to Lac de Gras. The composition of water stored in the mixolimnion is influenced by the following:

- Pit wall rock runoff;
- Direct precipitation/evaporation;
- Catchment runoff; and,
- Mass displaced vertically from the monimolimnion (see Section 4.1.2).

Maximum predicted Misery Pit mixolimnion concentrations for the reasonable estimate case and the updated assessment case are provided in Table 4-3.

With the exception of total phosphorus and arsenic, projected concentrations of all other constituents were lower in the reasonable estimate case in comparison to the updated assessment case (Table 4-3). Hydrodynamic results indicated more water, stored in the monimolimnion, will mix with the mixolimnion as a result of the lower density gradient observed in the reasonable estimate case. In addition, as presented above, concentrations of total phosphorus and arsenic were greater in the monimolimnion in the reasonable estimate case, in comparison to the reasonable estimate case. The higher concentrations, coupled with the increased volume of water mixing between the mixolimnion and the monimolimnion, results in higher concentrations of these constituents in the Misery Pit mixolimnion in the reasonable estimate case (Table 4-3).



Table 4-3: Simulated Maximum Misery Pit and Jay Pit Monimolimnion Concentrations

Constituent	Units	Maximum Concentrations in Post-Closure Discharges-Mean Daily Values	
		Misery Monimolimnion	Jay Monimolimnion
Updated Assessment Case			
Total Dissolved Solids (TDS)	mg/	5,520	2,024
Chloride (Cl)	mg/L	3,359	1,211
Sulphate (SO ₄)	mg/L	5.2	3.3
Nitrate as N (NO ₃)	mg-N/L	22	11
Ammonium as N (NH ₄)	mg-N/L	5.0	2.5
Phosphorus, total (P)	mg/L	0.19	0.12
Total Aluminum (Al)	mg/L	1.2	0.018
Total Arsenic (As)	mg/L	0.0016	0.0011
Reasonable Estimate Case			
Total Dissolved Solids (TDS)	mg/L	4,329	1,008
Chloride (Cl)	mg/L	2,601	570
Sulphate (SO ₄)	mg/L	6.2	3.8
Nitrate as N (NO ₃)	mg-N/L	21	11
Ammonium as N (NH ₄)	mg-N/L	4.8	2.5
Phosphorus, total (P)	mg/L	0.21	0.089
Total Aluminum (Al)	mg/L	1.2	0.023
Total Arsenic (As)	mg/L	0.0018	0.0009

mg/L = milligrams per litre; mg-N/L = milligrams as nitrogen per litre.

4.1.3.1.3 Post-Closure: Jay Pit Monimolimnion

Hydrodynamic modelling (Section 4.1.2) predicted that a component of the water stored in the monimolimnion (bottom layer) of the Jay Pit will interact with the mixolimnion (upper layer) in Lac du Sauvage. The maximum projected Jay Pit monimolimnion concentrations were input into the Lac du Sauvage hydrodynamic model as a mass load calculated using the predicted volume replacements from the monimolimnion to the mixolimnion. Maximum predicted Jay Pit monimolimnion concentrations for the reasonable estimate case and the updated assessment case are provided in Table 4-3.

In general, maximum projected constituent concentrations were less in the reasonable estimate case in comparison to the updated assessment case (Table 4-3). For example, the updated assessment case TDS (2,024 mg/L) and chloride (1,211 mg/L) concentrations decreased to 1,008 mg/L and 570 mg/L, respectively, in the reasonable estimate scenario. Maximum total aluminum concentrations increased from 0.018 mg/L to 0.023 mg/L in the reasonable assessment case. The increase is attributed to wall rock runoff accounting for a higher proportion of the total inflow to the Jay Pit during back-flooding as a result of the groundwater inflows being reduced. The aluminum concentration used to represent the wall rock runoff is greater than the groundwater input concentration (Section 8E3.3 and 8E3.5 of the DAR) and the increased proportion of wall rock runoff during back-flooding results in a small increase in the maximum Jay Pit monimolimnion concentrations (Table 4-3).



4.1.3.1.4 Post-Closure: Jay Waste Rock Storage Area Seepage and Runoff to Lac du Sauvage

During post-closure, runoff from the Jay WRSA will drain towards Lac du Sauvage. As mentioned in Section 4.0, attenuation of nitrogen species in the Jay WRSA drainage during post-closure was included to account for flushing of residual nitrogen stored in the WRSA. This updated assumption was accounted for in the model by reducing the ammonium and nitrate concentrations to Lac du Sauvage baseline concentrations in post-closure (Table 4-4). Since nitrate is a component of TDS, Jay WRSA runoff TDS concentrations also decreased during post-closure. All other constituent concentrations were input in the same way as in the DAR (Section 8E3.4).

Table 4-4: Simulated Jay Waste Rock Storage Area Runoff Concentrations

Parameter	Units	Concentrations in Jay Waste Rock Storage Area Runoff-Operations		Concentrations in Jay Waste Rock Storage Area Runoff-Post-Closure	
		Average	Maximum	Average	Maximum
Updated Assessment Case					
Total Dissolved Solids (TDS)	mg/L	349	1,672	349	1,672
Nitrate as N (NO ₃)	mg-N/L	34	326	34	326
Ammonium as N (NH ₄)	mg-N/L	19.3	183.0	19.3	183.0
Reasonable Estimate Case					
Total Dissolved Solids (TDS)	mg/L	349	1672	199	383
Nitrate as N (NO ₃)	mg-N/L	34	326	0.0025	0.0025
Ammonium as N (NH ₄)	mg-N/L	19.3	183.0	0.0070	0.0070

mg/L = milligrams per litre; mg-N/L = milligrams as nitrogen per litre.

4.1.4 Near-field Mixing Model

A near-field mixing model was developed in Cormix to evaluate mixing of Misery Pit discharge in Lac du Sauvage. Details of this model are provided in Appendix 8F, Attachment 8F1 of the DAR. The purposes of the near-field mixing model were to estimate dilution, relative concentration, and plume geometry from a diffuser placed in Lac du Sauvage to discharge water from the Misery Pit. Simulations presented in Appendix 8F, Attachment 8F1 of the DAR were updated for the reasonable estimate case Misery Pit discharge predicted in the site water quality model.

4.1.4.1 Near-field Mixing Model Results and Discussion

A comparison of the predicted dilution between the updated assessment case and the reasonable estimate case model results is presented in Table 4-5 for the recommended diffuser configuration (10 m port spacing). Results of the reasonable estimate case model scenarios were similar to results presented in the DAR in terms of dilution and do not affect the recommended diffuser configuration presented in the DAR. Updates to the near-field mixing model as part of the reasonable estimate case do not affect the conclusions presented in the DAR or the inputs used in the Lac du Sauvage hydrodynamic model.



Table 4-5: Predicted Near Field Dilution in Lac du Sauvage

Parameter	Updated Assessment Case		Reasonable Estimate Case	
	Maximum Discharge Concentration	Dilution ^(a)	Maximum Discharge Concentration	Dilution ^(a)
	mg/L	x	mg/L	x
Under Ice				
Total Dissolved Solids	2,925	19	1,150	19
Chloride	1,712	19	605	19
Total Phosphorus (as P)	0.22	19	0.15	19
Nitrate (as N)	20	19	13	19
Strontium	11	19	4	19
Open Water				
Total Dissolved Solids	2,091	9	804	8
Chloride	1,196	9	395	8
Total Phosphorus (as P)	0.16	9	0.11	8
Nitrate (as N)	16	9	11	8
Strontium	8	9	2.6	8

a) Dilution Factor at End of Near Field, 16 m; assuming 10 port diffuser.

Note:

Mg/L = milligrams per litre.

4.1.5 Lake Hydrodynamic Models

Hydrodynamic models were developed for Lac du Sauvage and Lac de Gras using the GEMSS. Details of the development framework, calibration, inputs, and assumptions used in the Lac du Sauvage and Lac de Gras hydrodynamic models is provided in Appendix 8F of the DAR. The reasonable estimate case model scenario was anticipated to result in lower constituent loadings from Project discharges to Lac du Sauvage and Lac de Gras. Therefore, to provide an estimate of the changes to surface water quality in Lac du Sauvage and Lac de Gras, the lake hydrodynamic models were updated to account for changes to Project discharge quantities and qualities.

One of the source-term inputs to Lac de Gras under existing conditions and early operations of the Jay Project (2013 to 2023) is treated effluent from Diavik Mine. Water quality data for the Diavik Mine treated effluent discharge were obtained from monitored data at SNP stations 1645-18 and 1645-18b for 2009, 2010, 2011, 2012, and 2013 (WLWB 2014). From 2014 to 2023, the Diavik Mine effluent discharge was assigned a water chemistry profile equal to the average concentrations of monitored data. The volume of discharge from the Diavik Mine was based on measured discharge rates from 2009 – 2013, and followed projected discharge rates from the most recent water management plan (DDMI 2014).

Similar to the DAR model, a tracer constituent was used to estimate the metals concentrations in Lac du Sauvage and Lac de Gras. The average metals concentration from the Diavik Mine discharge was used to calculate metals concentrations in Lac de Gras as part of the reasonable estimate case model scenario.



4.1.5.1 Lake Hydrodynamic Model Results and Discussion

4.1.5.1.1 Lac du Sauvage

Results of the Lac du Sauvage reasonable estimate case hydrodynamic model are presented in Tables 4-6 to 4-8. Updated assessment case results are also presented for comparison. Time series plots for each parameter are presented in Appendix A. Results are presented for the three assessment locations in the lake: LDS-P1, LDS-P2, and LDS-P3.

In general, predicted concentrations were lower in the reasonable estimate case than in the updated assessment case (Tables 4-6 to 4-8). For example, peak TDS concentrations under the reasonable estimate case scenario were predicted to reach 43 mg/L, while in the updated assessment case peak TDS concentrations were predicted to reach 103 mg/L at location LDS-P1 (Table 4-6). The reduced groundwater inflows to the Jay Pit for the reasonable estimate case reduce Misery Pit discharge concentrations and as a result, the concentrations downstream are also lower.

A few parameters were predicted to be marginally higher at some assessment locations in the reasonable estimate case relative to the updated assessment case; however, these increases are considered to be negligible (less than 10%). These subtle increases were due to variations in predicted site discharge water quality between the updated assessment and reasonable estimate cases. The rationale for the increases in certain constituent concentrations at different points in the mine life is presented in Section 4.1.3.1. Overall, predicted concentrations for the Lac du Sauvage reasonable estimate case model were similar or lower than predicted concentrations in the updated assessment case.



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Table 4-6: Predicted Maximum Depth-Averaged Constituent Concentrations in Lac du Sauvage.

Parameter	Units	LDS-P1								LDS-P2								LDS-P3							
		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)	
		Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water
Reasonable Estimate Case																									
Total dissolved solids	mg/L	11	10	39	32	39	28	13	11	11	10	35	28	36	24	13	11	12	9.6	28	24	29	23	15	11
Chloride	mg/L	0.28	0.24	0.32	0.23	0.31	0.26	1.0	0.93	0.27	0.24	0.3	0.24	0.3	0.24	1.0	0.92	0.29	0.23	0.3	0.23	0.29	0.23	1.1	0.85
Sulphate	mg/L	1.8	1.6	2.7	1.9	2.5	2.0	1.4	1.2	1.8	1.5	2.5	1.9	2.4	1.8	1.3	1.2	1.9	1.5	2.2	1.9	2.2	1.7	1.6	1.1
Total ammonia	mg-N/L	0.033	0.027	0.15	0.13	0.14	0.074	0.038	0.028	0.033	0.027	0.13	0.1	0.13	0.06	0.037	0.026	0.037	0.027	0.097	0.076	0.10	0.056	0.041	0.025
Nitrate	mg-N/L	0.046	0.037	0.4	0.37	0.4	0.27	0.029	0.025	0.043	0.036	0.38	0.32	0.37	0.23	0.028	0.023	0.043	0.033	0.27	0.27	0.28	0.22	0.029	0.022
Total phosphorus (calculated)	mg-P/L	0.0072	0.007	0.01	0.0087	0.010	0.008	0.0075	0.0073	0.0072	0.007	0.010	0.0082	0.0097	0.0073	0.0075	0.0073	0.0073	0.0069	0.0087	0.0077	0.009	0.007	0.0079	0.0073
Phytoplankton (as Chlorophyll a)	µg/L	1.9	2.4	5.4	7.5	3.9	5.7	2.1	2.9	1.8	2.3	5.4	7.5	4.0	5.8	2.1	2.8	1.8	2.3	5.4	7.4	4.9	5.8	2.1	2.9
Total Aluminum	µg/L	4.4	8.8	51	55	51	42	12	16	4.4	8.8	49	47	47	37	12	15	4.4	8.8	37	42	38	36	13	15
Total Arsenic	µg/L	0.35	0.3	0.39	0.34	0.39	0.33	0.36	0.31	0.35	0.3	0.39	0.34	0.39	0.33	0.36	0.31	0.35	0.3	0.38	0.33	0.38	0.33	0.36	0.31
Updated Assessment Case																									
Total dissolved solids	mg/L	11	9.9	88	71	88	62	22	19	11	10.0	82	64	84	59	22	18	12	9.4	68	60	70	58	24	17
Chloride	mg/L	0.26	0.23	43	35	43	29	6.6	5.4	0.25	0.23	40	31	41	28	6.4	4.9	0.28	0.22	32	29	33	27	7.0	4.8
Sulphate	mg/L	1.5	1.4	2.0	1.6	1.9	1.5	1.4	1.2	1.5	1.4	1.9	1.5	1.9	1.5	1.4	1.2	1.7	1.3	1.8	1.5	1.8	1.4	1.7	1.1
Total ammonia	mg-N/L	0.031	0.025	0.17	0.13	0.17	0.076	0.057	0.049	0.031	0.025	0.16	0.09	0.16	0.069	0.058	0.05	0.036	0.025	0.13	0.092	0.14	0.064	0.061	0.046
Nitrate	mg-N/L	0.027	0.03	0.6	0.52	0.57	0.38	0.13	0.1	0.027	0.028	0.57	0.47	0.54	0.36	0.13	0.11	0.028	0.027	0.46	0.44	0.45	0.35	0.14	0.096
Total phosphorus (calculated)	mg-P/L	0.0072	0.007	0.012	0.0092	0.012	0.0079	0.0077	0.0074	0.0072	0.007	0.012	0.0078	0.012	0.0075	0.0077	0.0074	0.0073	0.0069	0.011	0.0079	0.011	0.0072	0.008	0.0073
Phytoplankton (as Chlorophyll a)	µg/L	1.8	2.4	11	14	8.1	11	2.1	2.8	1.8	2.3	11	14	8.4	11	2.1	2.8	1.8	2.3	11	14	10	11	2.1	2.8
Total Aluminum	µg/L	4.4	8.8	60	58	58	48	13	16	4.4	8.8	58	53	56	46	13	16	4.4	8.8	51	51	50	45	14	16
Total Arsenic	µg/L	0.35	0.3	0.41	0.36	0.41	0.35	0.36	0.31	0.35	0.3	0.41	0.35	0.41	0.34	0.36	0.31	0.35	0.3	0.4	0.35	0.4	0.34	0.36	0.31

mg/L = milligrams per litre; mg-N/L = milligrams as nitrogen per litre; mg-P/L = milligrams as phosphorus per litre; µg/L = micrograms per litre.



COMPENDIUM OF SUPPLEMENTAL WATER QUALITY MODELLING

Table 4-7: Predicted Maximum Surface Constituent Concentrations in Lac du Sauvage

Parameter	Units	LDS-P1								LDS-P2								LDS-P3							
		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)	
		Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water
Reasonable Estimate Case																									
Total dissolved solids	mg/L	14	9.9	31	30	32	27	17	11	13	9.6	30	28	30	25	17	11	13	9.6	28	24	29	23	17	11
Chloride	mg/L	0.33	0.24	0.33	0.23	0.32	0.26	1.2	0.98	0.32	0.23	0.33	0.23	0.3	0.24	1.1	0.94	0.32	0.23	0.32	0.23	0.31	0.22	1.2	0.85
Sulphate	mg/L	2.2	1.6	2.6	1.9	2.5	2.0	1.9	1.2	2.1	1.5	2.5	1.8	2.3	1.9	1.9	1.1	2.0	1.5	2.4	1.9	2.3	1.7	1.9	1.1
Total ammonia	mg-N/L	0.04	0.027	0.11	0.098	0.11	0.071	0.042	0.027	0.039	0.027	0.11	0.089	0.11	0.063	0.041	0.026	0.04	0.027	0.099	0.075	0.1	0.055	0.041	0.025
Nitrate	mg-N/L	0.052	0.036	0.3	0.35	0.31	0.27	0.031	0.024	0.049	0.033	0.29	0.32	0.3	0.24	0.031	0.023	0.046	0.033	0.27	0.27	0.28	0.22	0.03	0.022
Total phosphorus (calculated)	mg-P/L	0.0074	0.0069	0.0089	0.0082	0.0091	0.0078	0.0082	0.0073	0.0074	0.0069	0.0089	0.008	0.0091	0.0073	0.0081	0.0073	0.0074	0.0069	0.0086	0.0077	0.009	0.007	0.0082	0.0073
Phytoplankton (as Chlorophyll a)	µg/L	1.8	2.3	5.4	7.9	4.4	5.8	2.1	2.8	1.8	2.3	5.4	7.8	4.6	5.8	2.1	2.8	1.8	2.3	5.4	7.6	4.4	5.8	2.1	2.9
Total Aluminum	µg/L	4.4	8.8	41	51	42	41	13	16	4.4	8.8	40	48	40	38	13	15	4.4	8.8	38	42	38	36	13	15
Total Arsenic	µg/L	0.35	0.3	0.38	0.34	0.38	0.33	0.36	0.31	0.35	0.3	0.38	0.34	0.38	0.33	0.36	0.31	0.35	0.3	0.38	0.33	0.38	0.33	0.36	0.31
Updated Assessment Case																									
Total dissolved solids	mg/L	13	9.5	71	64	72	63	24	18	13	9.5	68	63	70	60	24	18	13	9.4	68	60	70	57	24	17
Chloride	mg/L	0.31	0.22	33	31	34	30	7.2	5.1	0.31	0.22	32	31	33	28	7.0	5.0	0.31	0.22	32	28	33	27	7.1	4.8
Sulphate	mg/L	1.8	1.4	2.0	1.6	1.9	1.5	2.0	1.2	1.8	1.3	1.9	1.6	1.8	1.5	2.0	1.2	1.8	1.3	1.9	1.5	1.8	1.4	2.0	1.2
Total ammonia	mg-N/L	0.038	0.025	0.13	0.12	0.14	0.077	0.073	0.055	0.038	0.025	0.13	0.093	0.14	0.07	0.082	0.051	0.038	0.025	0.13	0.091	0.14	0.064	0.07	0.05
Nitrate	mg-N/L	0.029	0.035	0.45	0.47	0.46	0.39	0.17	0.11	0.029	0.028	0.45	0.46	0.45	0.37	0.19	0.11	0.03	0.027	0.45	0.44	0.45	0.35	0.16	0.1
Total phosphorus (calculated)	mg-P/L	0.0073	0.0069	0.01	0.0083	0.011	0.0079	0.0083	0.0073	0.0073	0.0069	0.01	0.0078	0.011	0.0076	0.0084	0.0074	0.0074	0.0069	0.01	0.0079	0.011	0.0073	0.0083	0.0073
Phytoplankton (as Chlorophyll a)	µg/L	1.8	2.3	11	15	7.7	11	2.1	2.8	1.8	2.3	11	15	7.7	11	2.1	2.8	1.8	2.3	11	15	7.6	11	2.1	2.8
Total Aluminum	µg/L	4.4	8.8	50	54	51	48	14	16	4.4	8.8	50	52	50	47	14	16	4.4	8.8	50	51	50	45	14	16
Total Arsenic	µg/L	0.35	0.3	0.4	0.35	0.4	0.35	0.36	0.31	0.35	0.3	0.4	0.35	0.4	0.34	0.36	0.31	0.35	0.3	0.4	0.35	0.4	0.34	0.36	0.31

mg/L = milligrams per litre; mg-N/L = milligrams as nitrogen per litre; mg-P/L = milligrams as phosphorus per litre; µg/L = micrograms per litre.



Table 4-8: Predicted Maximum Constituent Concentrations in Lac du Sauvage

Parameter	Units	LDS-P1								LDS-P2								LDS-P3							
		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)	
		Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water
Reasonable Estimate Case																									
Total dissolved solids	mg/L	14	11	43	33	44	28	17	12	13	11	39	28	41	25	17	12	13	9.6	28	24	29	23	17	11
Chloride	mg/L	0.33	0.27	0.33	0.25	0.32	0.26	1.2	0.98	0.32	0.26	0.33	0.26	0.3	0.25	1.1	0.95	0.32	0.23	0.32	0.23	0.31	0.23	1.2	0.85
Sulphate	mg/L	2.2	1.8	2.7	2.0	2.6	2.1	1.9	1.3	2.1	1.7	2.6	2.2	2.5	1.9	1.9	1.3	2.0	1.5	2.4	1.9	2.3	1.8	1.9	1.1
Total ammonia	mg-N/L	0.04	0.028	0.16	0.17	0.16	0.076	0.042	0.028	0.039	0.028	0.15	0.13	0.14	0.063	0.041	0.03	0.04	0.027	0.099	0.076	0.1	0.056	0.041	0.025
Nitrate	mg-N/L	0.052	0.043	0.49	0.41	0.46	0.28	0.031	0.025	0.049	0.04	0.43	0.33	0.42	0.24	0.031	0.027	0.046	0.033	0.27	0.27	0.28	0.22	0.03	0.022
Total phosphorus (calculated)	mg-P/L	0.0074	0.0072	0.011	0.0094	0.011	0.0081	0.0082	0.0074	0.0074	0.0072	0.011	0.0091	0.01	0.0076	0.0081	0.0074	0.0074	0.0069	0.0088	0.0077	0.0091	0.007	0.0082	0.0073
Phytoplankton (as Chlorophyll a)	µg/L	1.9	2.4	5.4	7.9	5.2	5.8	2.2	2.9	1.8	2.4	5.4	7.8	5.3	5.8	2.1	2.8	1.8	2.3	5.4	7.6	5.2	5.8	2.1	2.9
Total Aluminum	µg/L	4.4	8.8	68	66	68	54	13	16	4.4	8.8	66	60	64	48	13	16	4.4	8.8	54	53	52	46	13	15
Total Arsenic	µg/L	0.35	0.3	0.42	0.36	0.42	0.34	0.36	0.31	0.35	0.3	0.42	0.35	0.42	0.34	0.36	0.31	0.35	0.3	0.41	0.34	0.4	0.34	0.36	0.31
Updated Assessment Case																									
Total dissolved solids	mg/L	13	11	100	76	103	63	24	19	13	11	94	65	96	60	24	20	13	9.5	68	60	71	58	24	17
Chloride	mg/L	0.31	0.26	51	38	52	30	7.2	5.5	0.31	0.25	47	32	48	28	7.0	5.6	0.31	0.22	32	29	34	27	7.1	4.8
Sulphate	mg/L	1.8	1.5	2.1	1.6	1.9	1.5	2.0	1.3	1.8	1.5	2.0	1.6	1.9	1.5	2.0	1.3	1.8	1.3	1.9	1.5	1.8	1.4	2.0	1.2
Total ammonia	mg-N/L	0.038	0.027	0.19	0.15	0.19	0.077	0.073	0.055	0.038	0.026	0.18	0.095	0.18	0.07	0.082	0.054	0.038	0.025	0.13	0.092	0.14	0.065	0.07	0.05
Nitrate	mg-N/L	0.032	0.035	0.69	0.57	0.67	0.39	0.17	0.12	0.03	0.032	0.65	0.48	0.63	0.37	0.19	0.11	0.03	0.027	0.48	0.44	0.46	0.35	0.16	0.1
Total phosphorus (calculated)	mg-P/L	0.0073	0.0072	0.013	0.01	0.013	0.0083	0.0083	0.0075	0.0073	0.0072	0.013	0.0085	0.012	0.0083	0.0084	0.0075	0.0074	0.0069	0.011	0.0079	0.011	0.0073	0.0083	0.0073
Phytoplankton (as Chlorophyll a)	µg/L	1.9	2.4	11	15	12	11	2.1	2.8	1.8	2.3	12	15	12	11	2.1	2.8	1.8	2.3	12	15	12	11	2.1	2.8
Total Aluminum	µg/L	4.4	8.8	65	67	64	48	14	16	4.4	8.8	63	54	61	47	14	16	4.4	8.8	52	51	50	45	14	16
Total Arsenic	µg/L	0.35	0.3	0.42	0.37	0.42	0.35	0.36	0.31	0.35	0.3	0.42	0.35	0.41	0.34	0.36	0.31	0.35	0.3	0.4	0.35	0.4	0.34	0.36	0.31

mg/L = milligrams per litre; mg-N/L = milligrams as nitrogen per litre; mg-P/L = milligrams as phosphorus per litre; µg/L = micrograms per litre.



4.1.5.1.2 Lac de Gras

Results of the Lac de Gras reasonable estimate case hydrodynamic model are presented in Tables 4-9 to 4-11. Updated assessment case results are also presented for comparison. Time series plots for each parameter are presented in Appendix B. Results are presented for the six assessment locations in the lake: LDG-P1, LDG-P2, LDG-P3, LDG-P4, LDG-P5, and LDG-P6.

Predicted constituent concentrations were generally lower in the reasonable estimate case than in the updated assessment case (Tables 4-9 to 4-11). Constituent concentrations were predicted to be lower in the reasonable estimate case as a result of the reduced conservatism related to key inputs (i.e., groundwater inflows) in the site water quality model.



COMPENDIUM OF SUPPLEMENTAL WATER QUALITY MODELLING

Table 4-9: Predicted Maximum Depth-Averaged Constituent Concentrations in Lac de Gras
Part A

Parameter	Units	LDG-P1								LDG-P2								LDG-P3							
		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)	
		Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water
Reasonable Estimate Case																									
Total dissolved solids	mg/L	19	18	18	17	16	16	15	14	19	17	18	18	16	16	15	15	19	17	18	18	16	16	15	14
Chloride	mg/L	3.4	3.1	3.0	2.8	1.8	1.7	1.4	1.3	3.1	2.8	3.1	2.9	2.0	2.0	1.5	1.5	3.1	2.9	3.1	2.9	2.0	1.9	1.5	1.4
Sulphate	mg/L	3.4	3.1	3.1	2.9	2.3	2.2	1.9	1.8	3.2	2.9	3.1	3.0	2.4	2.4	2.1	2.0	3.2	2.9	3.1	3.0	2.4	2.3	2.0	1.9
Total ammonia	mg-N/L	0.020	0.017	0.023	0.022	0.024	0.022	0.015	0.013	0.020	0.017	0.021	0.018	0.019	0.017	0.014	0.012	0.020	0.017	0.021	0.018	0.018	0.016	0.014	0.012
Nitrate	mg-N/L	0.065	0.059	0.048	0.050	0.050	0.054	0.023	0.022	0.045	0.040	0.044	0.040	0.033	0.031	0.022	0.021	0.045	0.041	0.044	0.039	0.031	0.029	0.022	0.020
Total phosphorus (calculated)	mg-P/L	0.0031	0.0029	0.0030	0.0029	0.0029	0.0029	0.0027	0.0026	0.0030	0.0028	0.0030	0.0029	0.0028	0.0028	0.0027	0.0026	0.0029	0.0028	0.0030	0.0028	0.0028	0.0027	0.0027	0.0026
Phytoplankton (as Chlorophyll a)	µg/L	0.8	0.9	0.8	1.0	0.7	0.8	0.5	0.5	0.9	1.2	1.0	1.5	0.8	1.1	0.6	0.7	0.9	1.2	1.0	1.4	0.8	1.0	0.5	0.7
Total Aluminum	µg/L	15	15	14	15	15	16	12	13	13	13	13	14	13	14	12	13	13	13	13	13	13	14	12	13
Total Arsenic	µg/L	0.29	0.28	0.28	0.27	0.27	0.27	0.27	0.26	0.28	0.27	0.28	0.27	0.28	0.27	0.27	0.27	0.28	0.27	0.28	0.27	0.28	0.27	0.28	0.27
Updated Assessment Case																									
Total dissolved solids	mg/L	22	20	22	21	24	24	19	18	21	19	20	19	21	20	20	19	20	19	20	19	20	20	19	18
Chloride	mg/L	3.8	3.4	5.7	5.5	6.5	7.2	4.6	4.3	3.4	3.0	3.8	3.6	4.9	4.7	4.6	4.4	3.4	3.1	3.7	3.4	4.6	4.4	4.4	4.1
Sulphate	mg/L	4.8	4.4	4.2	3.9	2.8	2.6	2.3	2.1	4.3	3.9	4.2	4.0	3.0	2.9	2.5	2.4	4.2	3.8	4.1	3.9	2.9	2.8	2.4	2.3
Total ammonia	mg-N/L	0.043	0.034	0.043	0.035	0.037	0.032	0.021	0.017	0.044	0.033	0.044	0.035	0.029	0.025	0.020	0.017	0.044	0.033	0.043	0.033	0.028	0.024	0.019	0.015
Nitrate	mg-N/L	0.086	0.075	0.059	0.070	0.071	0.078	0.028	0.028	0.047	0.043	0.041	0.036	0.037	0.035	0.023	0.022	0.047	0.042	0.038	0.028	0.034	0.031	0.023	0.022
Total phosphorus (calculated)	mg-P/L	0.0045	0.0040	0.0042	0.0039	0.0035	0.0034	0.0029	0.0028	0.0040	0.0035	0.0042	0.0037	0.0032	0.0031	0.0029	0.0028	0.0039	0.0032	0.0041	0.0031	0.0032	0.0029	0.0029	0.0027
Phytoplankton (as Chlorophyll a)	µg/L	3.4	3.9	3.1	3.7	1.5	1.9	0.7	0.7	3.8	4.8	3.4	5.0	1.6	2.1	0.8	1.0	3.8	5.1	3.5	5.2	1.6	2.2	0.7	1.0
Total Aluminum	µg/L	33	31	27	27	24	25	19	18	27	26	27	27	22	23	20	20	27	26	26	26	22	22	19	19
Total Arsenic	µg/L	0.43	0.40	0.40	0.38	0.33	0.32	0.31	0.30	0.40	0.38	0.39	0.38	0.34	0.33	0.32	0.31	0.39	0.37	0.39	0.38	0.34	0.33	0.32	0.31

mg/L = milligrams per litre; mg-N/L = milligrams as nitrogen per litre; mg-P/L = milligrams as phosphorus per litre; µg/L = micrograms per litre.



COMPENDIUM OF SUPPLEMENTAL WATER QUALITY MODELLING

Table 4-9: Predicted Maximum Depth-Averaged Constituent Concentrations in Lac de Gras
Part B

Parameter	Units	LDG-P4								LDG-P5								LDG-P6							
		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)	
		Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water
Reasonable Estimate Case																									
Total dissolved solids	mg/L	19	17	18	17	16	15	15	14	19	17	19	18	16	15	15	15	21	17	22	18	18	15	18	14
Chloride	mg/L	3.2	3.0	3.1	3.0	2.0	1.9	1.6	1.6	3.3	3.1	3.2	3.1	2.1	2.0	1.6	1.7	3.7	3.2	3.7	3.1	2.4	1.9	1.9	1.6
Sulphate	mg/L	3.2	2.9	3.1	3.0	2.4	2.2	2.0	2.0	3.2	2.9	3.2	3.0	2.4	2.3	2.1	2.0	3.7	3.0	3.7	3.0	2.8	2.3	2.4	2.0
Total ammonia	mg-N/L	0.020	0.017	0.021	0.018	0.017	0.015	0.014	0.012	0.020	0.016	0.021	0.018	0.017	0.015	0.014	0.012	0.022	0.016	0.024	0.018	0.020	0.015	0.016	0.012
Nitrate	mg-N/L	0.047	0.050	0.045	0.042	0.029	0.026	0.023	0.027	0.049	0.054	0.046	0.047	0.029	0.028	0.024	0.029	0.058	0.056	0.055	0.043	0.033	0.026	0.028	0.028
Total phosphorus (calculated)	mg-P/L	0.0029	0.0027	0.0030	0.0026	0.0028	0.0026	0.0027	0.0025	0.0029	0.0028	0.0030	0.0029	0.0028	0.0027	0.0027	0.0026	0.0031	0.0027	0.0032	0.0027	0.0030	0.0026	0.0029	0.0025
Phytoplankton (as Chlorophyll a)	µg/L	1.0	1.2	1.0	1.4	0.8	1.0	0.6	0.7	1.0	1.2	1.0	1.3	0.8	1.0	0.6	0.7	1.0	1.3	1.0	1.5	0.8	1.1	0.6	0.7
Total Aluminum	µg/L	13	13	13	14	13	14	13	13	13	13	13	14	13	14	13	14	14	14	14	14	15	14	14	14
Total Arsenic	µg/L	0.29	0.28	0.29	0.28	0.28	0.28	0.28	0.28	0.29	0.28	0.29	0.29	0.28	0.28	0.28	0.28	0.3	0.29	0.3	0.29	0.29	0.28	0.29	0.28
Updated Assessment Case																									
Total dissolved solids	mg/L	20	19	20	19	20	18	19	18	20	19	20	19	20	19	19	18	23	19	23	19	23	19	23	18
Chloride	mg/L	3.4	3.2	3.4	3.2	4.4	4.1	4.3	4.0	3.5	3.3	3.4	3.3	4.4	4.2	4.4	4.1	4.0	3.3	4.0	3.3	5.1	4.2	5.1	4.1
Sulphate	mg/L	4.1	3.7	4.0	3.8	2.9	2.7	2.4	2.3	4.1	3.8	4.1	3.9	3.0	2.8	2.4	2.3	4.7	3.7	4.8	3.9	3.5	2.8	2.9	2.3
Total ammonia	mg-N/L	0.044	0.033	0.043	0.034	0.027	0.022	0.020	0.015	0.044	0.033	0.044	0.036	0.027	0.023	0.020	0.016	0.050	0.033	0.050	0.034	0.031	0.022	0.023	0.015
Nitrate	mg-N/L	0.047	0.048	0.037	0.027	0.030	0.025	0.024	0.028	0.049	0.056	0.038	0.037	0.029	0.028	0.025	0.031	0.058	0.054	0.044	0.028	0.032	0.025	0.030	0.029
Total phosphorus (calculated)	mg-P/L	0.0037	0.0030	0.0040	0.0028	0.0031	0.0028	0.0028	0.0026	0.0037	0.0035	0.0040	0.0038	0.0031	0.0030	0.0029	0.0028	0.0040	0.0029	0.0042	0.0028	0.0033	0.0027	0.0031	0.0026
Phytoplankton (as Chlorophyll a)	µg/L	3.8	4.7	3.5	5.0	1.6	2.1	0.8	1.0	3.8	4.6	3.6	4.8	1.6	2.1	0.8	1.0	3.8	5.0	4.4	5.3	1.6	2.2	0.8	1.1
Total Aluminum	µg/L	26	25	25	25	21	21	19	20	26	25	26	25	21	22	20	20	29	25	29	26	25	22	22	20
Total Arsenic	µg/L	0.39	0.37	0.39	0.38	0.34	0.33	0.32	0.32	0.39	0.37	0.39	0.38	0.35	0.34	0.33	0.32	0.42	0.37	0.42	0.38	0.37	0.34	0.34	0.32

mg/L = milligrams per litre; mg-N/L = milligrams as nitrogen per litre; mg-P/L = milligrams as phosphorus per litre; µg/L = micrograms per litre.



COMPENDIUM OF SUPPLEMENTAL WATER QUALITY MODELLING

Table 4-10: Predicted Maximum Surface Constituent Concentrations in Lac de Gras
Part A

Parameter	Units	LDG-P1								LDG-P2								LDG-P3							
		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)	
		Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water
Reasonable Estimate Case																									
Total dissolved solids	mg/L	25	19	25	17	22	16	20	14	28	17	28	17	23	15	23	14	28	17	26	17	22	15	22	14
Chloride	mg/L	4.1	3.3	3.9	2.7	2.4	1.7	1.9	1.3	4.6	2.8	4.6	2.7	2.7	1.8	2.2	1.3	4.7	2.9	4.3	2.8	2.5	1.8	2.2	1.4
Sulphate	mg/L	4.3	3.3	4.2	2.8	3.0	2.1	2.7	1.8	4.8	2.9	4.7	2.8	3.3	2.2	3.1	1.8	4.7	2.9	4.4	2.9	3.1	2.2	2.9	1.9
Total ammonia	mg-N/L	0.028	0.017	0.033	0.019	0.031	0.020	0.020	0.012	0.030	0.017	0.032	0.018	0.028	0.017	0.021	0.012	0.029	0.016	0.030	0.018	0.025	0.016	0.019	0.012
Nitrate	mg-N/L	0.067	0.064	0.061	0.042	0.061	0.048	0.028	0.022	0.066	0.041	0.055	0.032	0.045	0.028	0.030	0.018	0.066	0.040	0.053	0.036	0.038	0.028	0.031	0.020
Total phosphorus (calculated)	mg-P/L	0.0035	0.0030	0.0035	0.0028	0.0033	0.0027	0.0032	0.0026	0.0037	0.0026	0.0037	0.0026	0.0034	0.0025	0.0033	0.0025	0.0037	0.0027	0.0035	0.0026	0.0032	0.0026	0.0032	0.0026
Phytoplankton (as Chlorophyll a)	µg/L	0.8	0.9	0.9	1.0	0.9	0.9	0.5	0.5	0.9	1.4	1.0	1.7	0.8	1.4	0.6	0.9	0.9	1.2	1.0	1.4	0.8	1.0	0.5	0.7
Total Aluminum	µg/L	16	16	18	14	17	15	14	13	17	13	17	13	17	14	16	13	17	13	16	13	17	14	16	13
Total Arsenic	µg/L	0.30	0.28	0.30	0.27	0.29	0.27	0.29	0.26	0.31	0.27	0.31	0.27	0.29	0.27	0.29	0.26	0.31	0.27	0.31	0.27	0.30	0.27	0.30	0.27
Updated Assessment Case																									
Total dissolved solids	mg/L	28	21	30	20	29	23	26	18	32	19	30	18	29	19	29	18	30	19	28	19	29	19	28	18
Chloride	mg/L	4.5	3.7	7.4	4.8	7.1	6.5	5.9	4.2	5.2	3.1	5.5	3.6	6.9	4.5	6.4	4.1	5.0	3.1	5.2	3.4	6.6	4.3	6.3	4.1
Sulphate	mg/L	5.7	4.7	5.5	3.8	3.7	2.6	3.1	2.1	6.6	3.9	6.0	3.7	4.0	2.7	3.4	2.2	6.1	3.8	5.7	3.8	3.8	2.7	3.4	2.2
Total ammonia	mg-N/L	0.060	0.034	0.060	0.034	0.045	0.029	0.026	0.016	0.066	0.033	0.061	0.032	0.040	0.025	0.026	0.015	0.063	0.033	0.058	0.033	0.037	0.024	0.025	0.015
Nitrate	mg-N/L	0.069	0.083	0.074	0.051	0.073	0.066	0.042	0.028	0.064	0.041	0.048	0.027	0.048	0.030	0.034	0.021	0.063	0.040	0.043	0.023	0.040	0.028	0.033	0.022
Total phosphorus (calculated)	mg-P/L	0.0048	0.0041	0.0046	0.0034	0.0038	0.0030	0.0033	0.0027	0.0051	0.0030	0.0046	0.0028	0.0036	0.0026	0.0034	0.0026	0.0048	0.0030	0.0045	0.0028	0.0035	0.0027	0.0033	0.0026
Phytoplankton (as Chlorophyll a)	µg/L	3.4	4.0	3.9	3.9	2.4	2.5	0.7	0.7	3.8	5.4	4.7	5.5	1.6	2.6	0.8	1.3	3.8	5.2	4.6	5.2	1.6	2.2	0.7	1.0
Total Aluminum	µg/L	34	33	32	25	29	24	22	19	40	27	36	25	29	22	25	19	37	26	34	26	29	22	25	19
Total Arsenic	µg/L	0.45	0.42	0.43	0.37	0.36	0.32	0.33	0.30	0.49	0.38	0.46	0.37	0.37	0.32	0.35	0.30	0.47	0.37	0.45	0.37	0.37	0.33	0.35	0.31

mg/L = milligrams per litre; mg-N/L = milligrams as nitrogen per litre; mg-P/L = milligrams as phosphorus per litre; µg/L = micrograms per litre.



COMPENDIUM OF SUPPLEMENTAL WATER QUALITY MODELLING

Table 4-10: Predicted Maximum Surface Constituent Concentrations in Lac de Gras Part B

Parameter	Units	LDG-P4								LDG-P5								LDG-P6							
		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)	
		Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water
Reasonable Estimate Case																									
Total dissolved solids	mg/L	28	17	28	18	22	15	23	14	29	18	29	18	22	15	24	15	28	18	30	18	23	15	24	14
Chloride	mg/L	4.8	3.0	4.7	3.1	2.7	1.9	2.3	1.6	5.0	3.4	5.0	3.1	2.7	1.9	2.5	1.6	4.9	3.2	5.0	3.1	2.8	1.9	2.5	1.7
Sulphate	mg/L	4.8	2.9	4.8	3.0	3.1	2.2	3.1	2.0	5.0	3.0	5.0	3.0	3.3	2.2	3.3	2.0	4.8	3.0	5.0	3.0	3.3	2.2	3.3	2.0
Total ammonia	mg-N/L	0.030	0.016	0.032	0.018	0.024	0.015	0.019	0.012	0.030	0.017	0.033	0.018	0.024	0.015	0.020	0.012	0.030	0.016	0.033	0.018	0.025	0.015	0.020	0.012
Nitrate	mg-N/L	0.069	0.054	0.060	0.043	0.037	0.026	0.033	0.027	0.073	0.070	0.064	0.046	0.040	0.029	0.038	0.029	0.071	0.057	0.065	0.043	0.038	0.026	0.037	0.029
Total phosphorus (calculated)	mg-P/L	0.0037	0.0026	0.0036	0.0026	0.0032	0.0025	0.0033	0.0025	0.0037	0.0027	0.0037	0.0027	0.0033	0.0026	0.0033	0.0025	0.0036	0.0027	0.0037	0.0027	0.0033	0.0026	0.0034	0.0025
Phytoplankton (as Chlorophyll a)	µg/L	0.9	1.2	1.0	1.5	0.8	1.0	0.6	0.7	1.0	1.2	1.0	1.4	0.8	1.0	0.6	0.7	1.0	1.3	1.0	1.5	0.8	1.1	0.5	0.7
Total Aluminum	µg/L	17	13	17	14	17	14	16	13	18	14	18	14	17	15	17	14	18	14	18	14	18	14	17	14
Total Arsenic	µg/L	0.32	0.28	0.32	0.29	0.30	0.28	0.30	0.28	0.32	0.29	0.32	0.29	0.31	0.30	0.31	0.28	0.32	0.29	0.32	0.29	0.31	0.28	0.31	0.28
Updated Assessment Case																									
Total dissolved solids	mg/L	31	19	29	19	28	18	29	18	30	19	31	19	29	18	30	18	31	19	32	19	27	18	30	18
Chloride	mg/L	5.3	3.2	4.9	3.3	6.3	4.1	6.3	4.0	5.0	3.5	5.2	3.3	6.5	4.1	6.6	4.1	5.3	3.4	5.4	3.3	6.1	4.1	6.7	4.1
Sulphate	mg/L	6.4	3.7	6.0	3.8	3.8	2.7	3.5	2.3	6.0	3.8	6.3	3.8	3.9	2.7	3.7	2.3	6.3	3.7	6.5	3.8	4.0	2.7	3.7	2.3
Total ammonia	mg-N/L	0.066	0.033	0.062	0.034	0.035	0.023	0.025	0.015	0.062	0.033	0.065	0.034	0.037	0.023	0.025	0.015	0.065	0.033	0.067	0.034	0.036	0.022	0.026	0.015
Nitrate	mg-N/L	0.065	0.051	0.043	0.028	0.036	0.025	0.034	0.029	0.071	0.072	0.044	0.030	0.037	0.027	0.038	0.031	0.067	0.054	0.046	0.027	0.035	0.026	0.038	0.029
Total phosphorus (calculated)	mg-P/L	0.0048	0.0028	0.0046	0.0028	0.0034	0.0026	0.0034	0.0025	0.0046	0.0031	0.0047	0.0032	0.0035	0.0028	0.0034	0.0026	0.0047	0.0029	0.0048	0.0028	0.0035	0.0027	0.0035	0.0026
Phytoplankton (as Chlorophyll a)	µg/L	3.8	4.8	4.4	5.2	1.6	2.1	0.8	1.0	3.8	4.8	4.2	5.1	1.6	2.2	0.8	1.0	3.8	5.0	4.1	5.3	1.6	2.2	0.8	1.1
Total Aluminum	µg/L	38	25	35	25	28	21	25	19	35	25	37	25	29	22	26	20	37	25	38	25	28	22	26	20
Total Arsenic	µg/L	0.48	0.37	0.46	0.38	0.38	0.33	0.36	0.31	0.47	0.37	0.48	0.38	0.38	0.34	0.37	0.32	0.48	0.37	0.49	0.38	0.39	0.34	0.37	0.32

mg/L = milligrams per litre; mg-N/L = milligrams as nitrogen per litre; mg-P/L = milligrams as phosphorus per litre; µg/L = micrograms per litre.



COMPENDIUM OF SUPPLEMENTAL WATER QUALITY MODELLING

Table 4-11: Predicted Maximum Constituent Concentrations in Lac de Gras
Part A

Parameter	Units	LDG-P1								LDG-P2								LDG-P3							
		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)	
		Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water
Reasonable Estimate Case																									
Total dissolved solids	mg/L	25	21	25	18	22	16	20	14	28	19	28	19	23	17	23	16	28	18	26	19	22	17	22	15
Chloride	mg/L	4.1	3.7	3.9	3.0	2.4	1.8	1.9	1.4	4.6	3.0	4.6	3.2	2.7	2.1	2.2	1.6	4.7	3.0	4.3	3.2	2.5	2.1	2.2	1.5
Sulphate	mg/L	4.3	3.7	4.2	3.1	3.0	2.2	2.7	1.9	4.8	3.1	4.7	3.3	3.3	2.5	3.1	2.2	4.7	3.1	4.4	3.2	3.1	2.5	2.9	2.1
Total ammonia	mg-N/L	0.028	0.018	0.033	0.025	0.031	0.025	0.020	0.013	0.030	0.017	0.032	0.019	0.028	0.017	0.021	0.013	0.029	0.017	0.030	0.018	0.025	0.016	0.019	0.012
Nitrate	mg-N/L	0.073	0.074	0.061	0.061	0.061	0.069	0.028	0.023	0.066	0.044	0.055	0.045	0.045	0.034	0.030	0.023	0.066	0.045	0.053	0.044	0.038	0.033	0.031	0.022
Total phosphorus (calculated)	mg-P/L	0.0035	0.0032	0.0035	0.0030	0.0033	0.0029	0.0032	0.0027	0.0037	0.0030	0.0037	0.0030	0.0034	0.0029	0.0033	0.0027	0.0037	0.0029	0.0035	0.0030	0.0032	0.0029	0.0032	0.0027
Phytoplankton (as Chlorophyll a)	µg/L	0.8	0.9	0.9	1.1	0.9	1.0	0.5	0.5	1.0	1.4	1.0	1.7	0.8	1.4	0.6	0.9	0.9	1.2	1.0	1.4	0.8	1.0	0.5	0.7
Total Aluminum	µg/L	16	17	18	17	17	19	14	13	17	14	17	14	17	15	16	14	17	14	16	14	17	15	16	14
Total Arsenic	µg/L	0.30	0.29	0.30	0.28	0.29	0.27	0.29	0.26	0.31	0.27	0.31	0.28	0.29	0.27	0.29	0.27	0.31	0.28	0.31	0.28	0.30	0.28	0.30	0.27
Updated Assessment Case																									
Total dissolved solids	mg/L	28	23	30	24	29	27	26	19	32	21	30	21	29	22	29	21	30	20	28	21	29	22	28	20
Chloride	mg/L	4.5	4.1	7.4	6.9	7.1	9.3	5.9	4.5	5.2	3.4	5.5	3.6	6.9	5.1	6.4	4.8	5.0	3.2	5.2	3.4	6.6	4.9	6.3	4.5
Sulphate	mg/L	5.7	5.3	5.5	4.2	3.7	2.8	3.1	2.2	6.6	4.2	6.0	4.3	4.0	3.1	3.4	2.6	6.1	4.0	5.7	4.2	3.8	3.0	3.4	2.4
Total ammonia	mg-N/L	0.060	0.040	0.060	0.038	0.045	0.035	0.026	0.018	0.066	0.035	0.061	0.039	0.040	0.027	0.026	0.018	0.063	0.033	0.058	0.037	0.037	0.025	0.025	0.017
Nitrate	mg-N/L	0.100	0.101	0.074	0.094	0.075	0.106	0.042	0.034	0.064	0.047	0.048	0.042	0.048	0.038	0.034	0.024	0.063	0.048	0.043	0.036	0.040	0.036	0.033	0.024
Total phosphorus (calculated)	mg-P/L	0.0048	0.0048	0.0046	0.0043	0.0038	0.0036	0.0033	0.0029	0.0051	0.0040	0.0046	0.0043	0.0036	0.0032	0.0034	0.0029	0.0048	0.0037	0.0045	0.0037	0.0035	0.0032	0.0033	0.0028
Phytoplankton (as Chlorophyll a)	µg/L	3.4	4.0	3.9	3.9	2.4	2.5	0.7	0.7	3.8	5.4	5.4	5.5	1.6	2.6	0.8	1.3	3.8	5.2	4.6	5.2	1.6	2.2	0.7	1.0
Total Aluminum	µg/L	36	37	32	29	29	29	22	19	40	28	36	29	29	24	25	21	37	26	34	28	29	24	25	21
Total Arsenic	µg/L	0.45	0.45	0.43	0.39	0.36	0.33	0.33	0.30	0.49	0.39	0.46	0.40	0.37	0.34	0.35	0.32	0.47	0.38	0.45	0.39	0.37	0.34	0.35	0.31

mg/L = milligrams per litre; mg-N/L = milligrams as nitrogen per litre; mg-P/L = milligrams as phosphorus per litre; µg/L = micrograms per litre.



COMPENDIUM OF SUPPLEMENTAL WATER QUALITY MODELLING

Table 4-11: Predicted Maximum Constituent Concentrations in Lac de Gras
Part B

Parameter	Units	LDG-P4								LDG-P5								LDG-P6							
		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)		Early Operations (2019-2023)		Late Operations (2024-2029)		Closure-Pit Refilling Period (2030-2033)		Post-Closure (2034-2060)	
		Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water	Under Ice	Open Water
Reasonable Estimate Case																									
Total dissolved solids	mg/L	28	17	28	18	22	16	23	14	29	18	29	19	22	16	24	15	28	18	30	19	23	16	24	15
Chloride	mg/L	4.8	3.0	4.7	3.1	2.7	1.9	2.3	1.6	5.0	3.4	5.0	3.3	2.7	2.1	2.5	1.8	4.9	3.2	5.0	3.2	2.8	2.1	2.5	1.7
Sulphate	mg/L	4.8	2.9	4.8	3.0	3.1	2.3	3.1	2.0	5.0	3.1	5.0	3.2	3.3	2.4	3.3	2.1	4.8	3.0	5.0	3.2	3.3	2.4	3.3	2.1
Total ammonia	mg-N/L	0.030	0.017	0.032	0.018	0.024	0.015	0.019	0.012	0.030	0.017	0.033	0.018	0.024	0.015	0.020	0.012	0.030	0.016	0.033	0.018	0.025	0.015	0.020	0.012
Nitrate	mg-N/L	0.069	0.054	0.060	0.043	0.037	0.027	0.033	0.027	0.073	0.070	0.064	0.051	0.040	0.029	0.038	0.035	0.071	0.057	0.065	0.044	0.038	0.028	0.037	0.029
Total phosphorus (calculated)	mg-P/L	0.0037	0.0028	0.0036	0.0028	0.0032	0.0027	0.0033	0.0026	0.0037	0.0029	0.0037	0.0029	0.0033	0.0028	0.0033	0.0027	0.0036	0.0027	0.0037	0.0027	0.0033	0.0027	0.0034	0.0026
Phytoplankton (as Chlorophyll a)	µg/L	1.0	1.2	1.0	1.5	0.8	1.0	0.6	0.7	1.0	1.2	1.0	1.4	0.8	1.0	0.6	0.7	1.0	1.3	1.0	1.5	0.8	1.1	0.6	0.7
Total Aluminum	µg/L	17	13	17	14	17	14	16	14	18	14	18	14	17	15	17	14	18	14	18	14	18	15	17	14
Total Arsenic	µg/L	0.32	0.28	0.32	0.29	0.30	0.28	0.30	0.28	0.32	0.29	0.32	0.29	0.31	0.30	0.31	0.29	0.32	0.29	0.32	0.29	0.31	0.28	0.31	0.28
Updated Assessment Case																									
Total dissolved solids	mg/L	31	19	29	19	28	20	29	18	30	19	31	20	29	20	30	19	31	19	32	20	27	21	30	19
Chloride	mg/L	5.3	3.2	4.9	3.3	6.3	4.3	6.3	4.0	5.0	3.5	5.2	3.5	6.5	4.5	6.6	4.3	5.3	3.4	5.4	3.5	6.1	4.6	6.7	4.4
Sulphate	mg/L	6.4	3.7	6.0	3.8	3.8	2.8	3.5	2.3	6.0	3.8	6.3	4.1	3.9	3.0	3.7	2.4	6.3	3.8	6.5	4.1	4.0	3.0	3.7	2.5
Total ammonia	mg-N/L	0.066	0.034	0.062	0.035	0.035	0.023	0.025	0.015	0.062	0.033	0.065	0.038	0.037	0.024	0.025	0.016	0.065	0.033	0.067	0.034	0.036	0.022	0.026	0.016
Nitrate	mg-N/L	0.065	0.051	0.043	0.033	0.036	0.028	0.034	0.029	0.071	0.072	0.044	0.041	0.037	0.030	0.038	0.037	0.067	0.054	0.046	0.028	0.035	0.026	0.038	0.030
Total phosphorus (calculated)	mg-P/L	0.0048	0.0036	0.0046	0.0037	0.0034	0.0031	0.0034	0.0027	0.0046	0.0037	0.0047	0.0041	0.0035	0.0031	0.0034	0.0028	0.0047	0.0029	0.0048	0.0029	0.0035	0.0028	0.0035	0.0027
Phytoplankton (as Chlorophyll a)	µg/L	3.8	4.8	4.4	5.2	1.6	2.1	0.8	1.0	3.8	4.8	4.4	5.1	1.6	2.2	0.8	1.0	3.8	5.0	4.7	5.4	1.6	2.2	0.8	1.1
Total Aluminum	µg/L	38	25	35	26	28	22	25	20	35	25	37	26	29	23	26	20	37	25	38	27	28	23	26	21
Total Arsenic	µg/L	0.48	0.37	0.46	0.38	0.38	0.33	0.36	0.32	0.47	0.37	0.48	0.39	0.38	0.35	0.37	0.32	0.48	0.37	0.49	0.39	0.39	0.34	0.37	0.32

mg/L = milligrams per litre; mg-N/L = milligrams as nitrogen per litre; mg-P/L = milligrams as phosphorus per litre; µg/L = micrograms per litre.



5.0 DESTEFFANY LAKE WATER QUALITY MODEL

On November 28, 2014, the Mackenzie Valley Environmental Impact Review Board (MVEIRB) provided Dominion Diamond Ekati Corporation (Dominion Diamond) with adequacy review comments on the Jay Project Developer's Assessment Report (DAR). Section 9.4 of the adequacy review report requested additional rationale for setting the water quality Effects Study Area equal to the outlet of Lac de Gras. A response was provided to the MVEIRB on January 19, 2015 as part of the adequacy response submission (Dominion Diamond 2015). As indicated in DAR-MVEIRB-20, Dominion Diamond committed to develop a water quality model downstream of the Lac de Gras outlet in the Coppermine River system. Desteffany Lake is approximately 20 kilometres (km) downstream of Lac de Gras on the Coppermine River system, with a surface area of approximately 49 square kilometres (km²) (Map 5-1). As the next lake downstream from Lac de Gras, it is an appropriate lake for assessing potential effects to water quality downstream in the Coppermine River. This memorandum provides the details of the Desteffany Lake water quality model, including a discussion of the approach, inputs, assumptions, and results of the model.

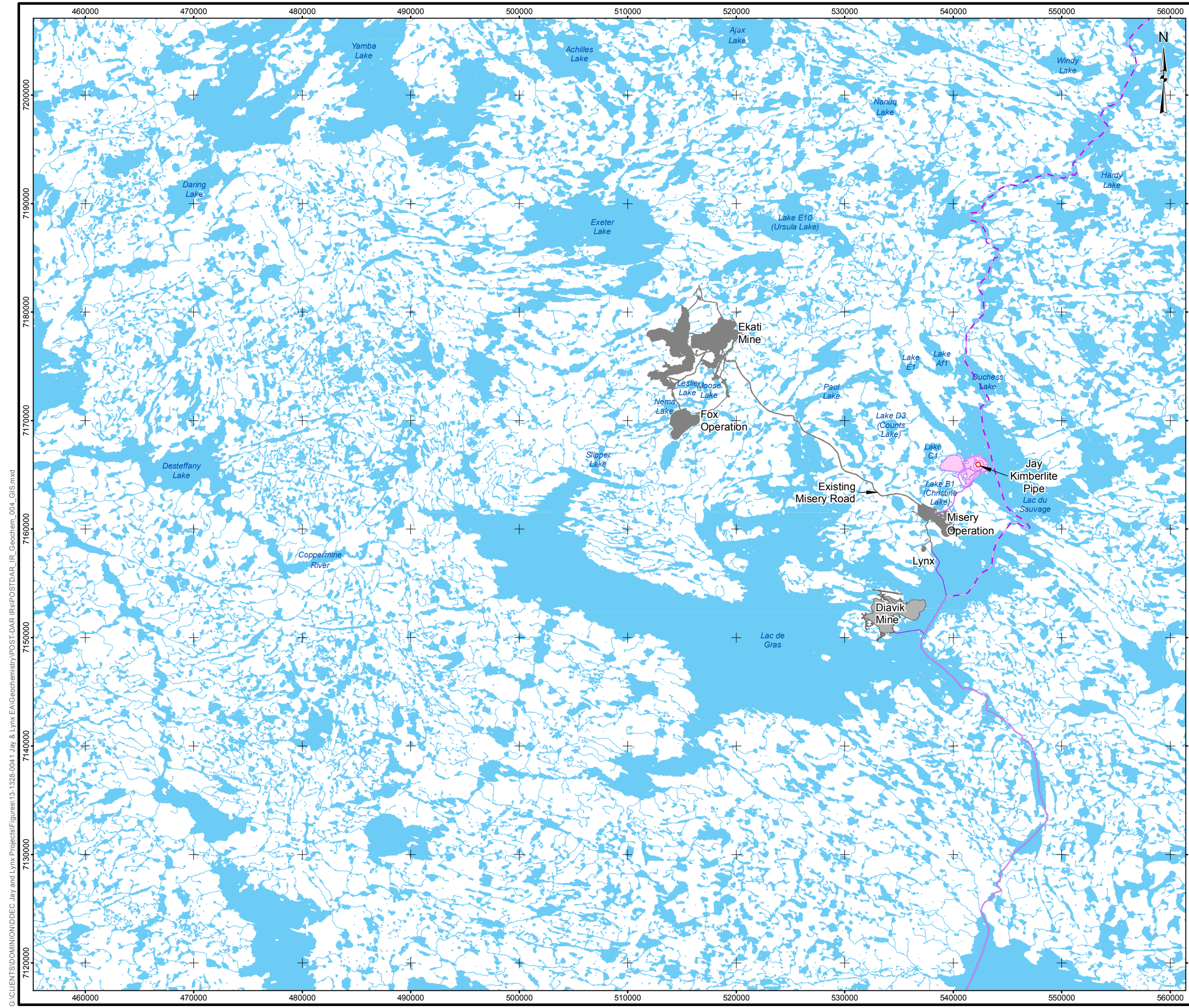
5.1 Model Approach

A deterministic site water quality model was developed for Desteffany Lake using GoldSim version 11.1. GoldSim is a graphical, object-oriented mathematical model where all input constituents and functions are defined by the user and are built as individual objects or elements linked together by mathematical expressions. The object-based nature of the model is designed to facilitate understanding of the various factors, which control an engineered or natural system and predict the future performance of the system.

In GoldSim, each flow that could influence the water quality in Desteffany Lake was itemized and assigned a source term chemical profile based on projected water qualities in Lac de Gras or baseline surface water quality monitoring data. Desteffany Lake was treated as a reservoir within the model and inflow volumes and concentrations were included as inputs to each reservoir to account for chemical loadings from natural areas, as well as outflow from Lac de Gras.

The water quality model was designed to estimate constituent concentrations in Desteffany Lake on a daily timestep from January 1, 2004 to December 31, 2060. The modelling interval was selected for the following reasons:

- Insufficient data were available to appropriately characterize the baseline conditions in Desteffany Lake. Therefore, measured Lac de Gras outlet water qualities were mixed with natural runoff in Desteffany Lake from 2004 to 2012 to provide sufficient time for the model to establish synthetic baseline conditions in Desteffany Lake, accounting for dilution downstream of the Lac de Gras outlet.
- Projected water qualities in Lac de Gras (Golder 2015) were estimated until December 31, 2060 to evaluate surface water quality changes in Lac de Gras during operations, closure and post-closure of the Project. The length of the Desteffany Lake model was selected to be consistent with projected water qualities in Lac de Gras.



LEGEND

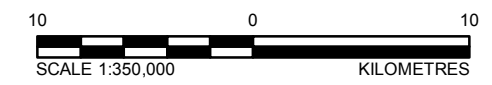
- EKATI MINE FOOTPRINT
- DIAVIK MINE FOOTPRINT
- PROPOSED JAY FOOTPRINT
- KIMBERLITE PIPE
- WINTER ROAD
- TIBBITT TO CONTWOYTO WINTER ROAD
- NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
- WATERCOURSE
- WATERBODY

REFERENCE

NATIONAL TOPOGRAPHIC BASE DATA (NTDB) 1:250,000
 CANVEC © NATURAL RESOURCES CANADA, 2012
 NATURAL RESOURCES CANADA, CENTRE FOR TOPOGRAPHIC INFORMATION, 2012
 DATUM: NAD83 PROJECTION: UTM ZONE 12N

DOCUMENT

COMPENDIUM OF SUPPLEMENTAL WATER QUALITY MODELING



PROJECT		DOMINION DIAMOND	JAY PROJECT NORTHWEST TERRITORIES, CANADA
DESTEFFANY LAKE LOCATION MAP			
		PROJECT 1419751 FILE No. POSTDAR_IR_Geochem_004_GIS	SCALE AS SHOWN REV 0
DESIGN MH 06/04/15	GIS LMS 07/04/15	MAP 5-1	
CHECK MH 07/04/15	REVIEW KM 07/04/15		

G:\CLIENTS\DOMINION\DEC Jay and Lynx\Projects\Figures\13-1328-004\1 Jay & Lynx\EA\Geochemistry\POST-DAR IRs\POSTDAR_IR_Geochem_004_GIS.mxd



The Desteffany Lake model was designed to estimate changes in Lac de Gras outlet water quality downstream in Desteffany Lake from additional natural attenuation from water stored in the lake and also from catchment runoff. Insufficient baseline water quality data were available for Desteffany Lake. Therefore, the model is only intended to semi-quantitatively identify the expected reduction constituent concentrations from the Lac de Gras outlet to the Desteffany Lake outlet assuming straight dilution from natural runoff. The Desteffany Lake model evaluated the attenuation of projected Lac de Gras outlet concentrations for the updated assessment case (see Section 2.0), as well as the reasonable estimate case (see Section 4.0). Model inputs, assumptions, and results are provided in the following subsections.

5.2 Model Inputs and Assumptions

5.2.1 Desteffany Lake Water Balance

No bathymetry or lake depth information were available for the development of the Desteffany Lake water quality model. Therefore, the capacity of the lake was assumed to be constant in the model and not change from initial conditions. Inflows to the lake from the Lac de Gras outlet and natural catchment were added and an equal volume was removed from the lake to maintain a constant volume. Lac de Gras outlet and natural catchment flows were taken from the regional water balance model (Appendix 8D of the DAR).

The initial volume in Desteffany Lake was estimated by multiplying the lake surface area (49 km²) by the depth. Since the depth information is not known a sensitivity analysis was completed for 10 and 25 m. To be consistent with the Lac de Gras hydrodynamic model, an ice thickness of 1.3 m was assumed prior to 2010 and an ice thickness of 1.5 m was assumed from 2010 to 2060.

5.2.2 Water Quality Inputs

5.2.2.1 Direct Precipitation and Natural Runoff

Direct precipitation was assumed to be pristine in the Desteffany Lake water quality model. Baseline surface water quality data representative of monitoring locations within Lac du Sauvage were used to represent the quality of natural runoff and direct precipitation within the Desteffany Lake watershed. This input was used to be consistent with the site water quality model, the pit hydrodynamic models, and the lake hydrodynamic models presented in the DAR. This input is considered to be the most appropriate for use in the Desteffany Lake water quality model, since the monitoring data are collected upstream of discharges from the Long Lake Containment Facility at the Ekati Mine operations and the Diavik Mine.

Background water quality data in Lac du Sauvage were collected between 2004 and 2013 at various surface water quality monitoring locations (see Map 8.2-6 in Section 8.2.5.1 of the DAR). The data used were collected during open water conditions by Rescan between 2004 and 2012, and by Golder Associates Ltd. in 2013 (see Section 8.2.5.1 of the DAR for additional information and references). The median concentration from the monitoring results was used as a model input source term for non-contact water (Table 8E3.2-1 of Appendix 8E of the DAR).



5.2.2.2 Lac de Gras Outlet Water Quality

The Lac de Gras Outlet water quality comprised of separate source terms for pre-simulation (i.e., “baseline” period) water quality and simulation water quality. For the first eight years of the model, baseline surface water quality data taken from the Lac de Gras outlet were used to represent the quality of water entering Desteffany Lake from Lac de Gras. Background water quality data in Lac de Gras were collected between 2007 and 2012, during both open water and under ice conditions, for the purpose of the Diavik Mine Aquatic Effects Monitoring Program (AEMP) reports. The results were separated into open water and under ice conditions (May to September, and October to April, respectively). The median concentration from these results was used to represent open water and under ice conditions between 2004 and 2012.

Simulated Lac de Gras outlet water quality for the updated assessment and reasonable estimate scenarios was used to represent the quality of water entering Desteffany Lake from Lac de Gras from 2013 onwards. These results include changes to water quality at the Lac de Gras outlet from all upstream developments including, Diavik, Ekati, and the proposed Jay Project. Results used were depth-averaged results from modelling location LDG-P6, and were input into the Desteffany Lake model as a time series.

5.3 Desteffany Lake Model Results and Discussion

Projected Desteffany Lake outlet constituent concentrations are presented in Figures 5-1 and 5-2 for the updated assessment and reasonable estimate cases, respectively. Based on the projected water qualities:

- The model indicates increases in constituent concentrations at the outlet of Lac de Gras from the Jay Project, and influences from the existing Diavik and Ekati operations, will also influence concentrations at the outlet of Desteffany Lake;
- Projected Desteffany Lake constituent concentrations were lower in the reasonable estimate scenario (Figure 5-2) in comparison to the updated assessment case (Figure 5-1);
- Projected constituent concentrations are similar for both the 10 and 25 m model sensitivities;
- The model is sensitive to ice formation and as a result peak concentrations were projected to occur in the 10 m depth sensitivity;
- Natural runoff reduces concentrations and projected values are generally less at the outlet of Desteffany Lake in comparison to the Lac de Gras outlet;
- Total phosphorus concentrations increased in Desteffany Lake as a result of the natural runoff source term being assigned the baseline concentration for Lac du Sauvage (6.4 parts per billion [ppb]), which is greater than the projected concentrations at the outlet of Lac de Gras; and,
- Projected total arsenic concentrations at the Desteffany Lake outlet were similar to the Lac de Gras outlet in the updated assessment case because the natural runoff source term (0.3 ppb) was not much lower than the maximum predicted Lac de Gras outlet concentration (0.42 ppb). Therefore, the reduction of this parameter is less in comparison to other parameters that exhibit greater relative differences between projected Lac de Gras outlet and Desteffany Lake natural runoff water quality, such as total dissolved solids.



As noted above, the Desteffany Lake model indicates changes to water quality at the outlet of Lac de Gras will be detectable at the outlet of Desteffany Lake but constituent concentrations are generally expected to be lower at the outlet of Desteffany in comparison to the Lac de Gras outlet. Increases in constituent concentrations in Desteffany Lake only occurred when the natural runoff source term concentration was greater than the projected Lac de Gras outlet water quality. The surface water quality assessment at the outlet of Lac de Gras indicated the projected concentrations, based on several conservative assumptions (see Appendix 8E of the DAR), will not result in significant adverse effects to surface water quality. As described in DAR-MVEIRB-20, while hydrodynamic modelling results indicate that there are measureable water quality changes at the outlet of Lac de Gras, the absolute difference in constituent concentrations between Base Case and Application Case is small, with all concentrations predicted to be well below the aquatic life and drinking water guidelines and objectives. Similarly, since projected concentrations are lower at the outlet of Desteffany Lake, in comparison to the outlet of Lac de Gras, no adverse effects to surface water quality are expected downstream of the outlet of Lac de Gras.

Figure 5-1: Projected Desteffany Lake Outlet Water Quality - Updated Assessment Case

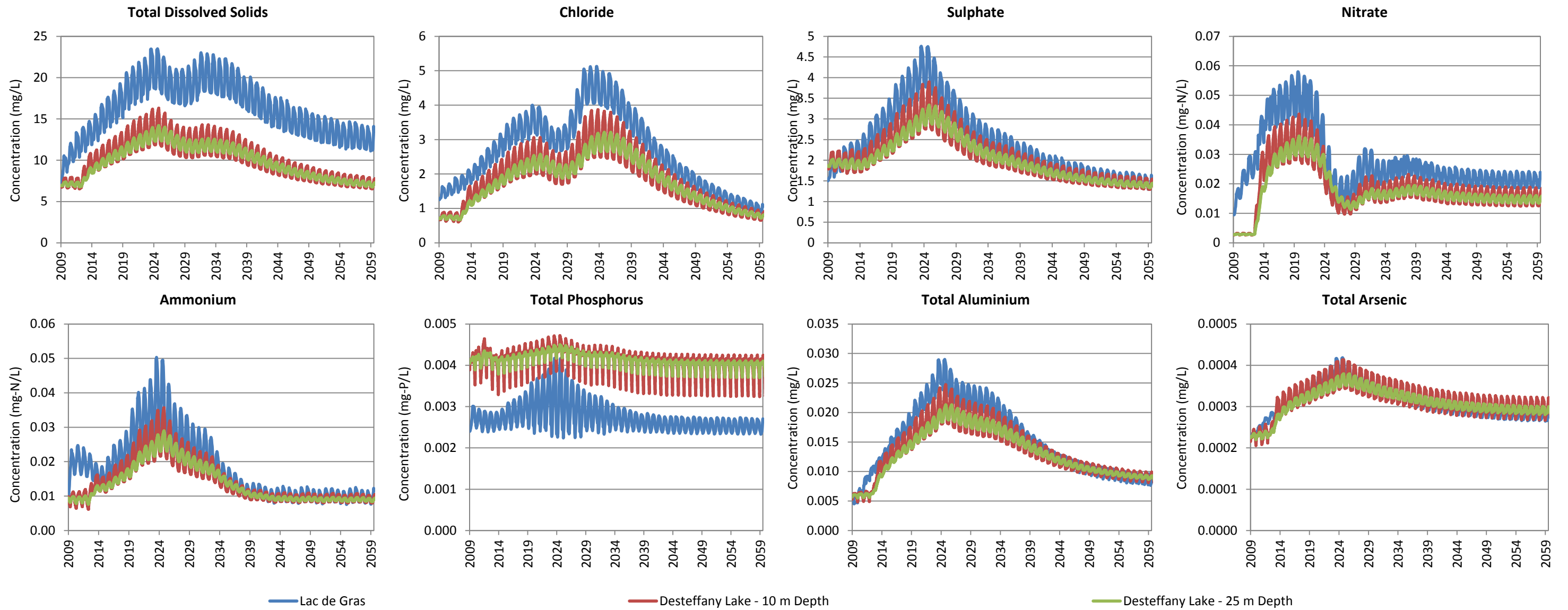
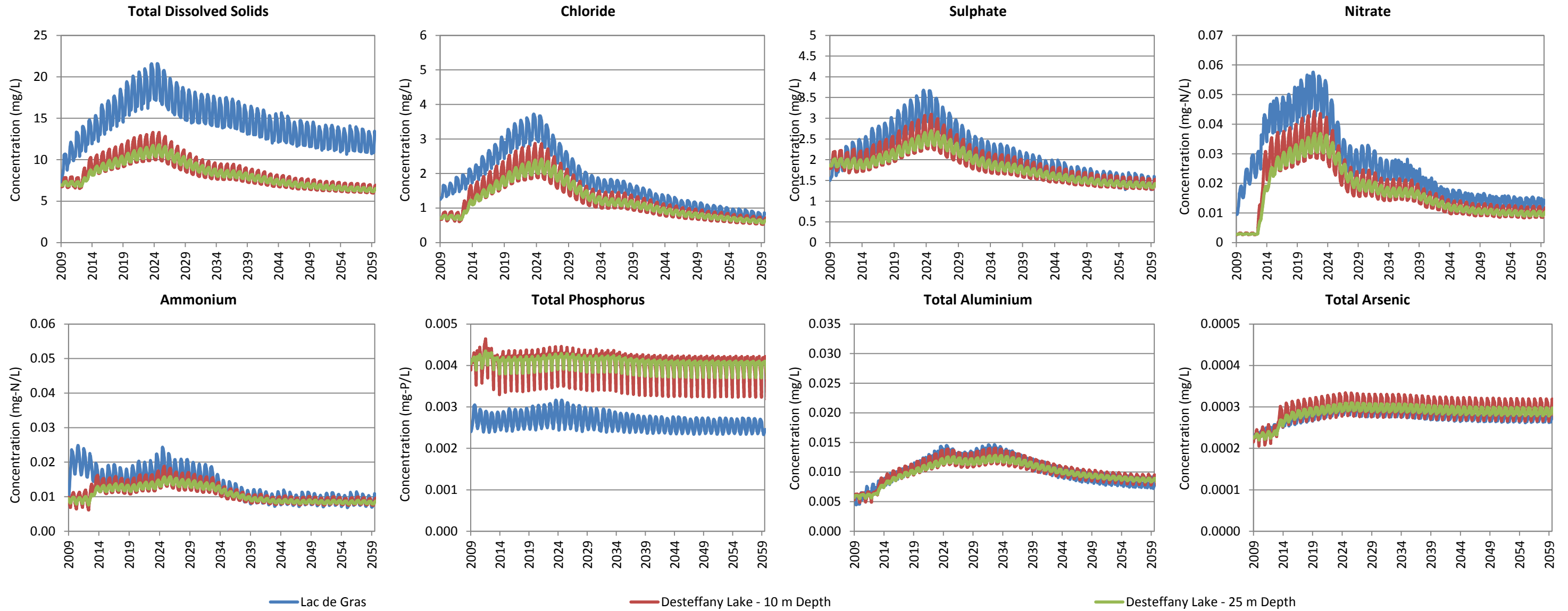


Figure 5-2: Projected Desteffany Lake Outlet Water Quality, Reasonable Estimate Case





6.0 SUMMARY

As part of the environmental impact review process, and based on Project information requests submitted to the MVEIRB by interveners, several additional model updates were made to provide supporting results in information request responses. The following additional model updates were completed and included in this compendium:

- Updated assessment case;
- No Jay development case;
- Reasonable estimate case; and,
- Desteffany Lake water quality modelling.

A summary of the key findings in each of the above model cases is presented in the following summary sections.

6.1 Updated Assessment Case

The following changes were made for the updated assessment case:

- Wind sheltering coefficients, dynamic shading, and the climate record for the pit lake hydrodynamic models were updated (Section 2.1.1);
- The Diavik Mine discharge rates from 2014 to 2023 from the most recent water management plan (DDMI 2014) were used in the Lac de Gras hydrodynamic model; and,
- Water quantities discharged from the B watershed to Lac du Sauvage were updated.

As a result of these changes, the hydrodynamic models of Misery and Jay pits, the post-closure site water quality model, the regional water balance model, and the hydrodynamic models of Lac du Sauvage and Lac de Gras were run to generate updated assessment case predictions.

The overall pattern and strength of stratification in Misery and Jay pits were predicted to be similar in the updated assessment case to those predicted for the DAR. Predicted steady-state constituent concentrations in the mixolimnions of the Jay and Misery pits for the updated assessment case were greater than predicted concentrations for the DAR case (Table 2-2). Increases in the predicted constituent concentrations in the mixolimnions for the updated assessment case were attributed to the increased wind sheltering coefficient (Table 2-1). The increased wind sheltering coefficient resulted in an increase in the predicted volumes of water transferred from the Jay and Misery pit monimolimnions to the mixolimnions during post-closure.

Predicted constituent concentrations in Lac du Sauvage and Lac de Gras were not sensitive to increases in constituent concentrations in the Jay and Misery pit mixolimnions. Predicted constituent concentrations in Lac du Sauvage and Lac de Gras were not sensitive to increases in B watershed inflows and to updates made to the Diavik Mine discharge rates, respectively. Constituent concentrations in Lac du Sauvage and Lac de Gras were predicted to be similar in the updated assessment case to those predicted for the DAR case. Therefore, the updates to the water quality models do not change the conclusion of the DAR, which is the Jay Project will not result in significant adverse effects to surface water quality, aquatic health, and the use of water for drinking.



6.2 No Jay Development Case

The no Jay development case evaluated predicted changes to water quality in Lac de Gras for a no Jay development case. The following changes were made as part of this modelling assessment:

- The Lac du Sauvage hydrodynamic model used in the DAR (Appendix 8F of the DAR) was extended to 2060 to predict future conditions in the lake without the development of the Project. In this case, inputs applied during the calibration period were extended throughout the entire simulation period to reflect “No Jay Development”;
- Input water quantity and quality from the Slipper Lake discharge and Misery Pit overflow to Lac de Gras were revised based on updated modelling completed by ERM Rescan of the Koala and King-Cujo watersheds without the development of the Project (Robb 2015a);
- The discharge rate from Diavik Mine to Lac de Gras was updated to reflect the most recent water management plan (DDMI 2014); and,
- Water discharge rates from the B watershed to Lac du Sauvage were updated.

For the no Jay development case, constituent concentrations in Lac du Sauvage were predicted to remain near baseline concentrations until 2060 (Appendix A). Constituent concentrations in Lac de Gras were predicted to increase between 2009 and 2024 and then decrease to steady-state concentrations prior to 2060 (Appendix B). Constituent concentrations in Lac de Gras were predicted to be similar for the no Jay development and the updated assessment cases between 2009 and 2024. The predicted increases in constituent concentrations in Lac de Gras between 2009 and 2024 are related to discharges from the existing Diavik and Ekati mines in the Koala watershed. Constituent concentrations in Lac de Gras were predicted to be lower for the no Jay development case compared to the updated assessment case between 2024 and 2060 because in the updated assessment case, water quality in Lac de Gras is being changed by discharges from the Project, which begin in 2024.

6.3 Reasonable Estimate Case

The following model inputs and assumptions were modified as part of the reasonable estimate case:

- Expected groundwater inflows to the Jay Pit were estimated and incorporated into the site mass-balance water quality model;
- Attenuation of nitrogen species in the Jay WRSA drainage during post-closure was included; and,
- Average observed discharge constituent concentrations were used to represent the effluent quality from Diavik Mine to Lac de Gras between 2014 and 2023.

These changes required the models developed as part of the DAR to be updated. In general, the above changes resulted in decreases in predicted site discharges and in decreases in predicted constituent concentrations in Lac du Sauvage and Lac de Gras. Some constituent concentrations in the site water quality model were predicted to increase in the reasonable estimate case compared to the updated assessment case because of less lake water flowing to the Jay Pit during operations and because of the increased influence of pit wall rock runoff on water quality; however, predicted increases in constituent concentrations were small and predicted concentrations of these constituents in Lac du Sauvage and Lac de Gras were similar to those presented in the



updated assessment case (Section 2.0). Therefore, since predicted concentrations in Lac du Sauvage and Lac de Gras are lower than those presented in the updated assessment case, the DAR conclusion that mining of the Jay Project is not projected to result in significant adverse effects to water quality is applicable to the reasonable estimate case.

6.4 Desteffany Lake Water Quality Model

A water quality model was developed to evaluate the natural attenuation of constituent concentrations from the outlet of Lac de Gras to the outlet of Desteffany Lake. Due to the lack of physical parameters (i.e., bathymetry in Desteffany Lake) and baseline surface water quality monitoring data, a calibrated model could not be developed for Desteffany Lake. Therefore, the model was designed to semi-quantitatively address the reduction of constituent concentrations in Desteffany Lake. Quantitative evaluation relative to existing conditions is, therefore, not possible. However, even though a calibrated model cannot be developed at this time, the Desteffany Lake model provides an indication of the attenuation of constituent concentrations between the outlet of Lac de Gras to the outlet of Desteffany Lake.

The model indicated the Lac de Gras outlet concentrations were generally reduced by natural runoff and concentrations were lower at the outlet of Desteffany Lake. Constituents that were greater in the Desteffany Lake natural runoff source term chemical profile in comparison the Lac de Gras outlet were projected to increase in Desteffany Lake (e.g., total phosphorus). The water quality projections included in the DAR indicate that the Jay Project in combination with existing developments in the watershed will not result in significant adverse effects to surface water quality at the outlet of Lac de Gras. Therefore, no adverse effects to surface water quality at the outlet of Desteffany Lake are expected since the only constituents projected to increase did so as a result of the natural runoff source term concentration.



7.0 CLOSURE

We trust this report satisfies your current requirements. Should you have any questions or require additional information, please do not hesitate to contact the undersigned.

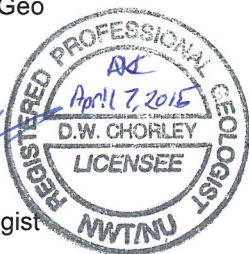
GOLDER ASSOCIATES LTD.

Prepared by

Michael K. Herrell, M.Sc., P. Geo
Senior Geochemist

Paul Beddoes, M.Sc., R.P. Bio
Environmental Scientist

Don Chorley, M.Sc., P. Geo
Principal, Senior Hydrogeologist



Kannappan Thiagarajan, M.Tech., M.Eng., E.I.T.
Water Quality Modeller

Alison Snow, M.A.Sc.
Water Quality Specialist

Kristina Skeries, M.Sc.
Environmental Specialist

Christine Bieber, M.Sc., P. Geo
Senior Hydrogeologist

Reviewed by

Jerry Vandenberg, M.Sc., PChem
Associate, Senior Environmental Chemist

Kristine Mason, M.Sc., P. Biol
Associate, Fisheries Biologist, Technical Director

PB/KT/AS/KS/CB/DC/JV/MKH/KM/ki

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https://capws.golder.com/sites/1313280041jaycardinal/environment_assessment_review/3200_round_1_irs/101_appendices/app_b-jayproject_modelingcompendium.docx



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APPENDIX A

Lac du Sauvage Time Series

Figure A-1: Predicted Total Dissolved Solids Concentrations in Lac du Sauvage

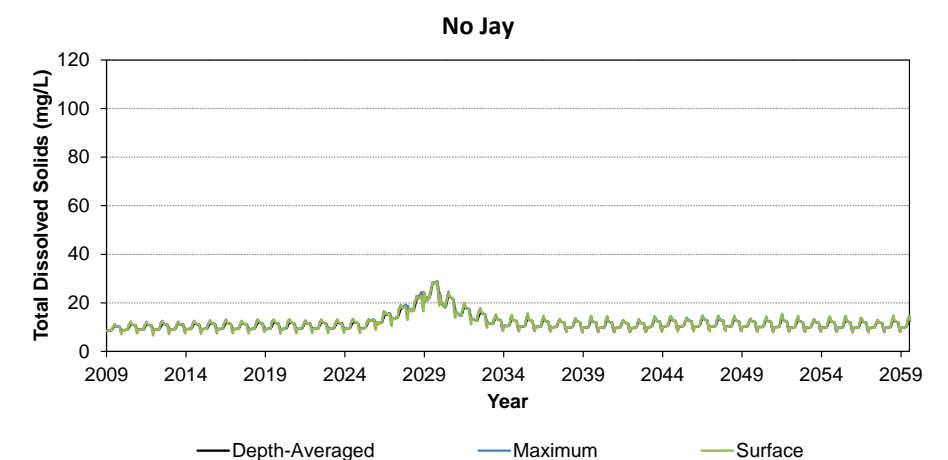
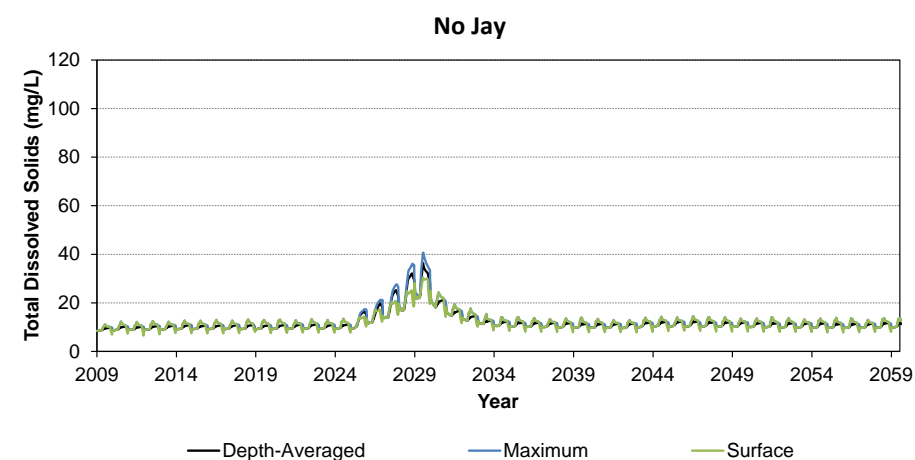
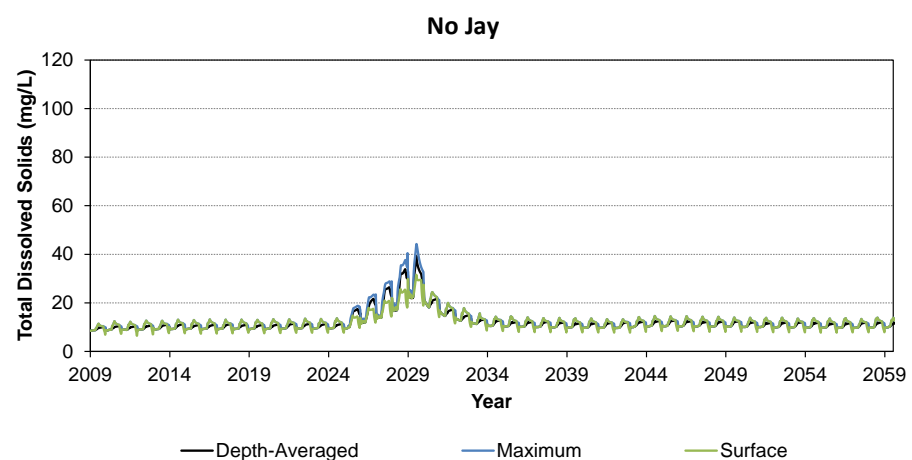
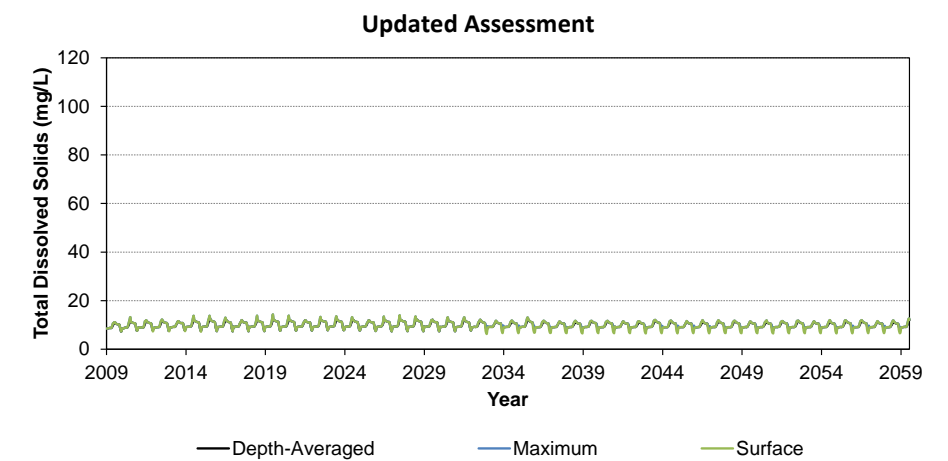
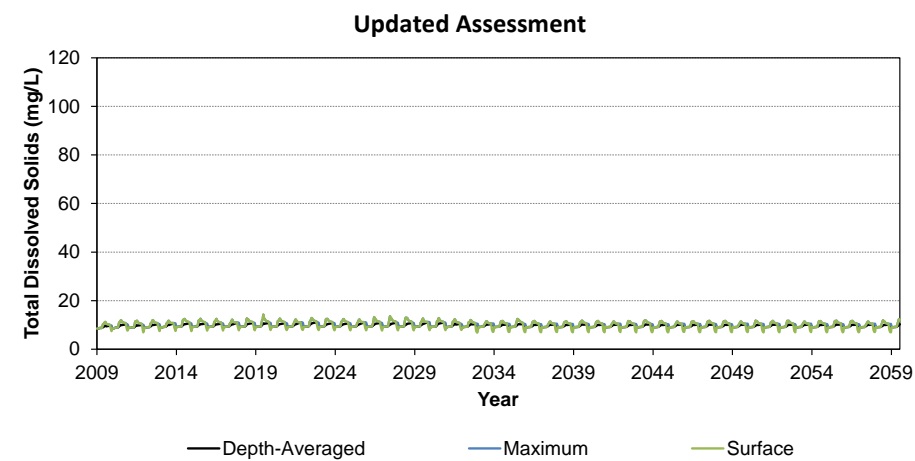
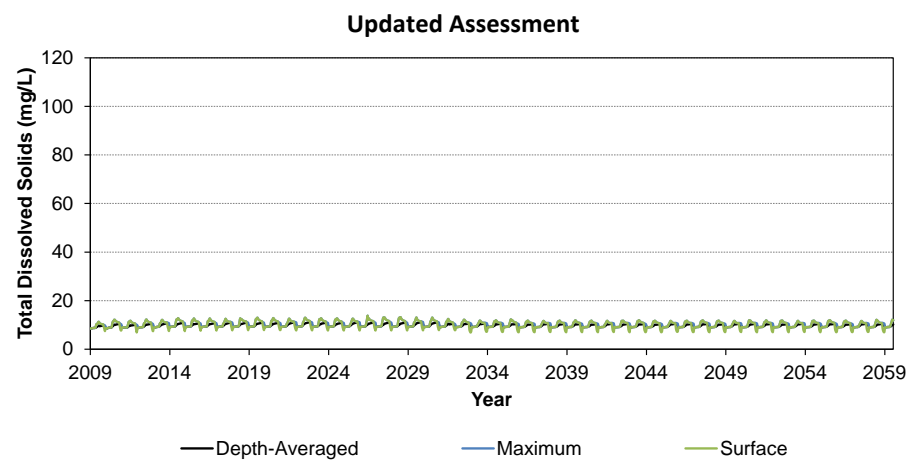
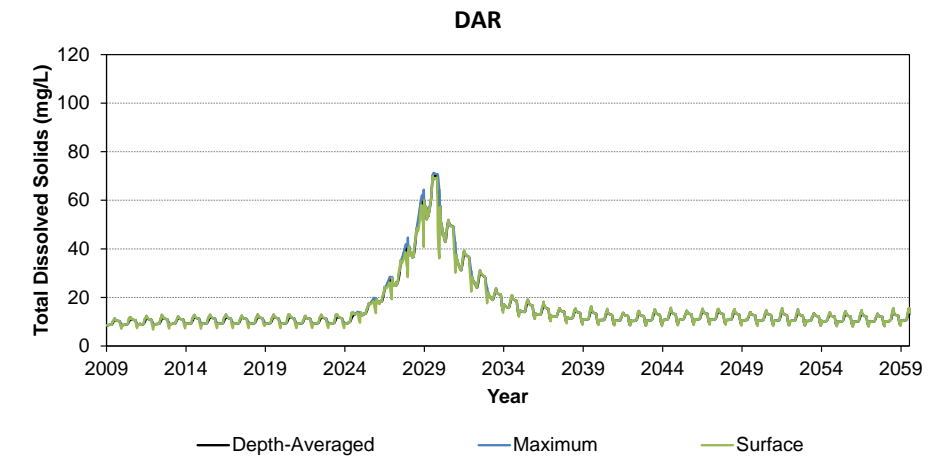
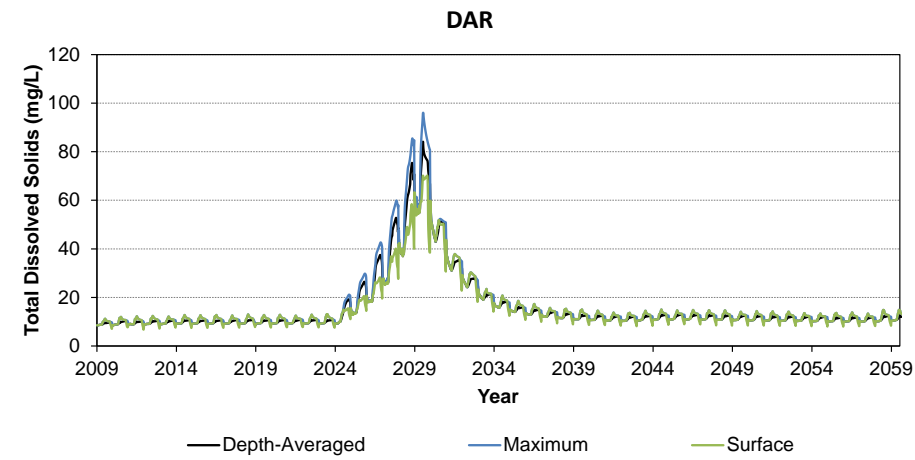
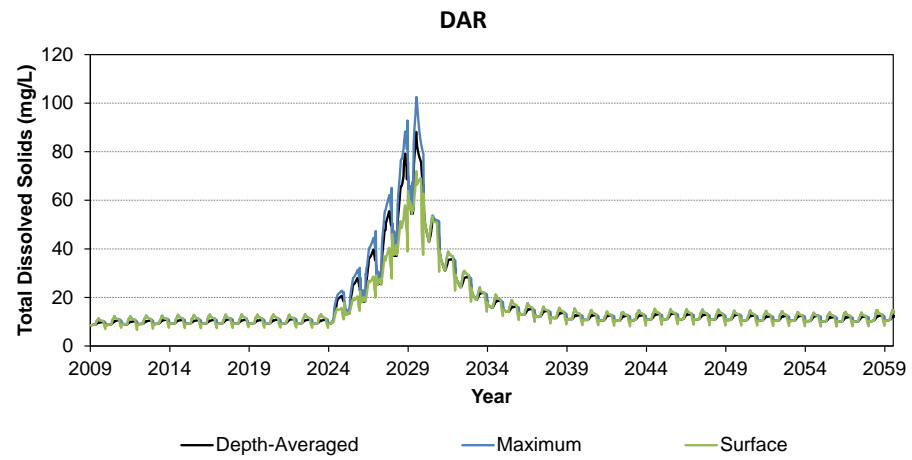
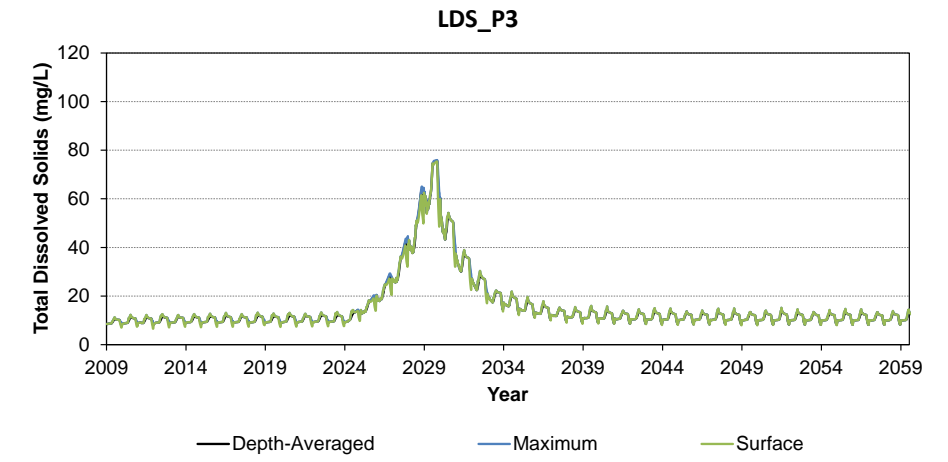
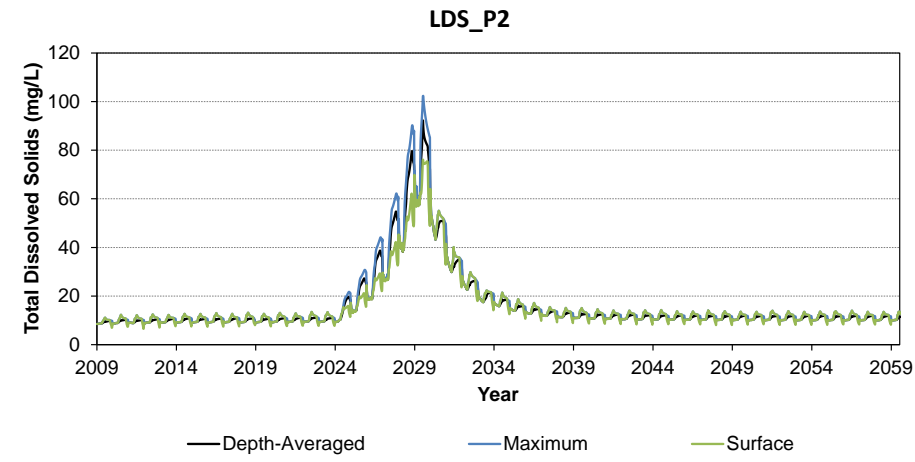
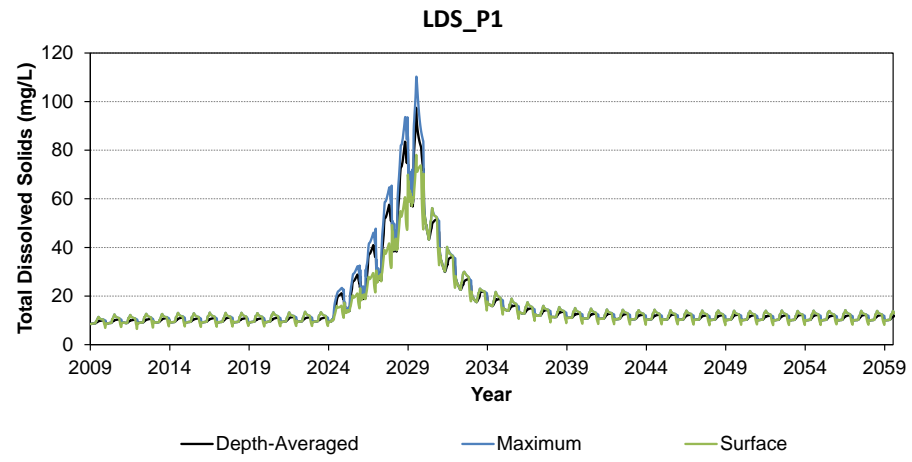


Figure A-2: Predicted Chloride Concentrations in Lac du Sauvage

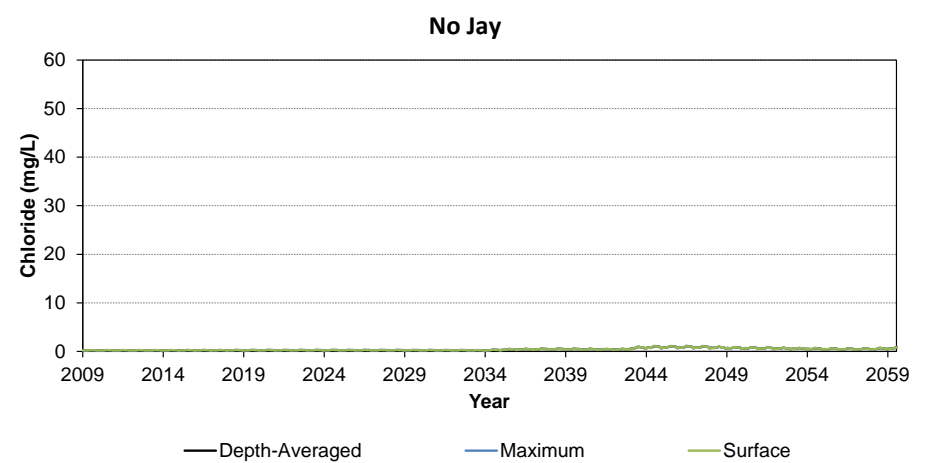
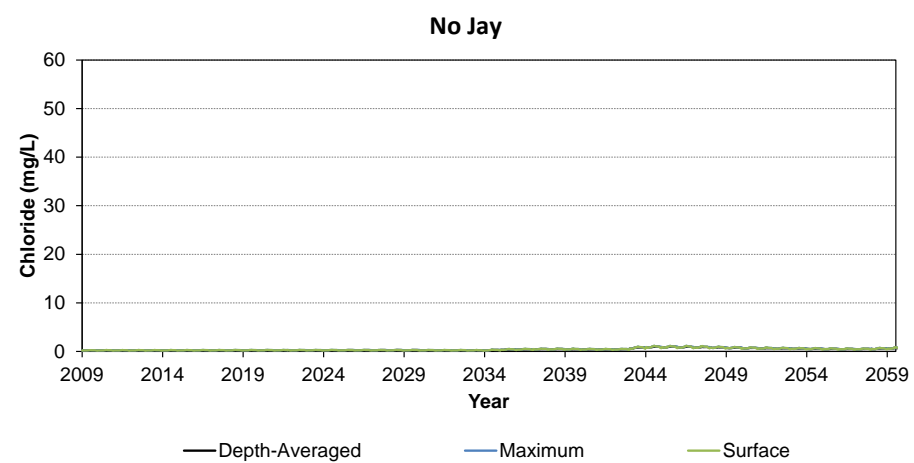
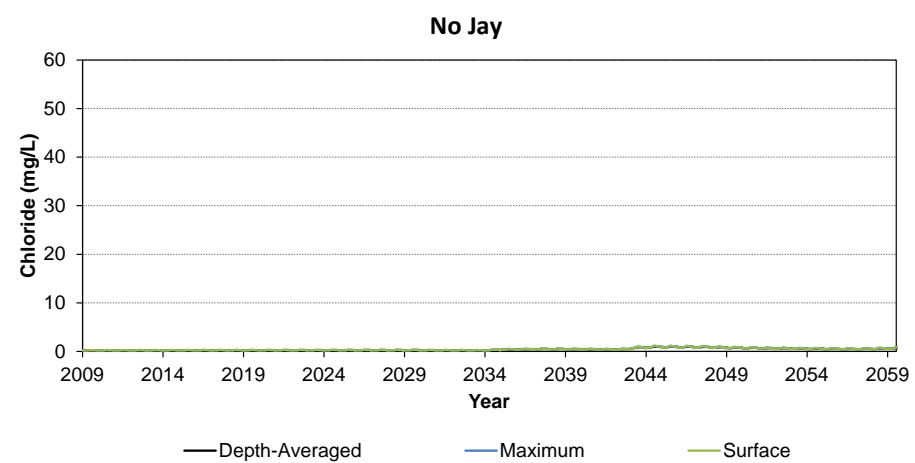
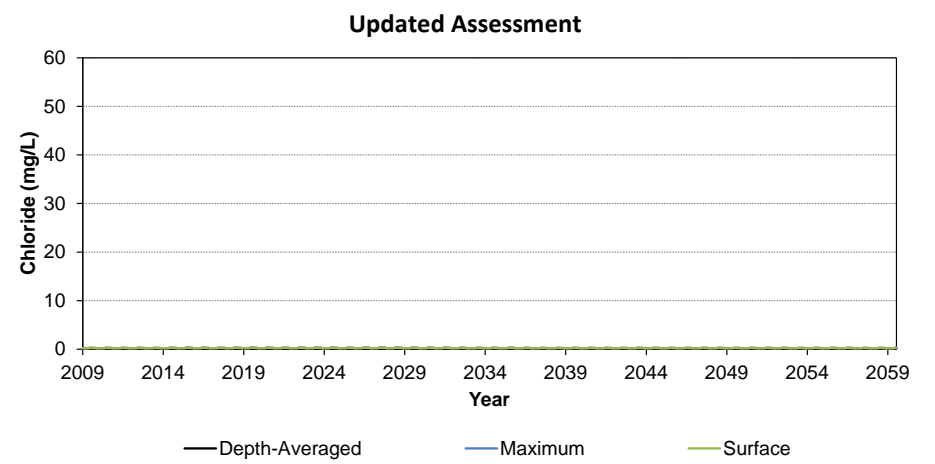
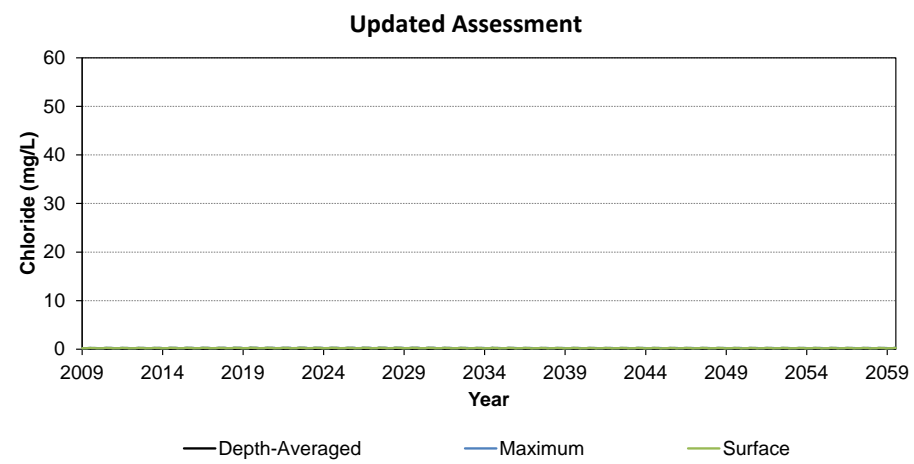
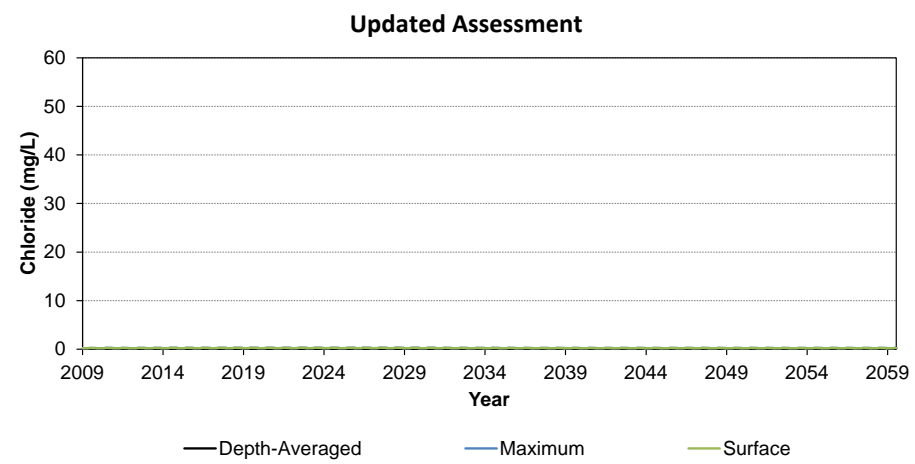
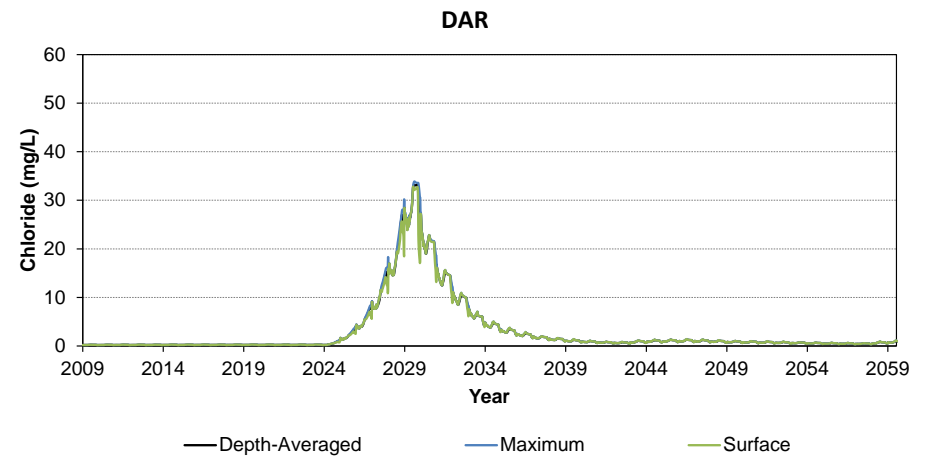
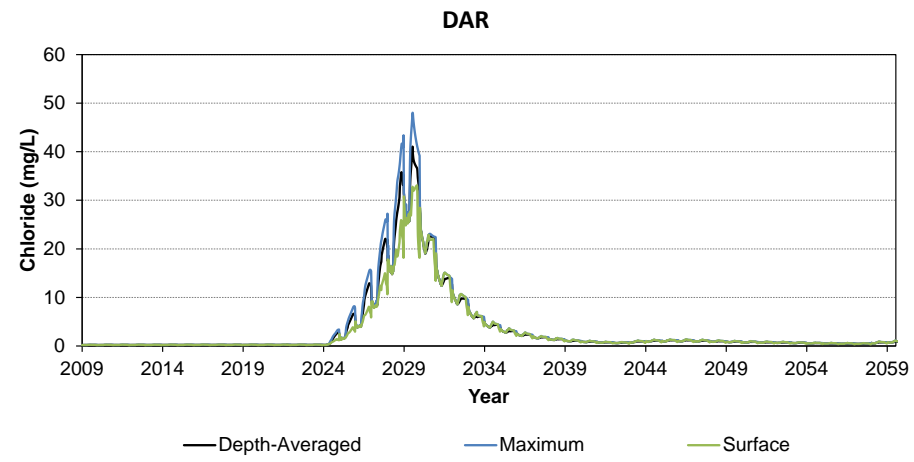
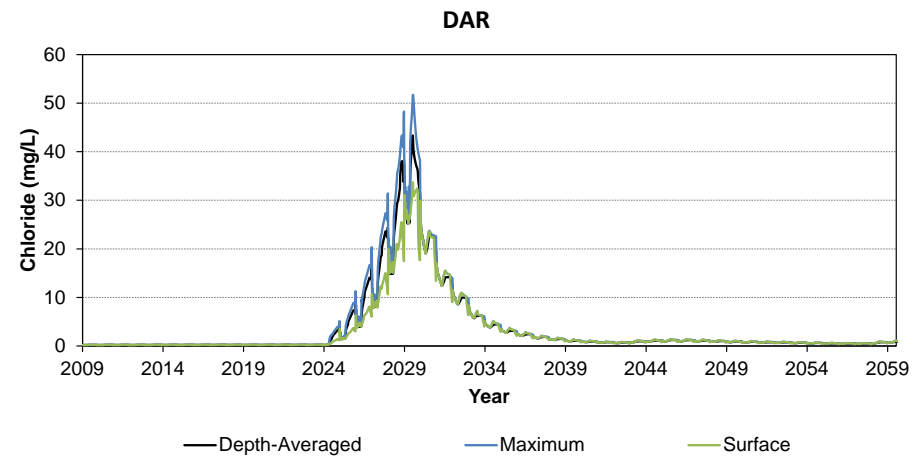
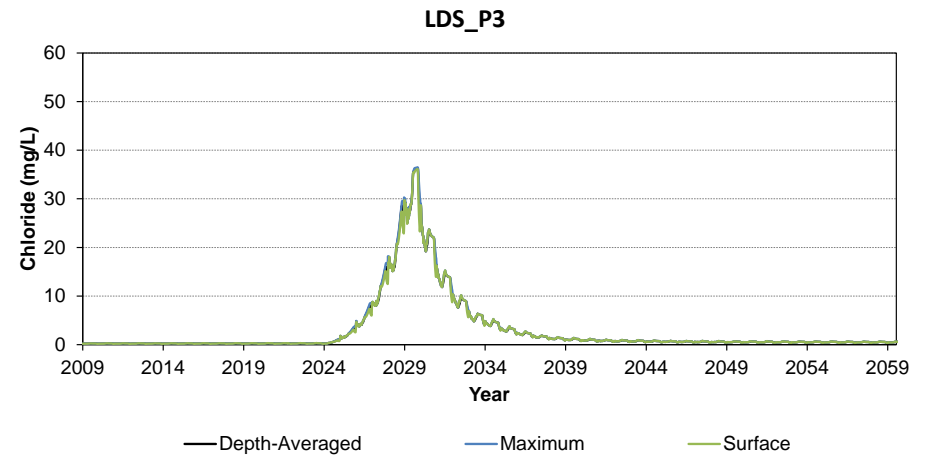
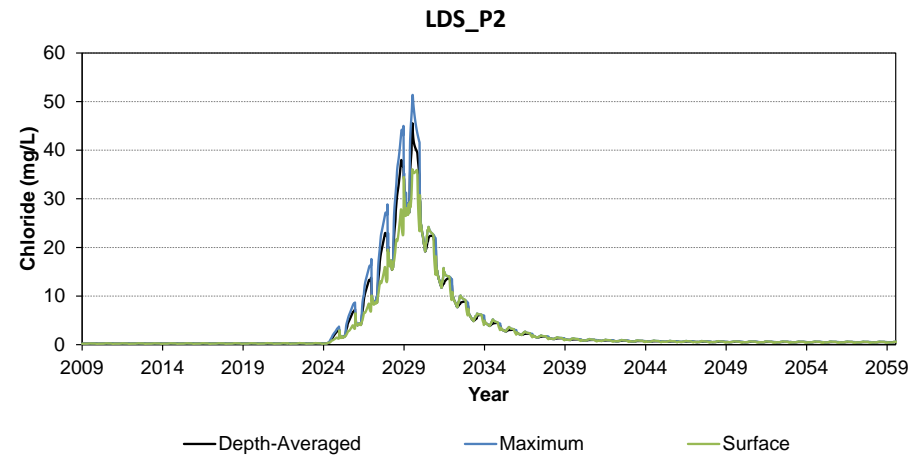
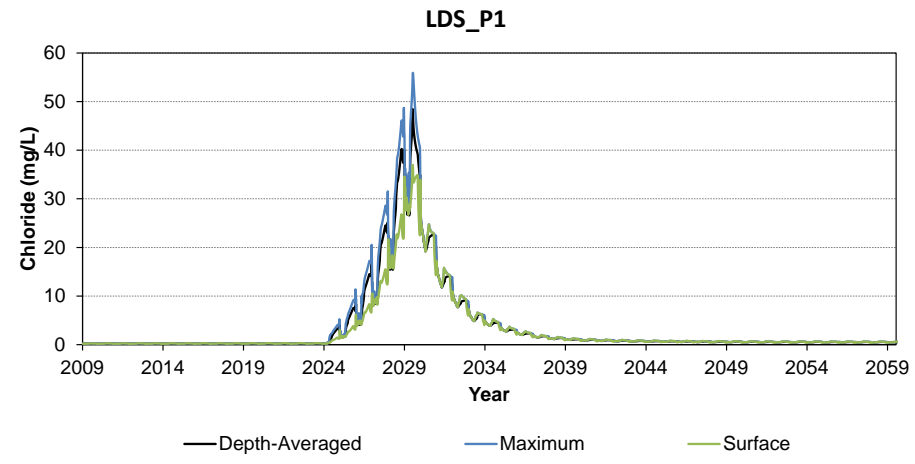


Figure A-3: Predicted Sulphate Concentrations in Lac du Sauvage

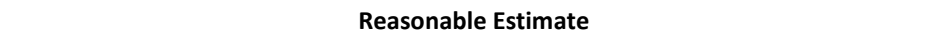
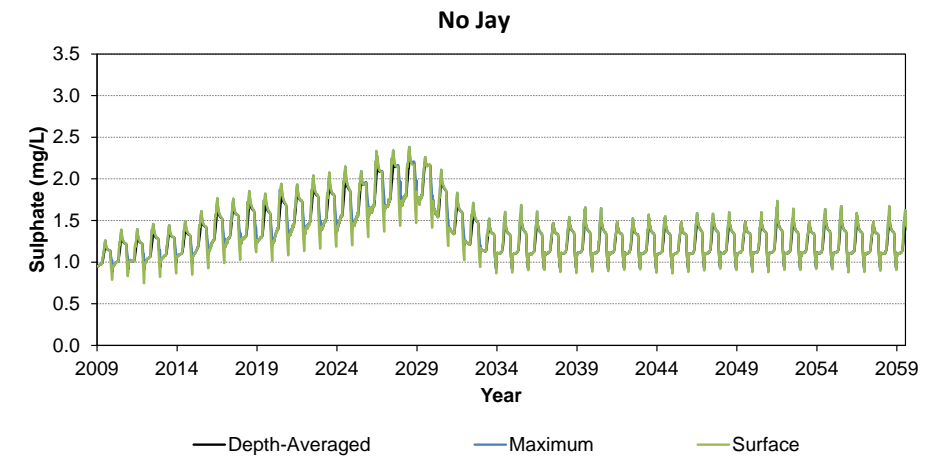
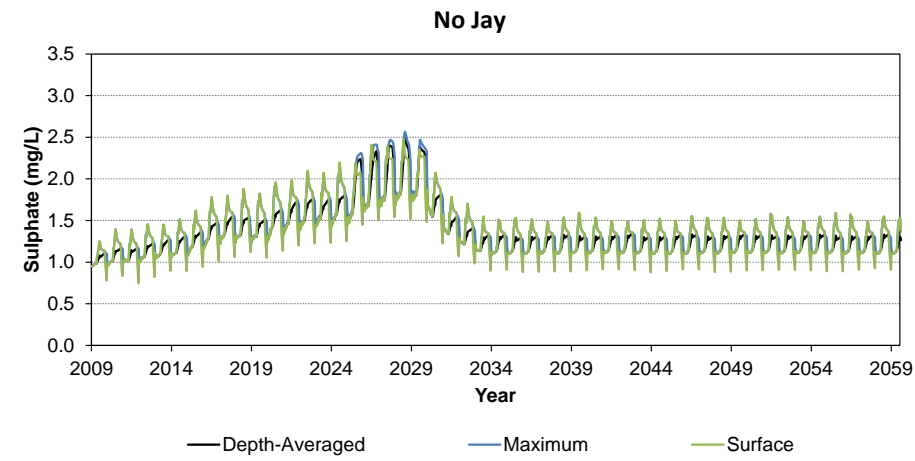
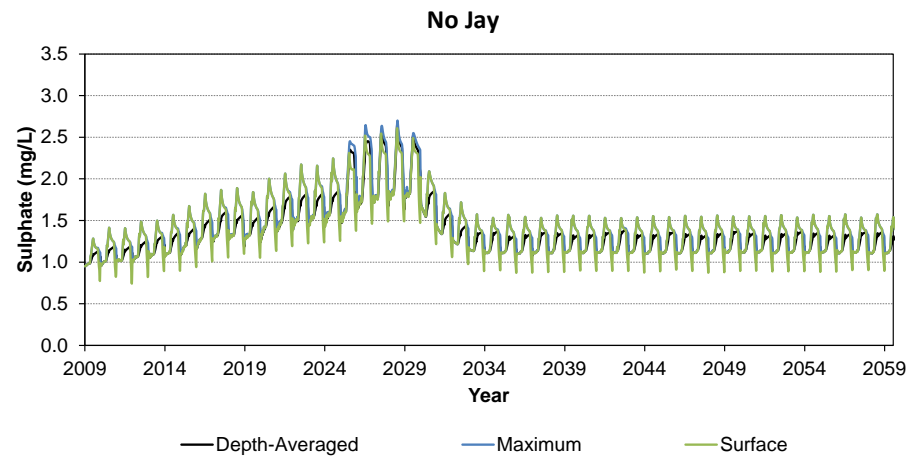
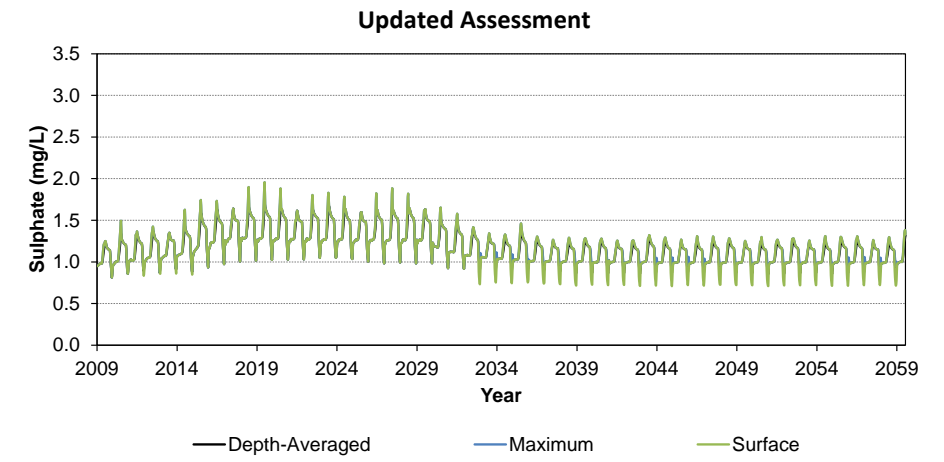
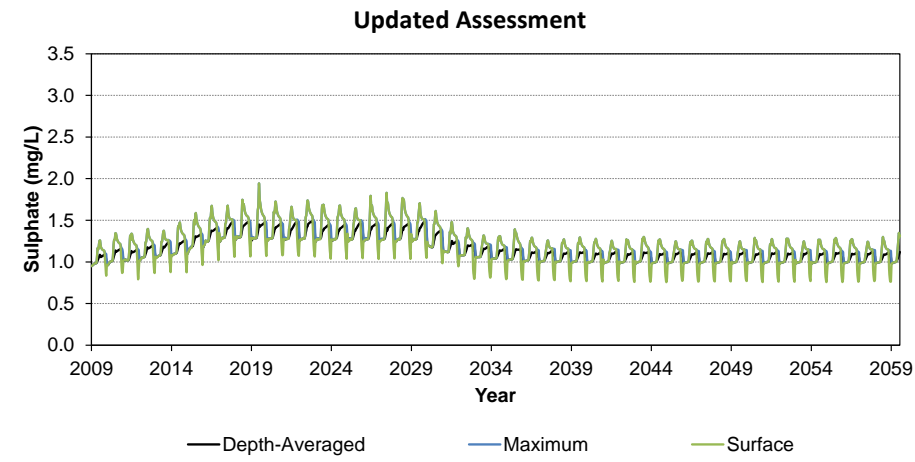
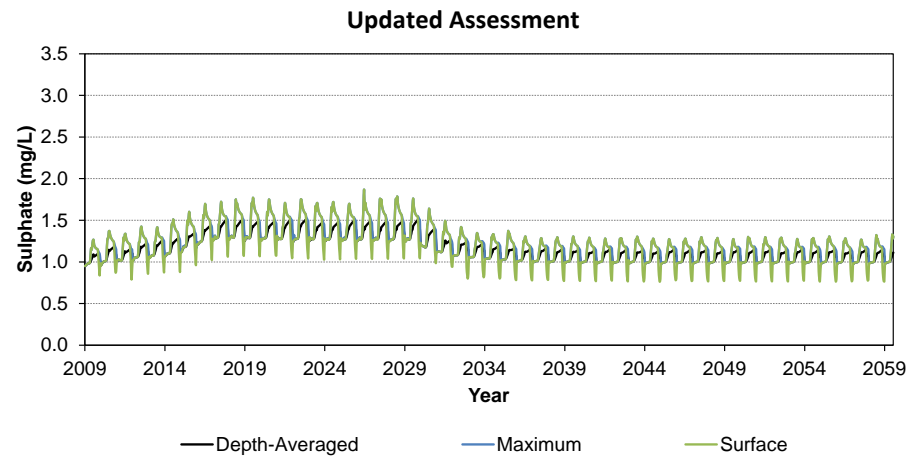
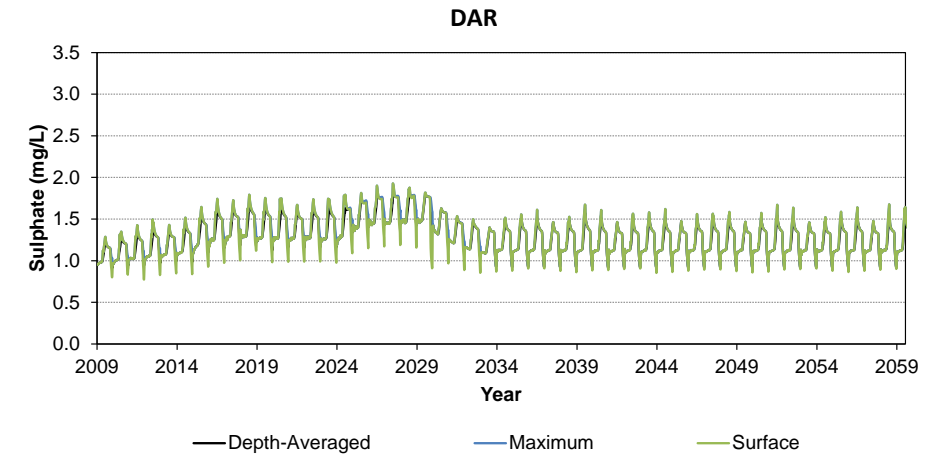
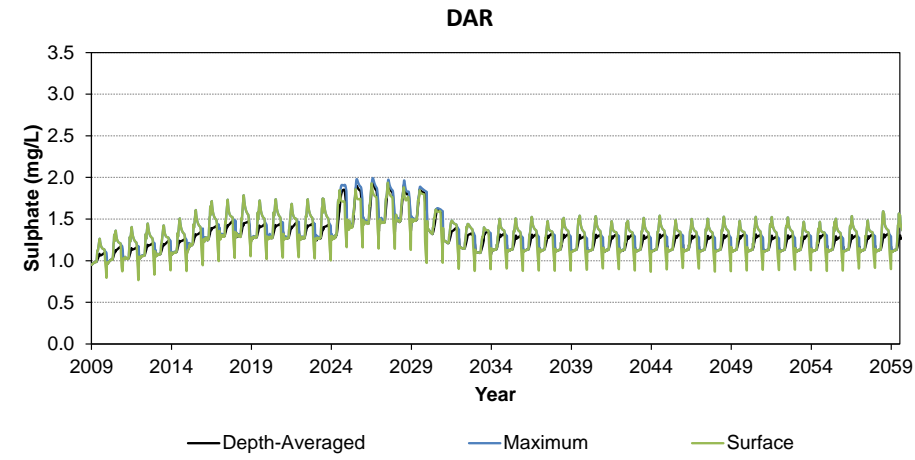
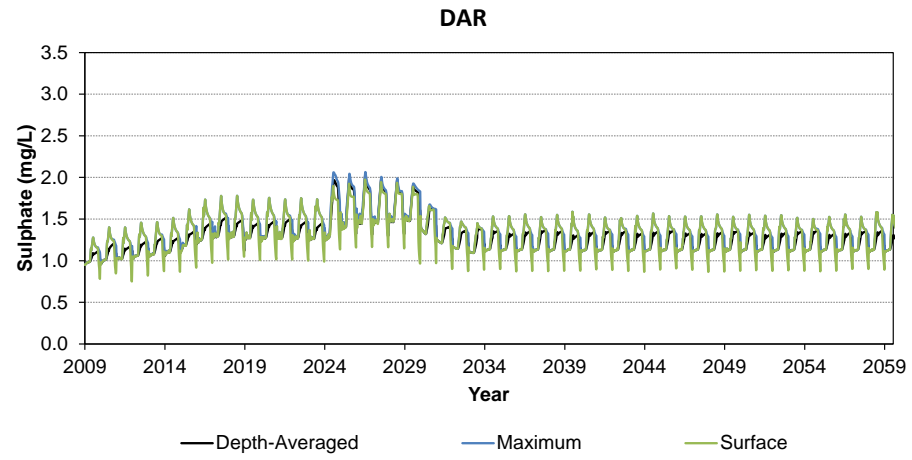
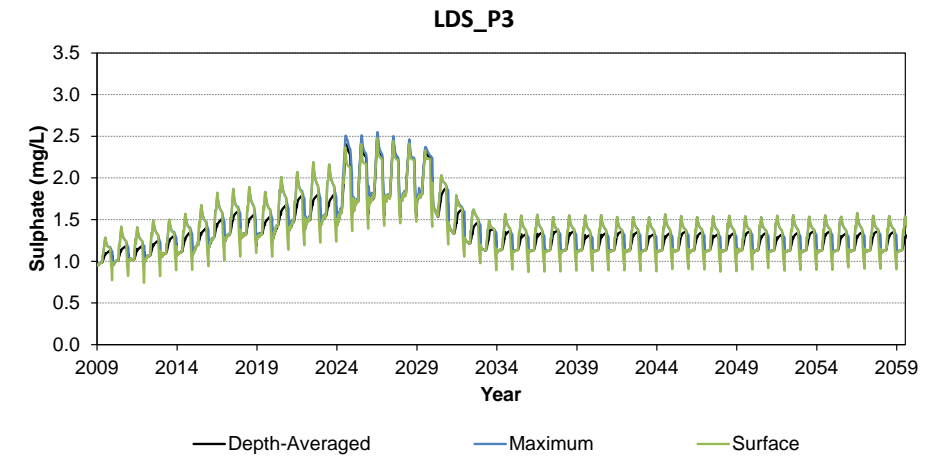
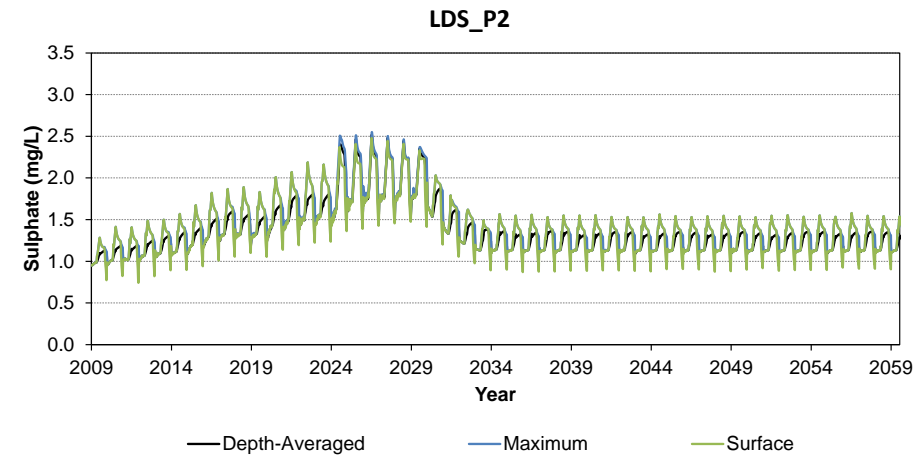
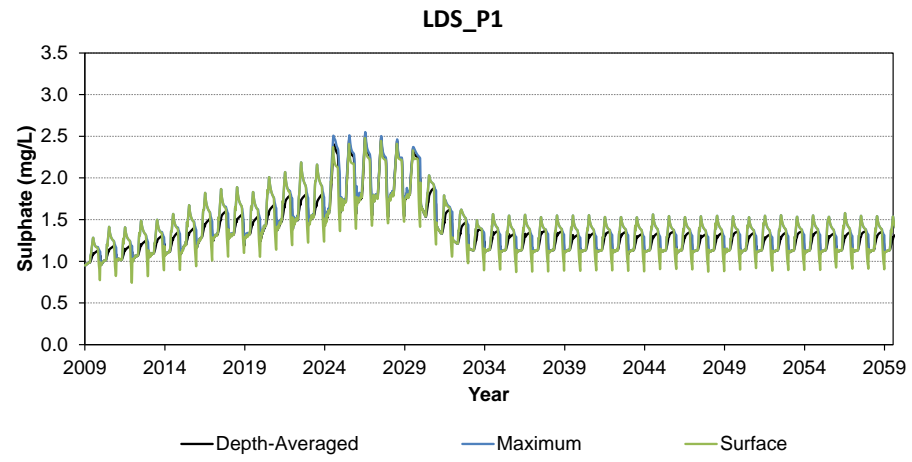


Figure A-4: Predicted Total Ammonia Concentrations in Lac du Sauvage

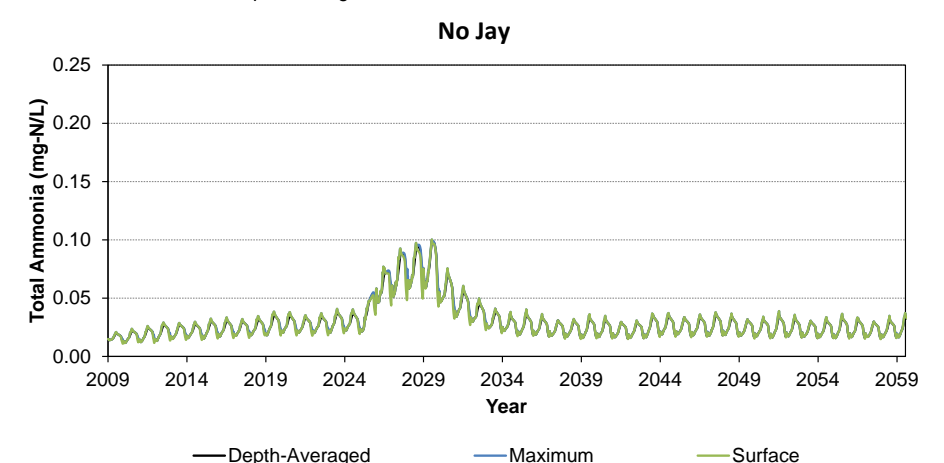
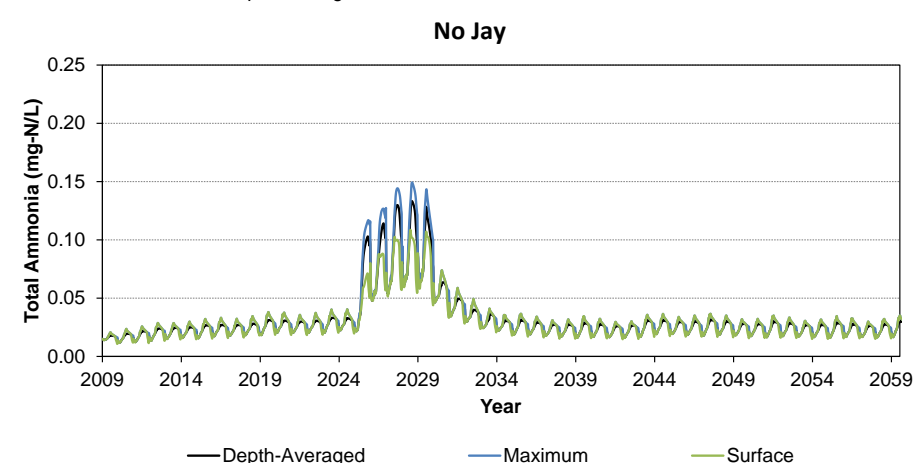
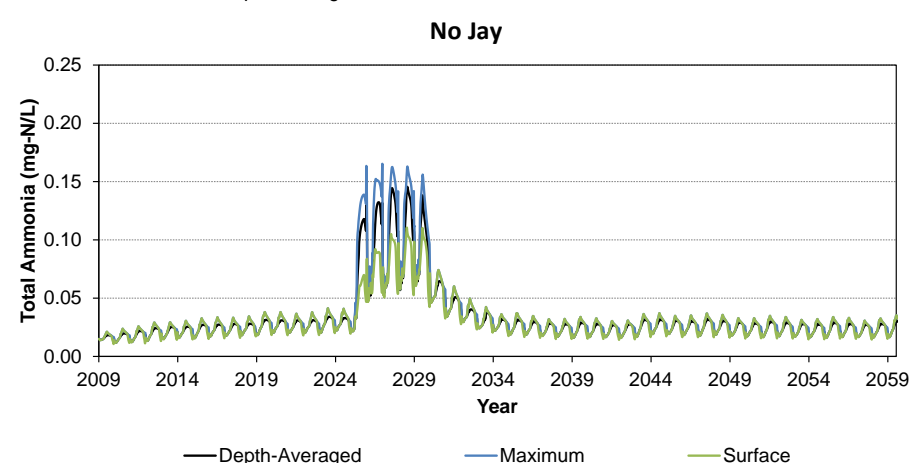
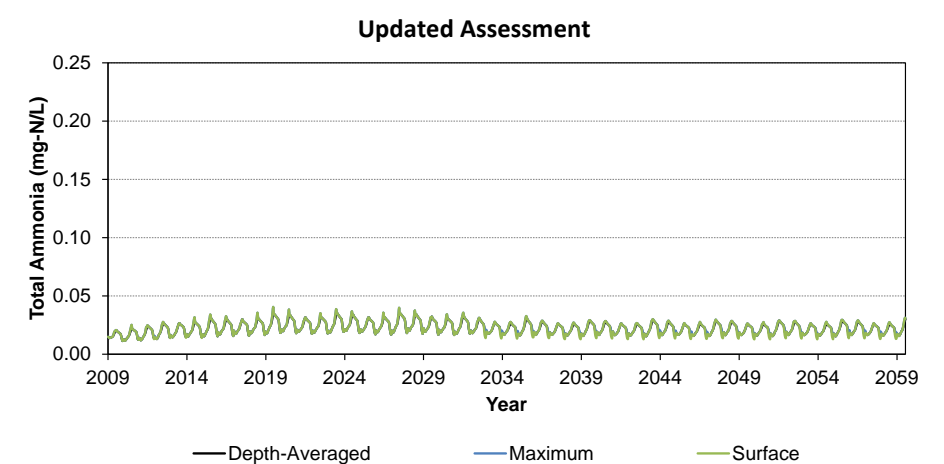
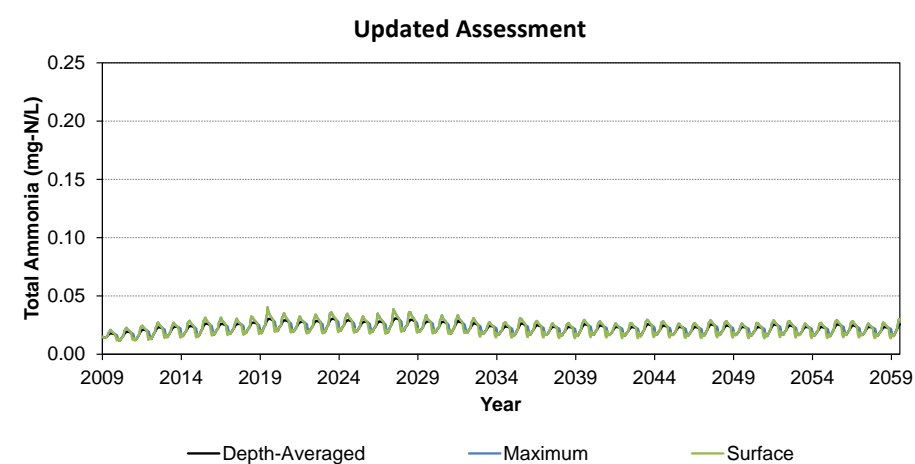
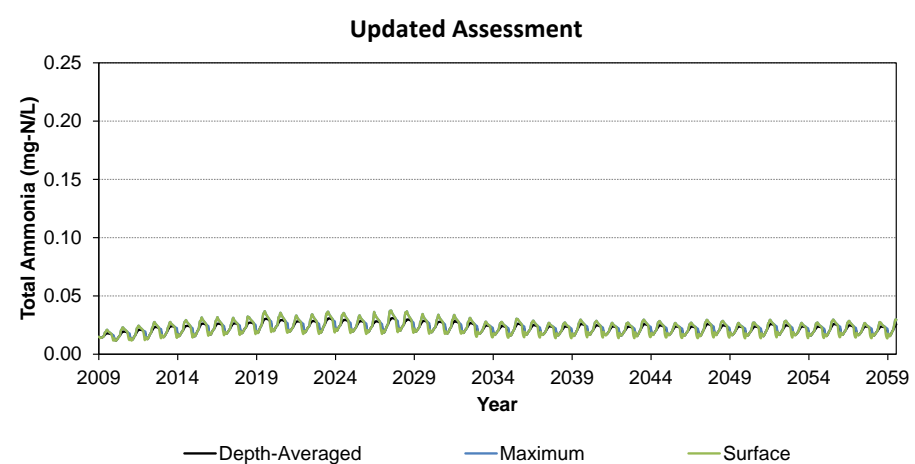
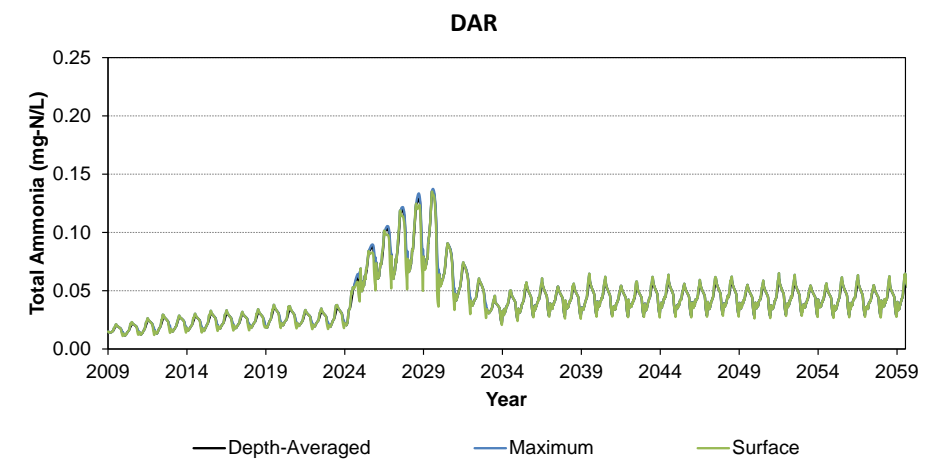
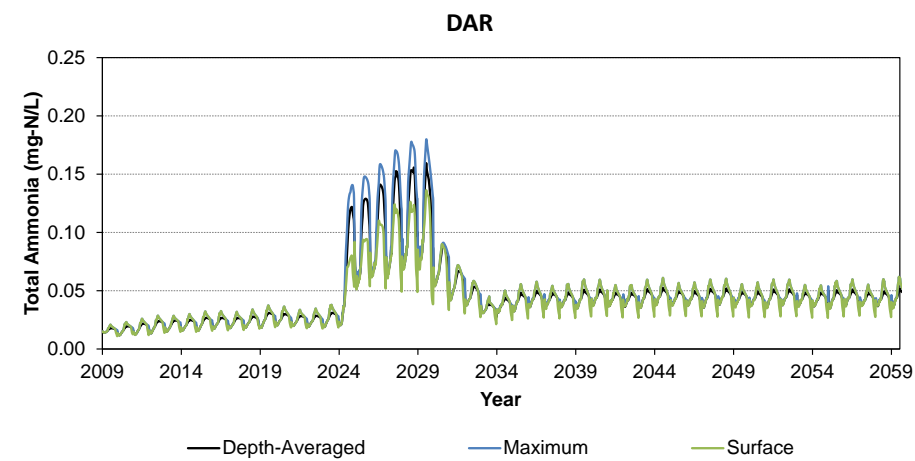
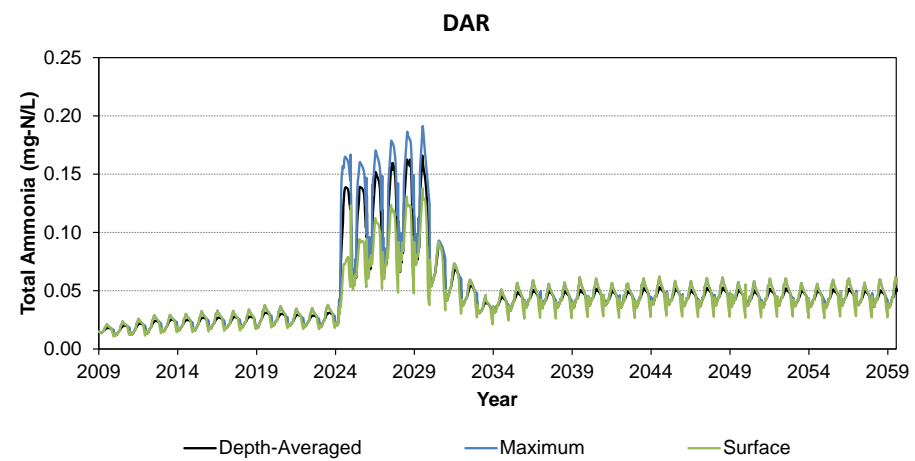
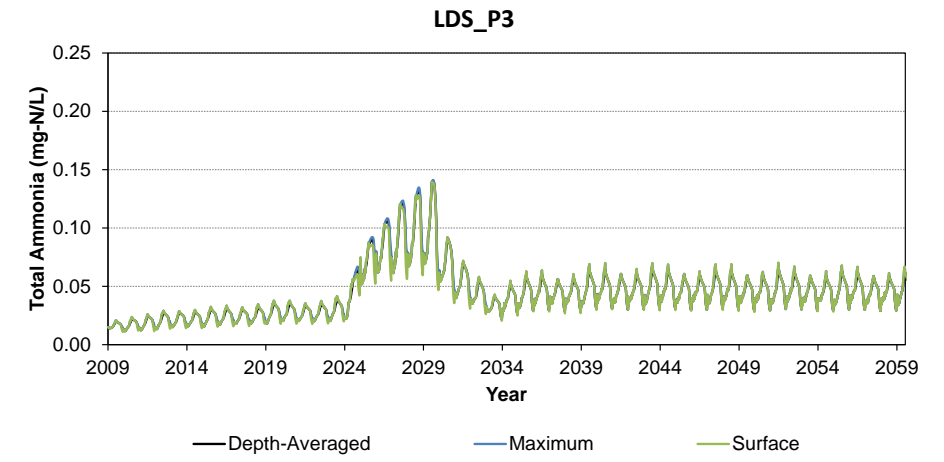
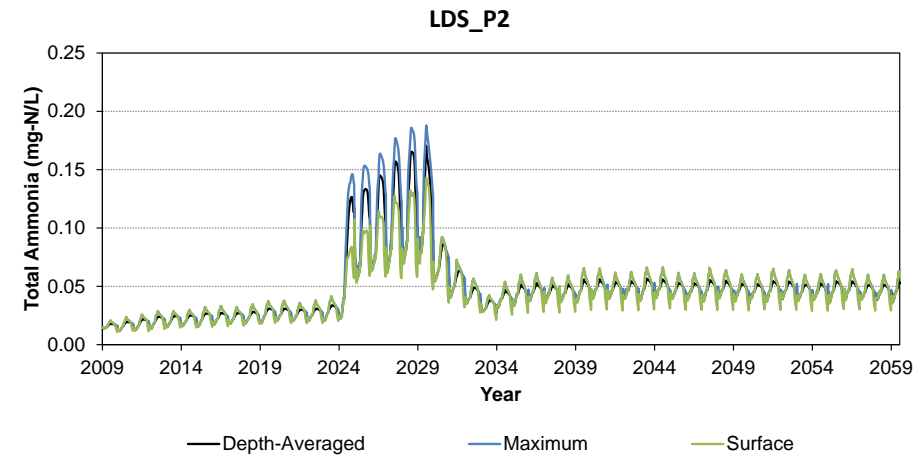
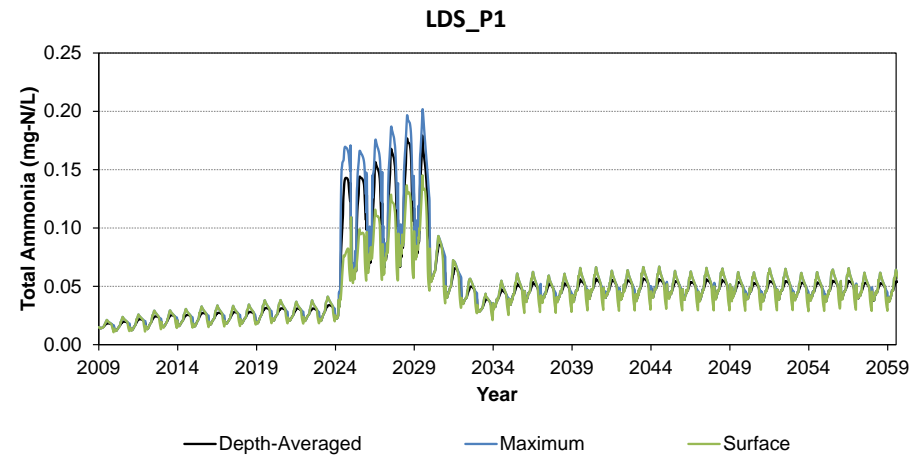


Figure A-5: Predicted Nitrate Concentrations in Lac du Sauvage

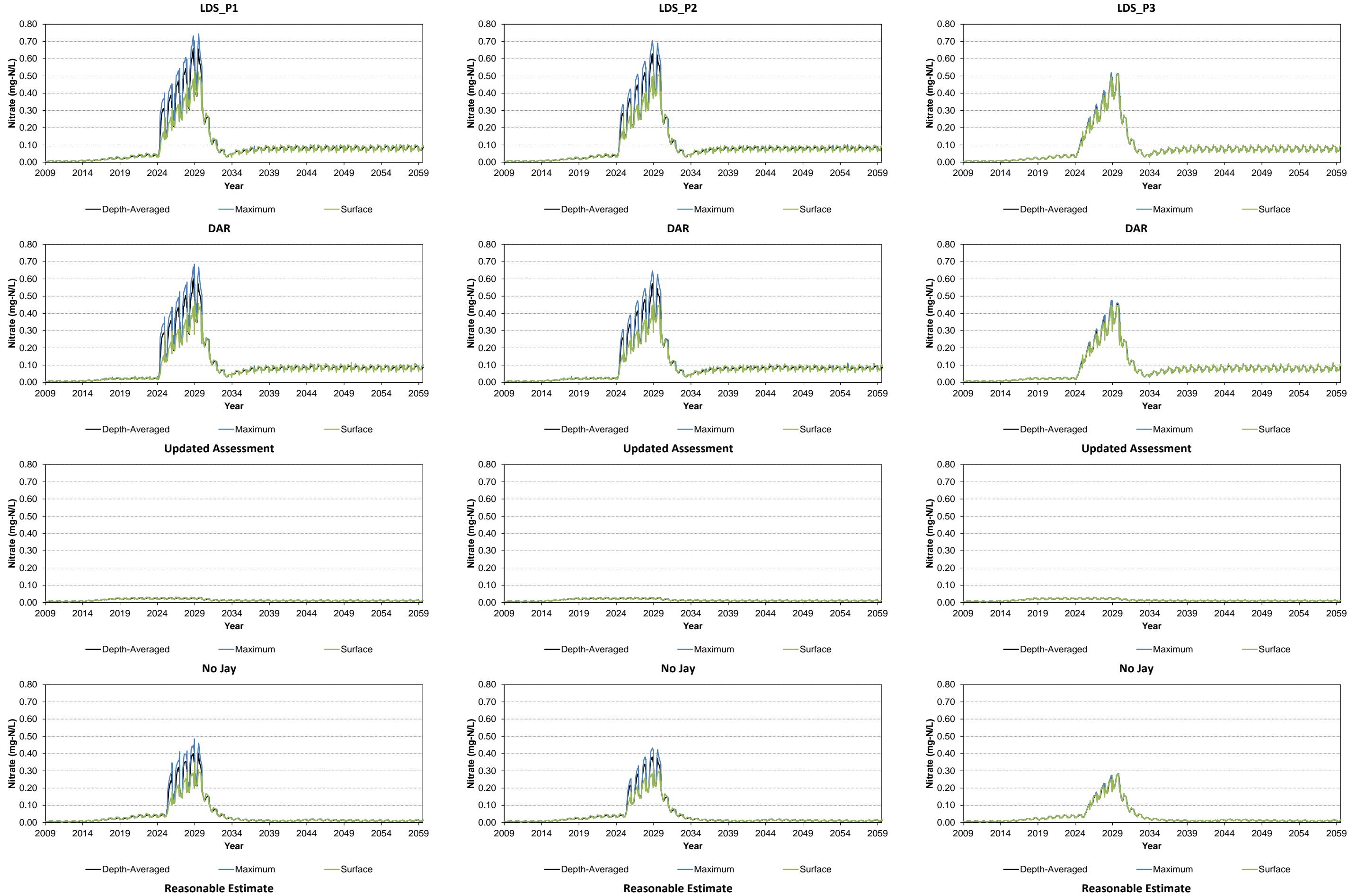


Figure A-6: Predicted Total Phosphorus Concentrations in Lac du Sauvage

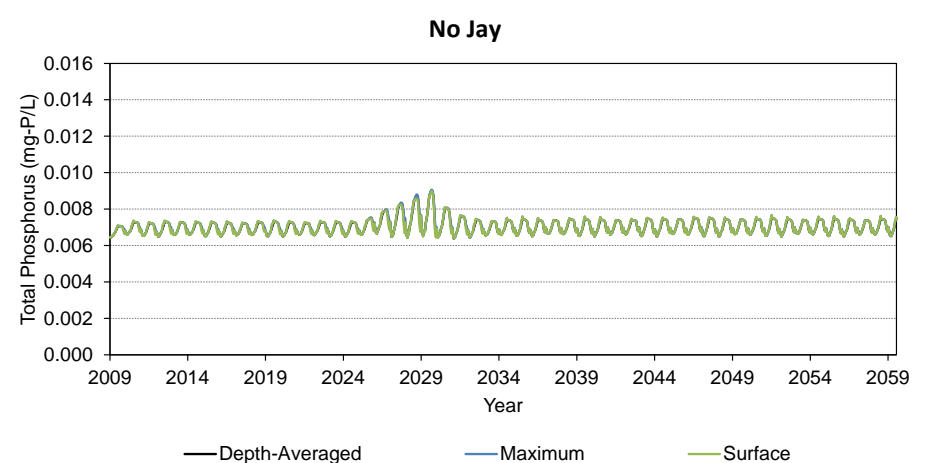
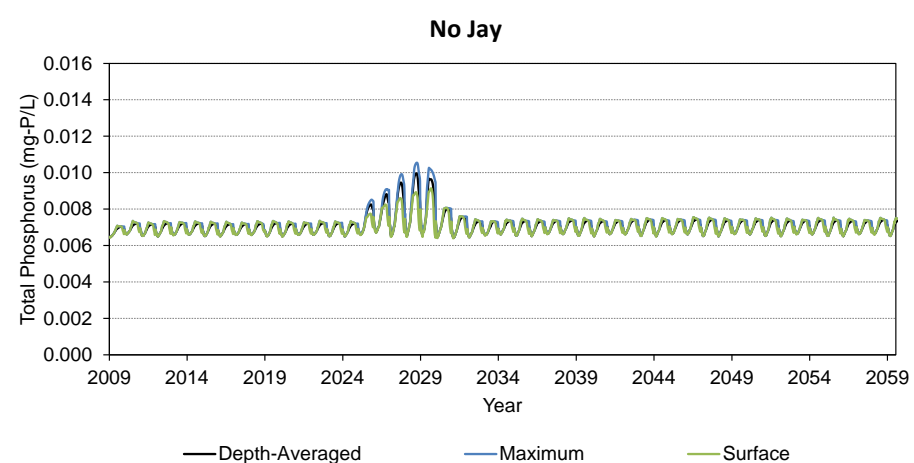
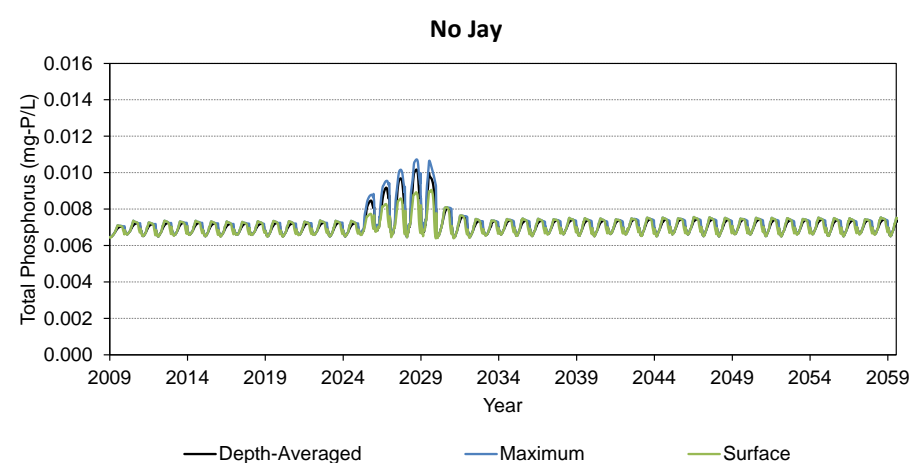
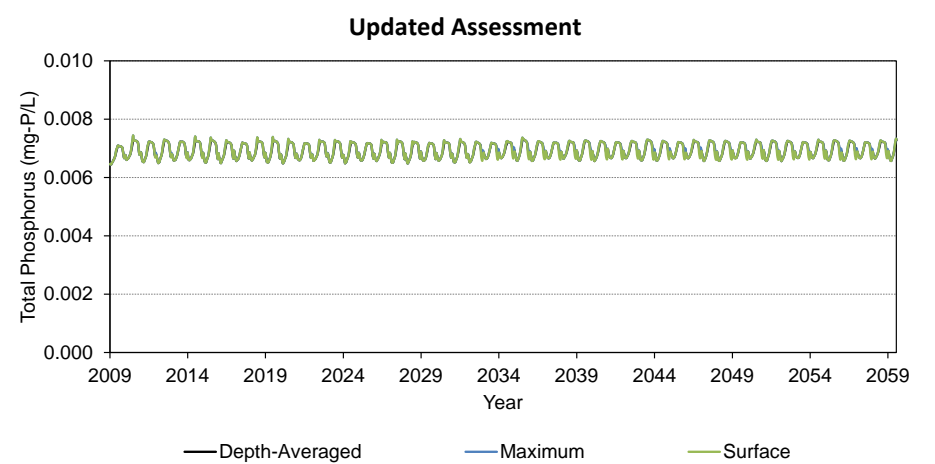
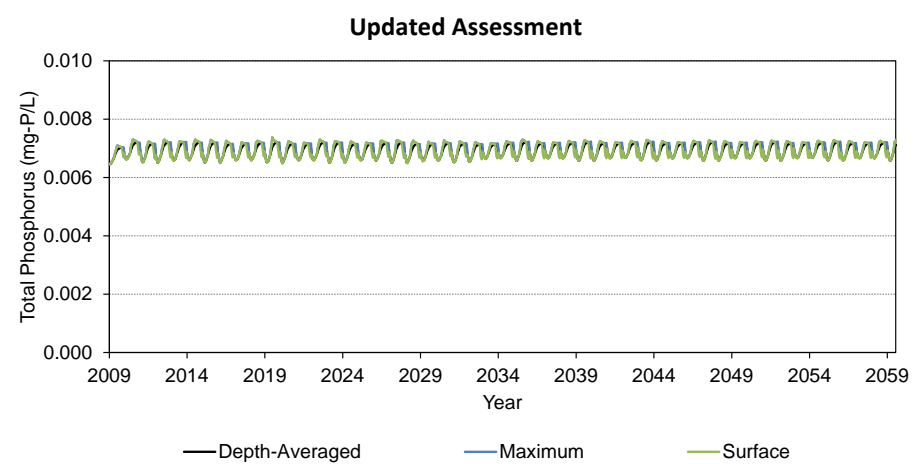
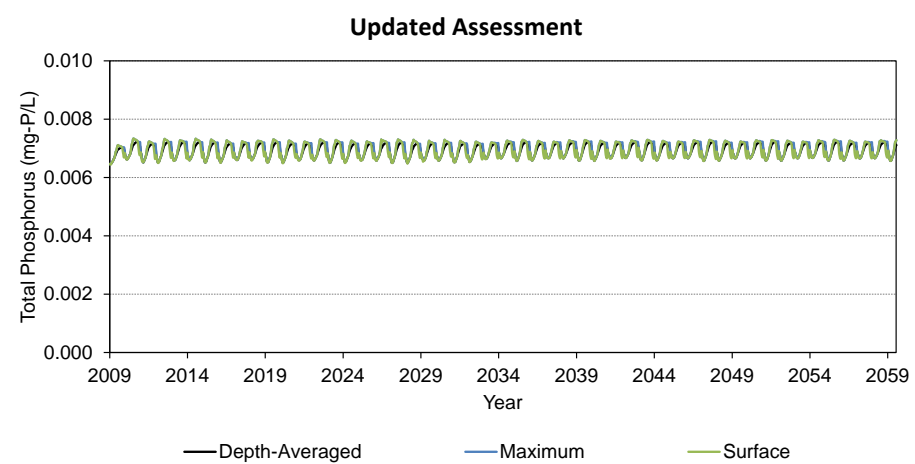
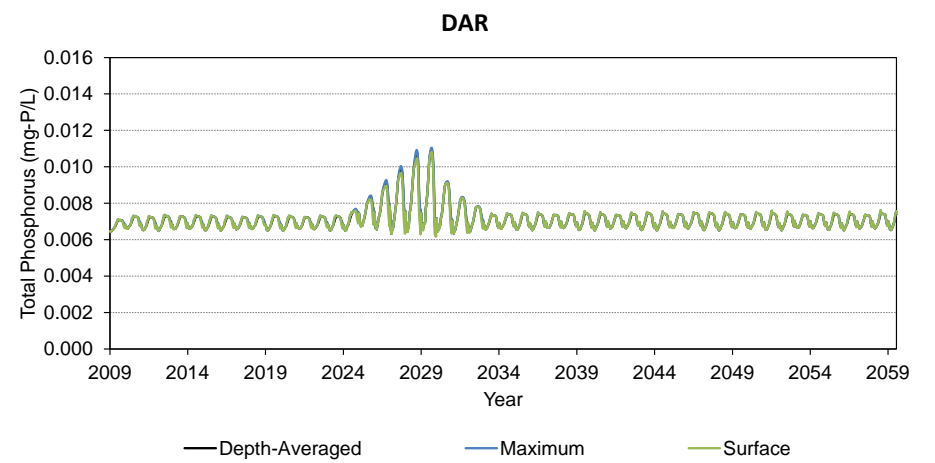
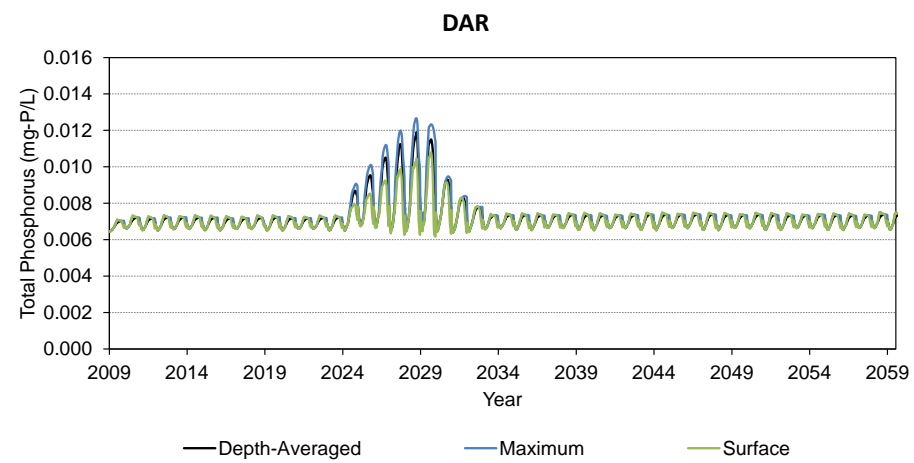
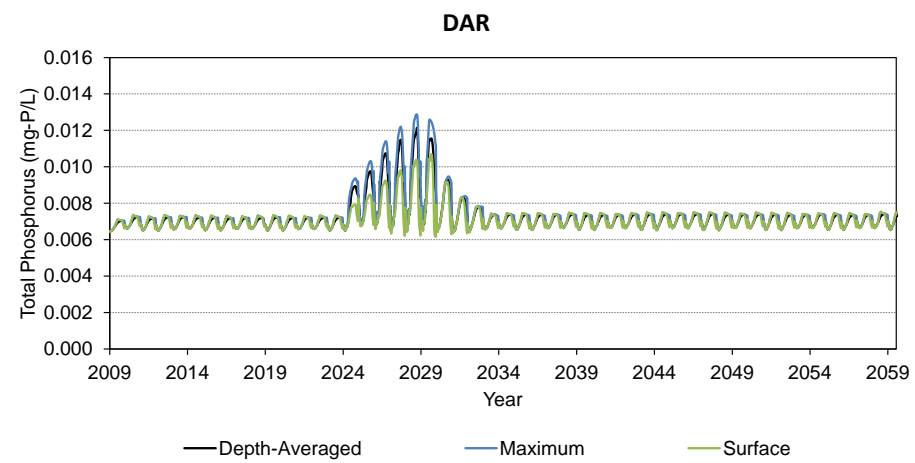
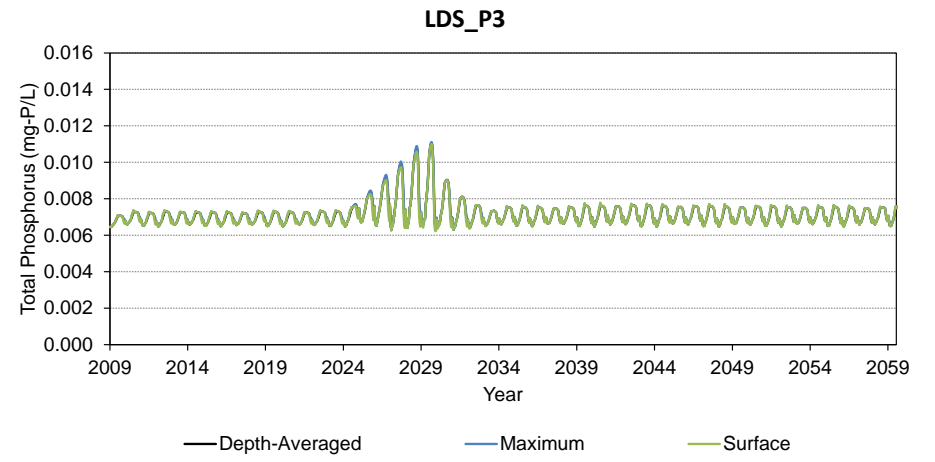
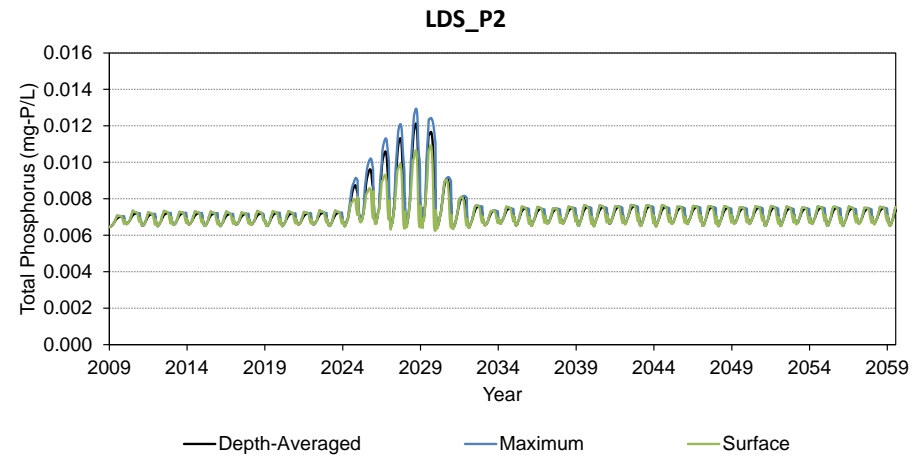
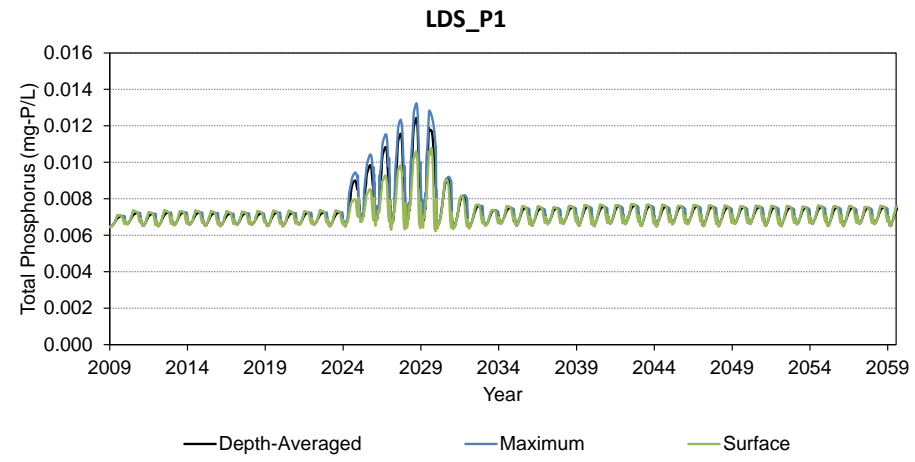


Figure A-7: Predicted Phytoplankton Concentrations in Lac du Sauvage

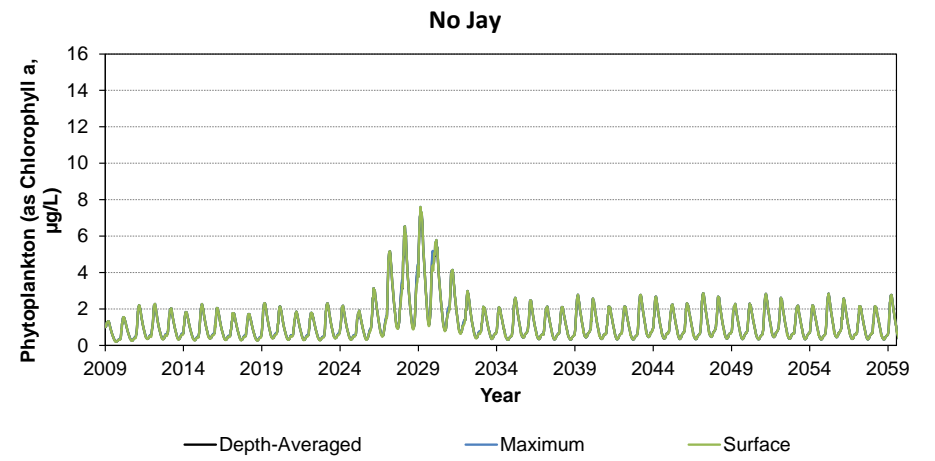
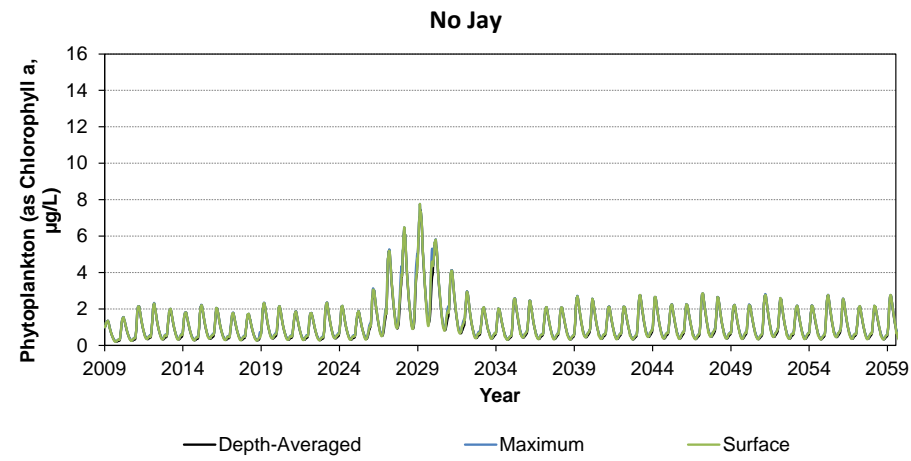
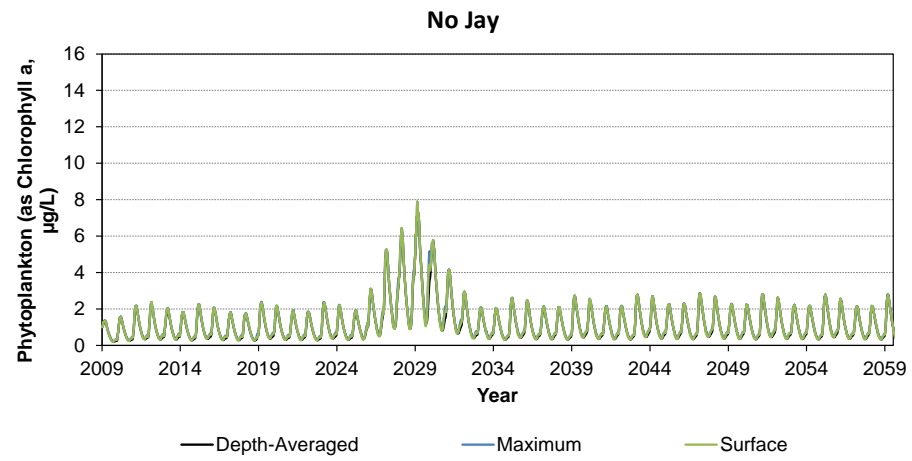
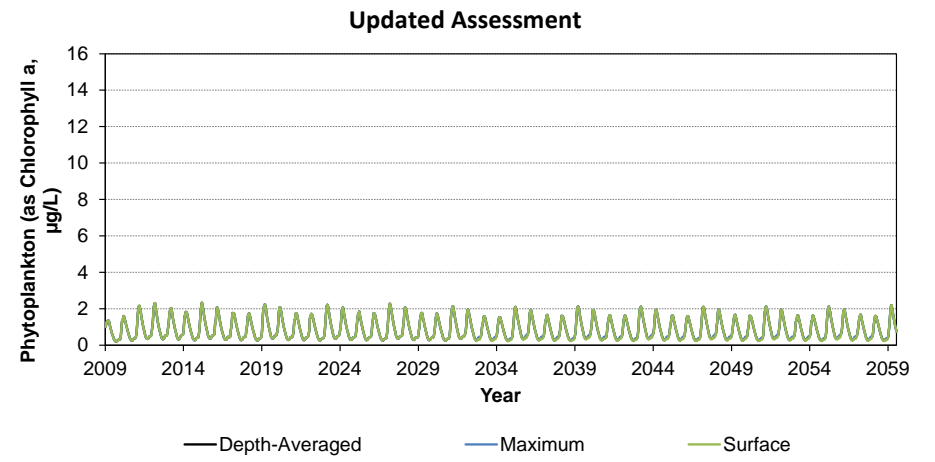
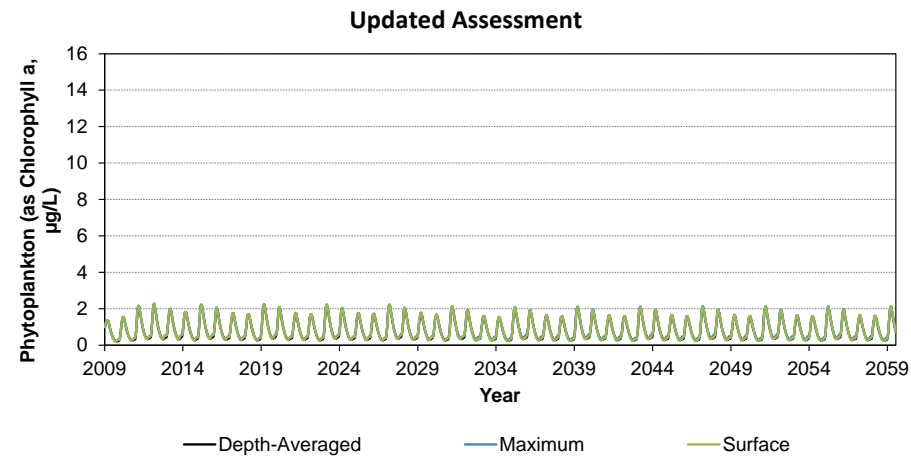
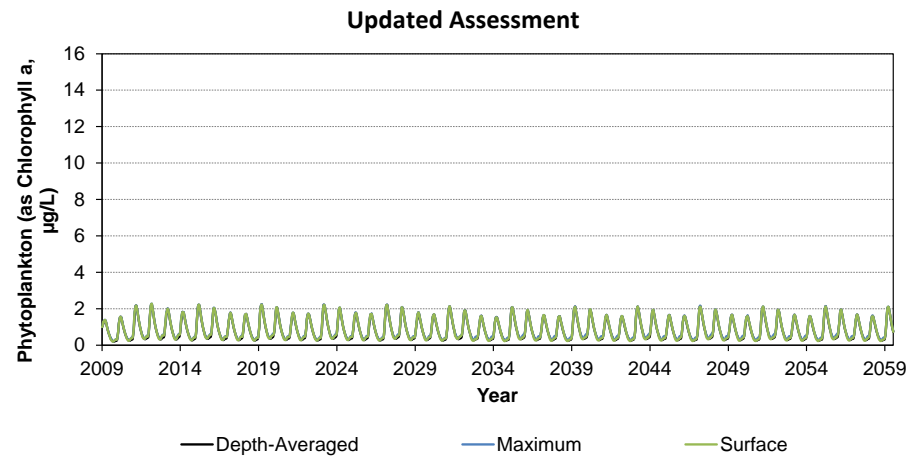
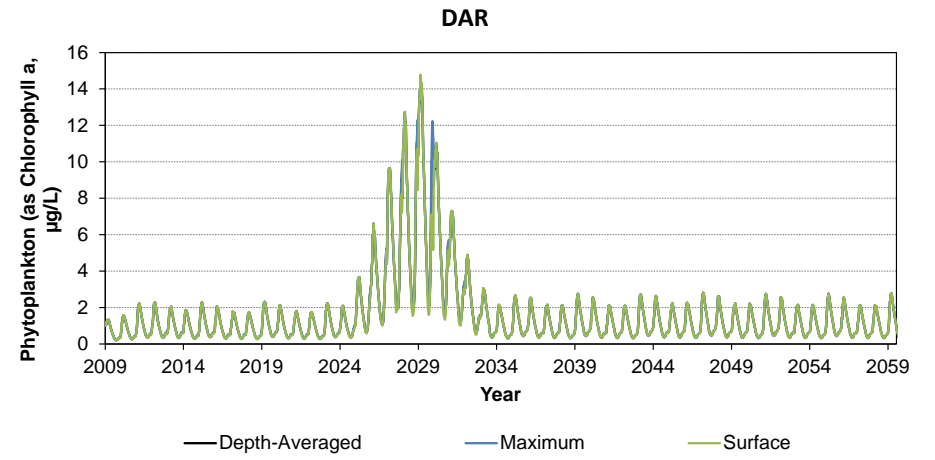
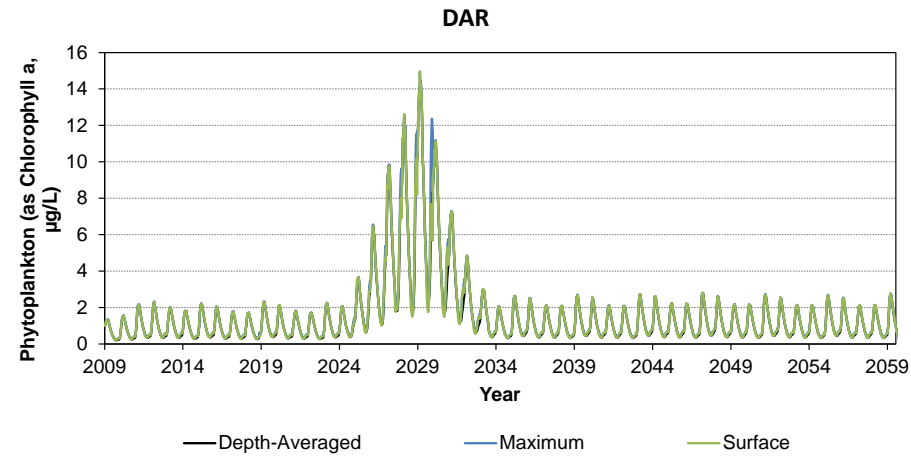
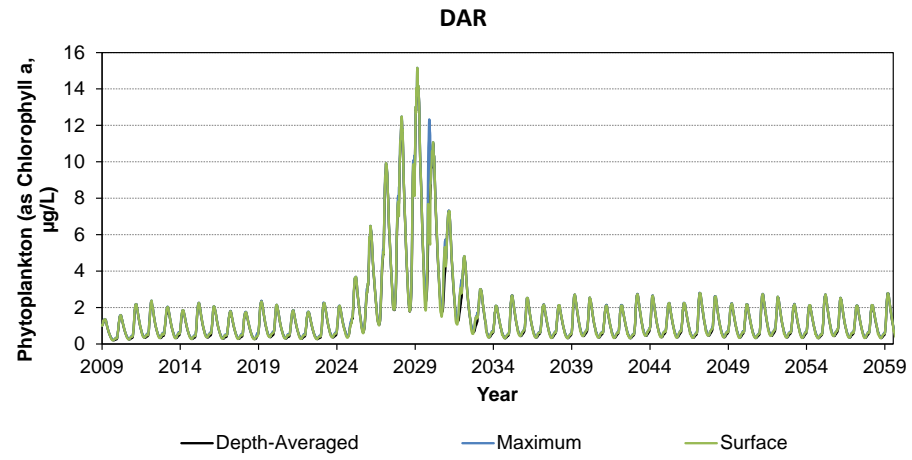
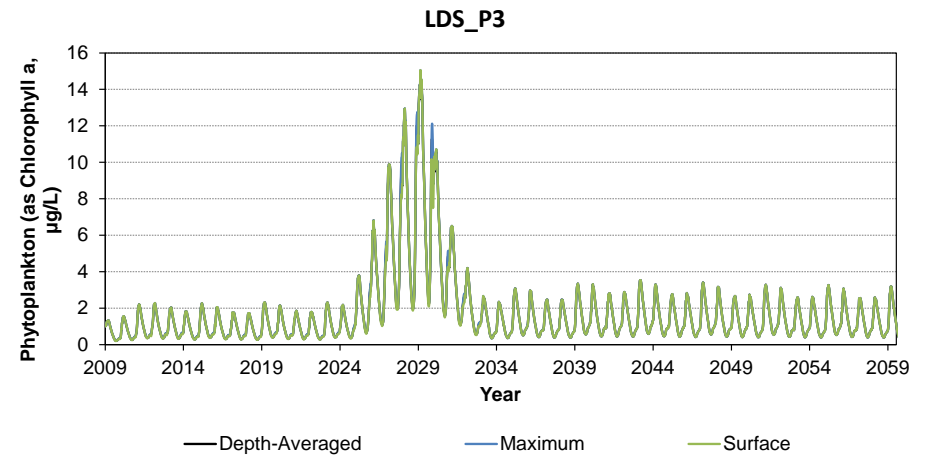
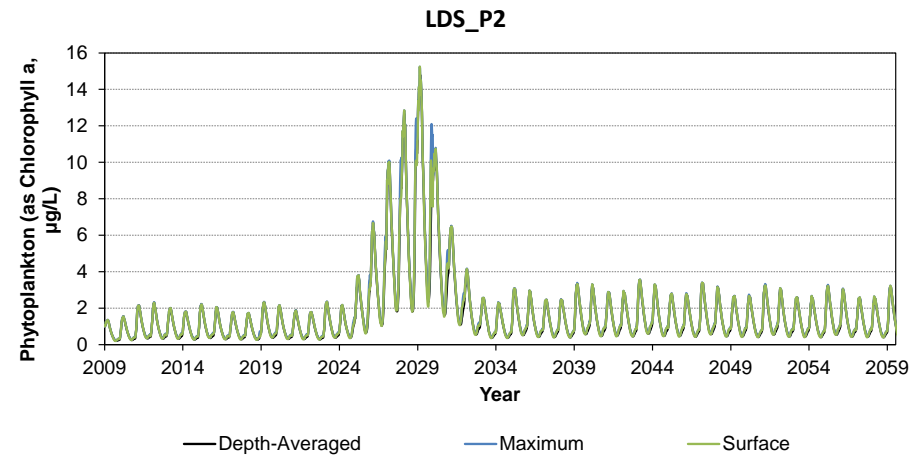
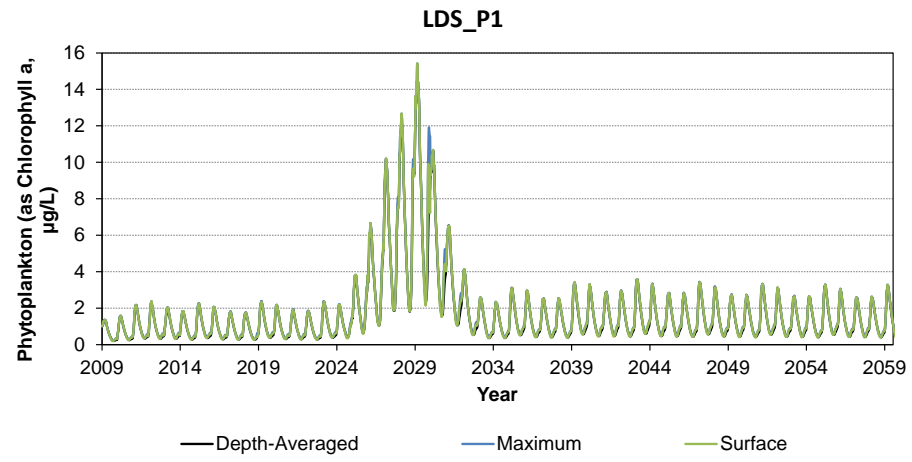


Figure A-8: Predicted Total and Dissolved Aluminum Concentrations in Lac du Sauvage

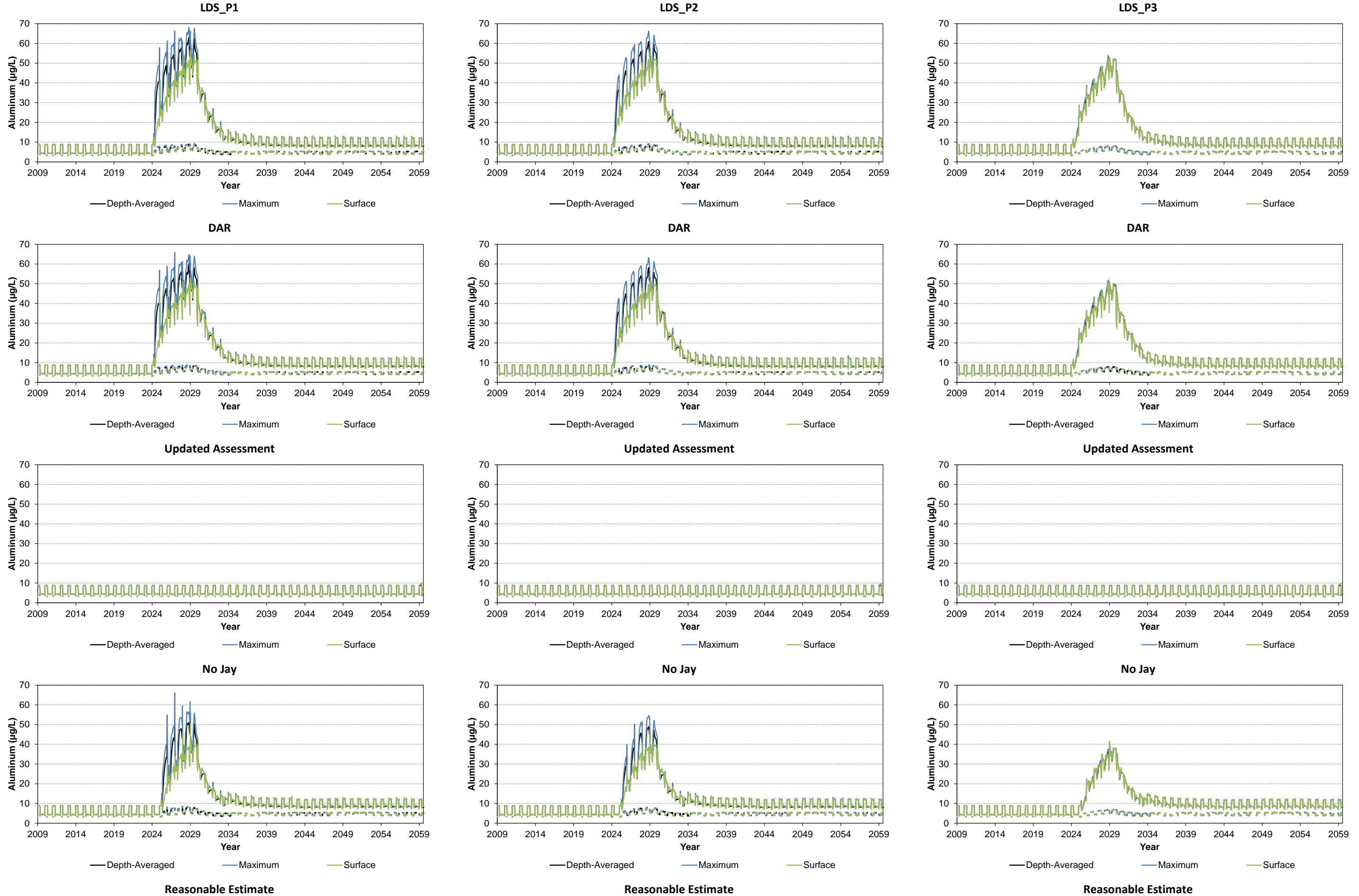
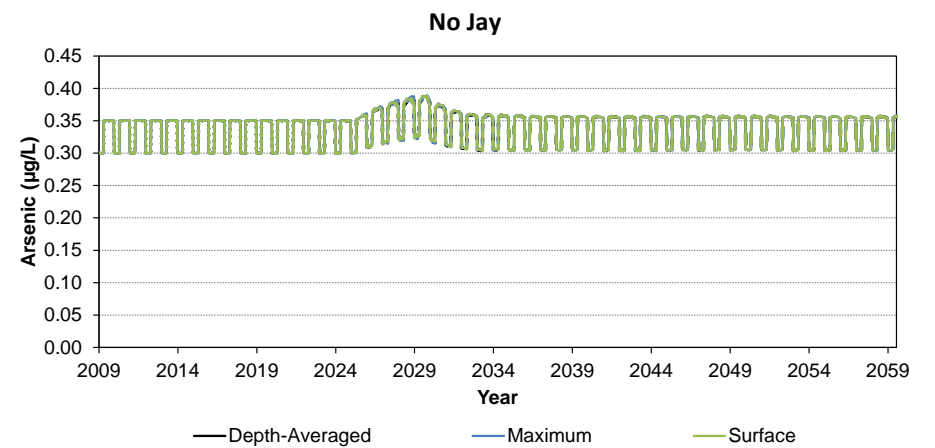
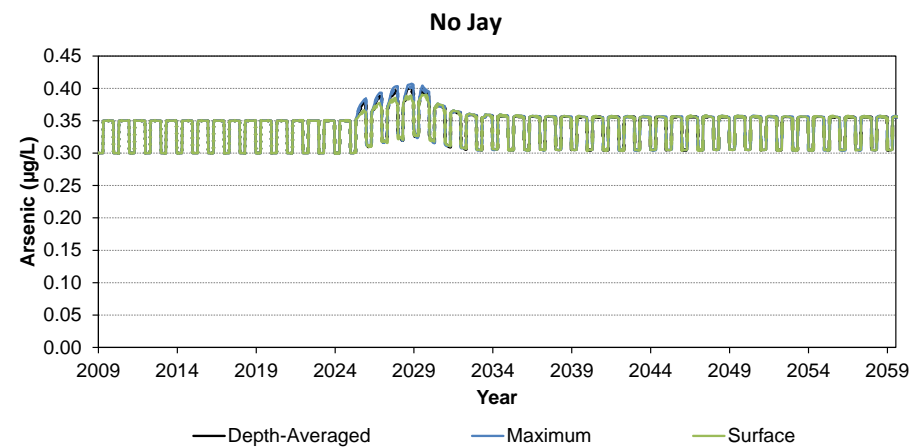
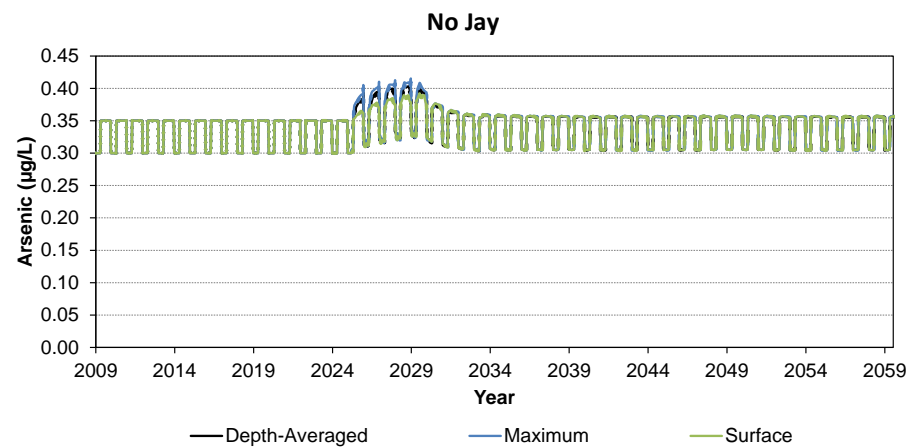
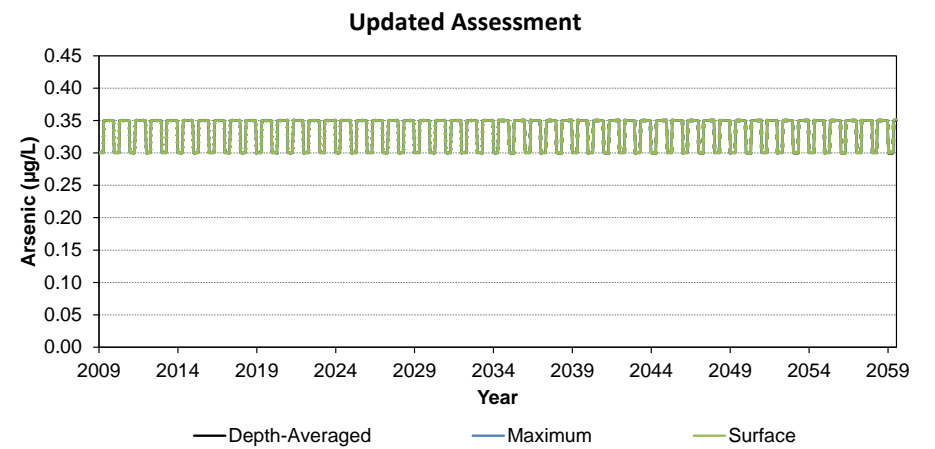
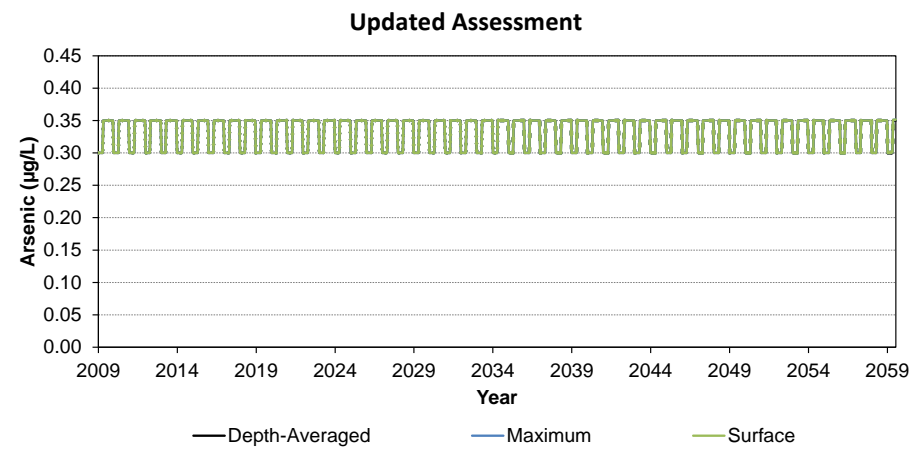
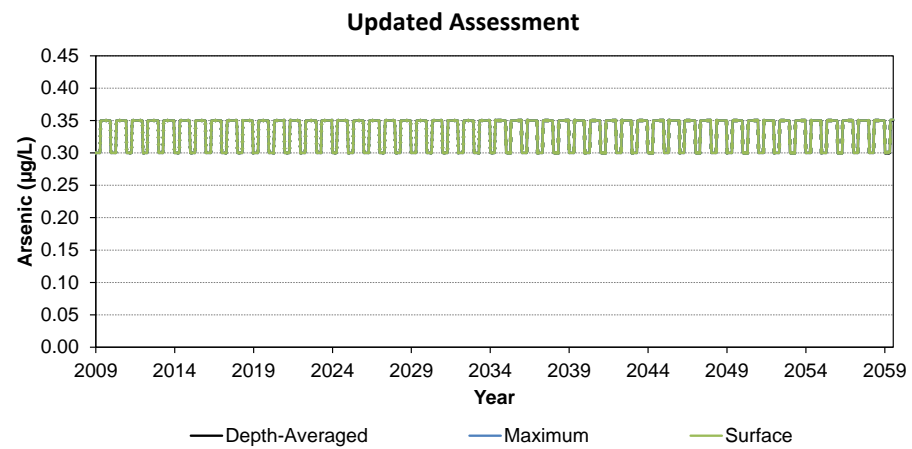
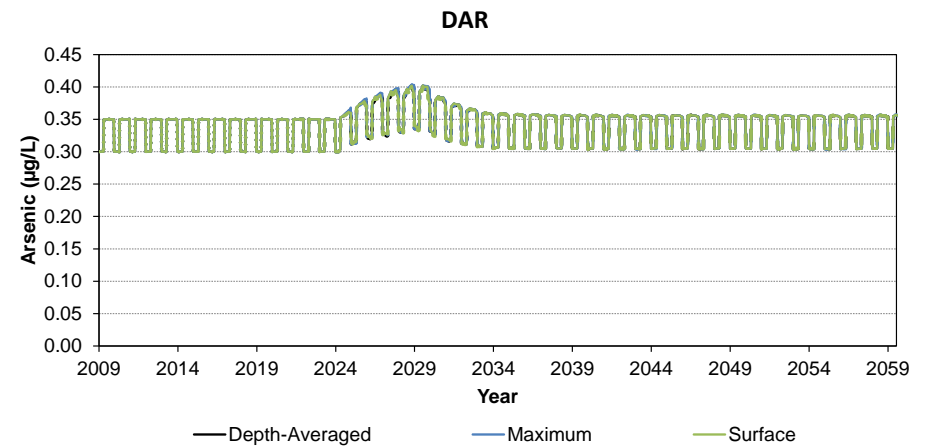
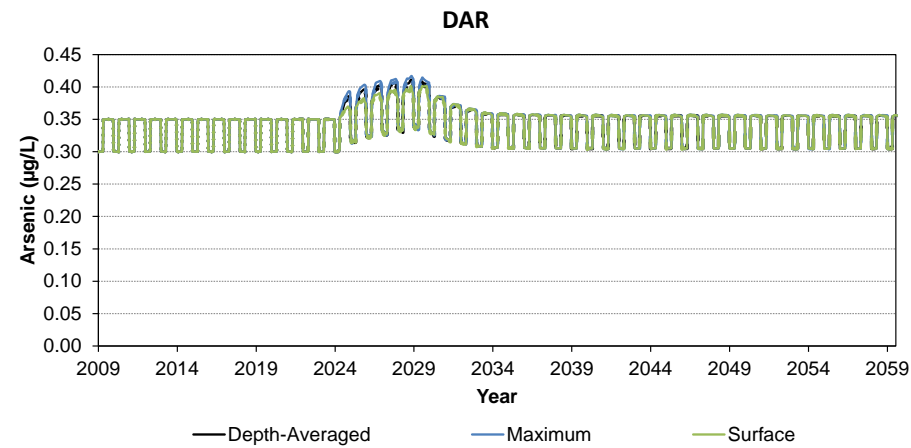
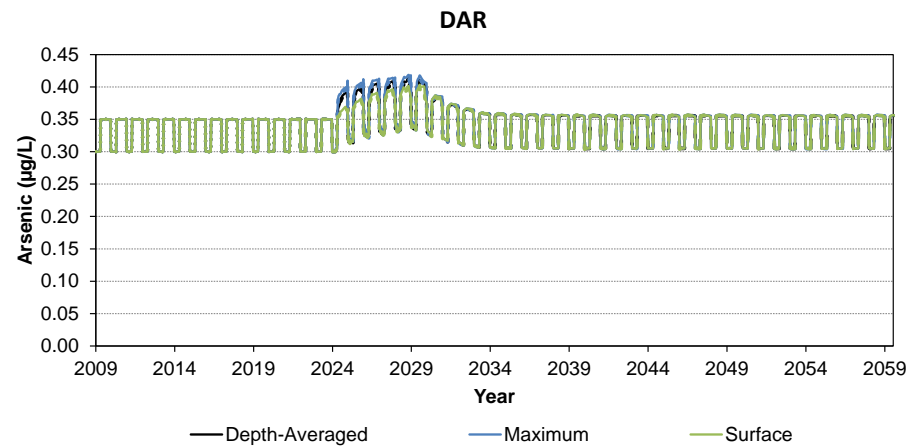
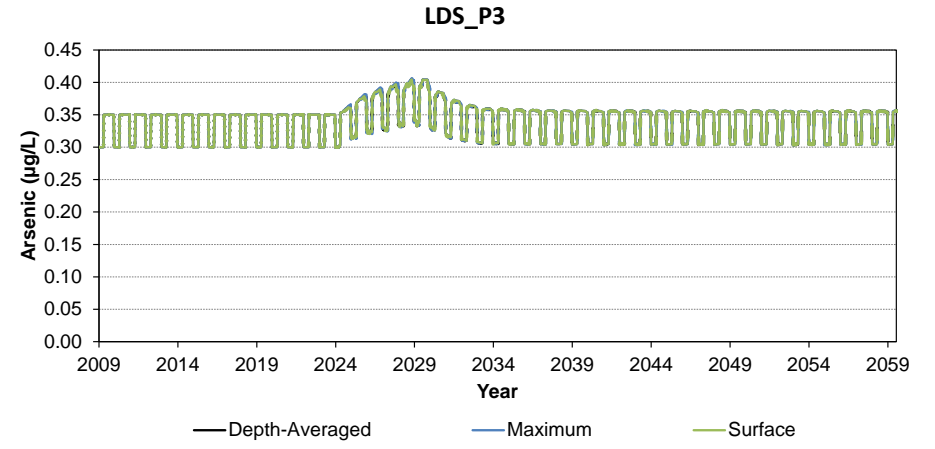
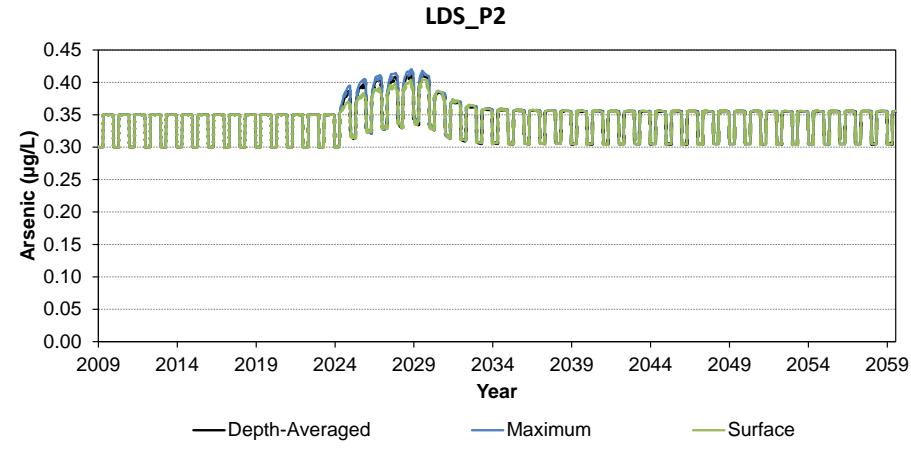
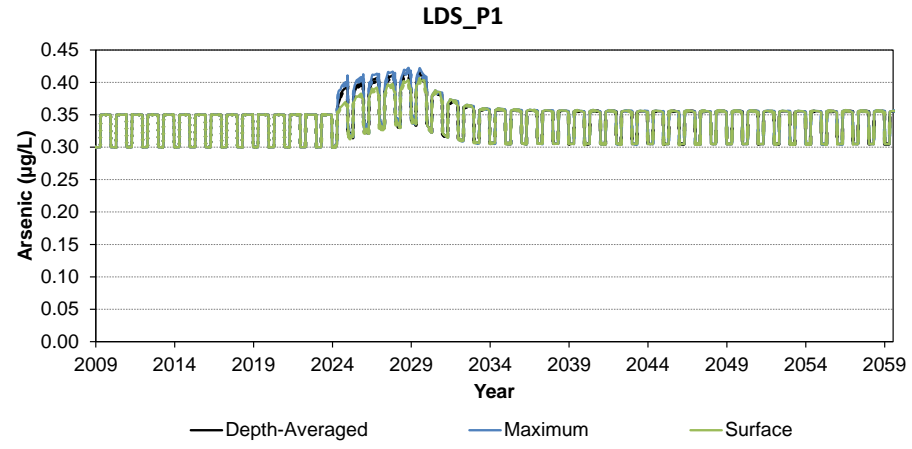


Figure A-9: Predicted Total and Dissolved Arsenic Concentrations in Lac du Sauvage

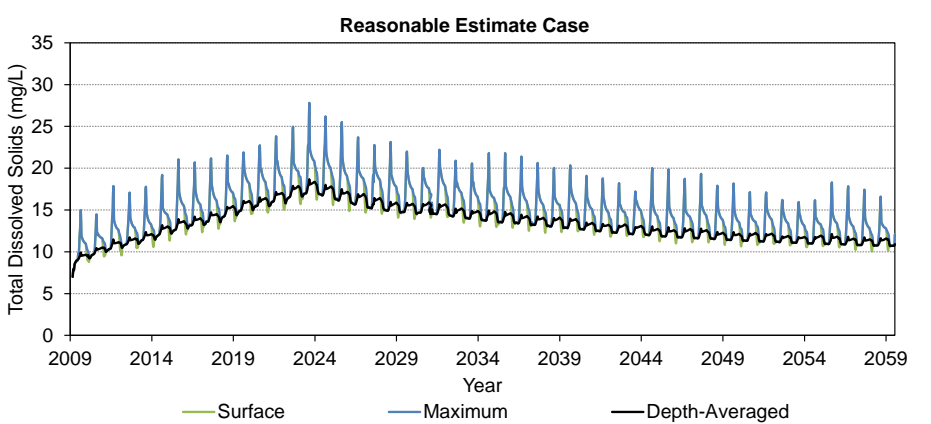
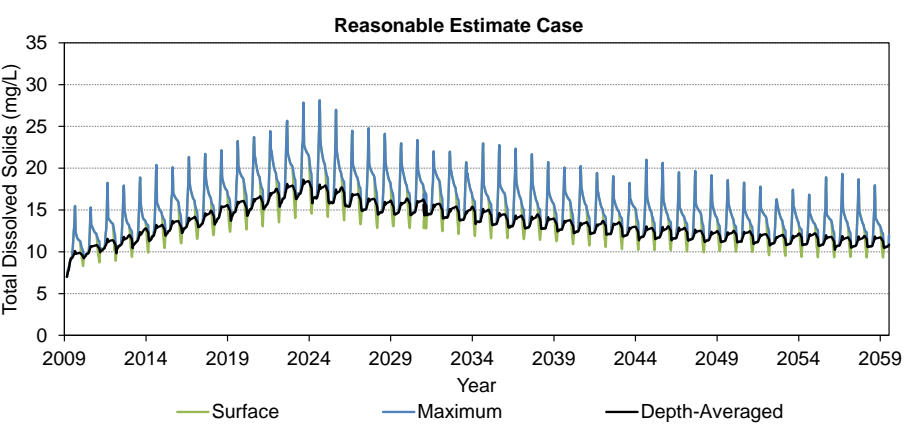
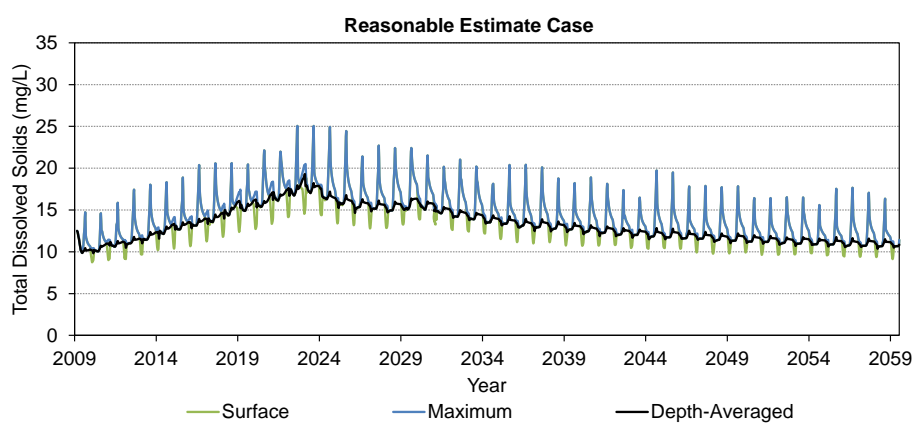
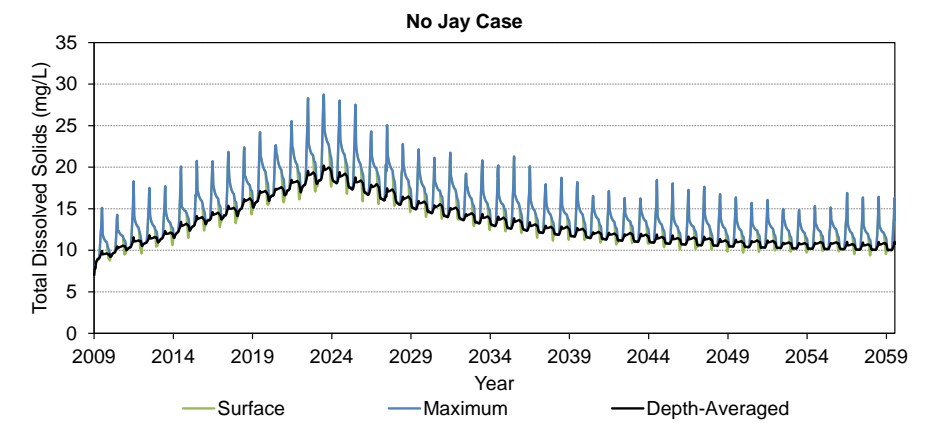
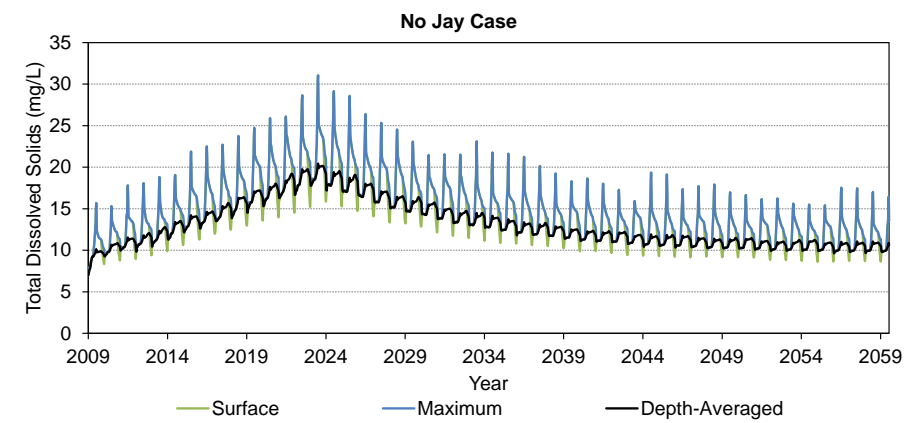
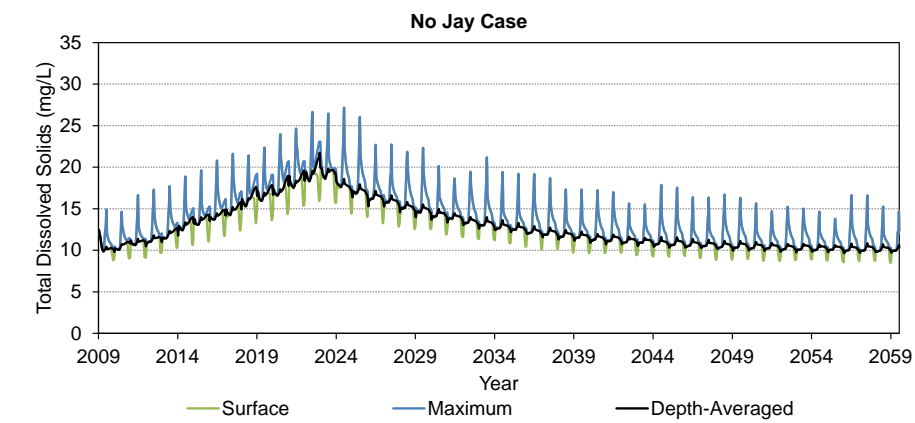
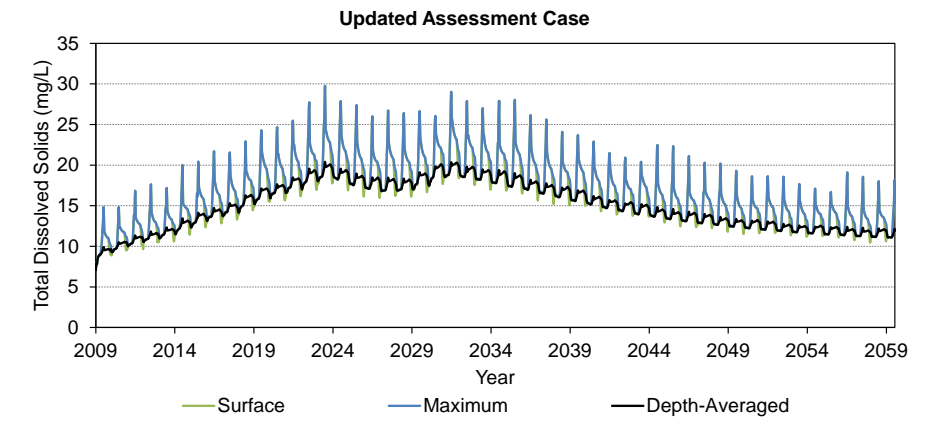
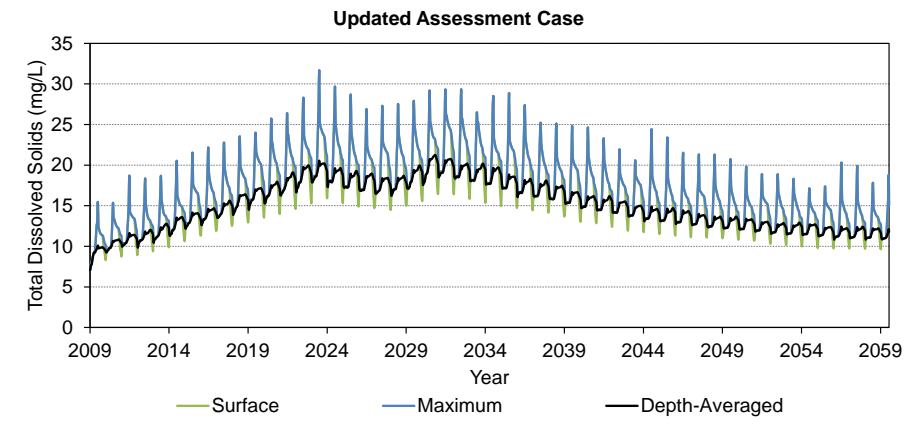
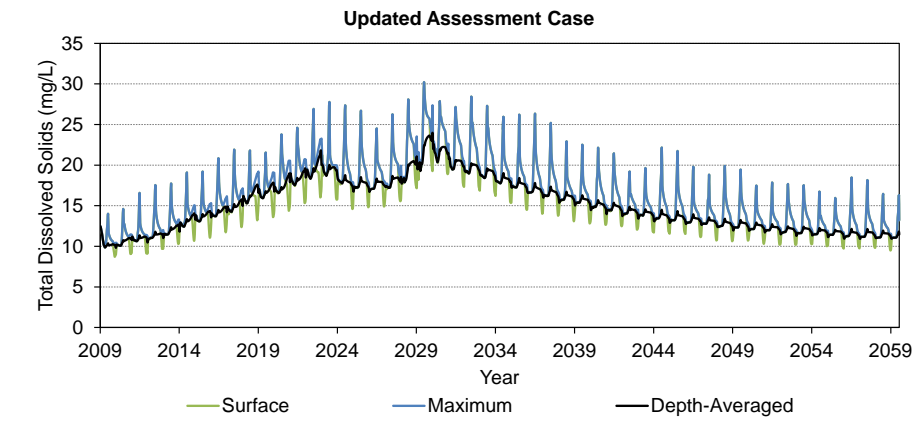
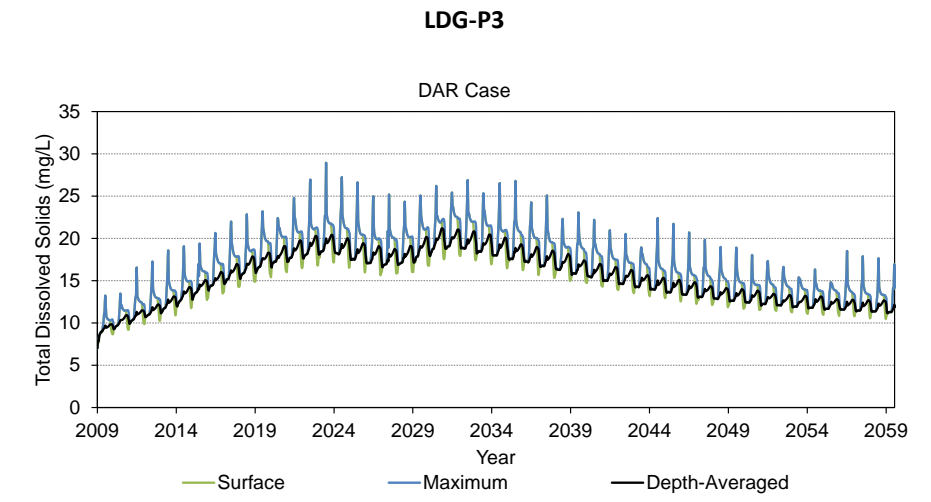
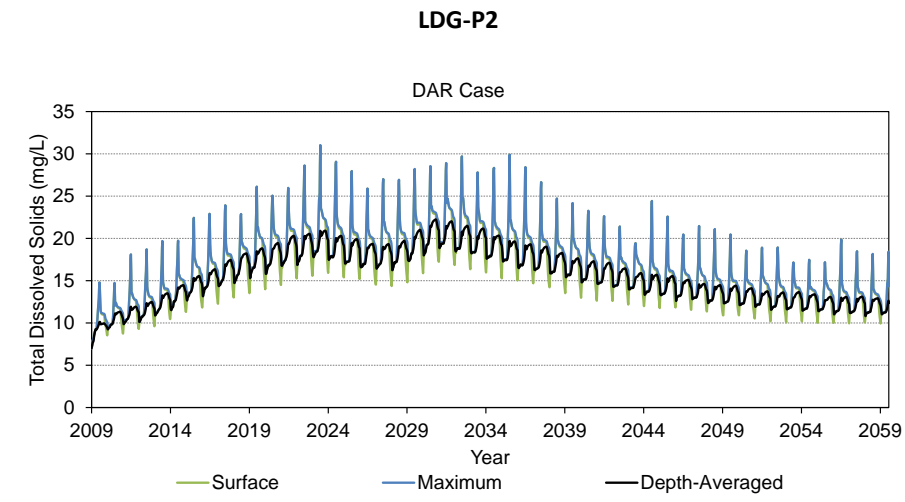
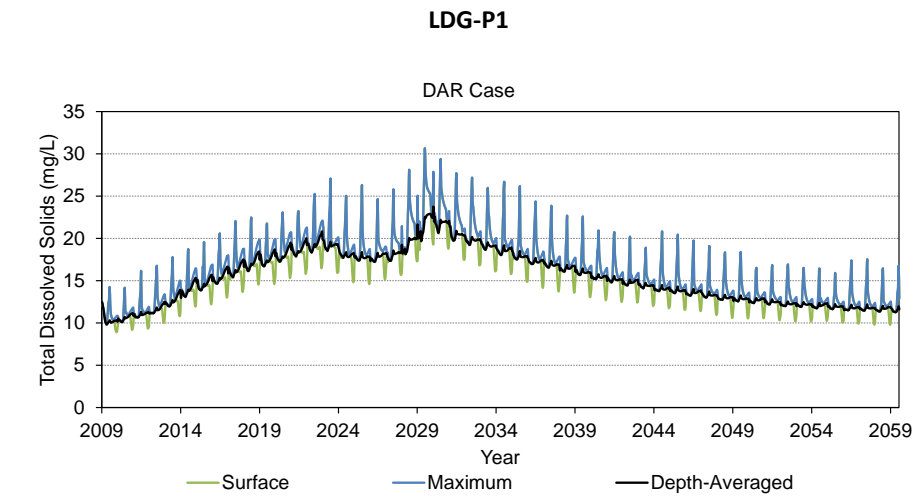




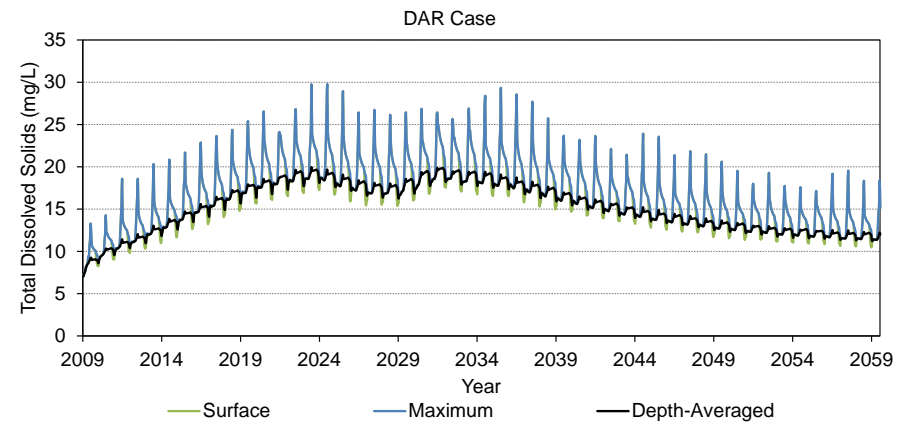
APPENDIX B

Lac de Gras Time Series

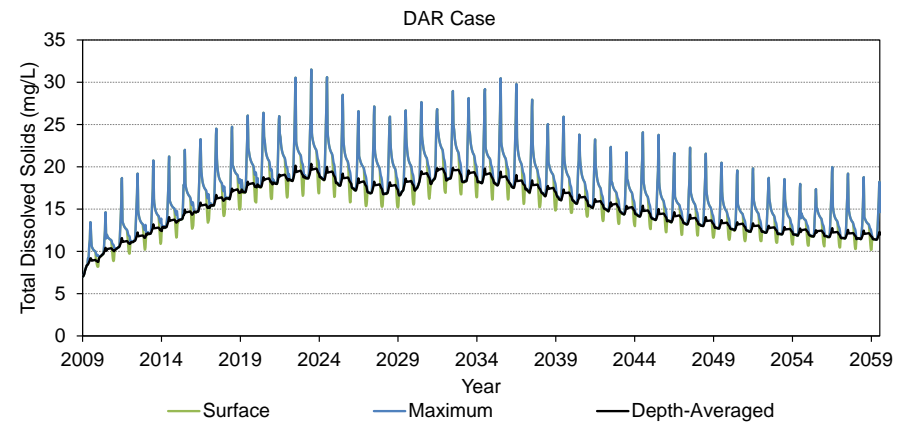
Figure B-1: Predicted Total Dissolved Solids Concentrations in Lac de Gras



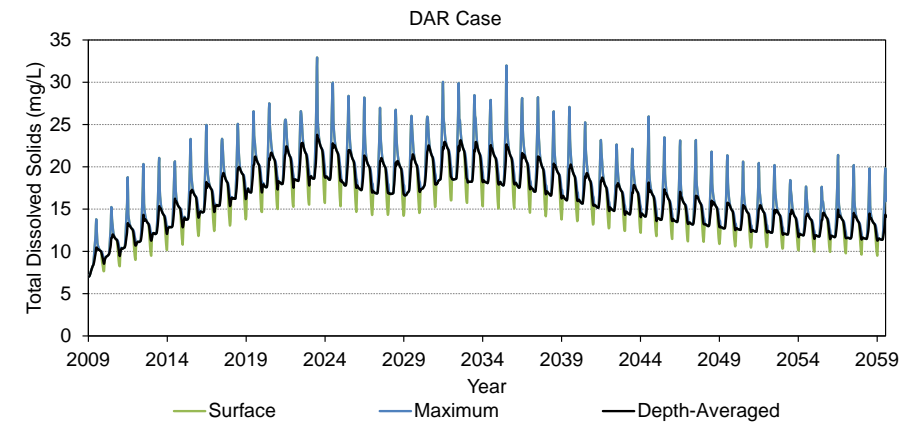
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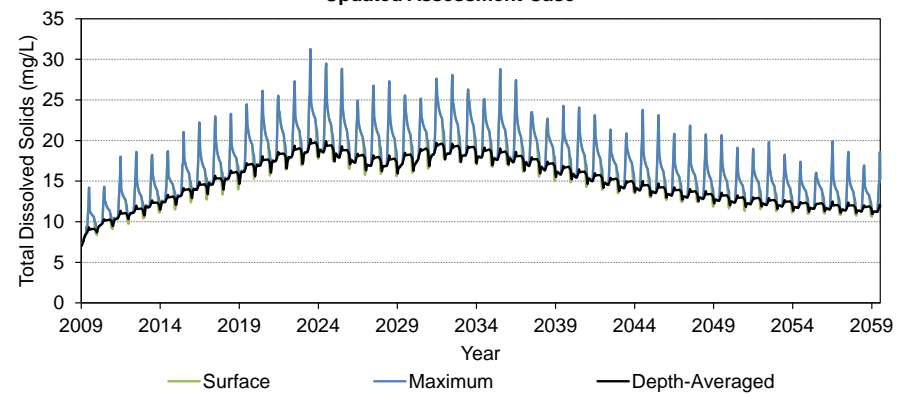
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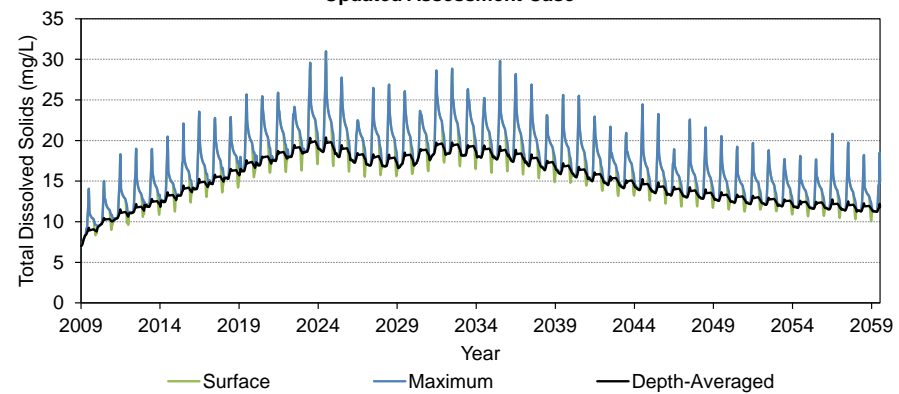
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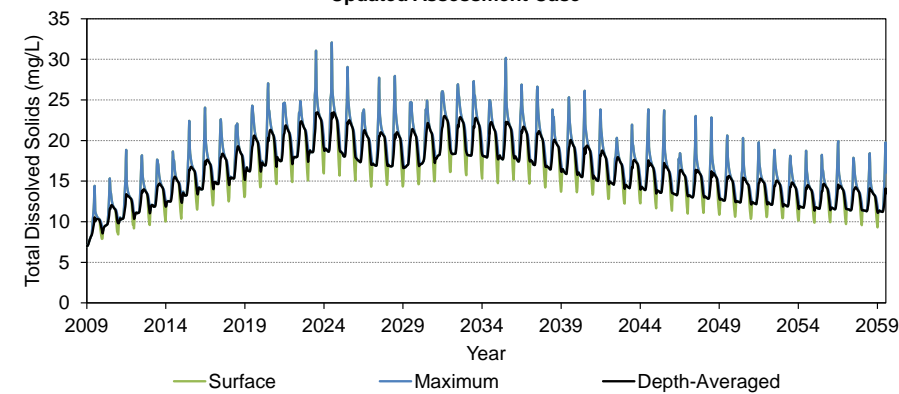
Updated Assessment Case



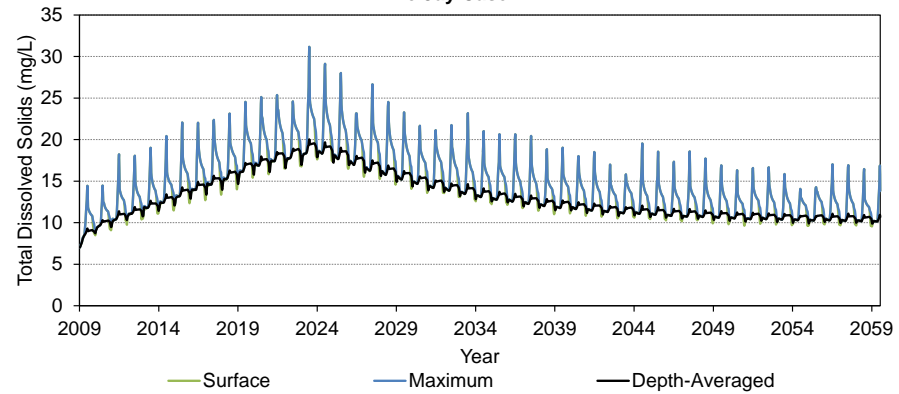
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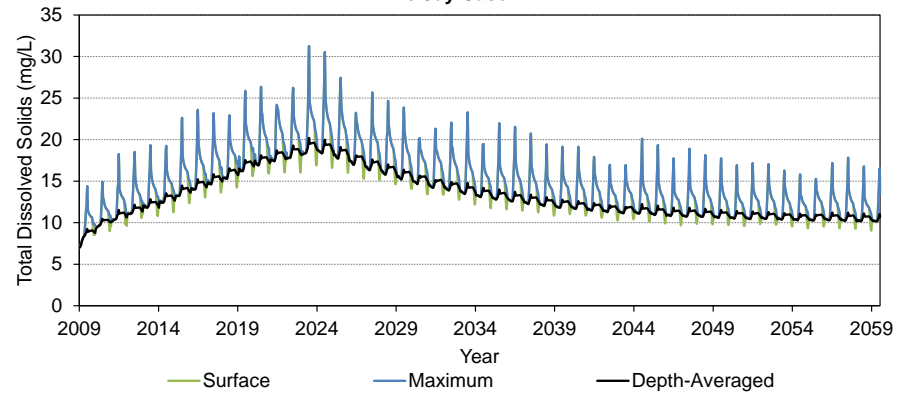
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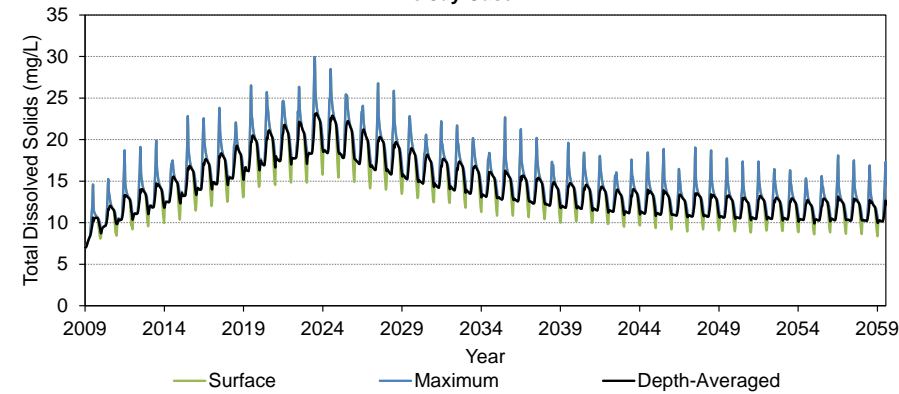
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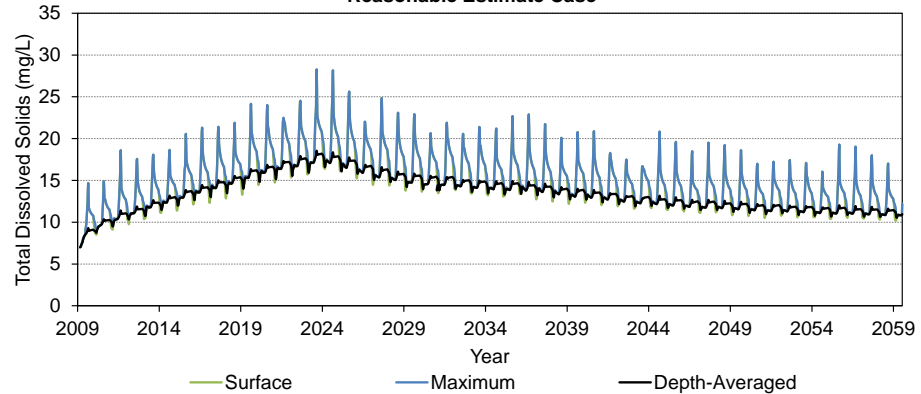
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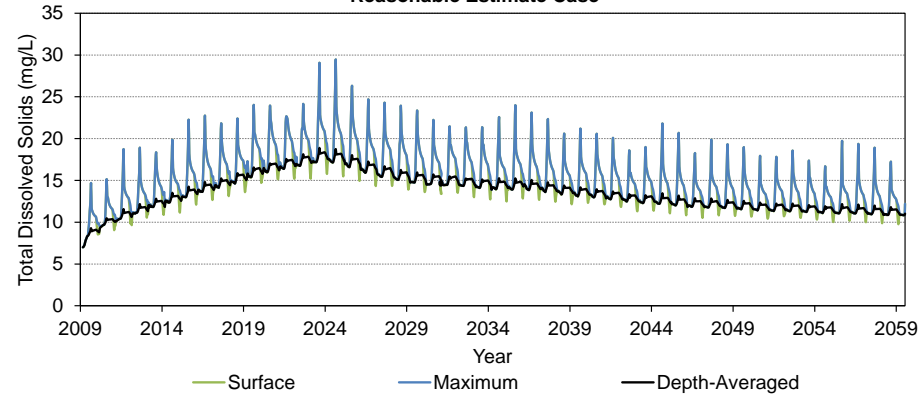
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Reasonable Estimate Case



Reasonable Estimate Case



Reasonable Estimate Case

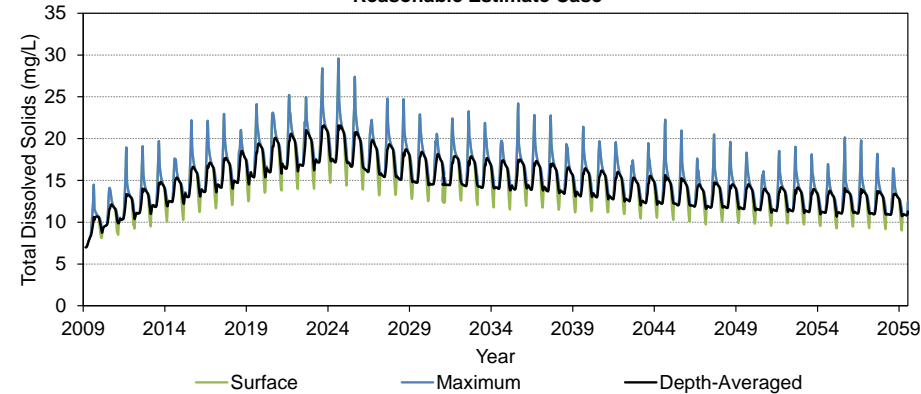
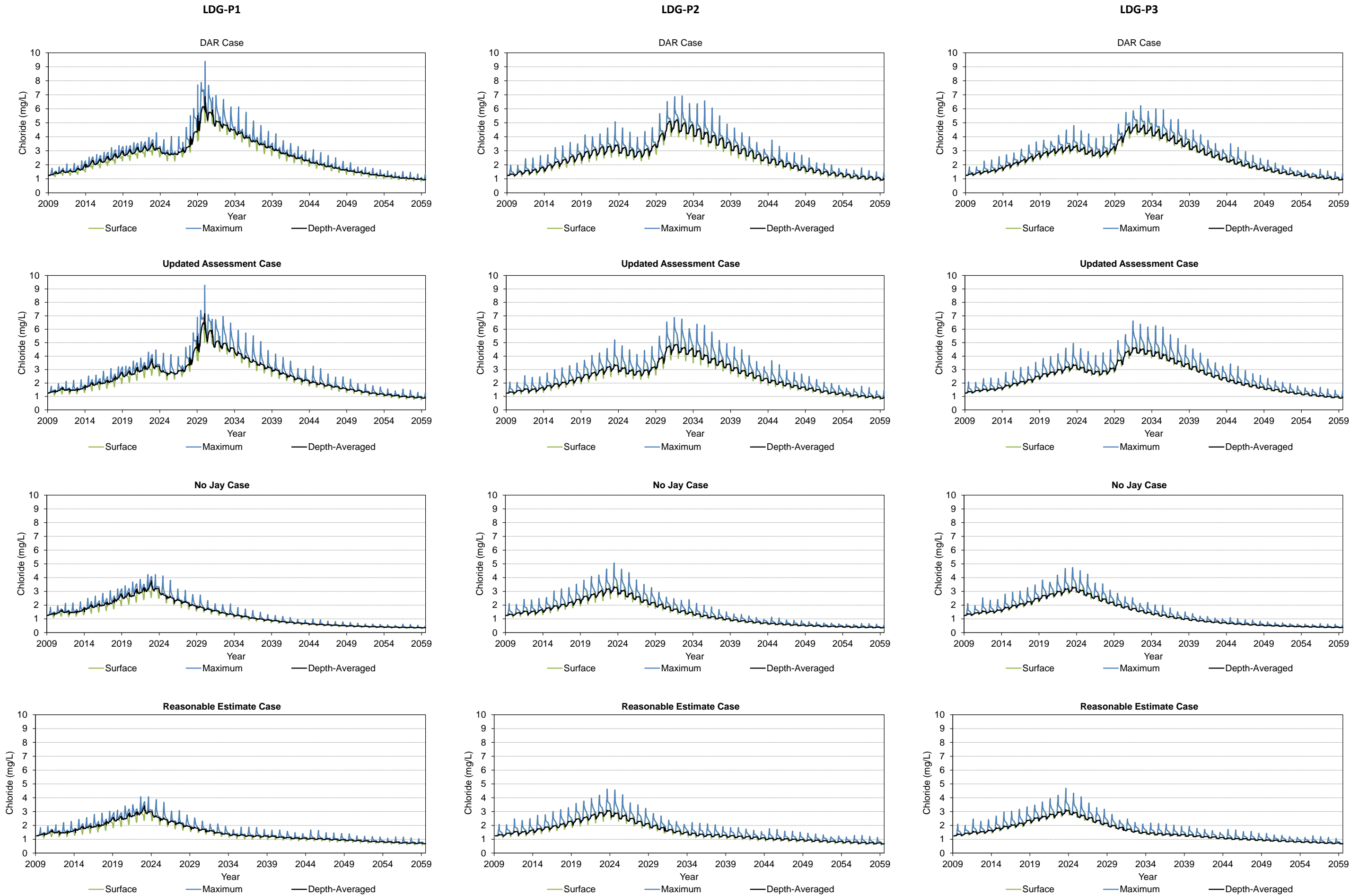
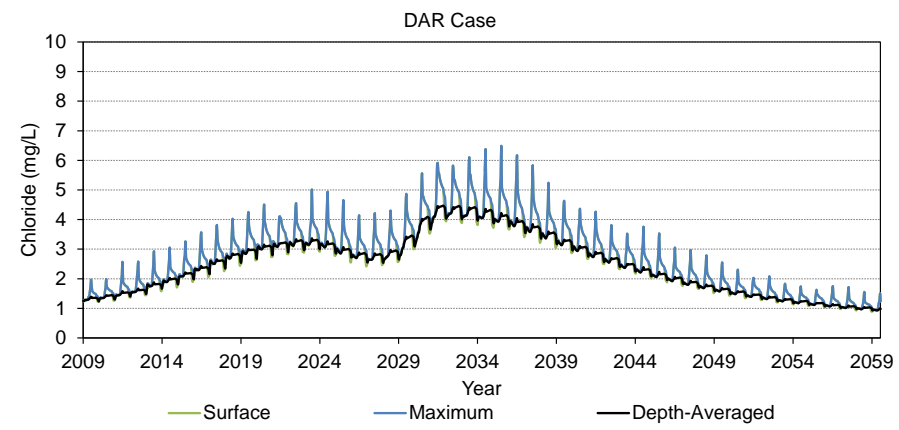


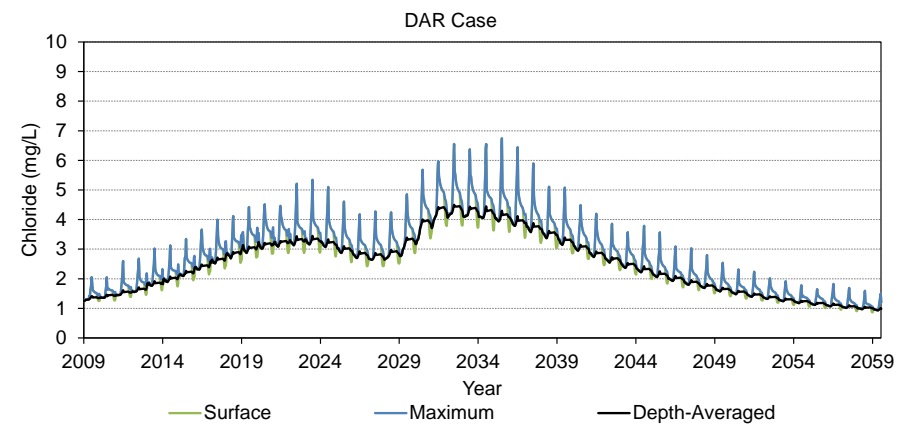
Figure B-2: Predicted Chloride Concentrations in Lac de Gras



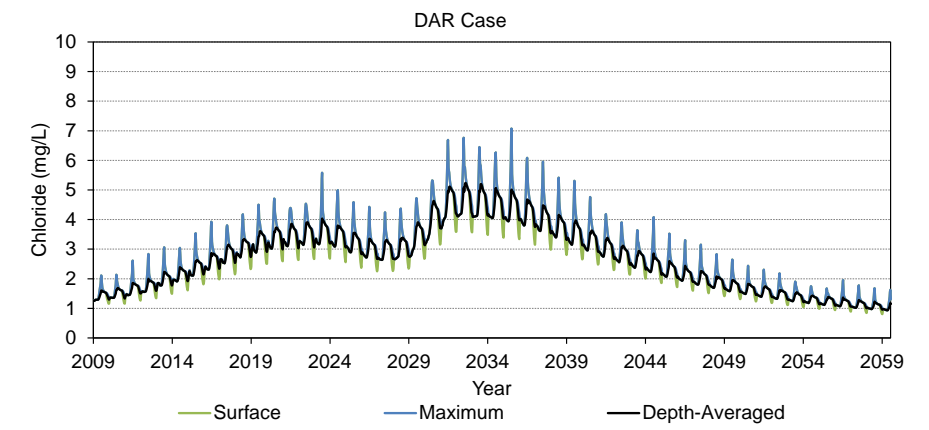
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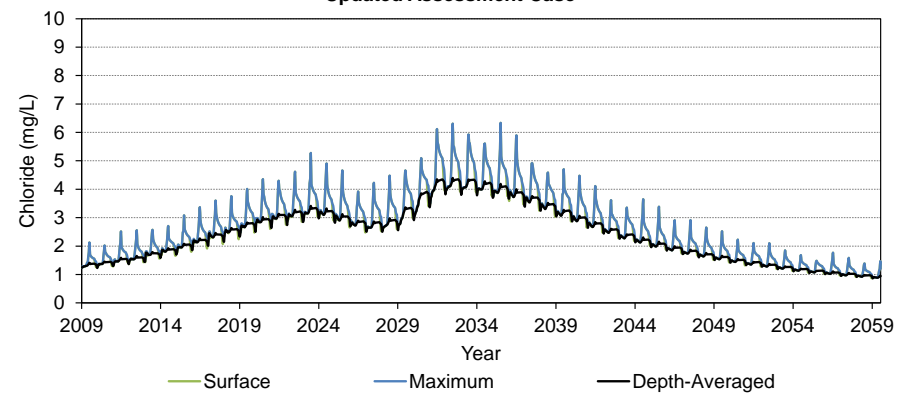
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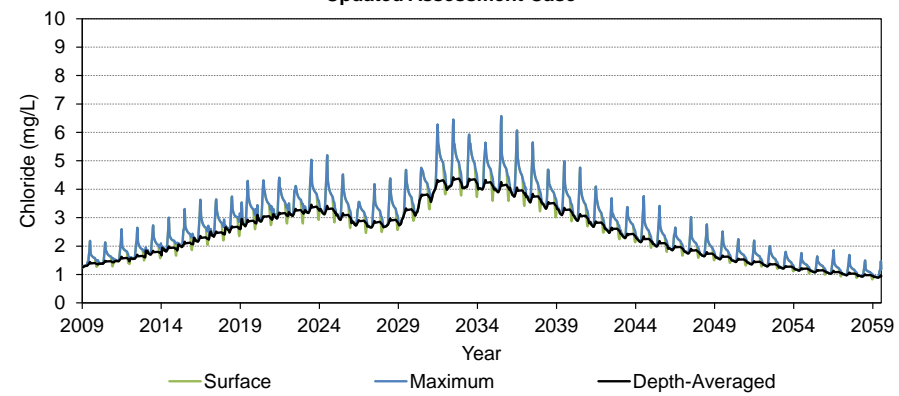
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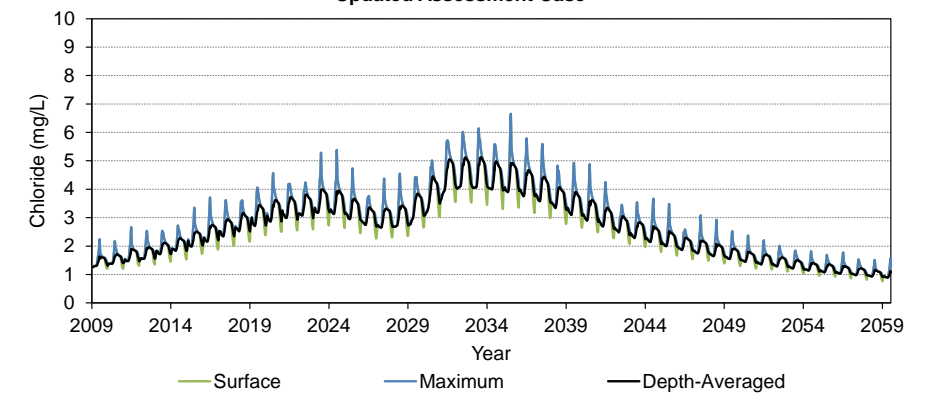
Updated Assessment Case



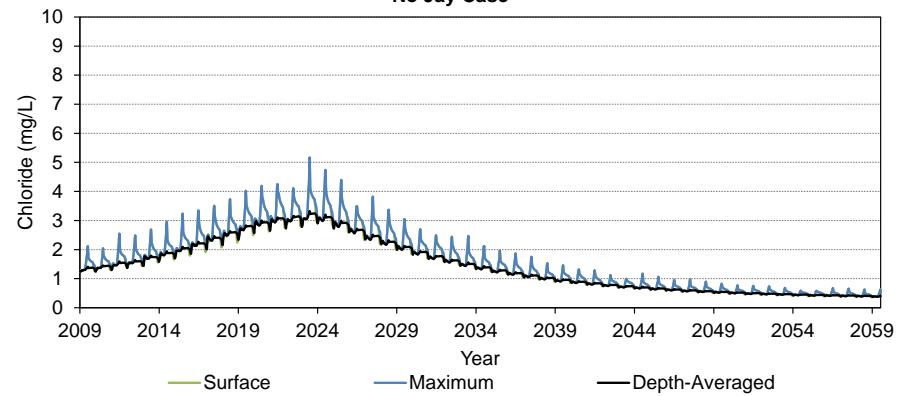
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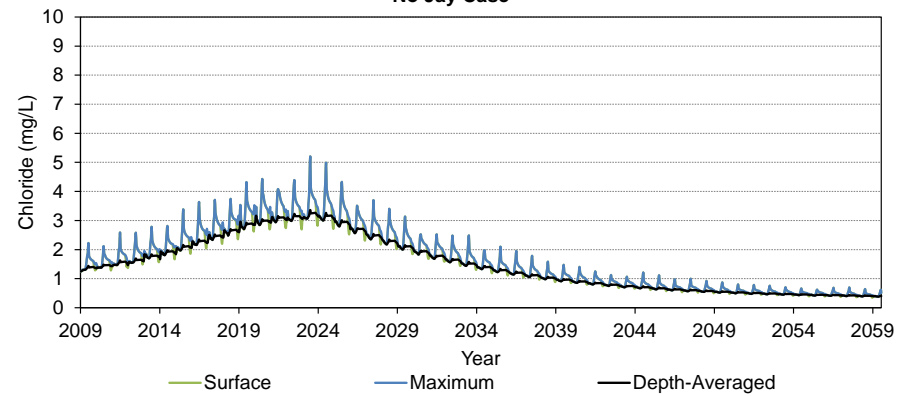
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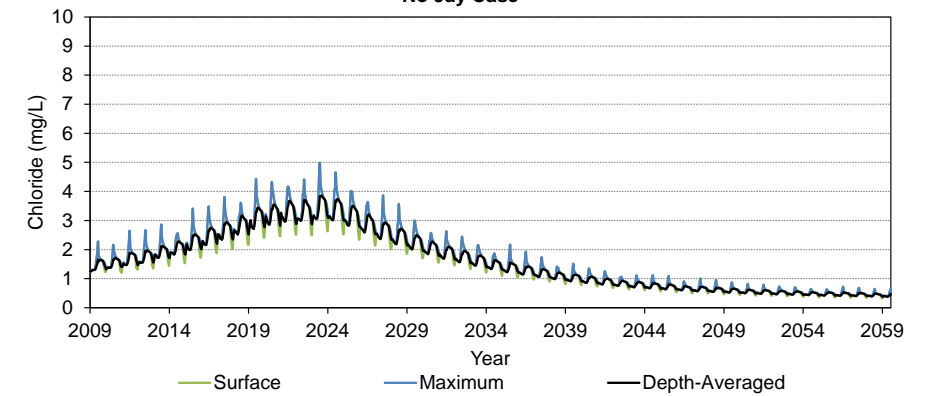
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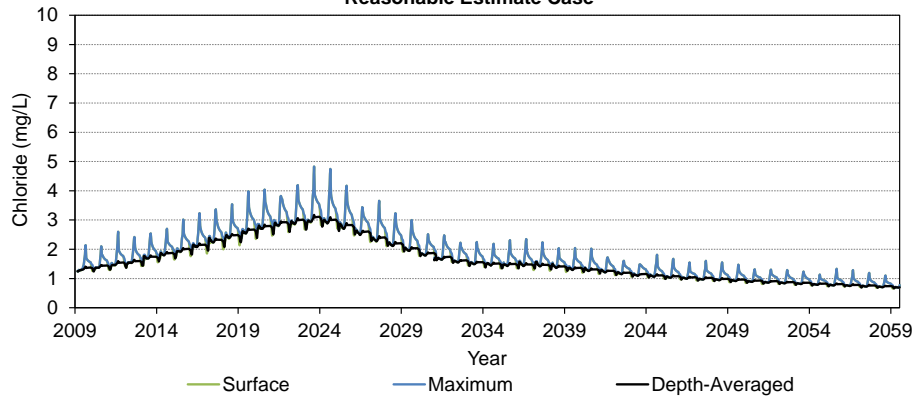
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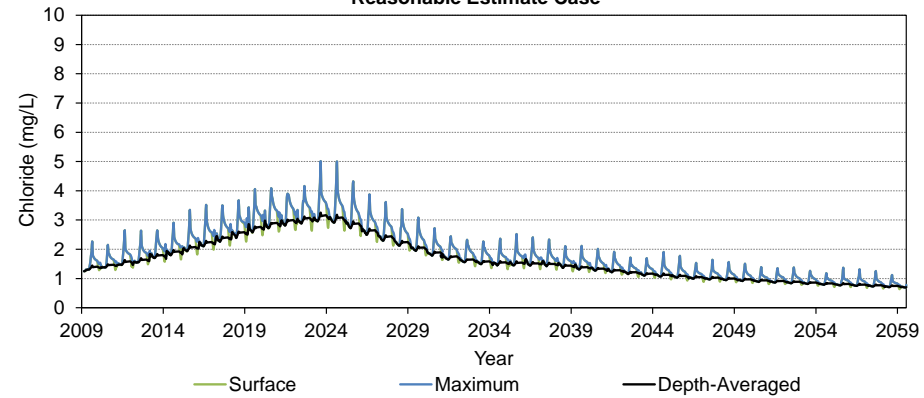
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Reasonable Estimate Case



Reasonable Estimate Case



Reasonable Estimate Case

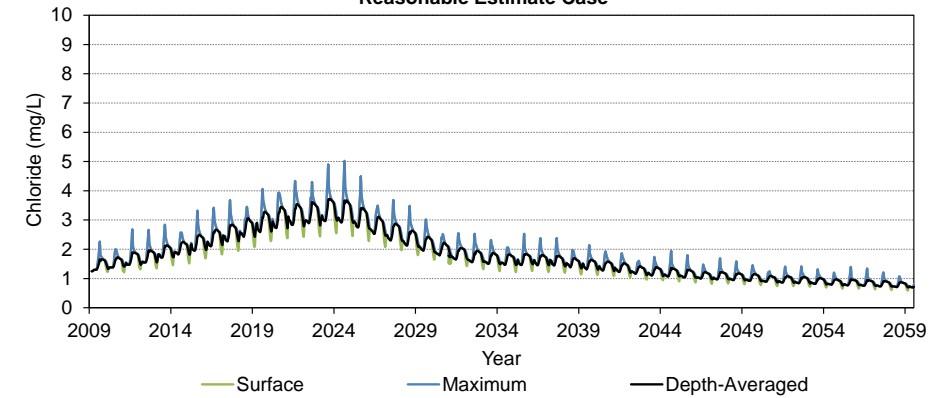
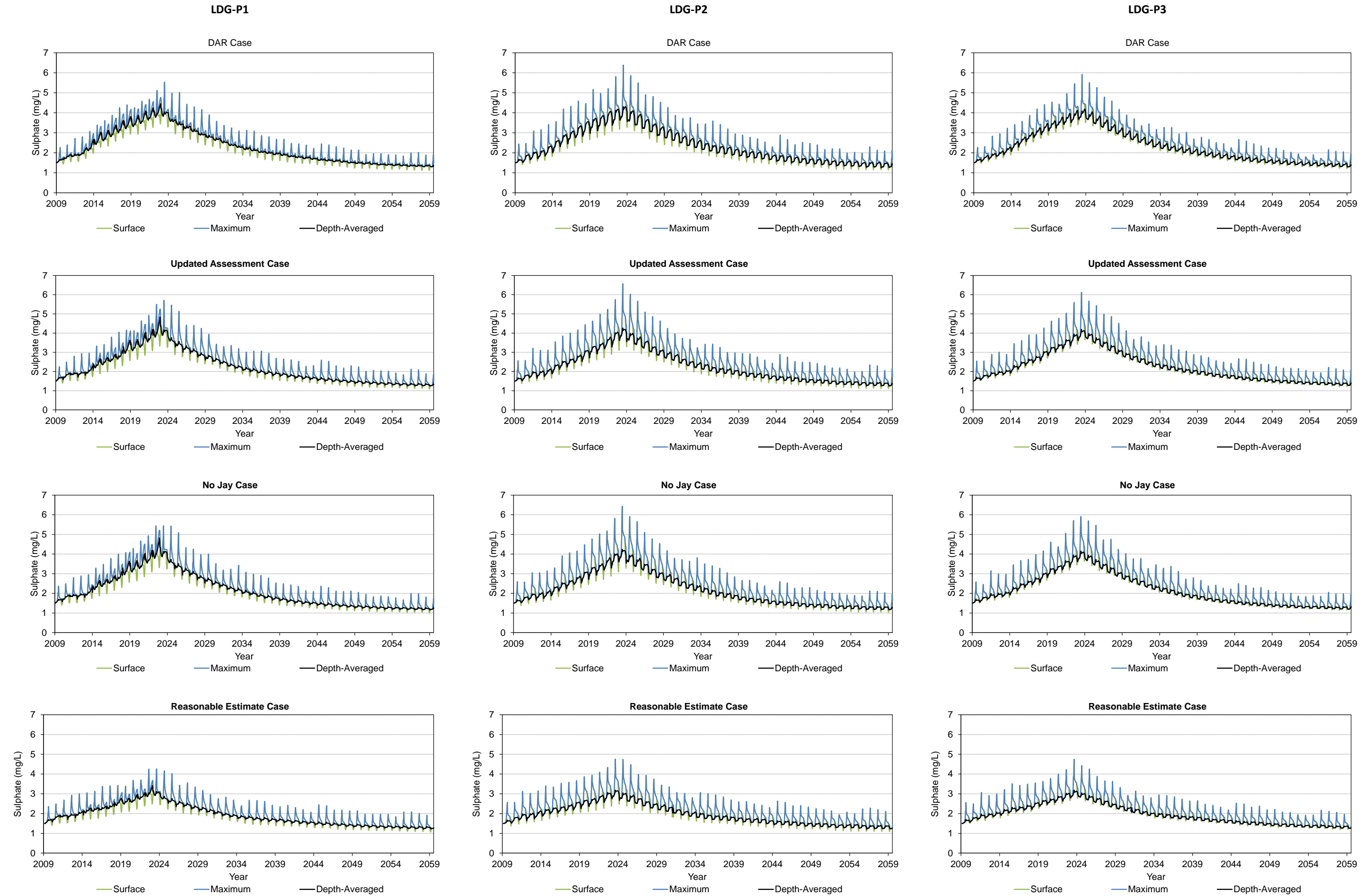
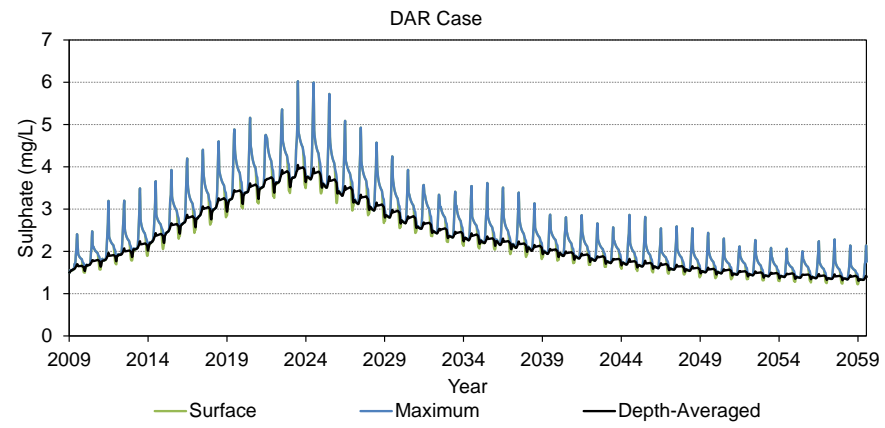


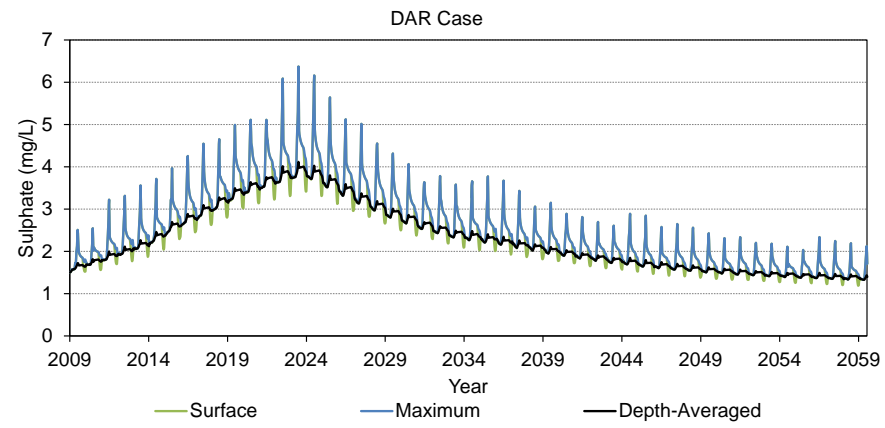
Figure B-3: Predicted Sulphate Concentrations in Lac de Gras



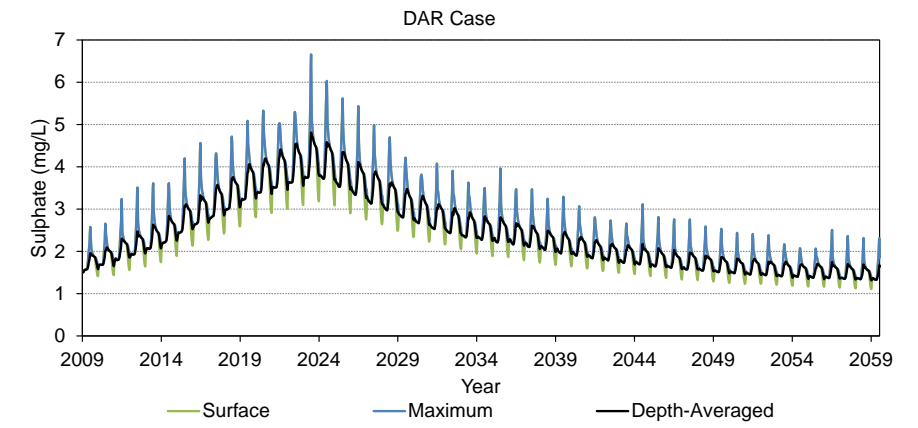
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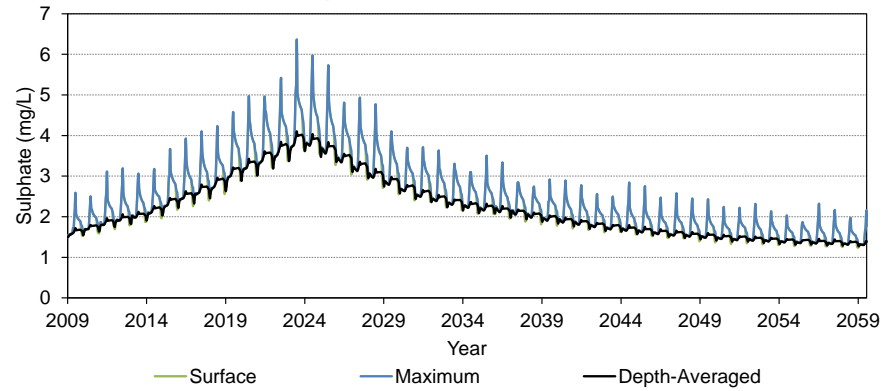
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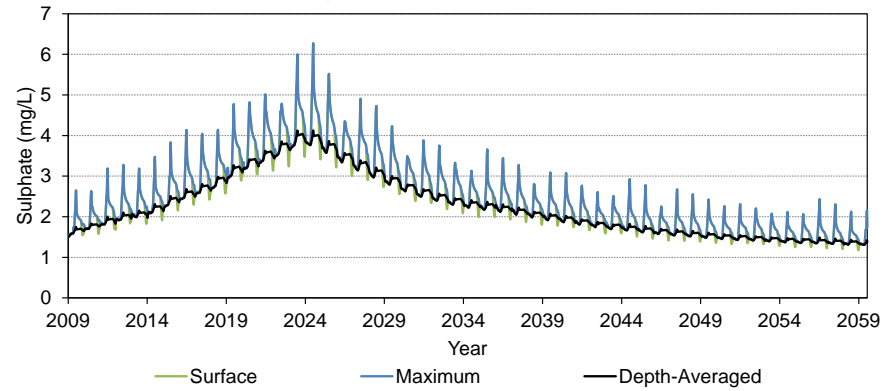
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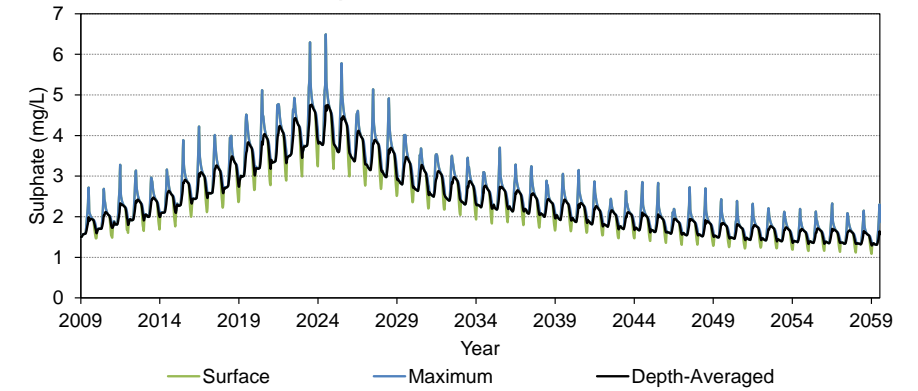
Updated Assessment Case



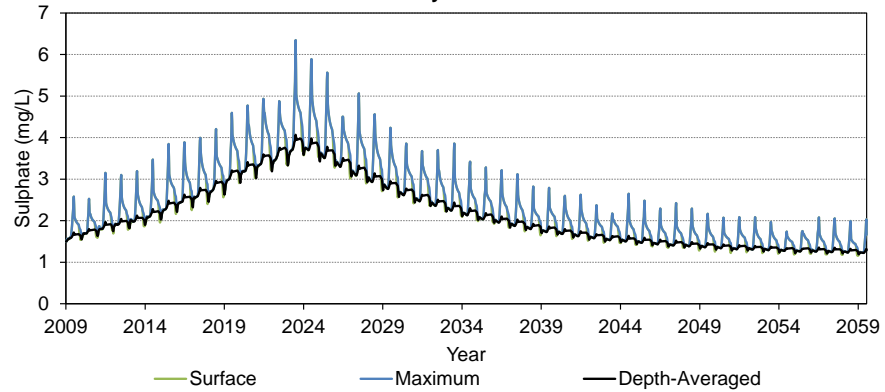
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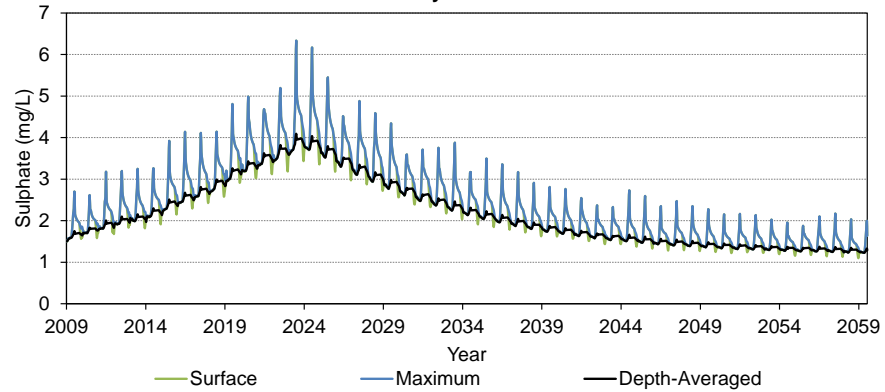
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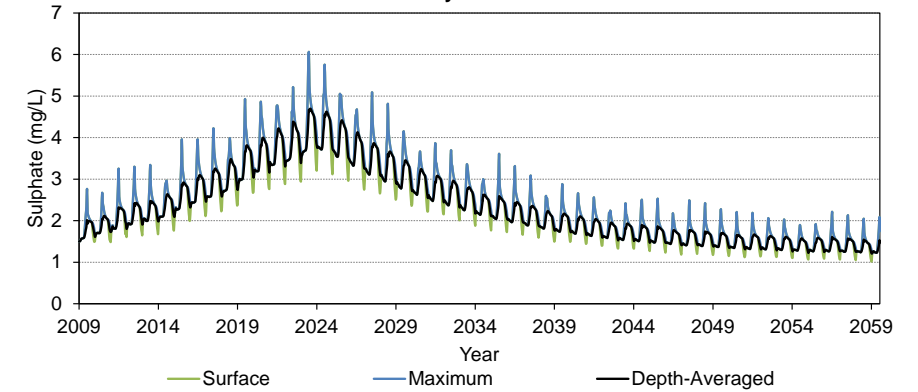
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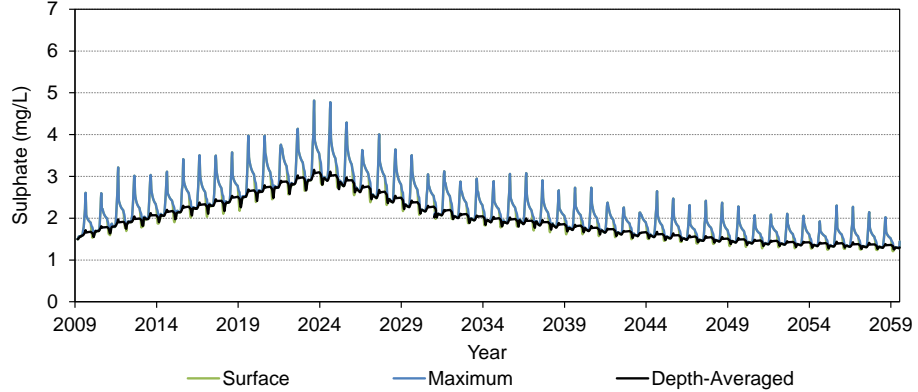
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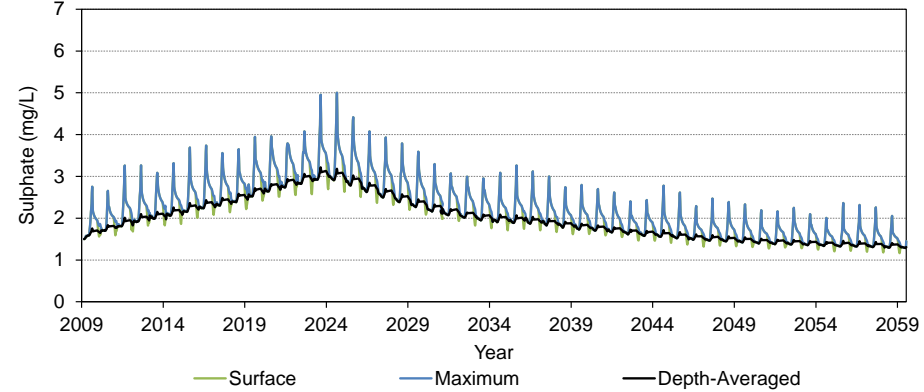
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Reasonable Estimate Case



Reasonable Estimate Case



Reasonable Estimate Case

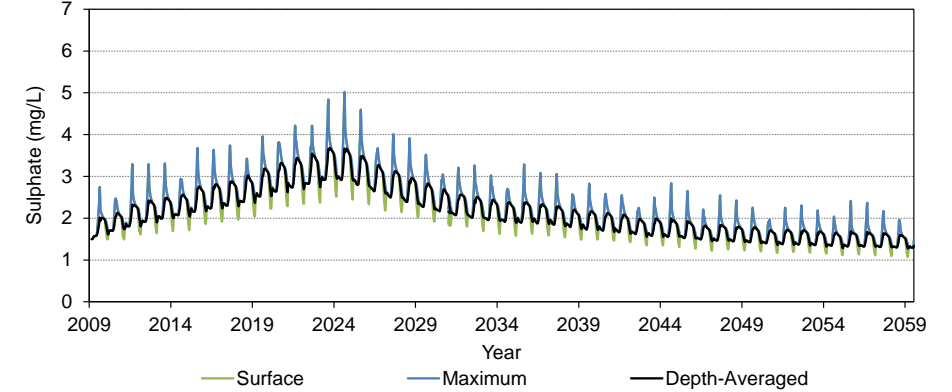
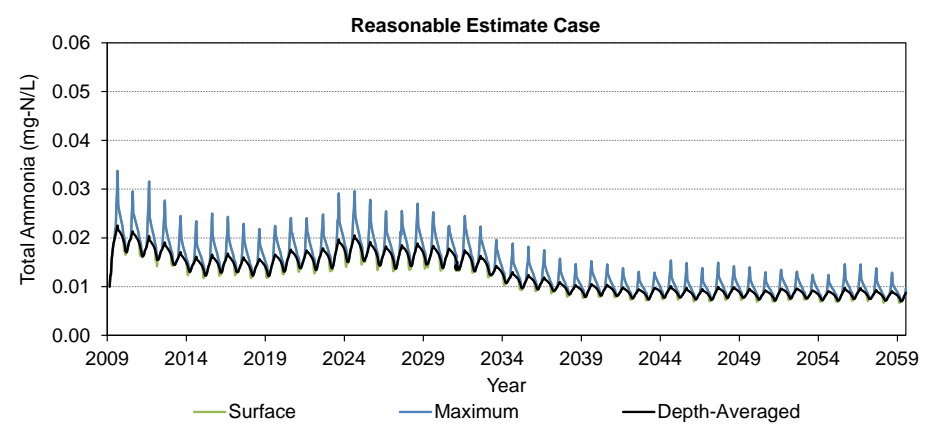
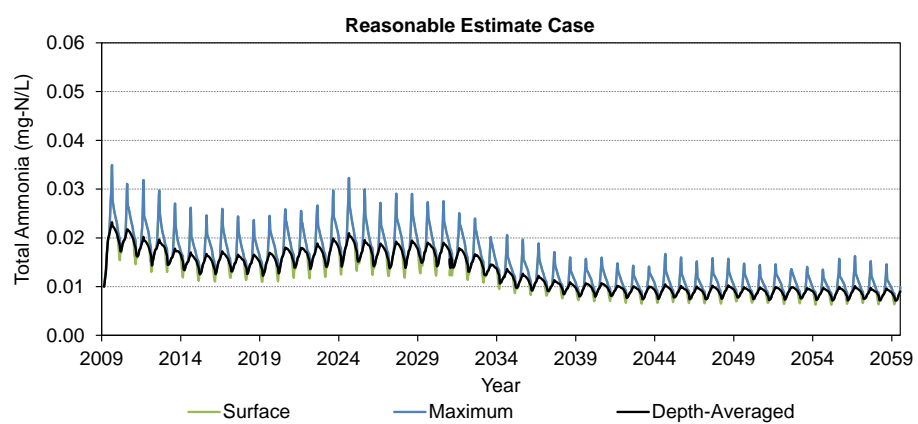
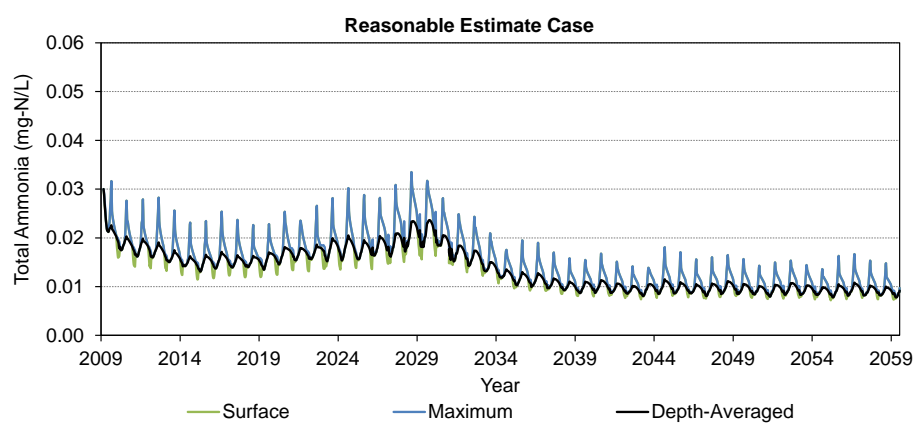
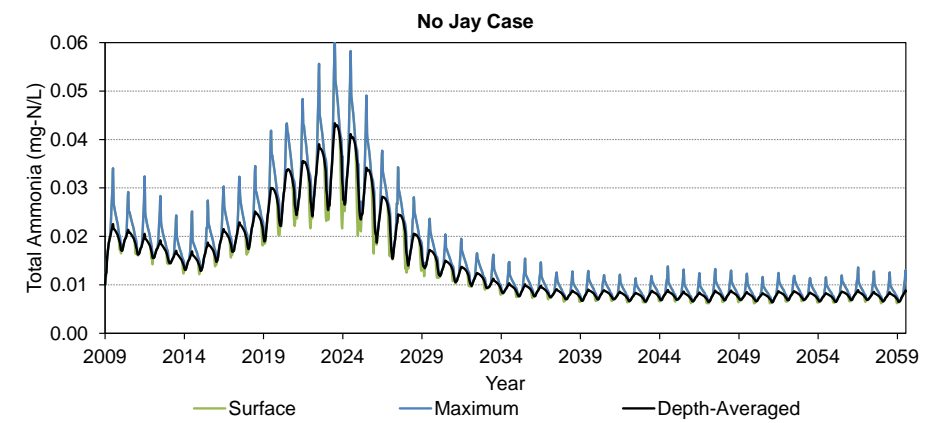
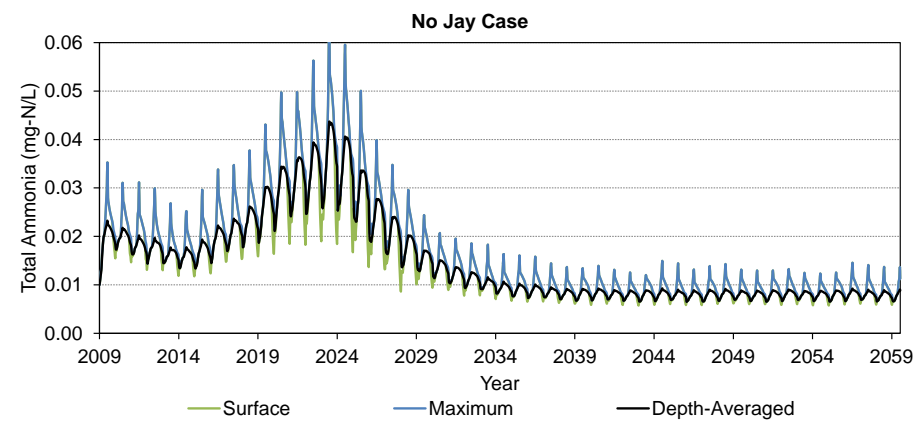
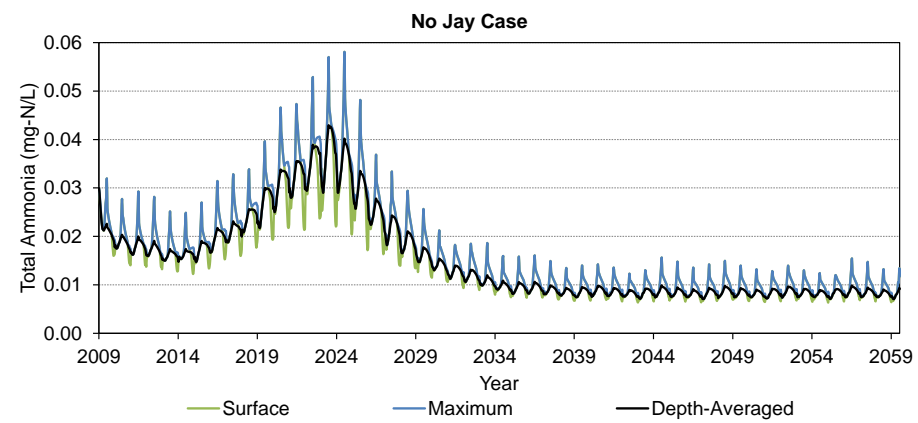
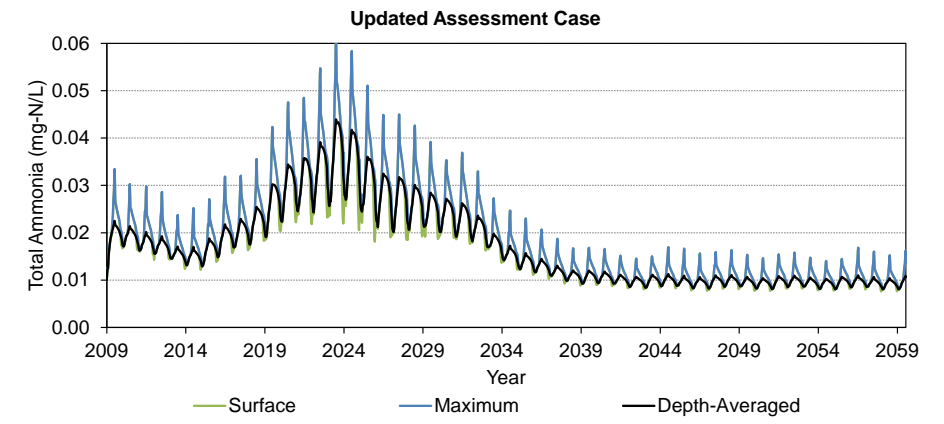
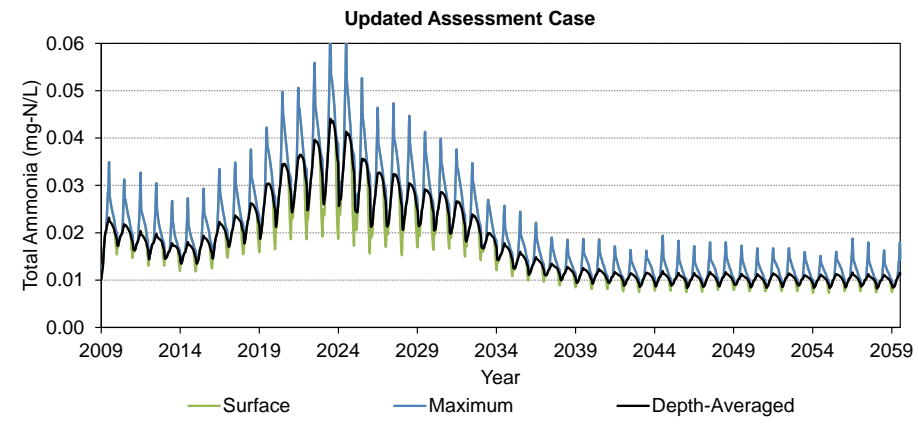
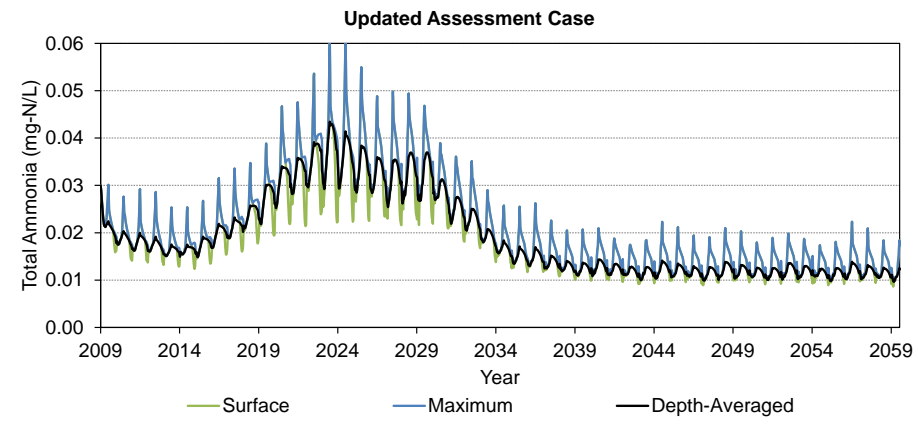
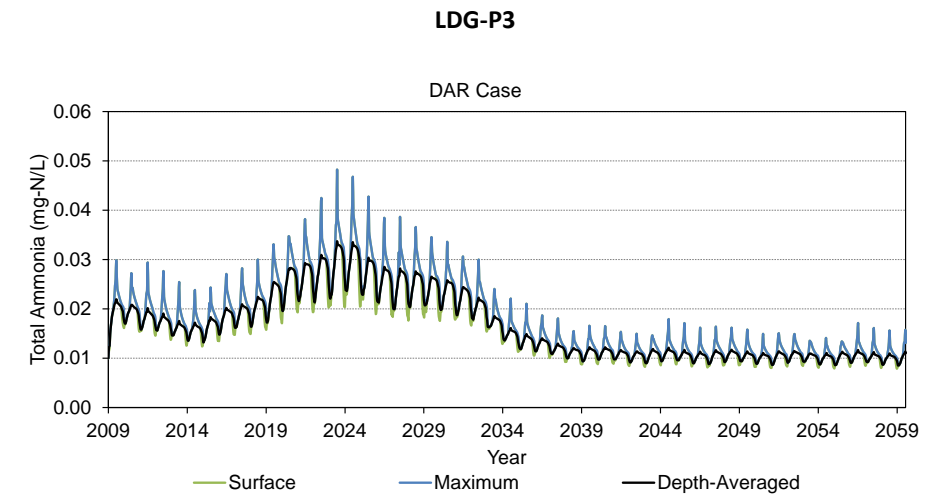
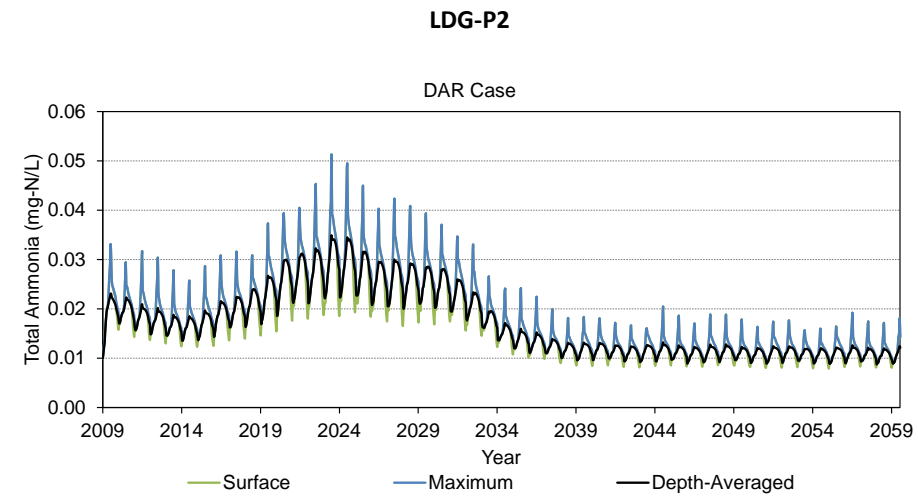
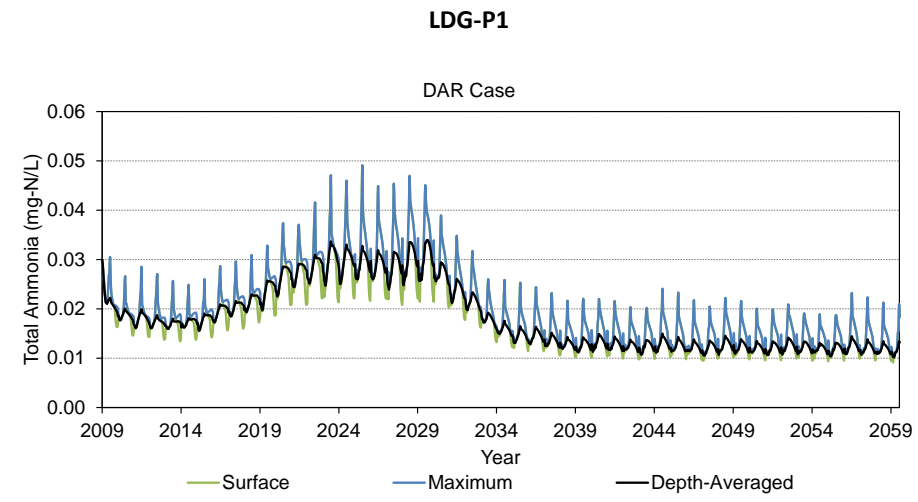
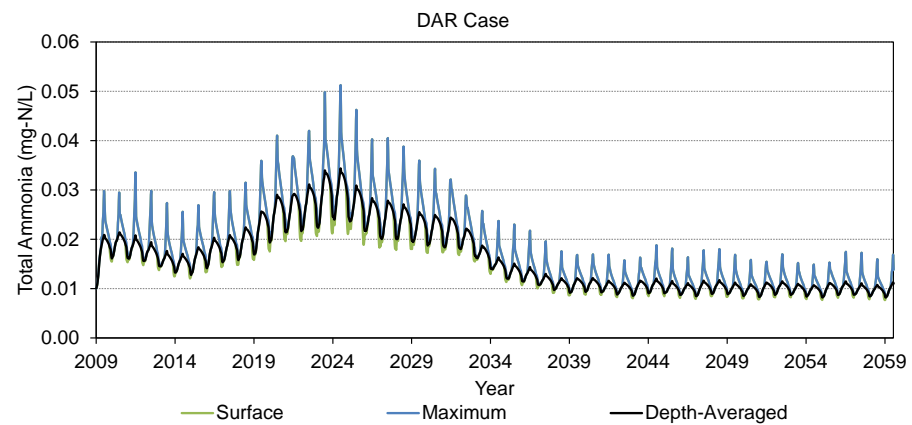


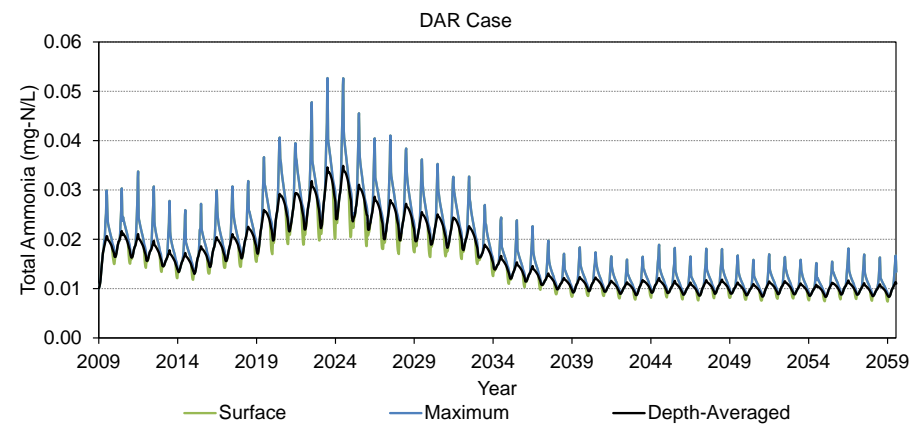
Figure B-4: Predicted Total Ammonia Concentrations in Lac de Gras



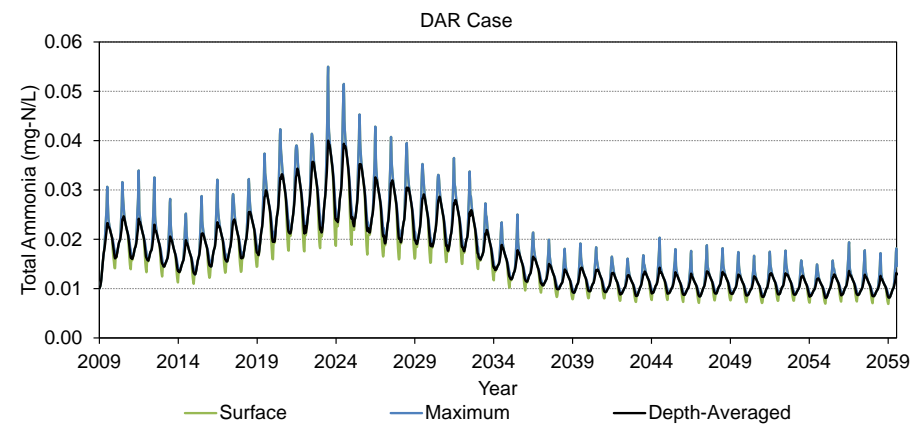
LDG-P4



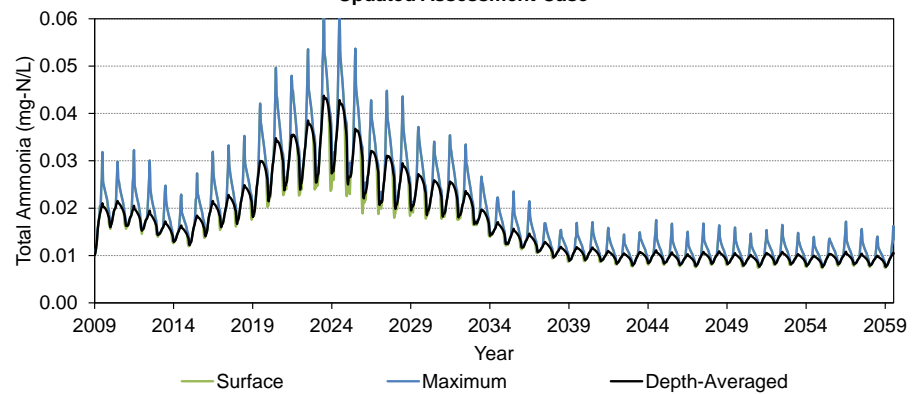
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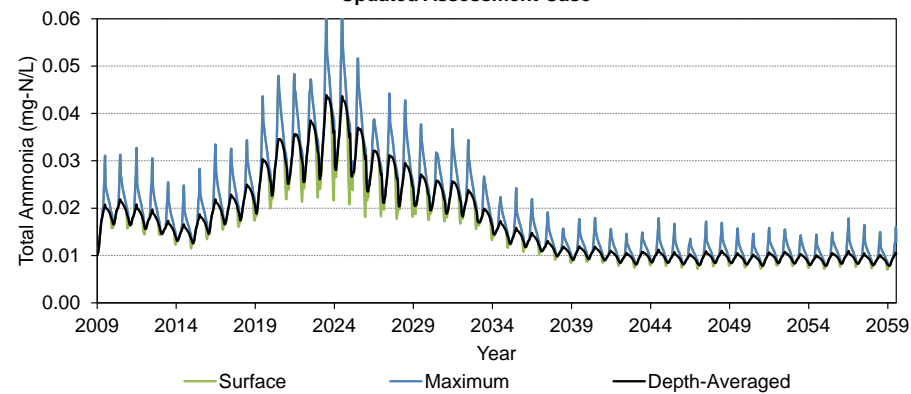
LDG-P6



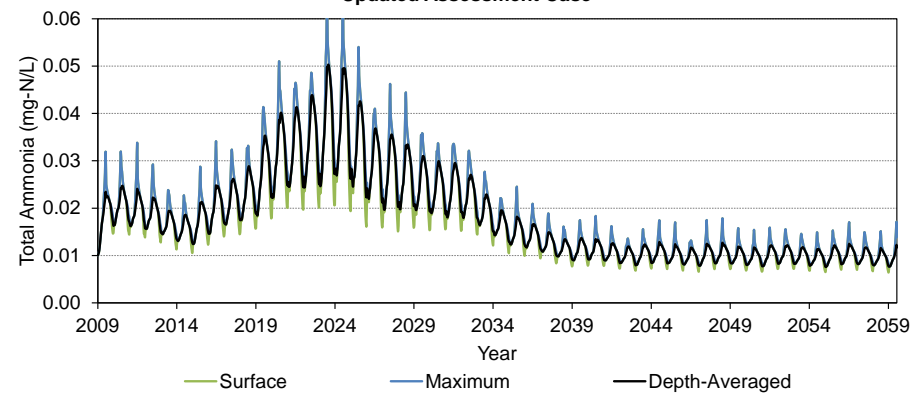
Updated Assessment Case



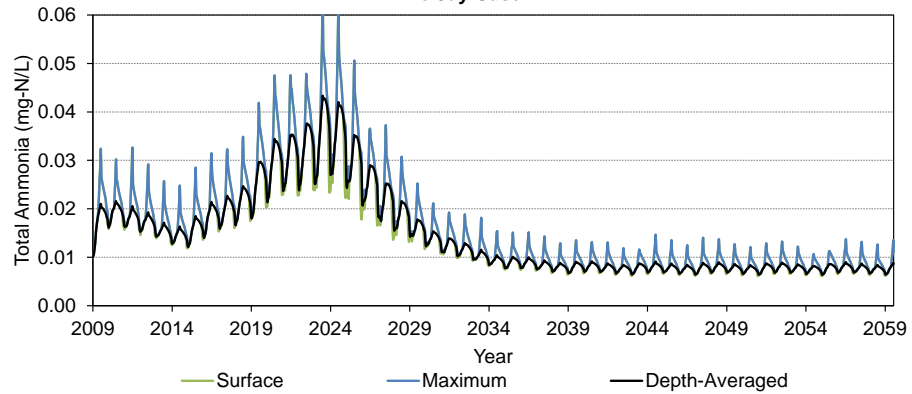
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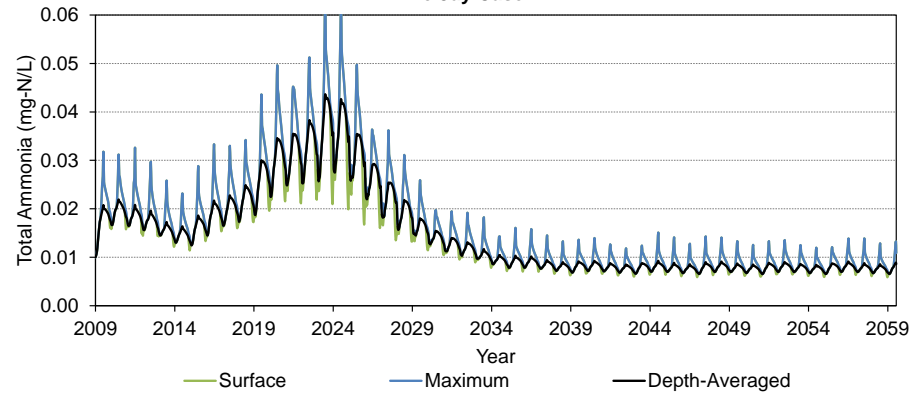
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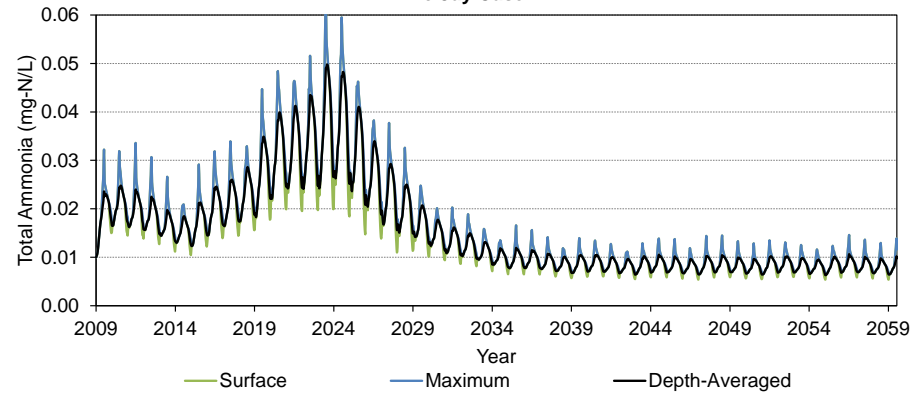
No Jay Case



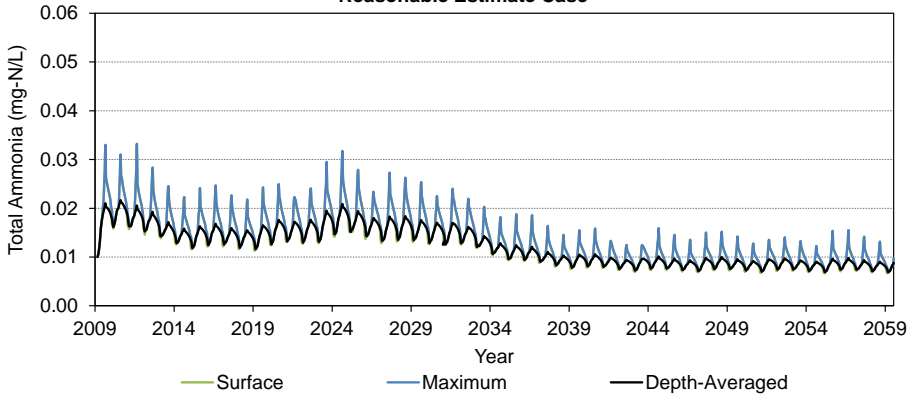
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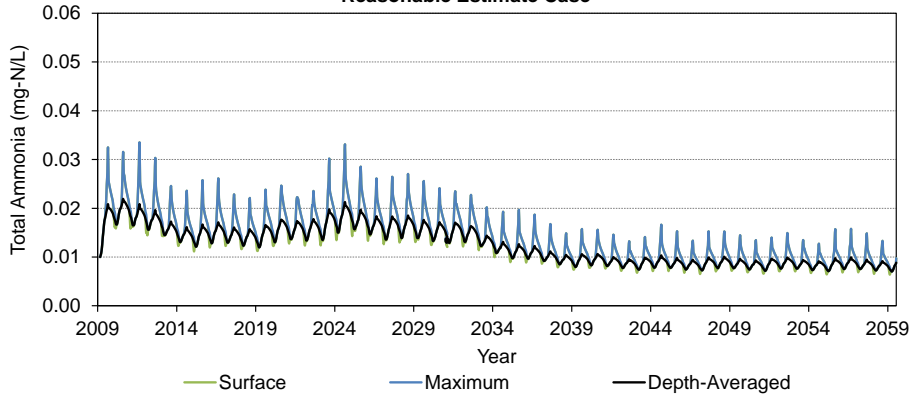
No Jay Case



Reasonable Estimate Case



Reasonable Estimate Case



Reasonable Estimate Case

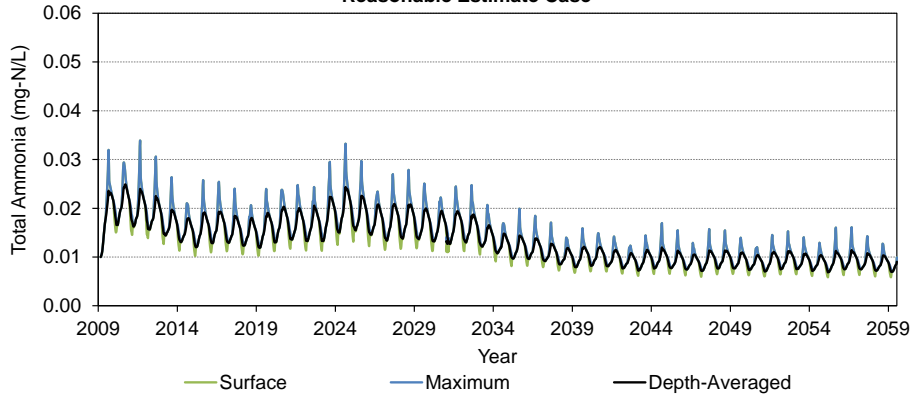
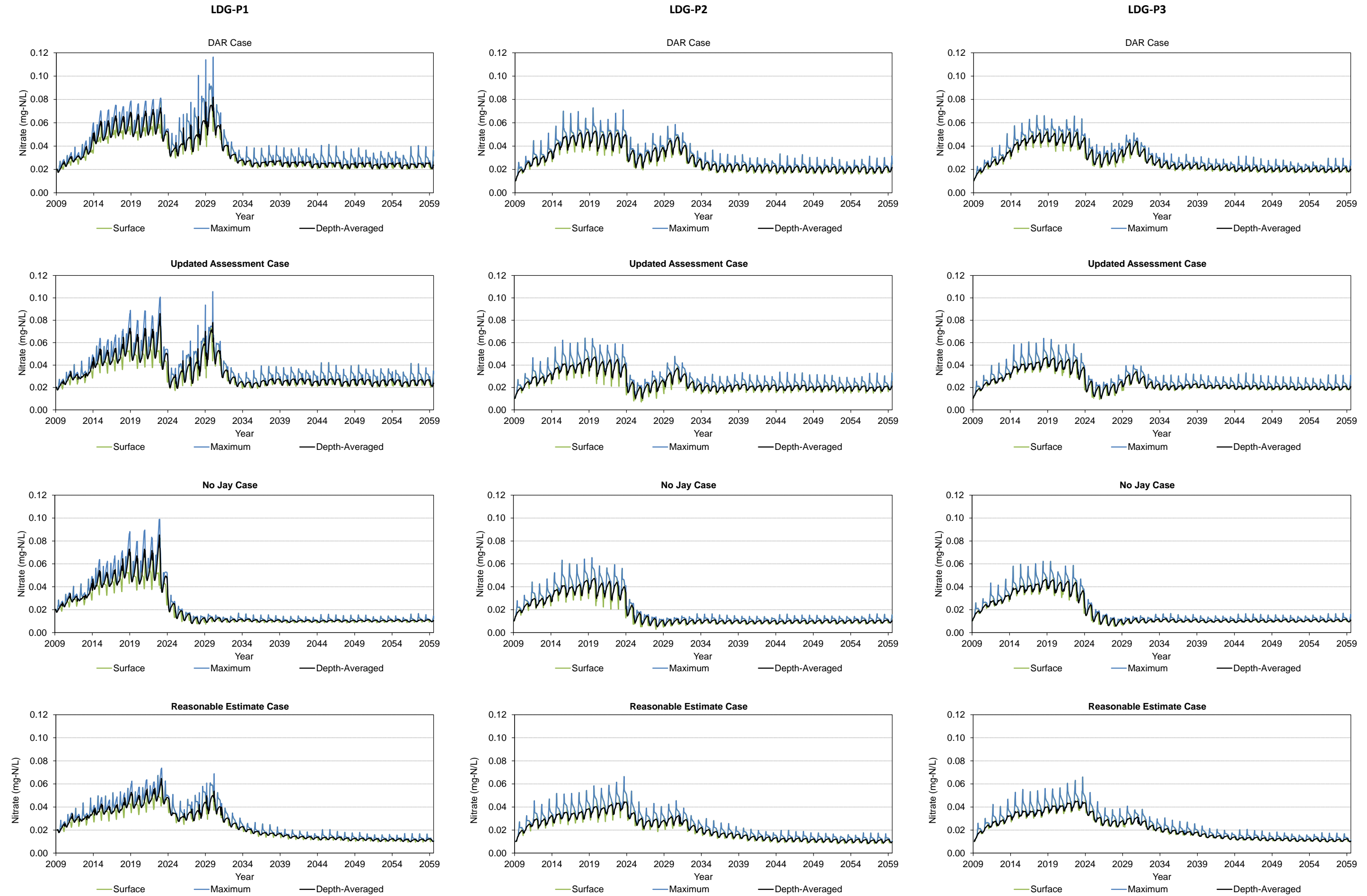


Figure B-5: Predicted Nitrate Concentrations in Lac de Gras



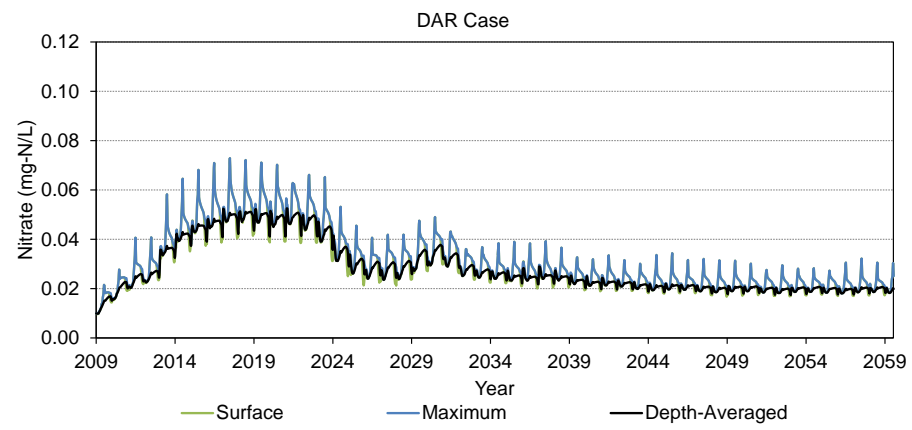
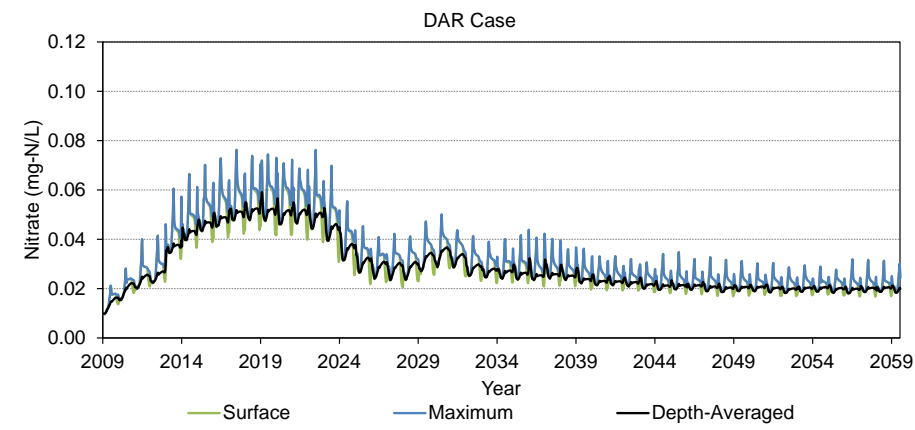
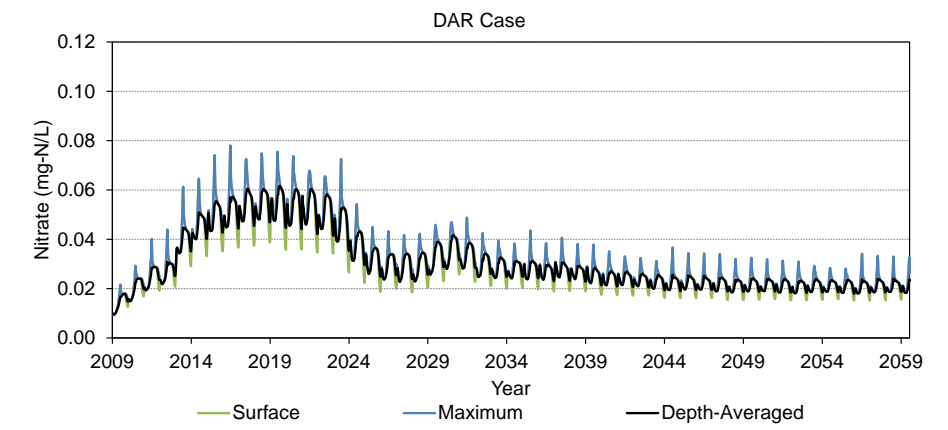
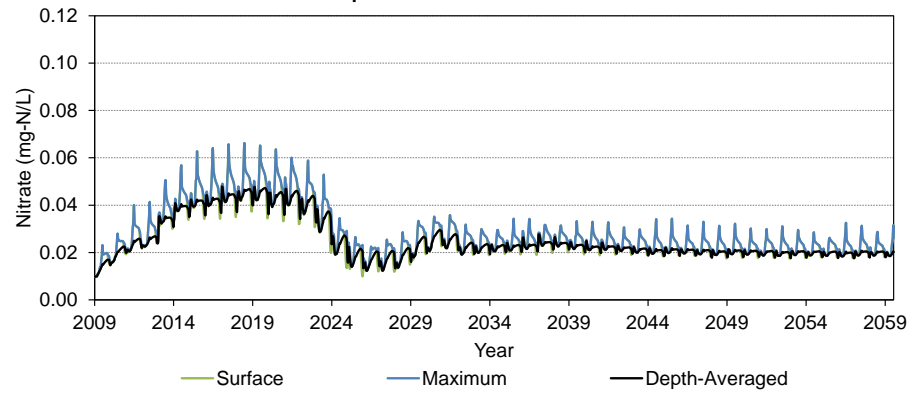
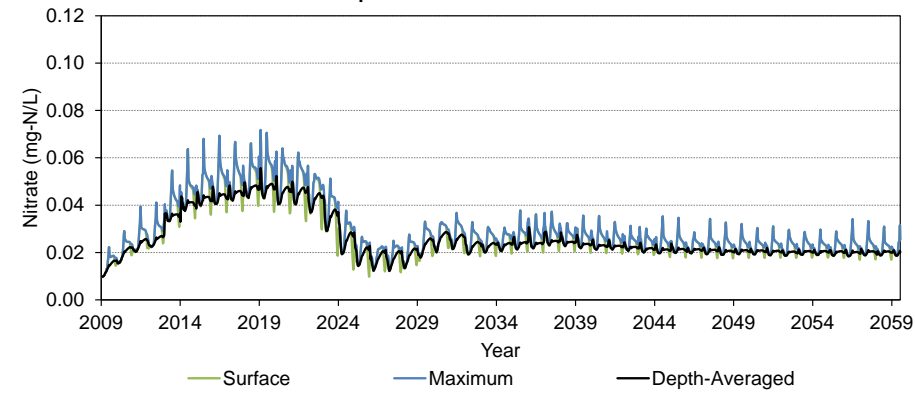
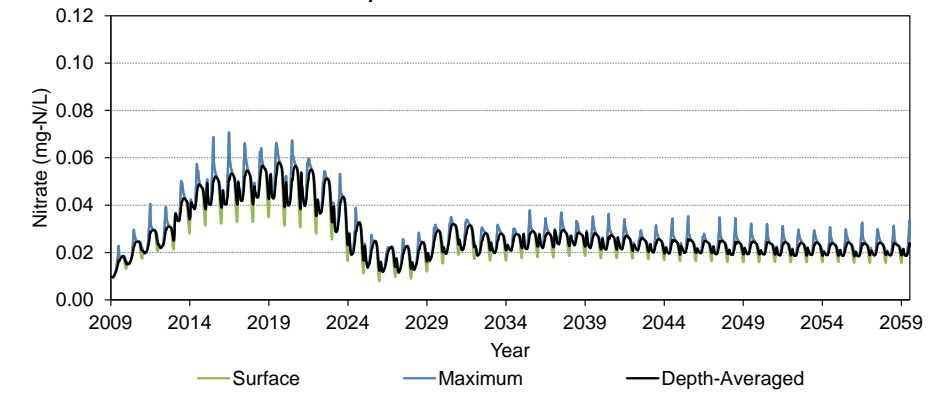
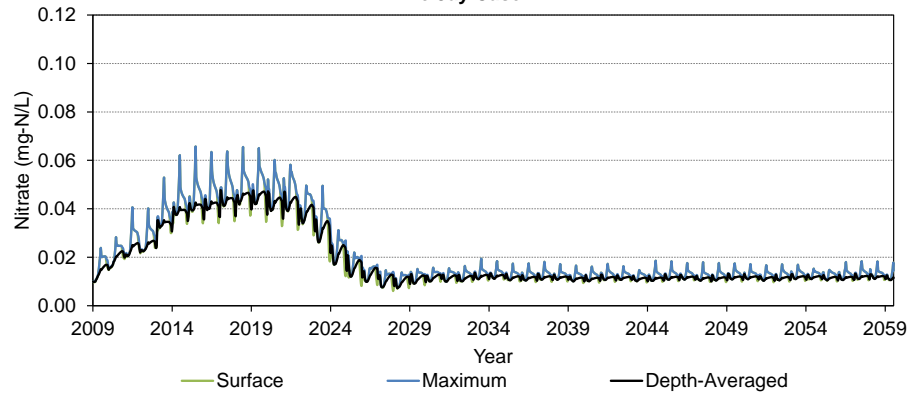
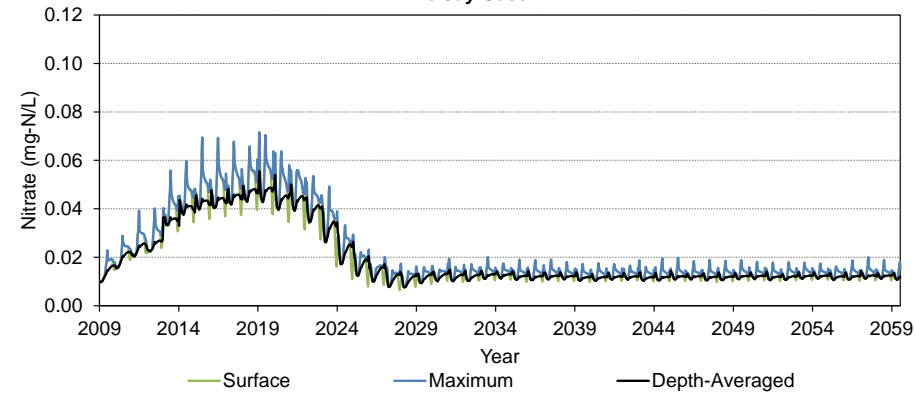
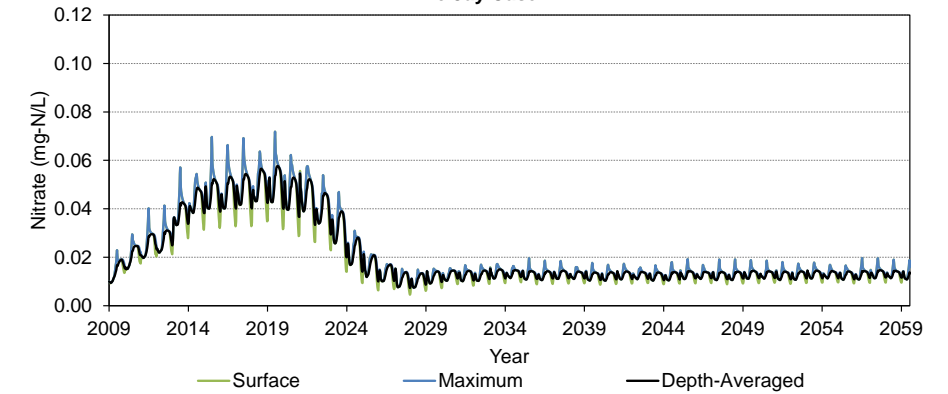
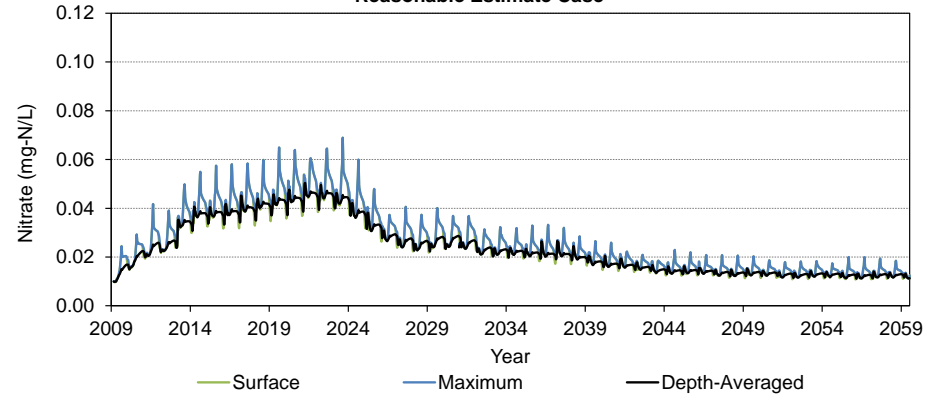
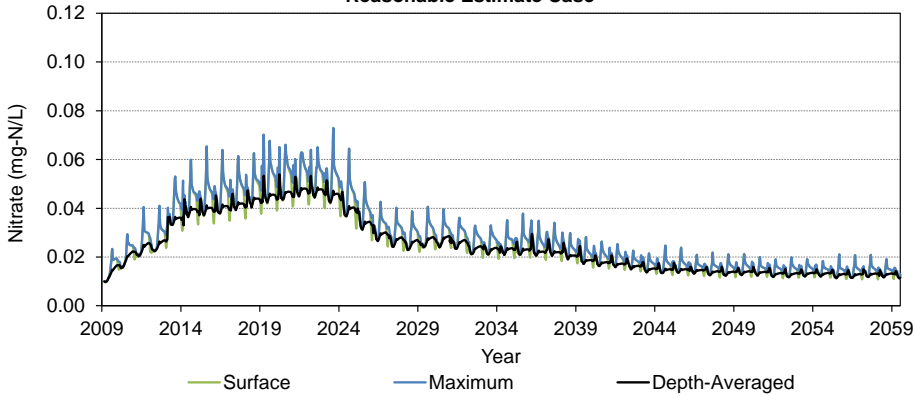
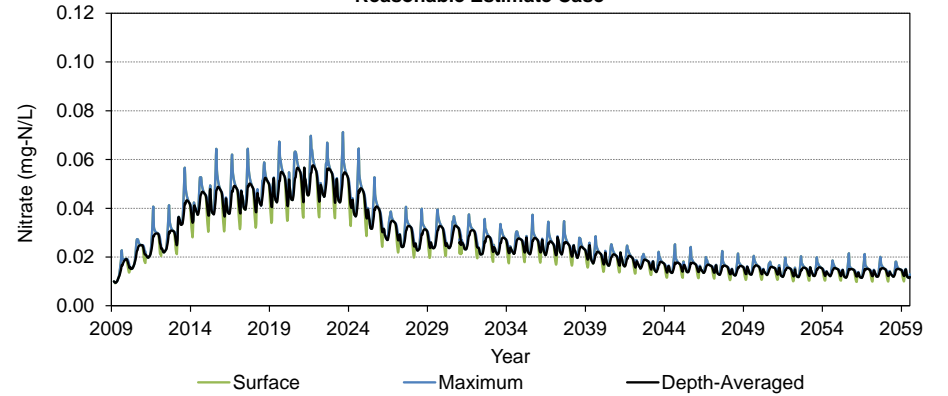
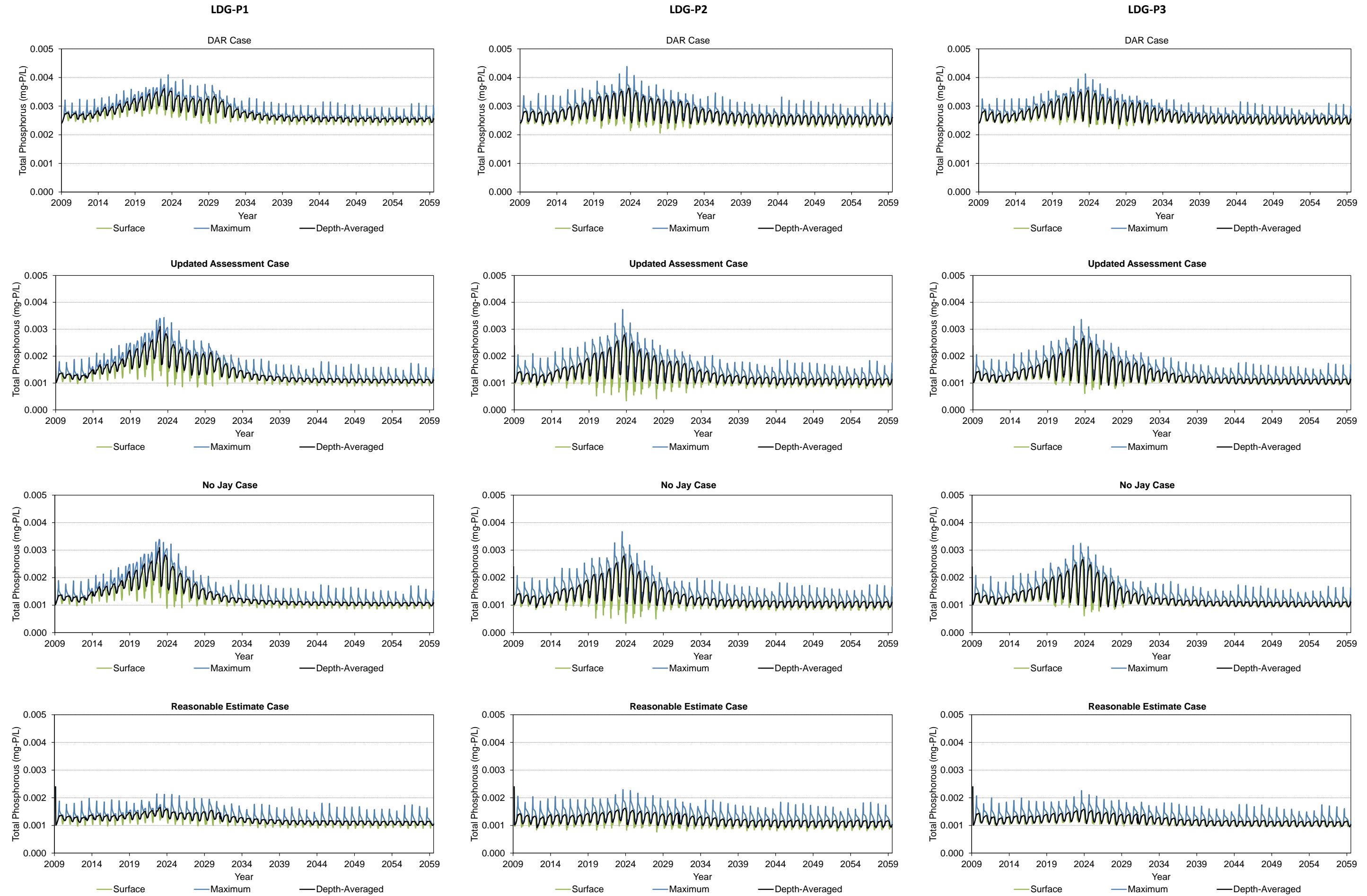
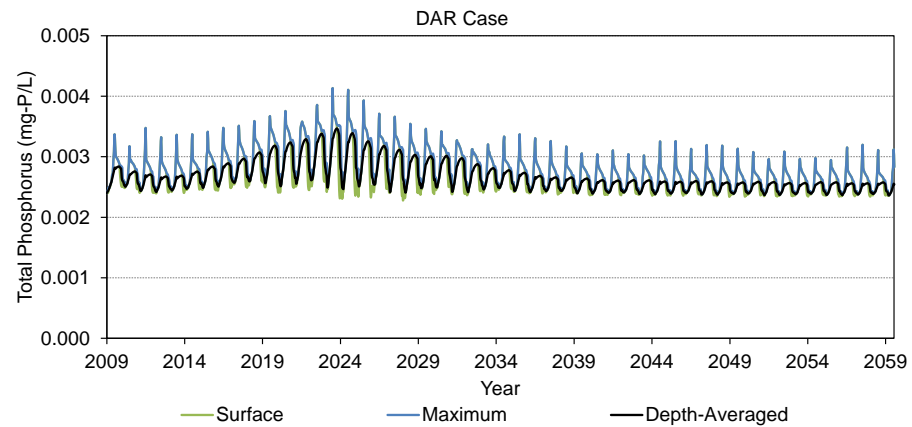
LDG-P4**LDG-P5****LDG-P6****Updated Assessment Case****Updated Assessment Case****Updated Assessment Case****No Jay Case****No Jay Case****No Jay Case****Reasonable Estimate Case****Reasonable Estimate Case****Reasonable Estimate Case**

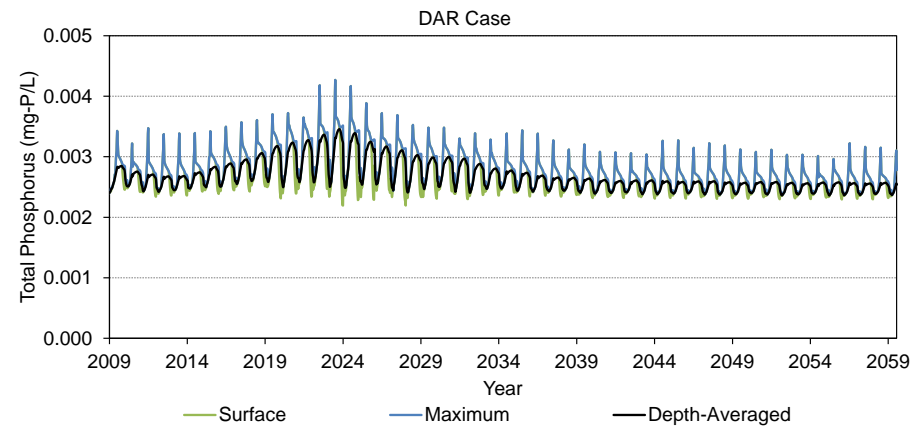
Figure B-6: Predicted Total Phosphorus Concentrations in Lac de Gras



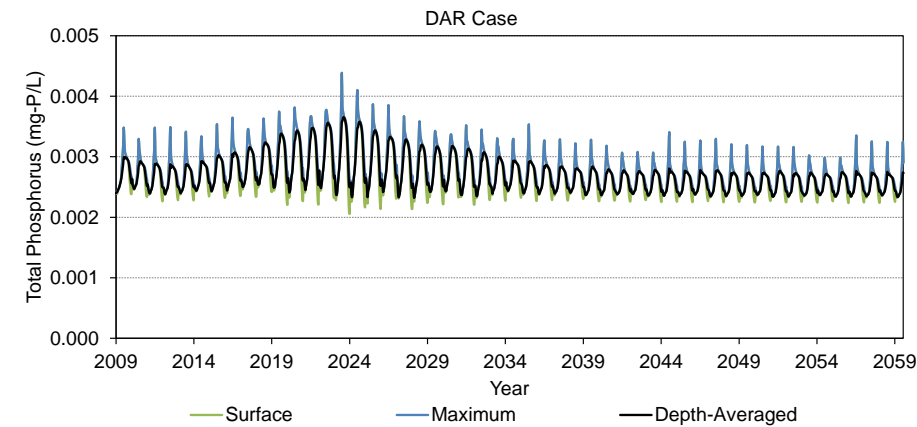
LDG-P4



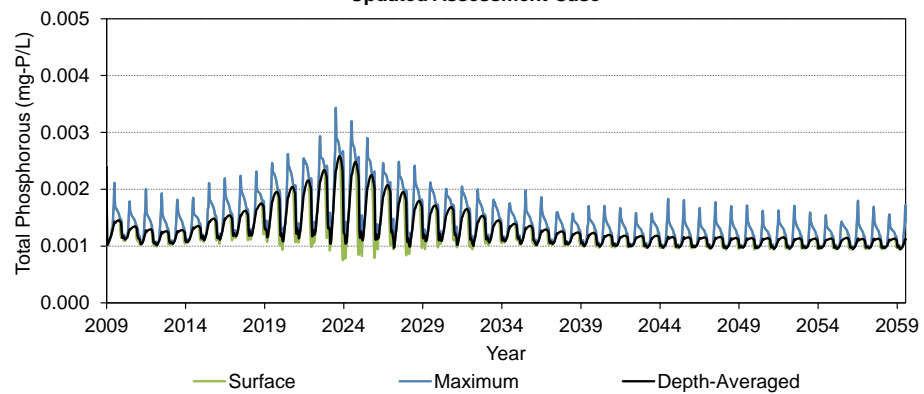
LDG-P5



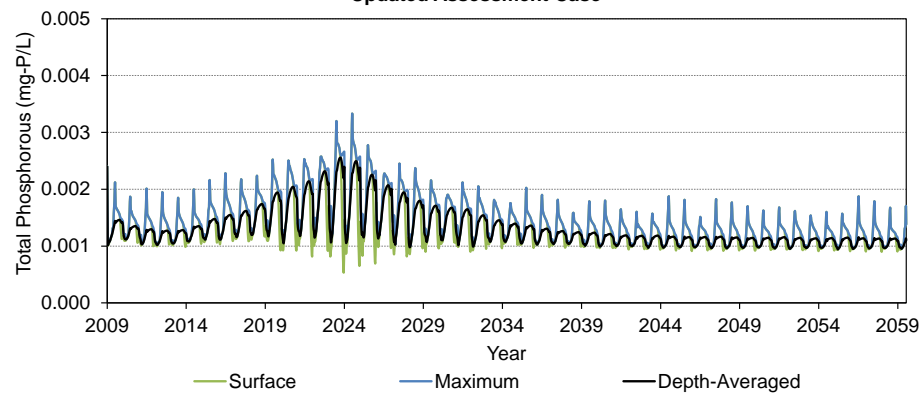
LDG-P6



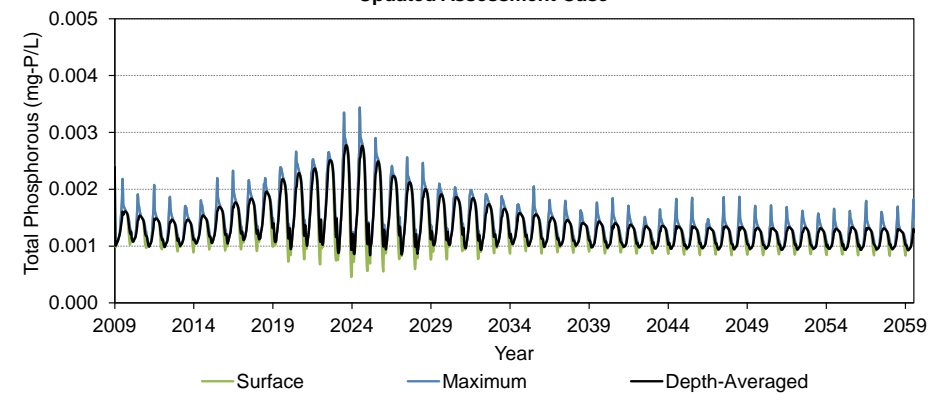
Updated Assessment Case



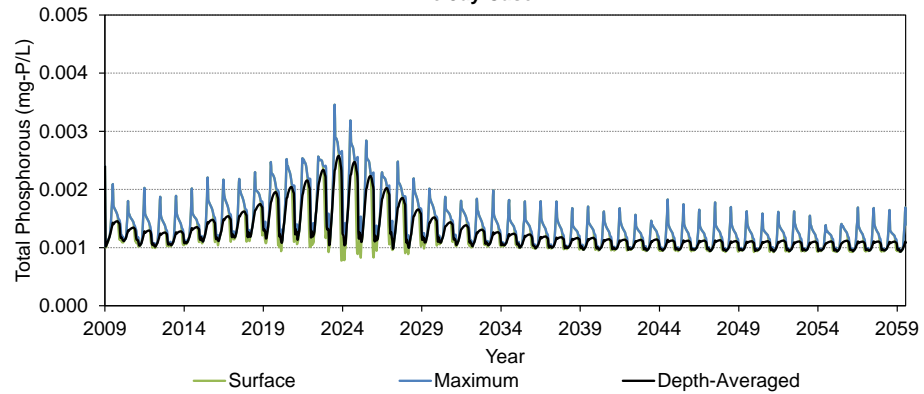
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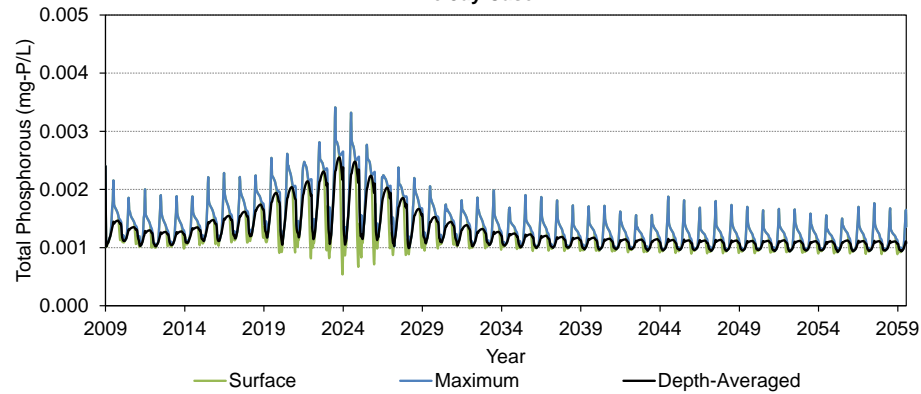
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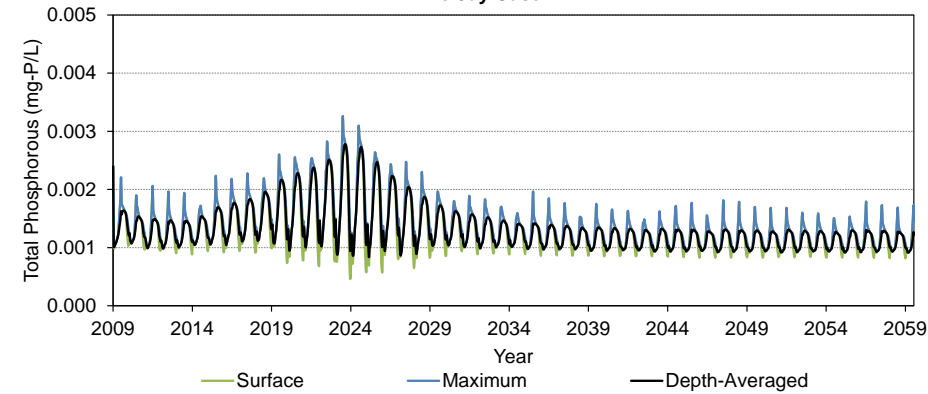
No Jay Case



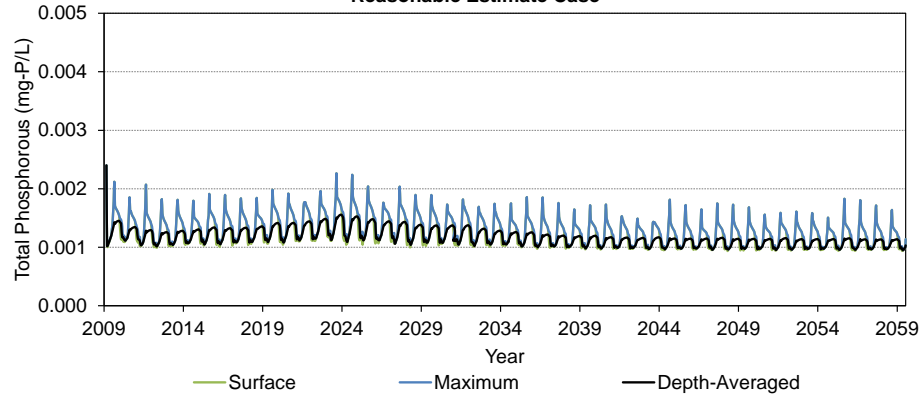
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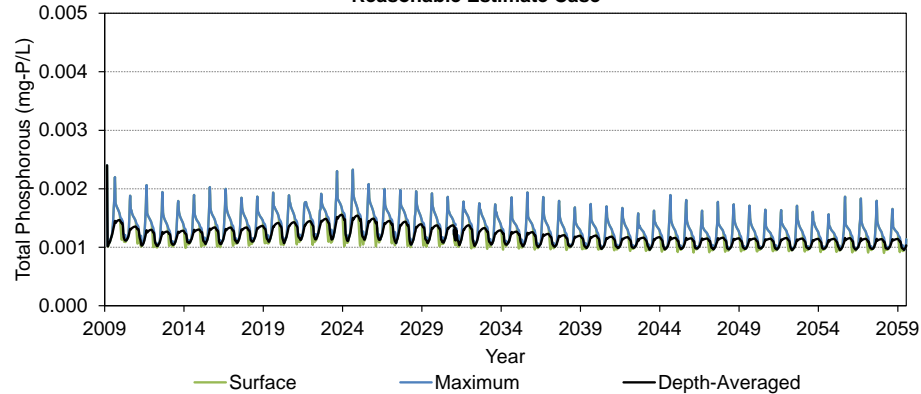
No Jay Case



Reasonable Estimate Case



Reasonable Estimate Case



Reasonable Estimate Case

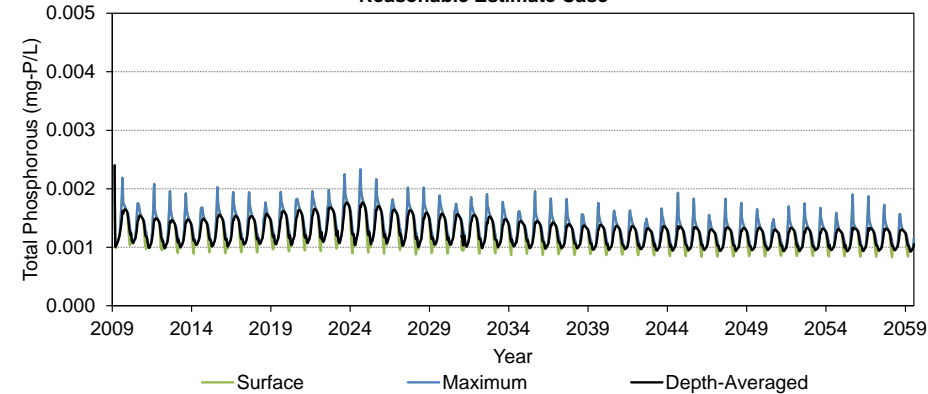
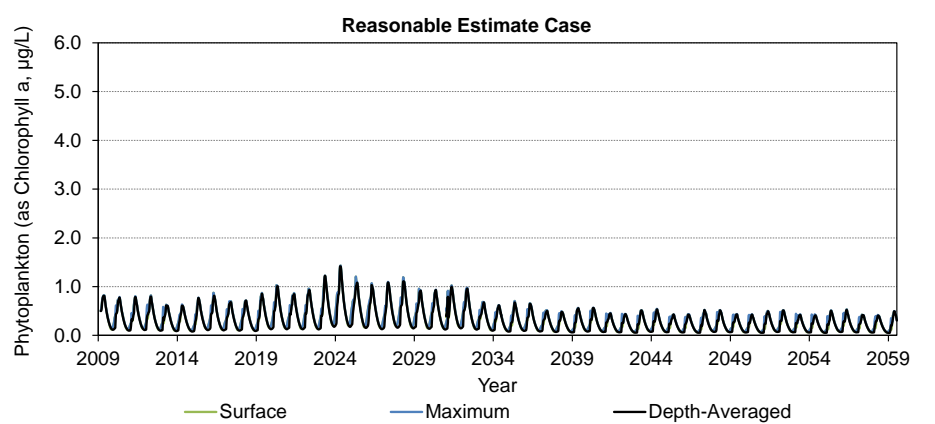
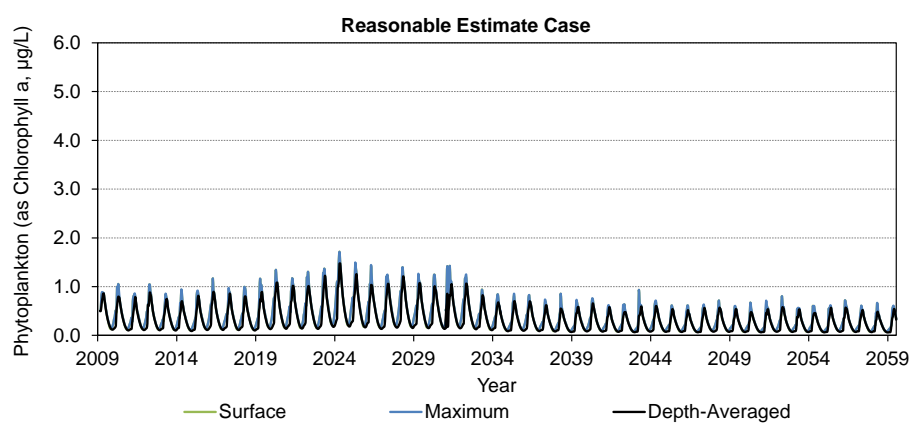
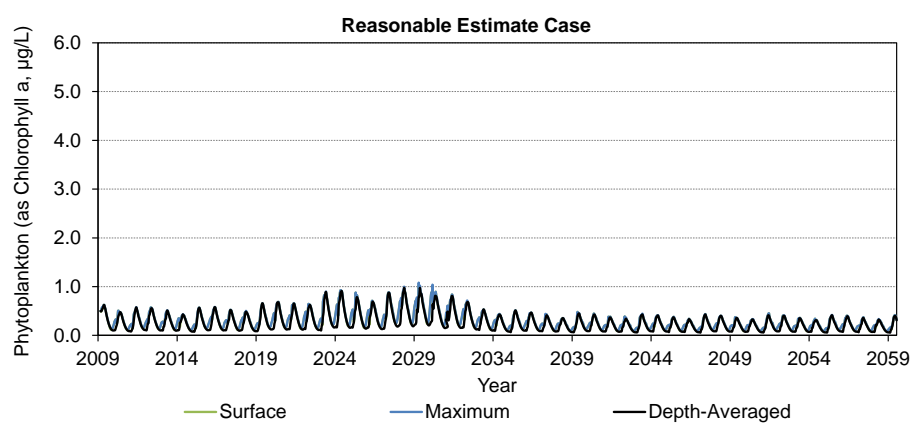
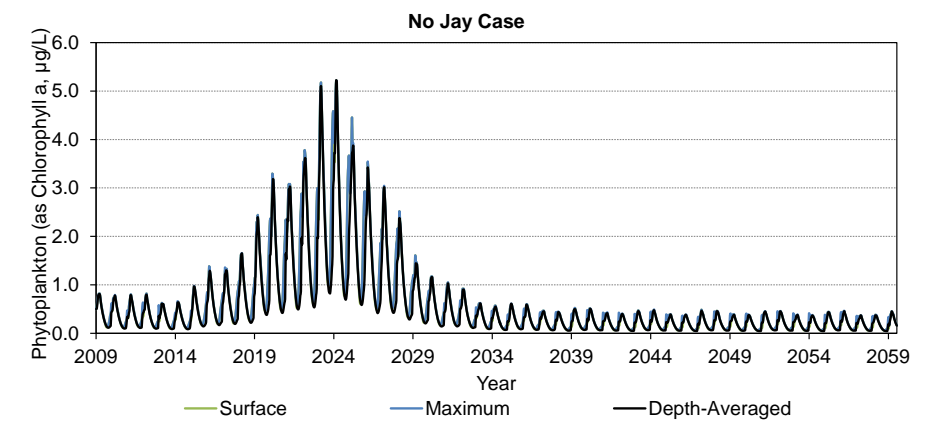
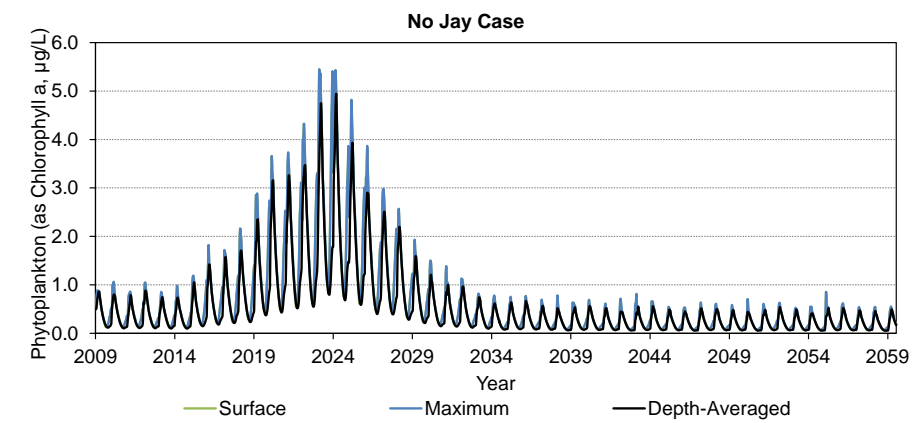
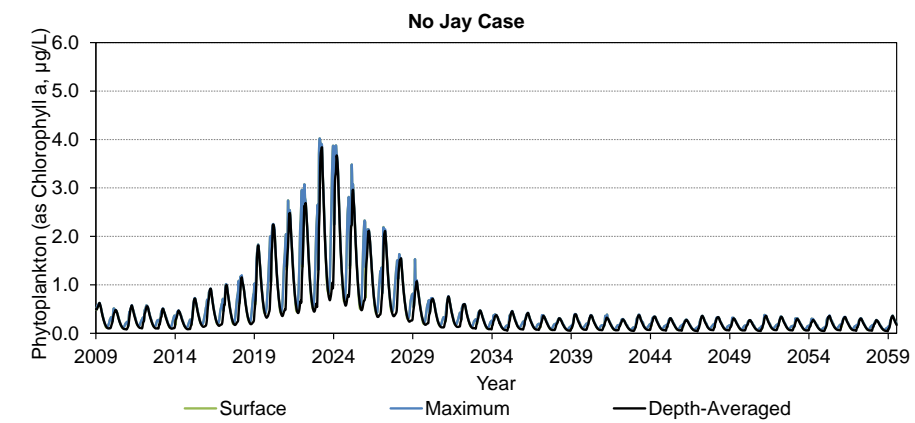
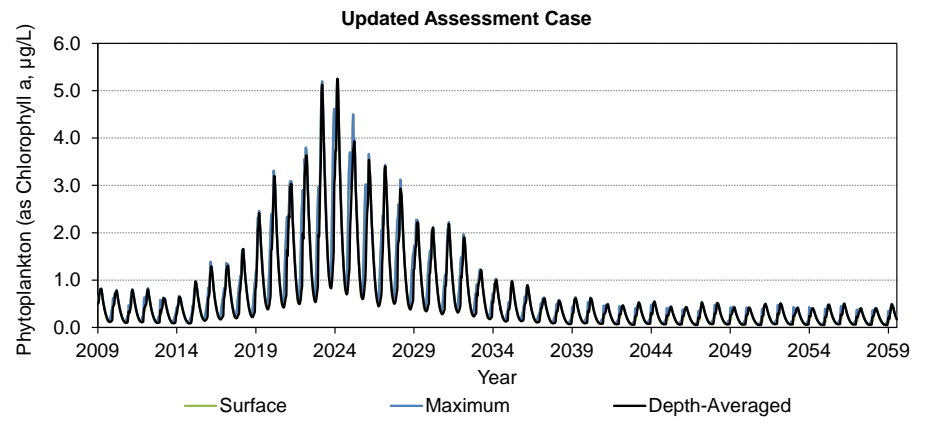
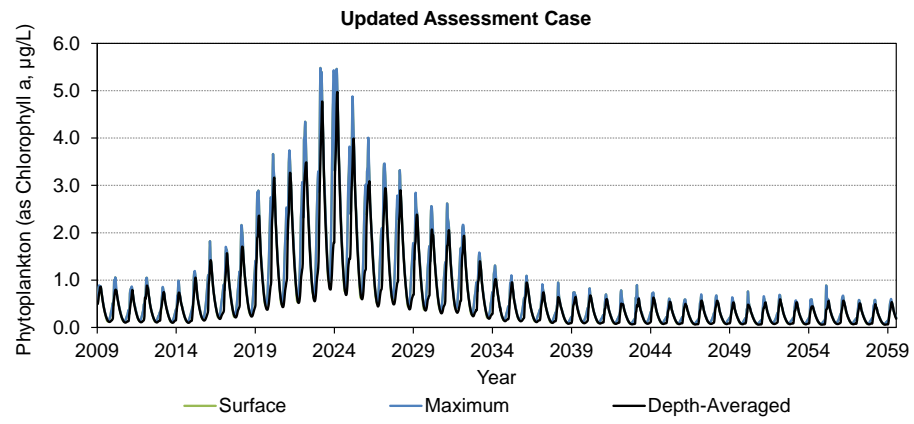
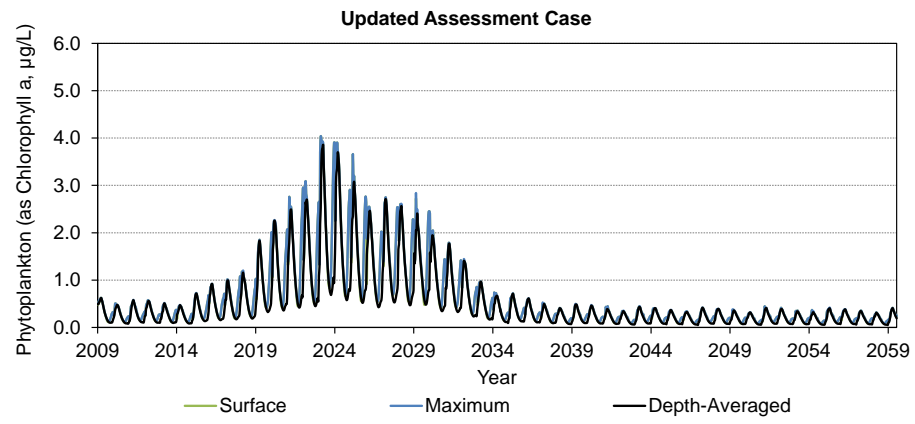
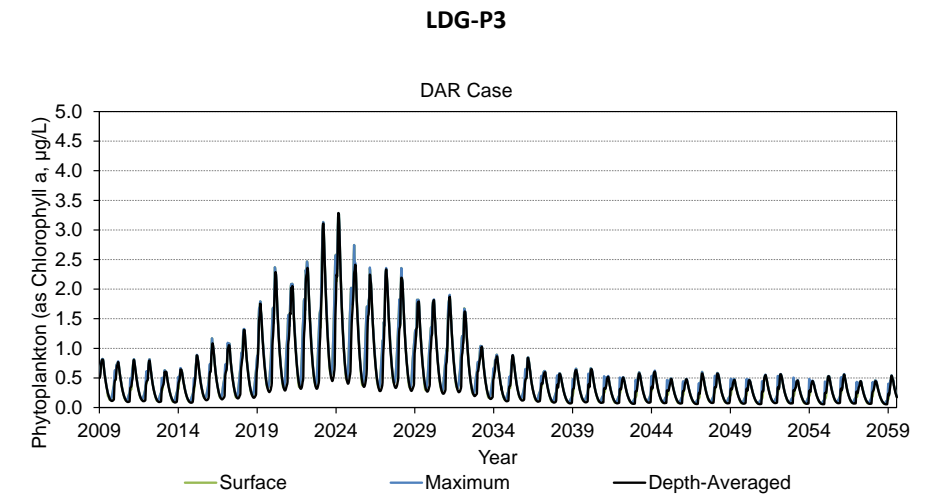
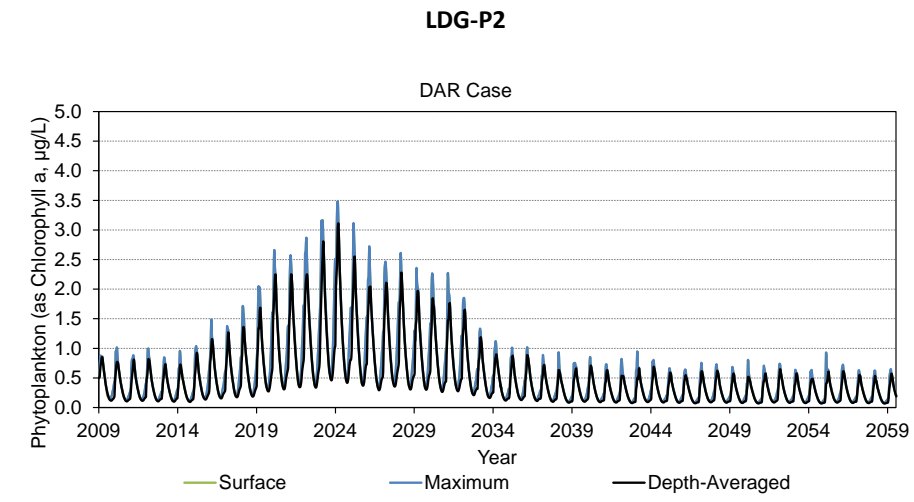
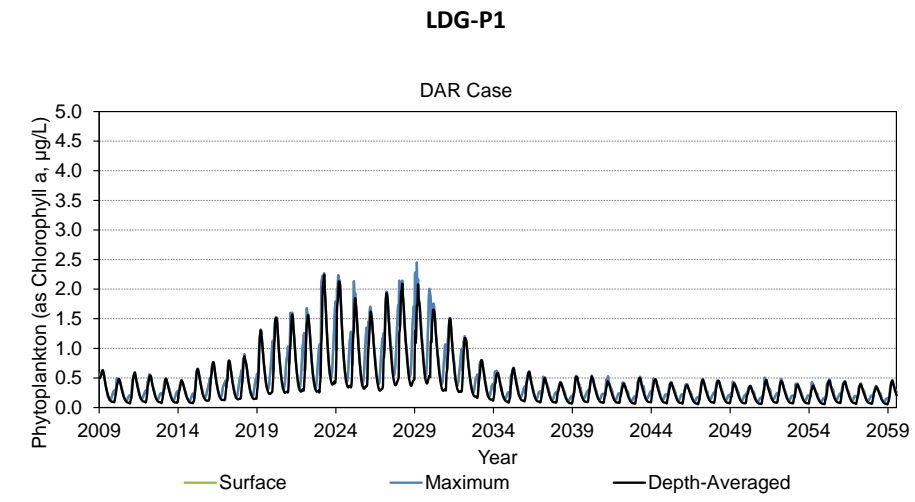
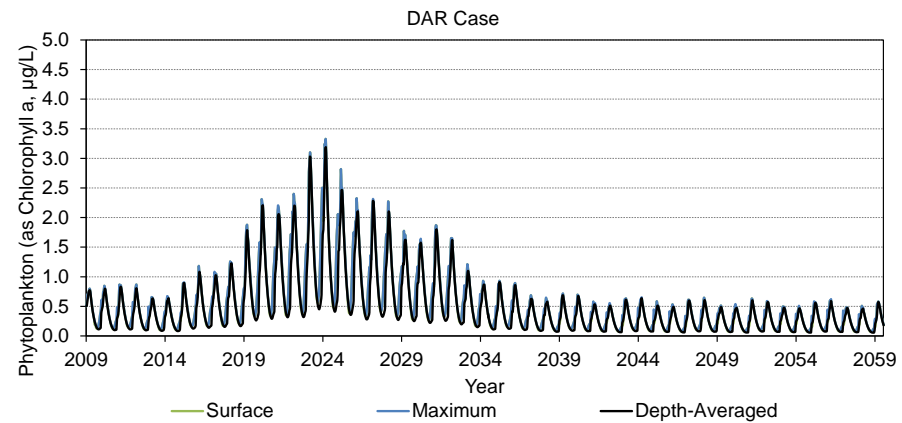


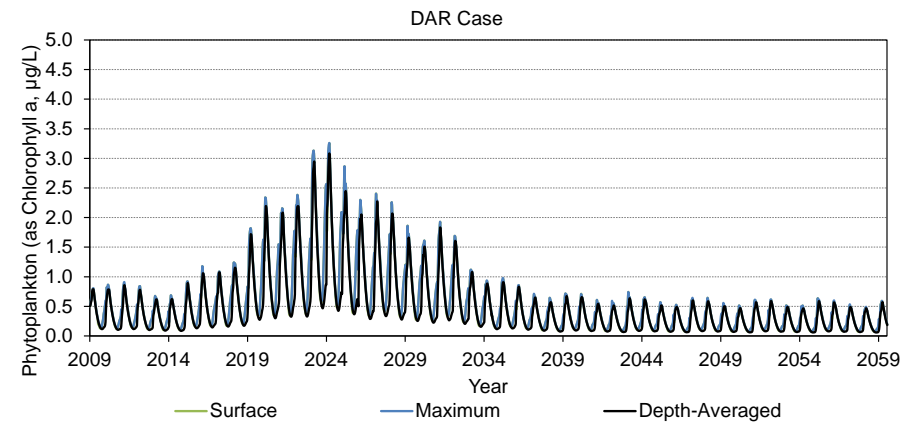
Figure B-7: Predicted Phytoplankton Concentrations in Lac de Gras



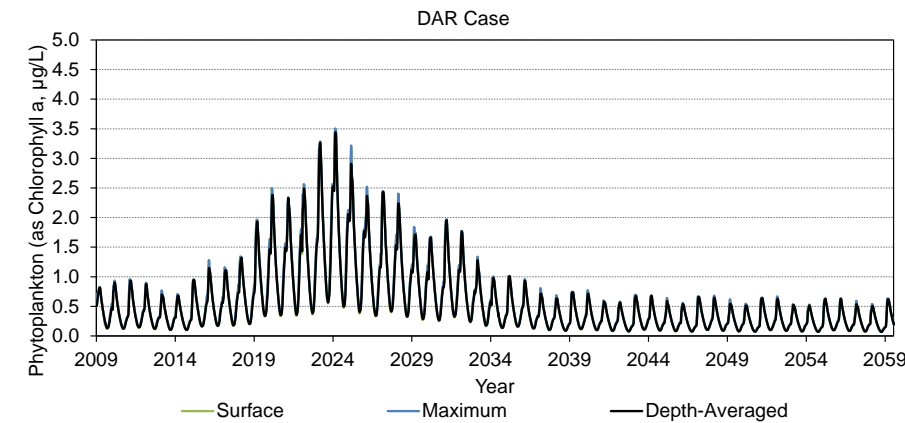
LDG-P4



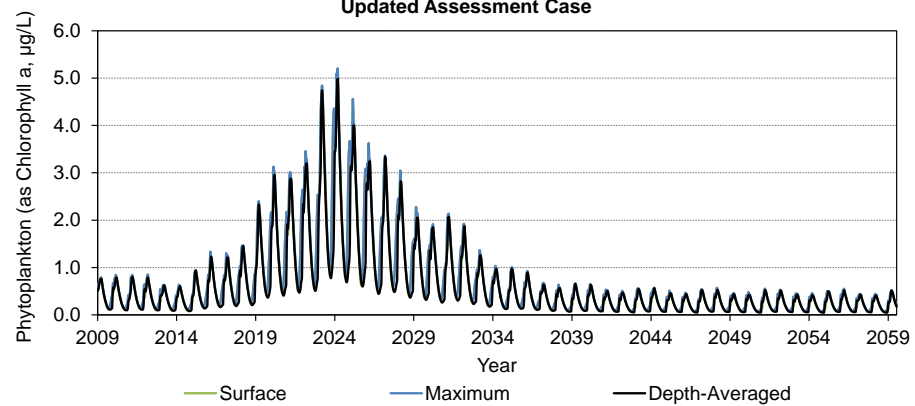
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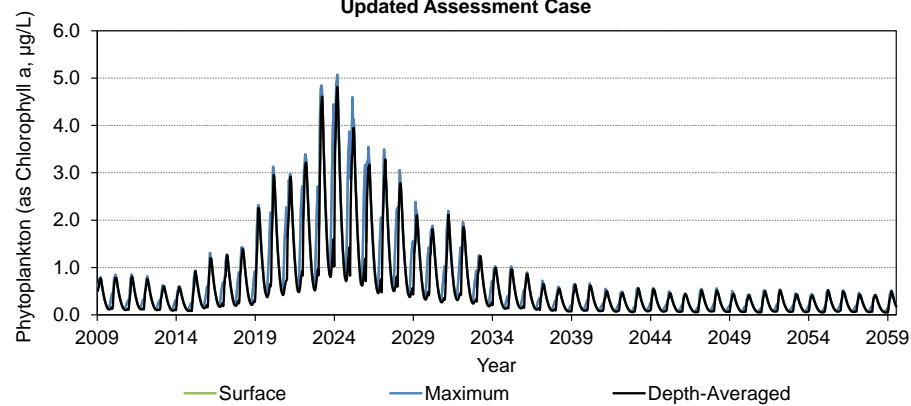
LDG-P6



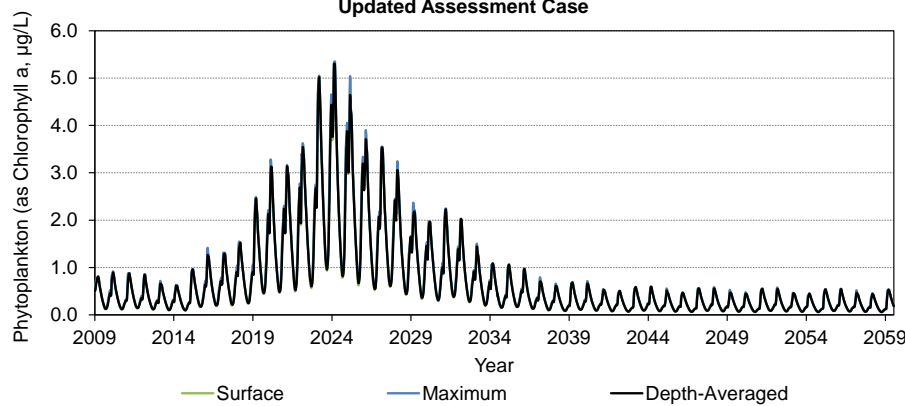
Updated Assessment Case



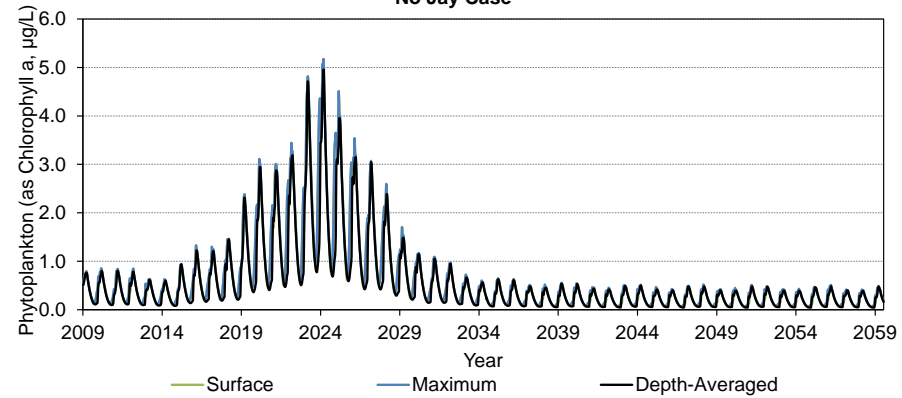
Updated Assessment Case



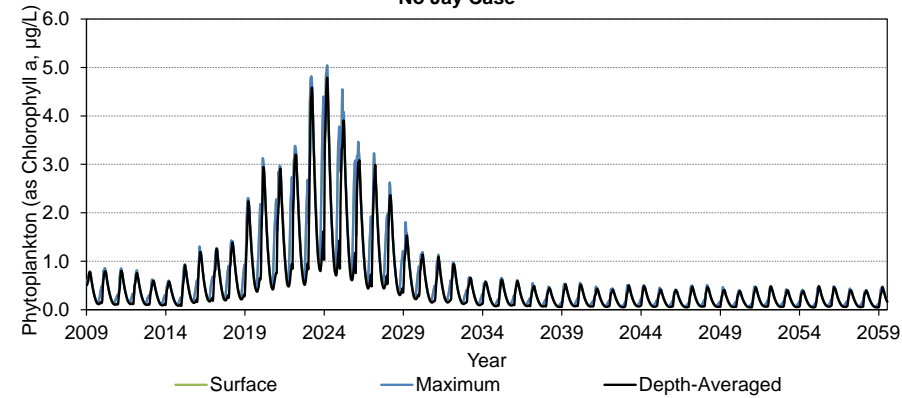
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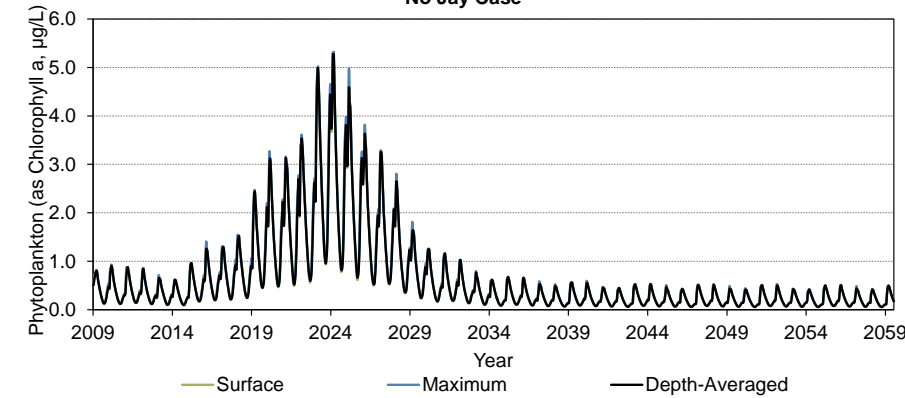
No Jay Case



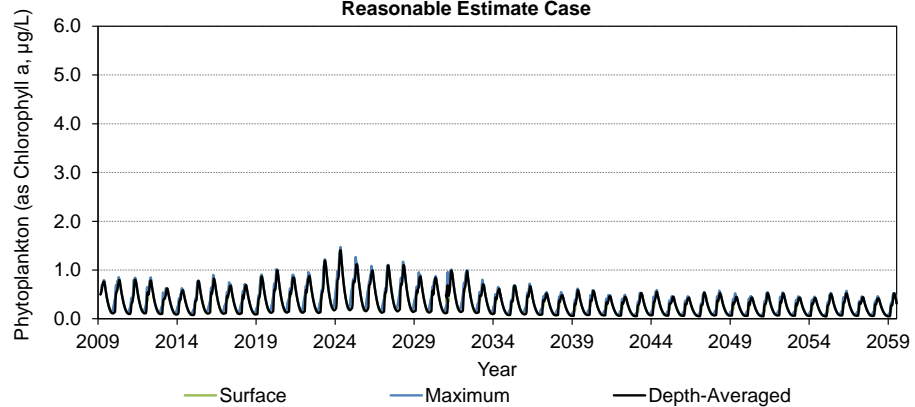
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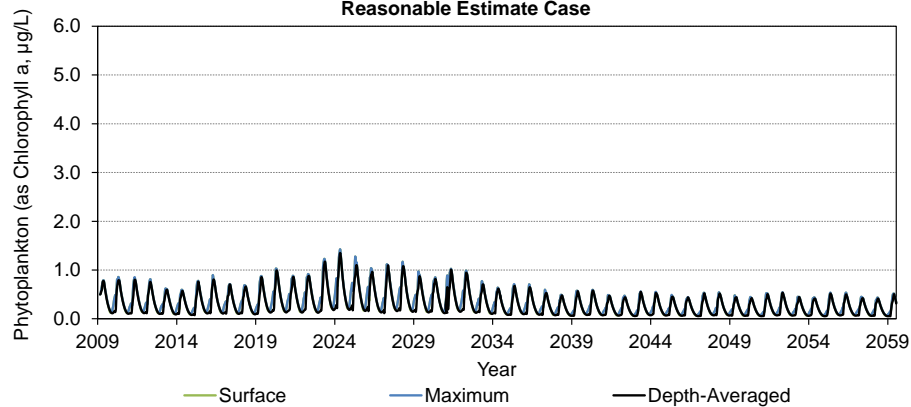
No Jay Case



Reasonable Estimate Case



Reasonable Estimate Case



Reasonable Estimate Case

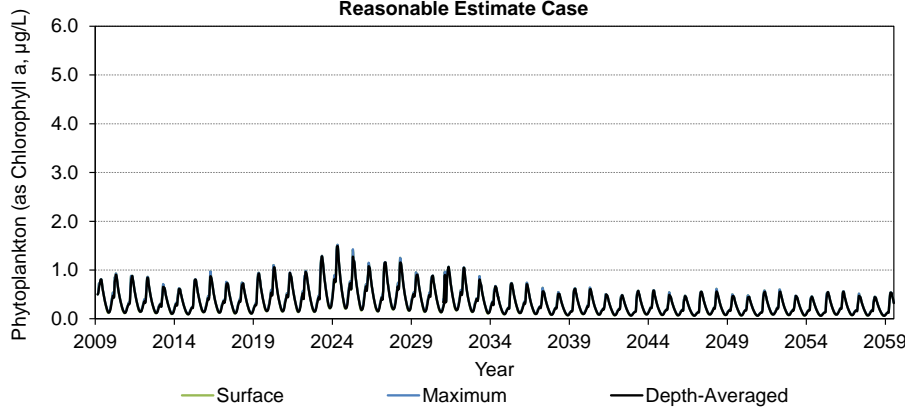
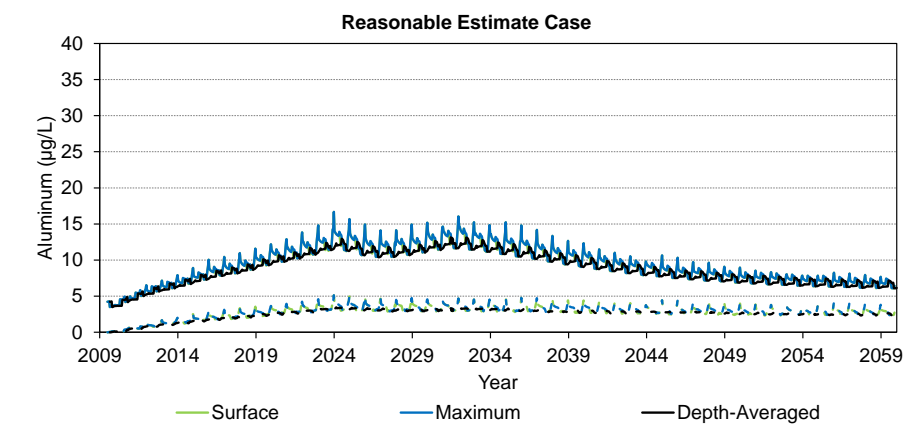
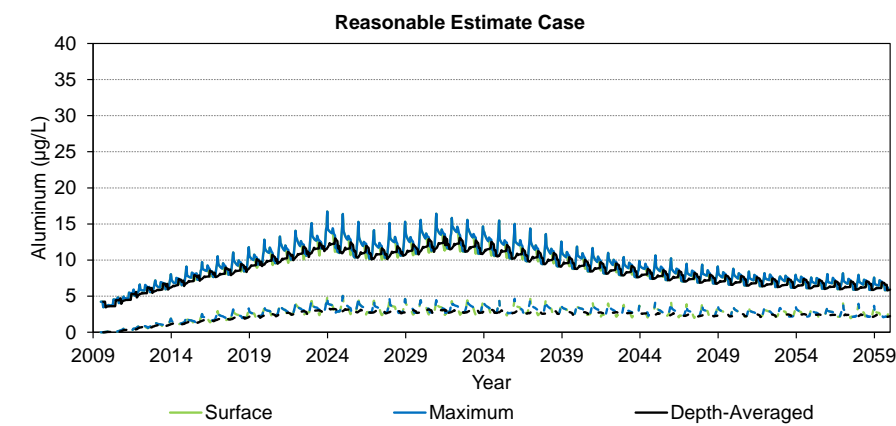
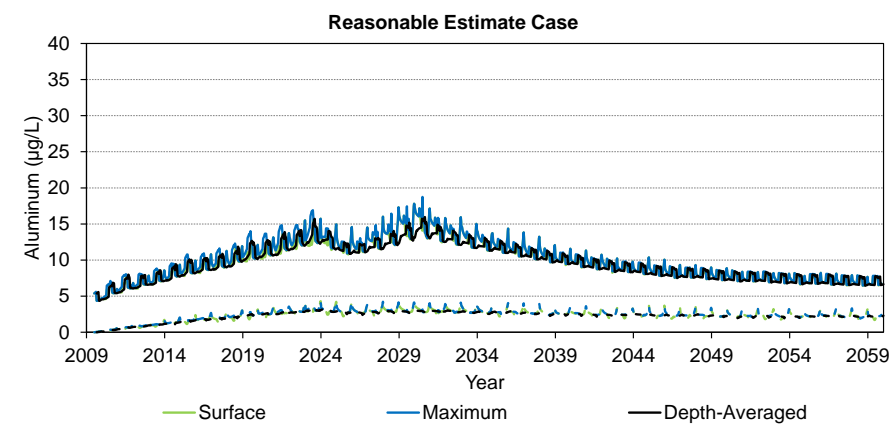
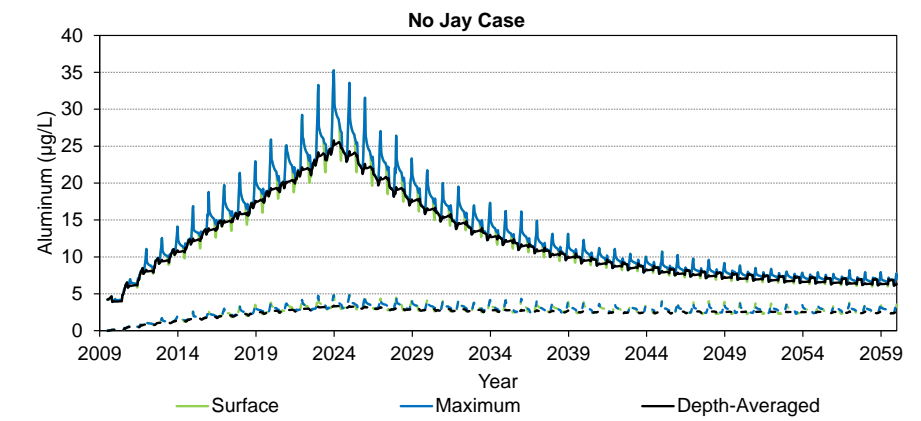
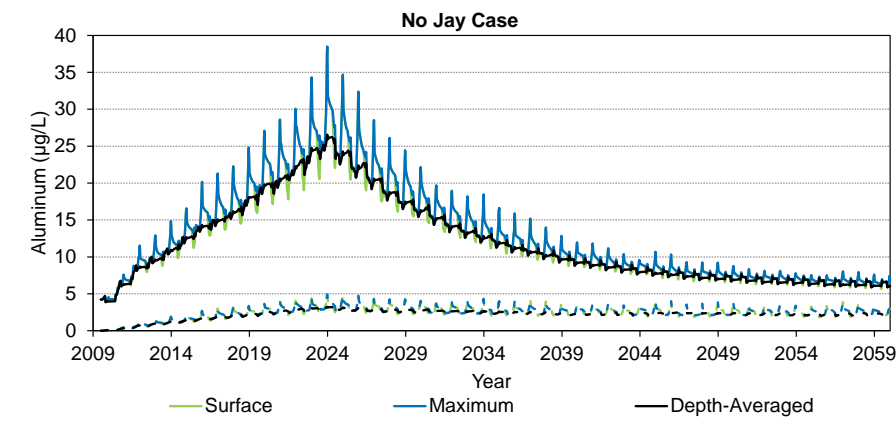
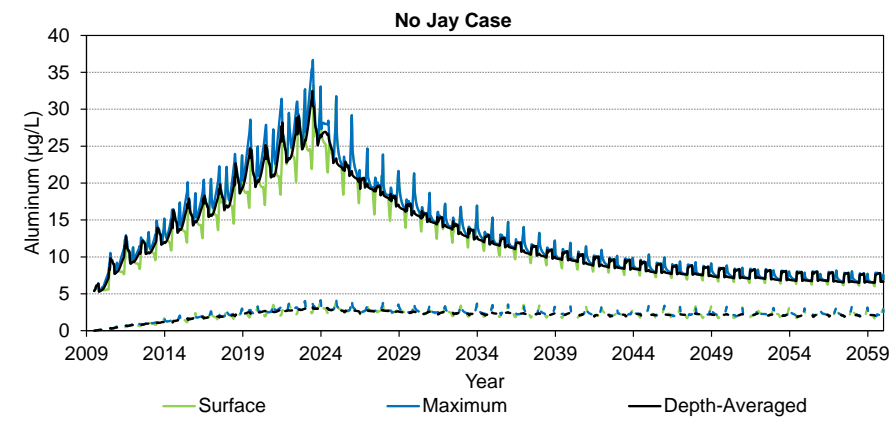
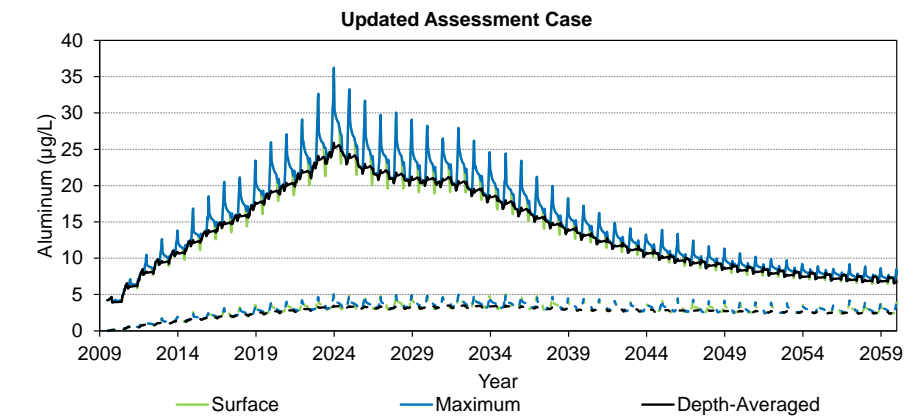
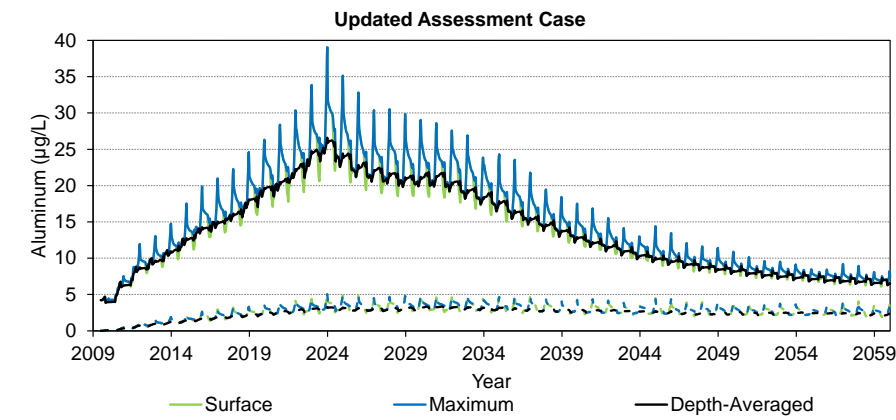
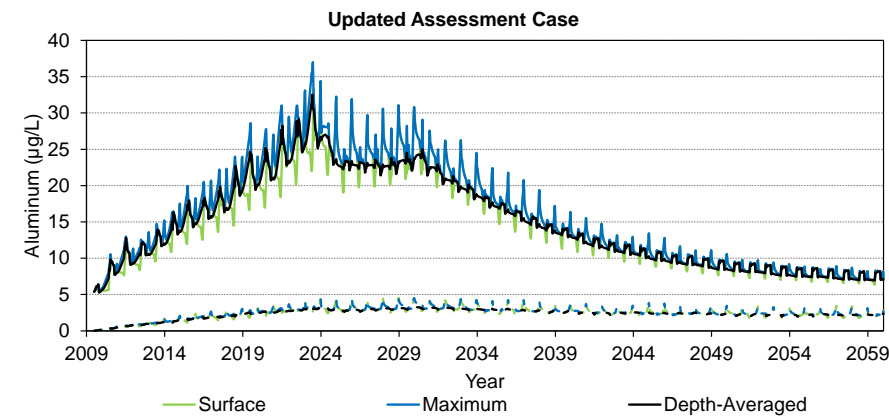
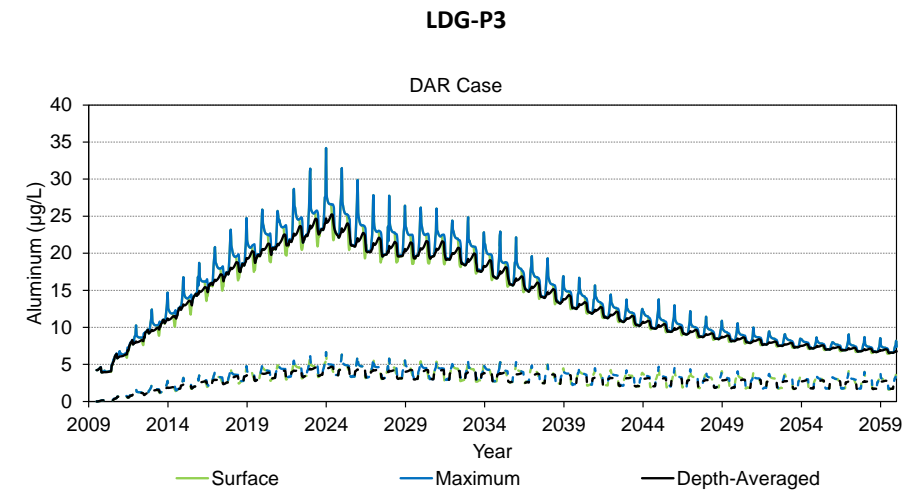
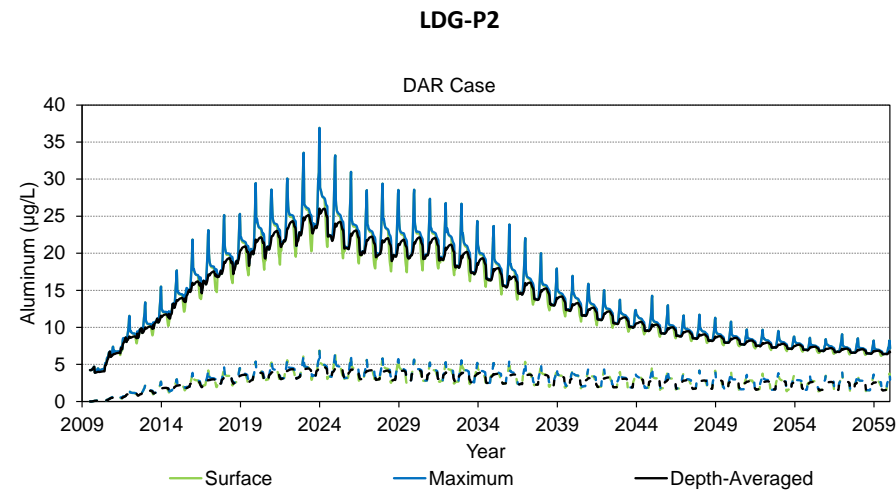
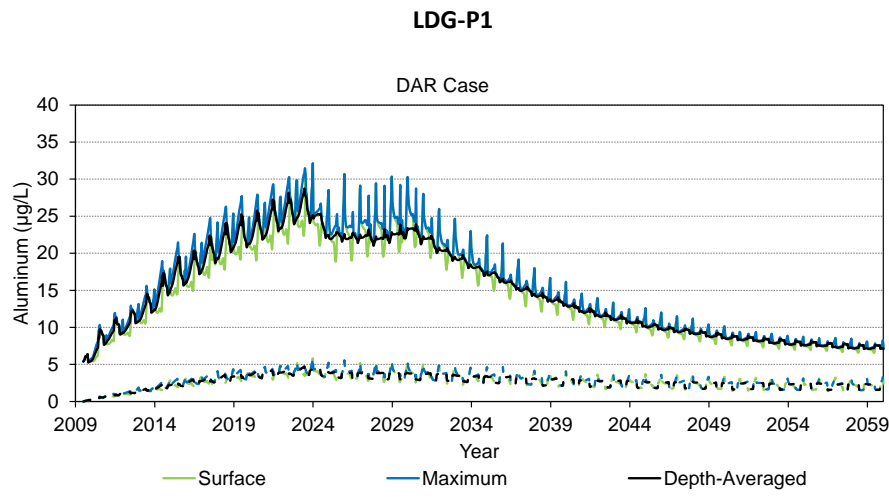
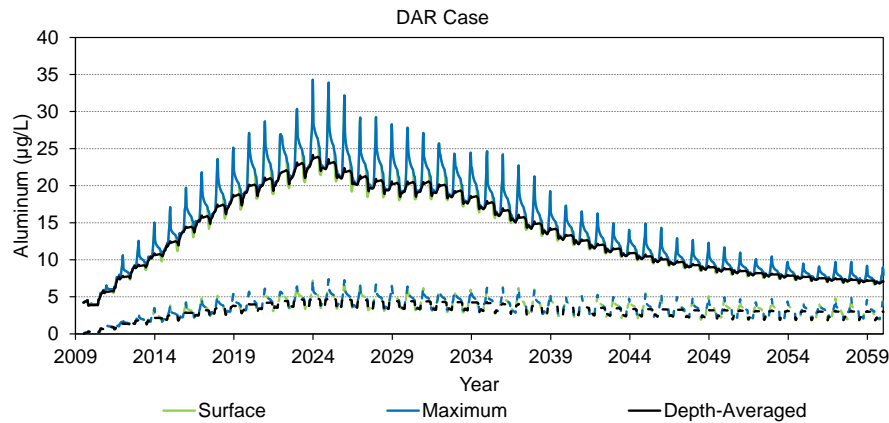


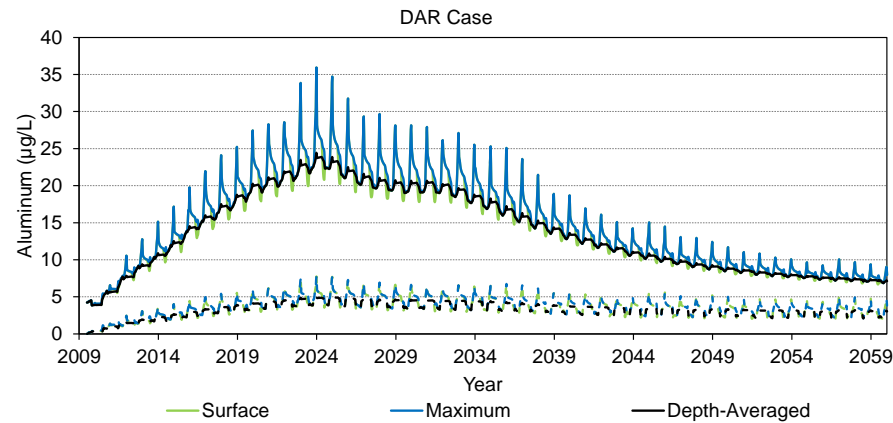
Figure B-8: Predicted Total and Dissolved Aluminum Concentrations in Lac de Gras



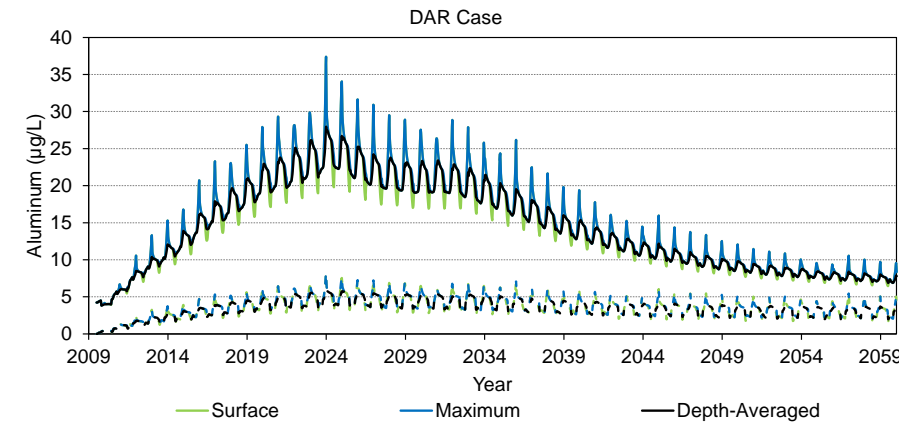
LDG-P4



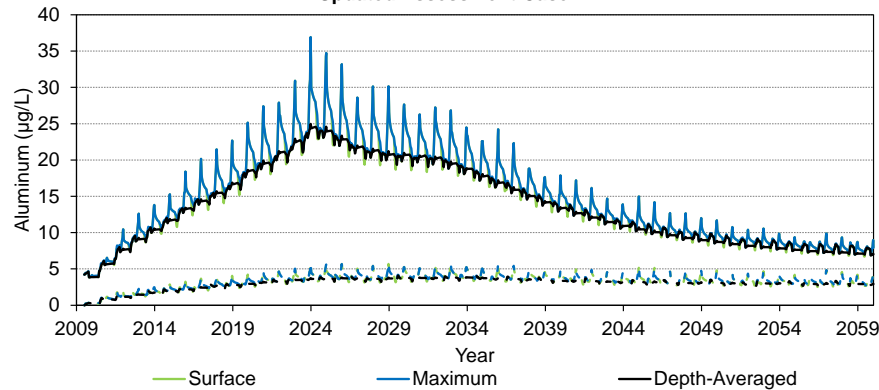
LDG-P5



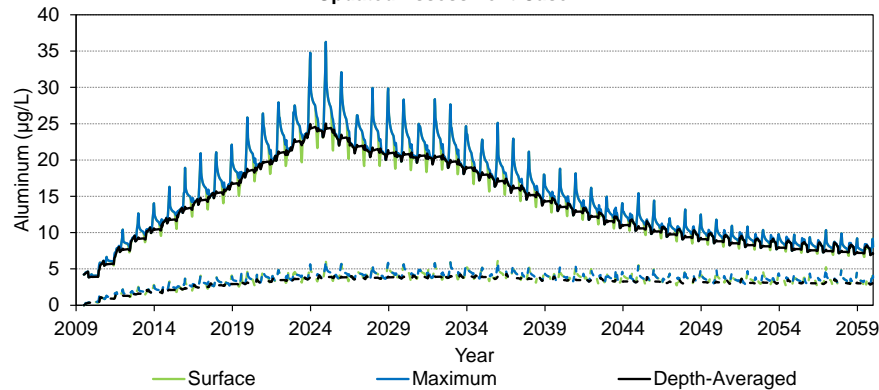
LDG-P6



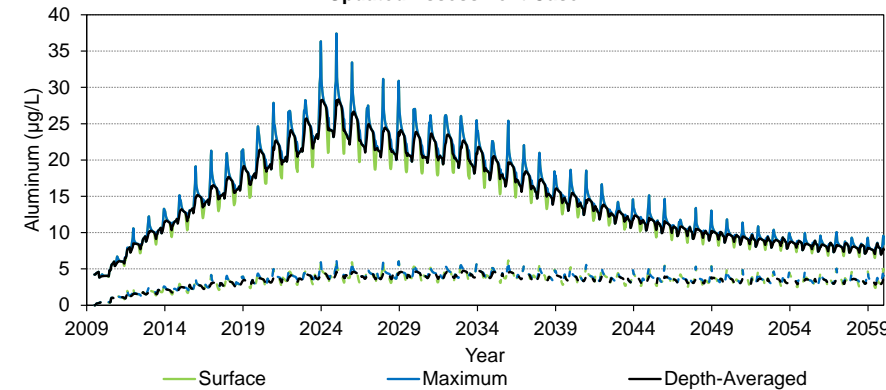
Updated Assessment Case



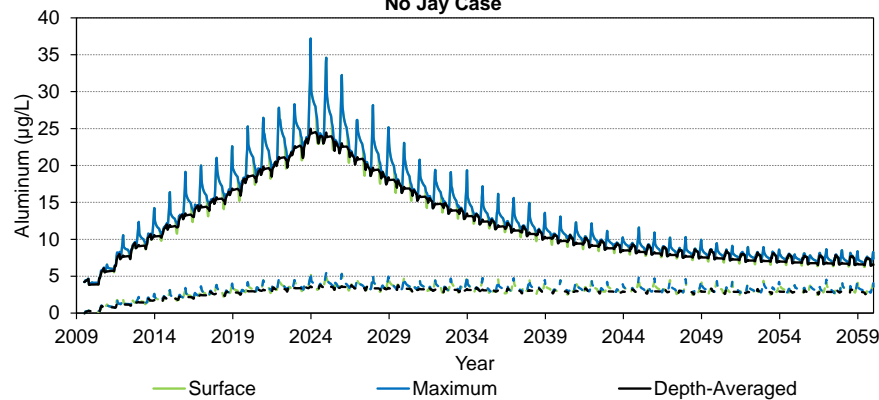
Updated Assessment Case



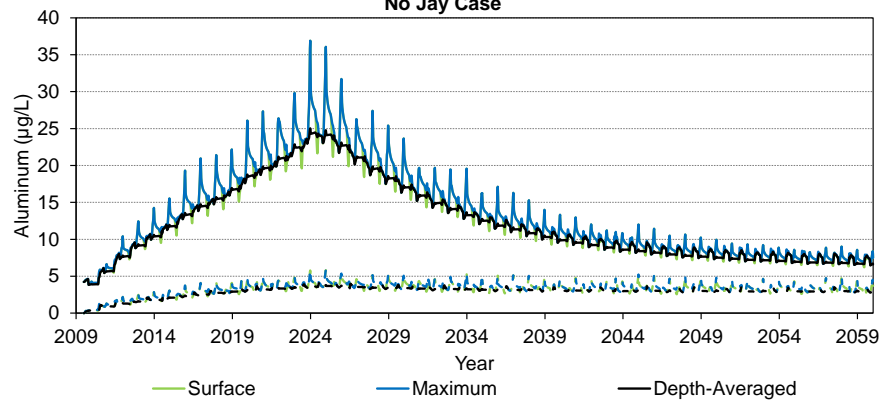
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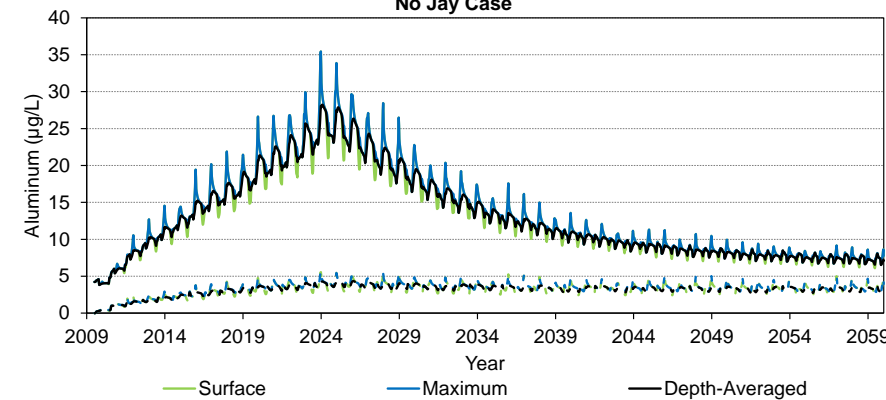
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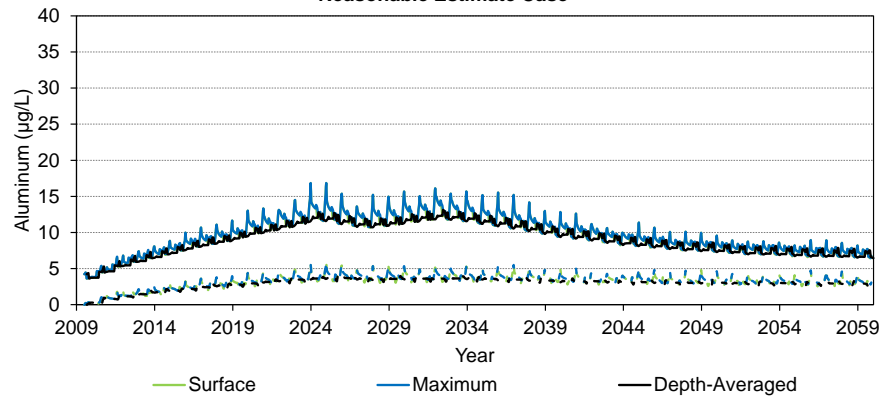
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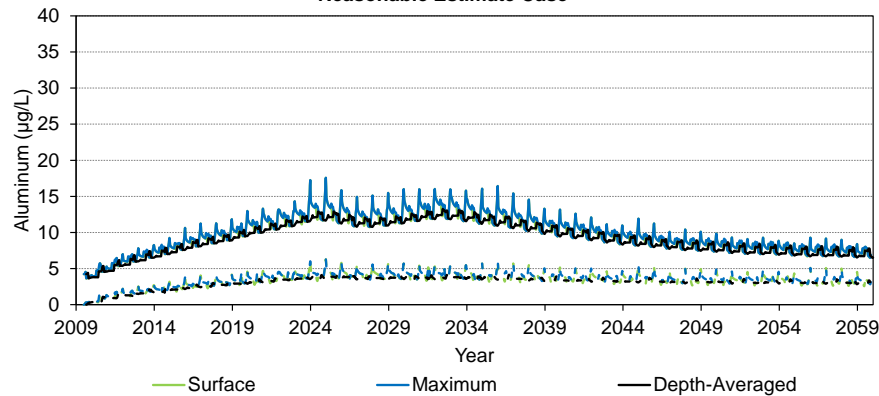
No Jay Case



Reasonable Estimate Case



Reasonable Estimate Case



Reasonable Estimate Case

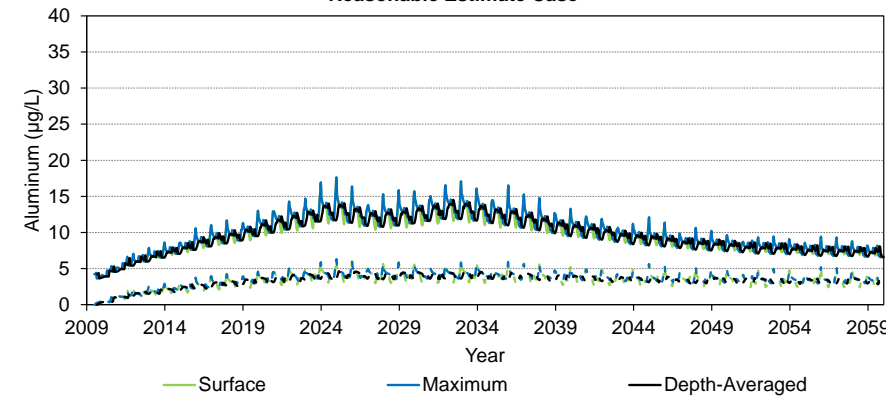
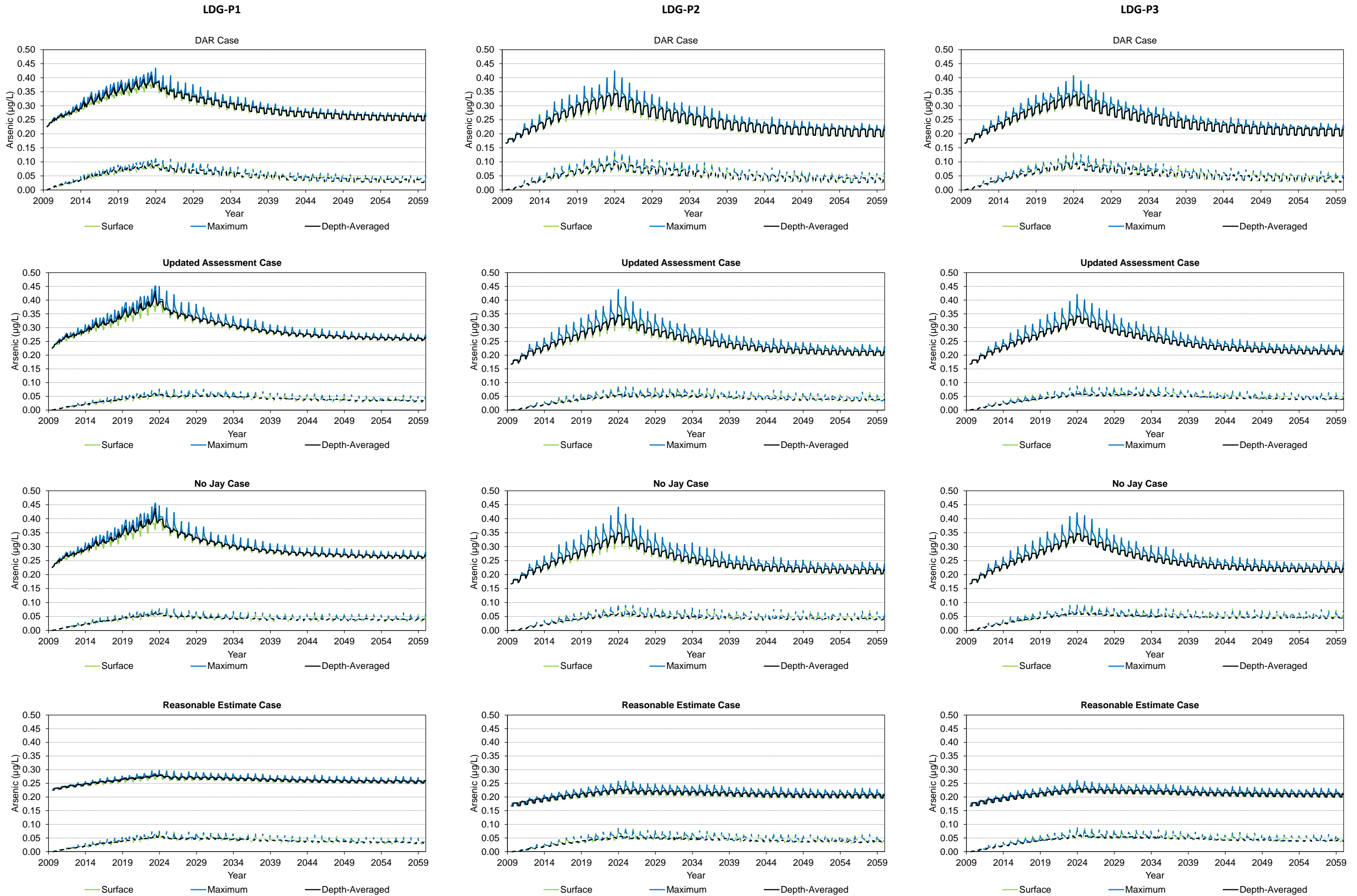
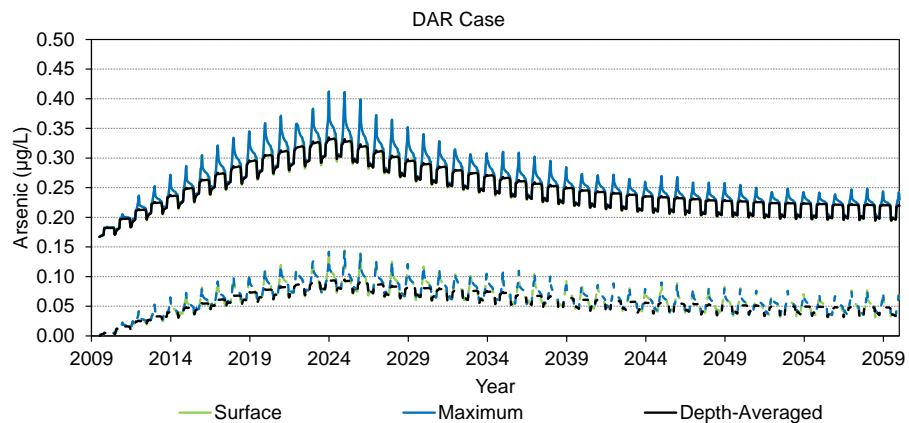
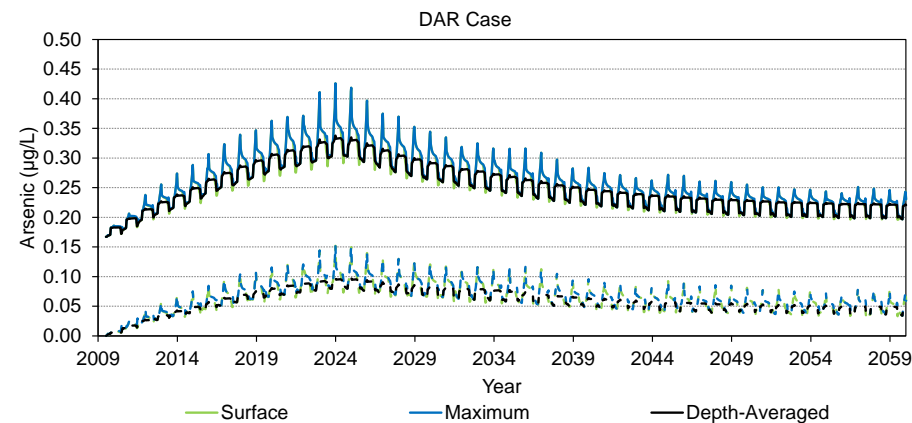
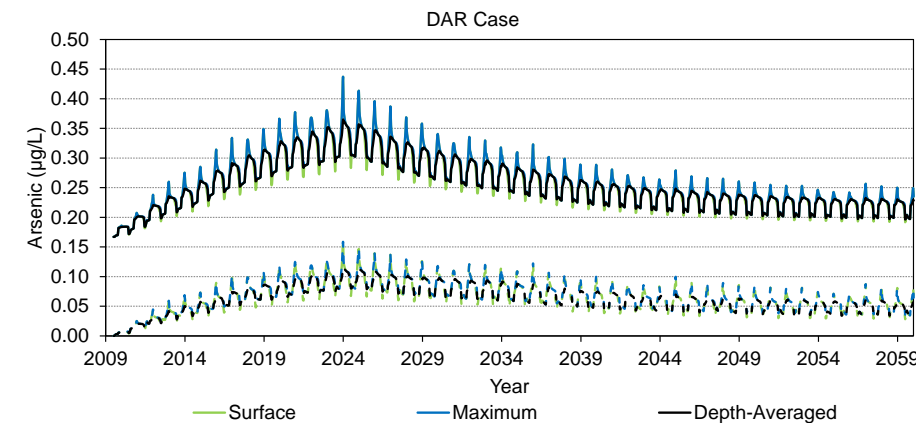
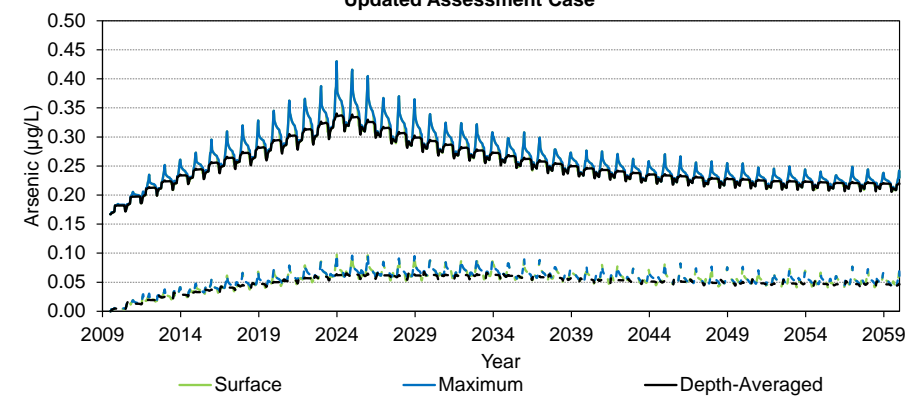
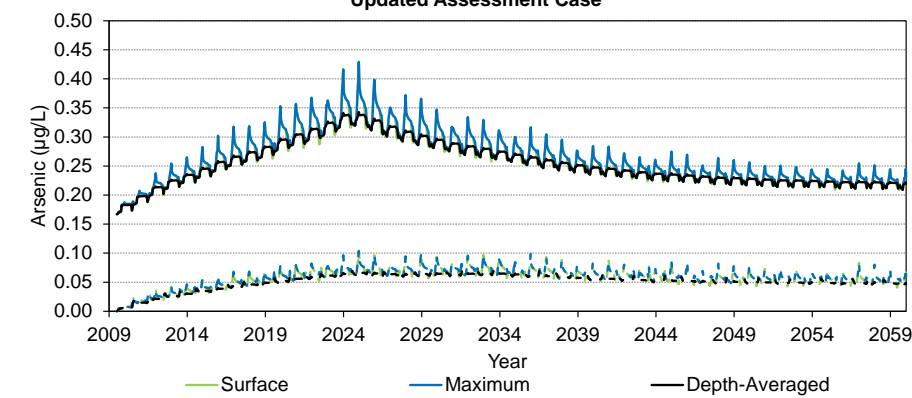
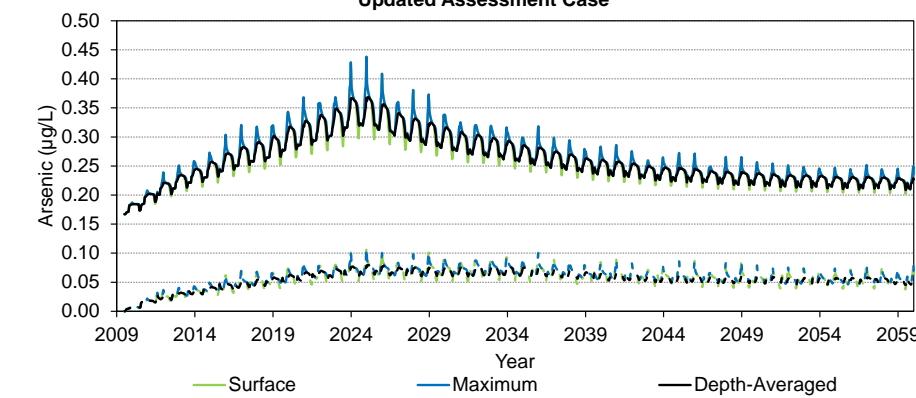
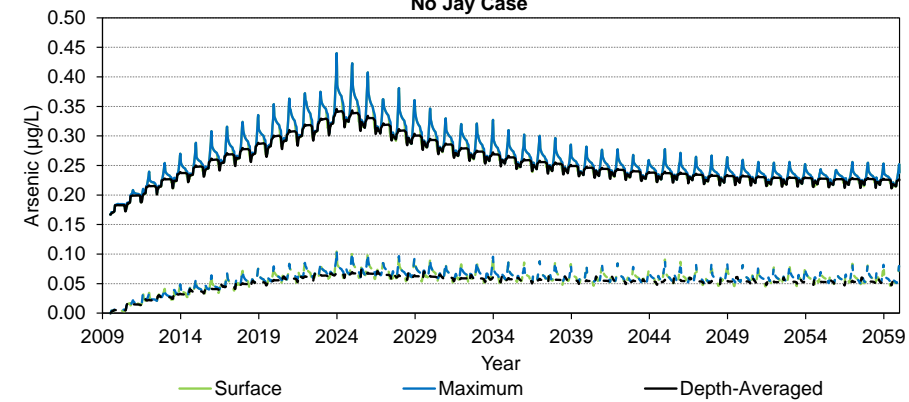
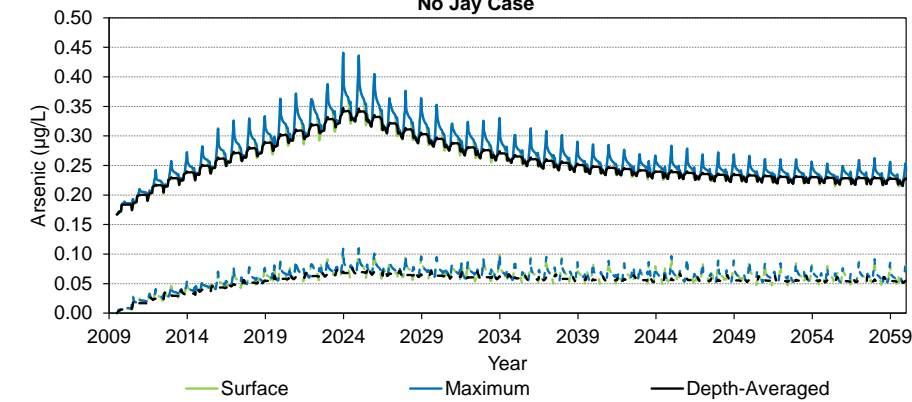
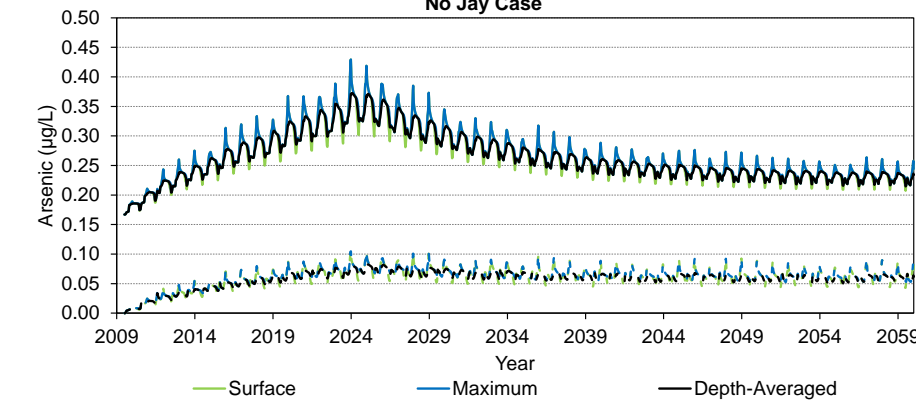
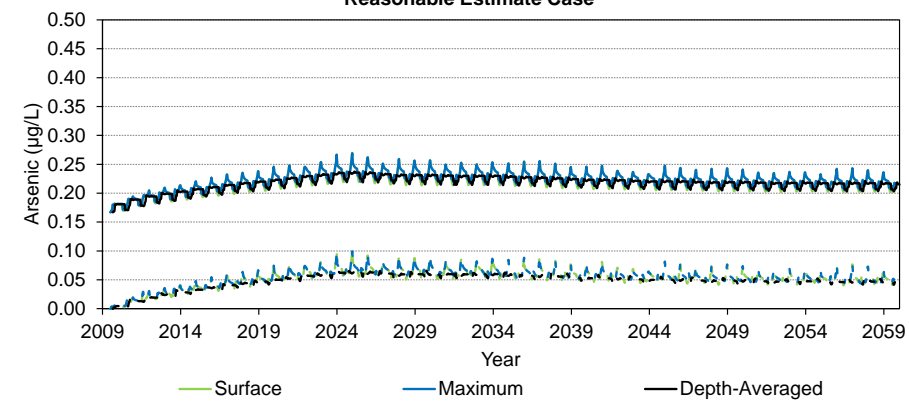
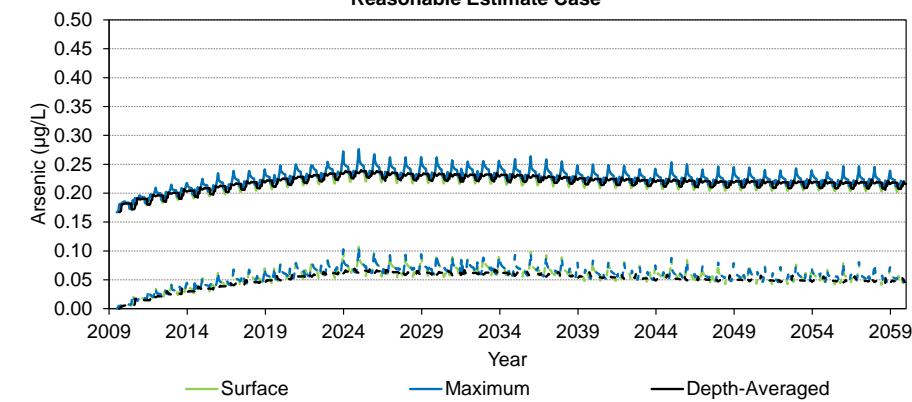
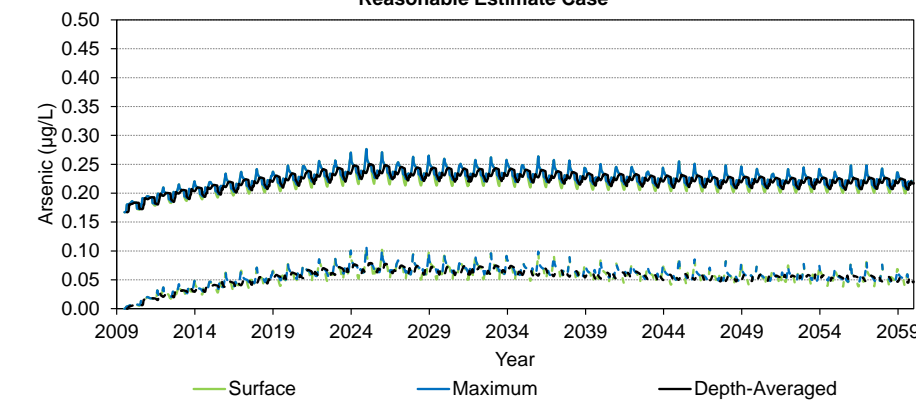


Figure B-9: Predicted Total and Dissolved Arsenic Concentrations in Lac de Gras



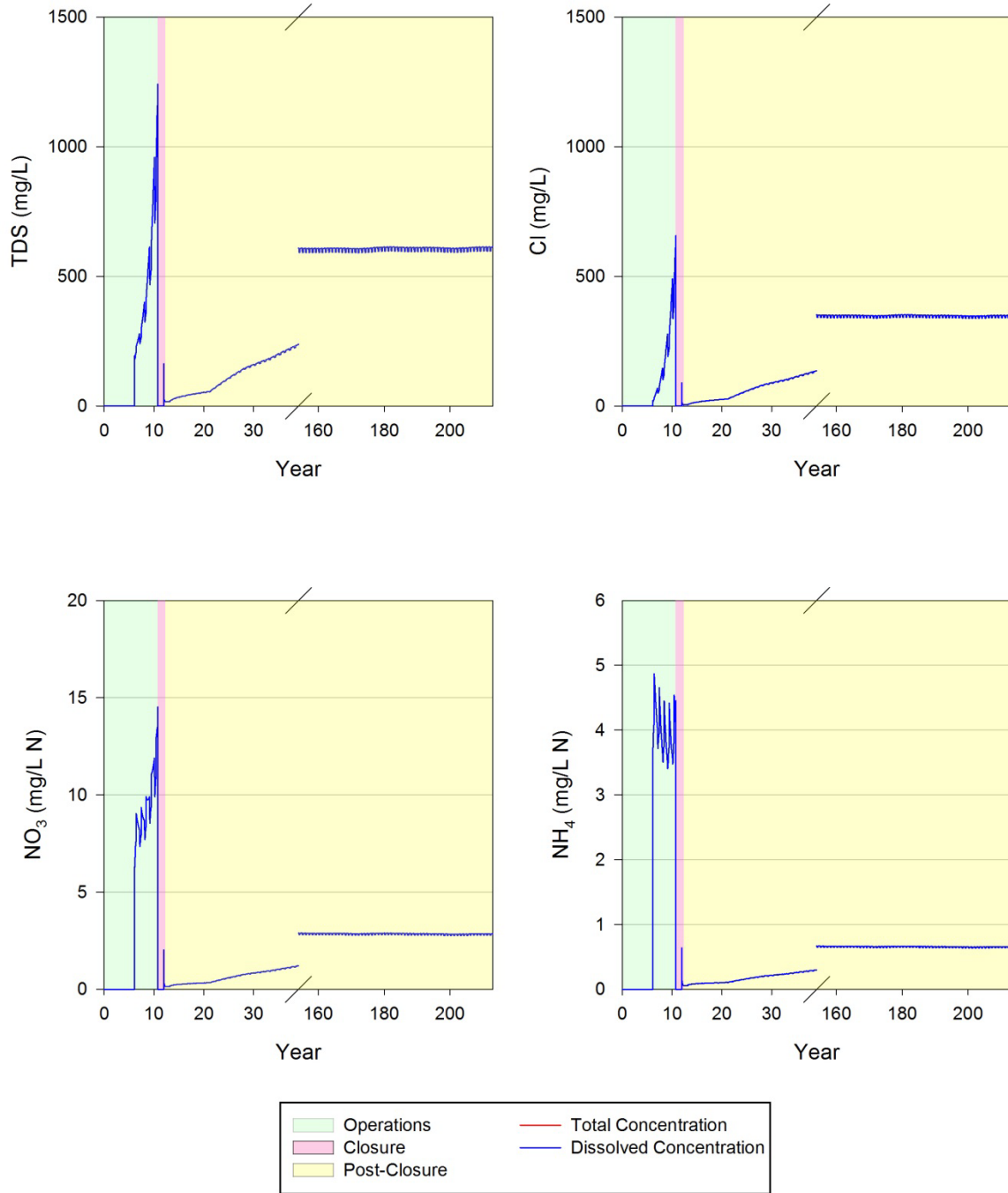
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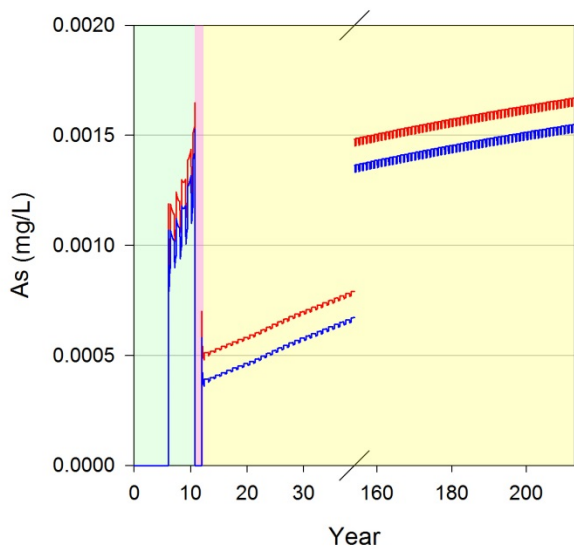
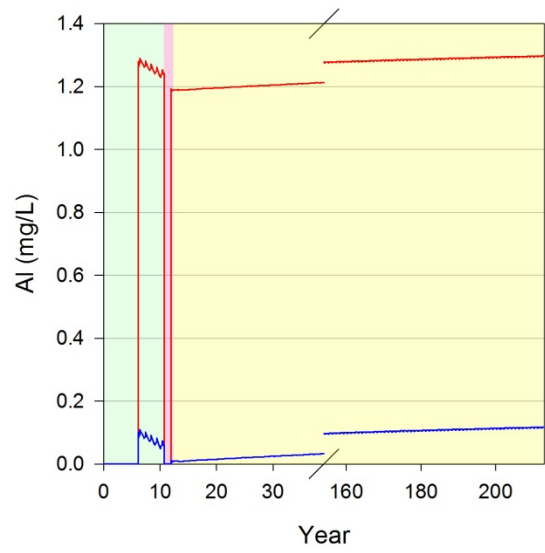
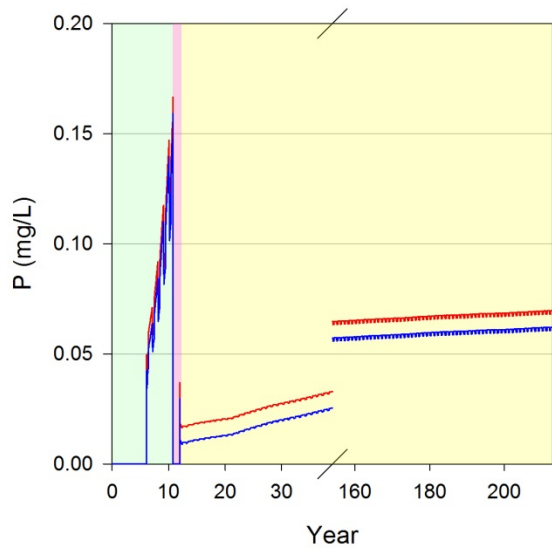


APPENDIX C

Projected Misery Pit Discharge Concentrations

Appendix C – Projected Misery Pit Discharge Concentrations





As a global, employee-owned organisation with over 50 years of experience, Golder Associates is driven by our purpose to engineer earth's development while preserving earth's integrity. We deliver solutions that help our clients achieve their sustainable development goals by providing a wide range of independent consulting, design and construction services in our specialist areas of earth, environment and energy.

For more information, visit golder.com

Africa	+ 27 11 254 4800
Asia	+ 86 21 6258 5522
Australasia	+ 61 3 8862 3500
Europe	+ 44 1628 851851
North America	+ 1 800 275 3281
South America	+ 56 2 2616 2000

solutions@golder.com
www.golder.com

Golder Associates Ltd.
6089 Trapp Avenue
Burnaby, British Columbia, V3N 2V3
Canada
T: +1 (604) 298 6604

