Appendix 26

Meadowbank and Whale Tail 2023 CREMP Report

2023 Core Receiving Environment Monitoring Program

Meadowbank Complex

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EXECUTIVE SUMMARY

This report presents findings from the 2023 Core Receiving Environment Monitoring Program (CREMP). The purpose of the CREMP is to determine if activities at Meadowbank, Whale Tail, and Baker Lake are causing changes in water quality, sediment chemistry, phytoplankton, and benthic invertebrates. Changes within the study area lakes are identified using early warning triggers and statistical analyses. The assessment includes the use of early warning *triggers* and action *thresholds* to support management decisions within the Aquatic Effects Management Program (AEMP). The AEMP is the overarching 'umbrella' program that integrates results of individual, but related, monitoring programs for the purpose of implementing management actions before unacceptable adverse impacts occur to aquatic life.

Meadowbank

Results for the Meadowbank study area lakes are presented below and summarized in **Table ES-1**.

Water Quality (Limnology & Water Chemistry)

Water quality monitoring for limnology and chemistry was completed in March, July, August, and September 2023 according to the CREMP study design. The May sampling event was cancelled due to unsafe ice conditions. Limnology profiles were taken at the Near-Field (NF) areas—Third Portage Lake (TPN, TPE), Second Portage Lake (SP), and Wally Lake (WAL)—in the winter months when ice conditions were safe (January, February, April, November, and December).

The NF areas close to the mine have higher concentrations of dissolved solids and constituent major ions such as calcium and magnesium compared to baseline/reference conditions. This observation is consistent with previous findings. While these changes to water quality are mine-related, the observed concentrations are still relatively low and there is no evidence to suggest concentrations are increasing year-over-year or that the observed concentrations would result in adverse ecological effects. Consistent with previous reporting cycles, there were no trigger exceedances in 2023 for any water quality parameters with CCME water quality guidelines (WQG), including metals. In the context of the assessment framework outlined in the Final Environmental Impact Statement (FEIS), the magnitude of potential effect on water quality in each of the near-field lakes in 2023 was considered *low* (i.e., less than the CCME WQGs) and consistent with the original predictions. **Routine water quality monitoring is recommended for 2024.**

Phytoplankton Community

Water samples for phytoplankton taxonomy were collected during each sampling event. From the 2023 BACI analysis, the phytoplankton community showed significant reductions relative to baseline for richness at TPE, however this reduction was less than the 20% trigger. Phytoplankton biomass increased above the 20% trigger at TPN and WAL, though this was not significant in the BACI analysis. The observed fluctuations in phytoplankton richness and biomass fall within the range of historical baseline/reference conditions and are likely due to natural variability. Ultimately, the long-term phytoplankton monitoring data demonstrates that mining operations have not contributed to pervasive changes in primary productivity among the NF areas. **The trends in phytoplankton biomass and richness will be reviewed again in 2024.**

Sediment Chemistry

The 2023 sediment program focused on NF and reference areas only and consisted of the routine grab sampling (particle size, total organic carbon [TOC], and organics analysis on the top 3–5 cm of sediment) and a sediment coring program (metals analysis on the top 1.5 cm of sediment).

Sediment core metals for which the 2023 mean exceeded the trigger value at the NF areas were formally assessed in the statistical BA model to assess whether concentrations are increasing over time. In 2023, mean sediment concentrations exceeded the trigger for chromium at TPE. There have been temporal changes in sediment chromium concentrations at TPE which were attributable to activities at the mine, but levels appear to have peaked in 2017 and have since declined. Current conditions do not pose risks to the benthos at TPE.

Sediment grab sampling was conducted at the NF and reference areas to support the benthic invertebrate community monitoring component of the CREMP. Sediment was analyzed for grain size and total organic carbon. **The next sediment coring program will be conducted in August 2026 to review trends in chemistry. In 2024, grab samples will be collected to support the benthic invertebrate community sampling program.**

Benthos Community

There were no statistically significant changes to the benthic invertebrate community at Meadowbank relative to baseline/reference conditions identified by the 2023 BACI assessment, except for an increase in richness at SP during the 2020-2023 time period. Richness at SP was within the range of reference area INUG in 2023. **The trends in benthos abundance and richness will be reviewed again in 2024.**

Whale Tail

The 2023 CREMP results for the Whale Tail study area are presented below and summarized in **Table ES-2**.

Overview of the Whale Tail CREMP

Data analysis for Whale Tail study areas follows the same methods and framework as Meadowbank. 2023 was the fifth full year where most Whale Tail study area lakes were classified as *impact*. Whale Tail South (WTS) and Kangislulik Lake[1] (KAN/MAM) switched from *control* to *impact* in 2018 coinciding with construction of the Whale Tail Dike. The status of Lake A20, Lake A76, and Lake DS1 switched to *impact* in January 2019. Nemo Lake (NEM) transitioned to *impact* after July 2019.

Water Quality (Limnology & Water Chemistry)

Surface water monitoring for limnology and water chemistry were completed in March, July, August, and September according to the CREMP study design for the Whale Tail study area. Sampling planned for May was cancelled due to unsafe ice conditions so an abbreviated sampling event took place at WTS and KAN/MAM in November [2]. Supplemental limnology profiles were taken at Whale Tail South (WTS), Kangislulik Lake (KAN/MAM), Nemo Lake (NEM), and Lake A20 in select winter months to verify that water quality is broadly within the range of expected values, particularly for conductivity and dissolved oxygen.

Changes in water quality in lakes downstream from the mine were predicted to occur during construction and operations. Water quality within the Whale Tail study area lakes exhibited fairly stable conditions during the baseline period. Consequently, when interpreting time series plots to examine spatial-temporal trends in water quality, the *signal* of development-related inputs was expected to be easily observed relative to the low *noise* levels of the baseline period. The following parameters have increased relative to baseline/reference conditions:

- *Ionic Compounds* – total dissolved solids and constituent ions such as calcium, magnesium, potassium, and sodium were elevated in the NF lakes and downstream of KAN/MAM to Lake A76.
- *Nutrients* – total Kjeldahl nitrogen, total phosphorus, total organic carbon, and dissolved organic carbon were elevated at NF area WTS and at MF area A20. These same parameters were elevated at KAN/MAM, though mean annual total phosphorus level declined in 2023 and did not exceed the trigger value. The elevated parameters are likely the result of inputs from flooded terrestrial habitats following impoundment, dewatering inputs from WTN, and the joining of WTS to A20.

[1] Previously referred to as Mammoth Lake (MAM).

[2] Sampling only occurred at WTS and KAN/MAM, therefore the November water chemistry was screened against FEIS predictions but not included in the formal BACI analysis.

- *Metals/metalloids* – total and dissolved lithium was elevated at WTS and KAN/MAM and dissolved silicon was elevated at DS1. These parameters do not have an effects-based guideline for protection of freshwater aquatic life.

Of the parameters with trigger exceedances, FEIS predictions were exceeded for total phosphorus at WTS and total alkalinity, TDS, total lithium, and several ionic compounds at WTS and KAN/MAM in one or more sampling events. Importantly, the absolute concentrations of these parameters remain *low*. Total phosphorus and arsenic at WTS and KAN/MAM are within the normal operating ranges and Level 0 water management strategy is in effect in 2024 as per the *Adaptive Management Plan*. **Routine water quality monitoring will continue in 2024 to track emerging spatial and temporal trends.**

Phytoplankton Community

Phytoplankton community sampling was completed at the same time as the water chemistry sampling program in 2023. Phytoplankton communities vary naturally throughout the year in total biomass (and density) and community composition (taxa richness). The primary stressors for the phytoplankton community include nutrients and metals in surface contact water discharged to KAN/MAM and WTS. Nutrient loading can manifest as an increase in total biomass or a change in community structure, while increasing metals concentrations would be expected to cause lower biomass and taxa diversity.

Increased total biomass was reported at WTS (102%), KAN/MAM (17%), A20 (243%), and NEM (19%) relative to control/baseline conditions with statistically significant ($p < 0.1$) results at WTS and A20. Phytoplankton biomass has increased above the 20% effect size at WTS since 2022 (not significant) and at A20 (significant in 2021) since 2021. These increases have corresponded to nutrient increases (total phosphorus trigger exceedances at both WTS and A20 since 2021), suggesting that phytoplankton enrichment at WTS and A20 is occurring. Despite this, the BACI results have not consistently demonstrated significant results in previous years. Furthermore, phytoplankton communities respond to a host of natural seasonal factors such as sunlight, and water temperature. According to the FEIS, phosphorus and nitrate levels are predicted to increase at both WTS and KAN/MAM until 2026, after which concentrations are predicted to decline. With these predicted increases in nutrients, phytoplankton biomass is expected to increase over the next three years of CREMP sampling. Phytoplankton productivity, biomass and richness, as well as associated patterns in key nutrients will continue to be tracked in 2024. **Phytoplankton community monitoring is scheduled for 2024 according to the CREMP Plan.**

Sediment Chemistry

Sediment chemistry in the Whale Tail study area is naturally elevated in several metals. Concentrations of these metals can be highly variable as the sediment chemistry of the lakes is spatially heterogenous. In 2023, mean sediment core concentrations of arsenic and chromium exceeded triggers and were significantly higher than the baseline period at WTS, KAN/MAM, and A20 when compared using the BA statistical model. Though mean arsenic concentrations exceeded triggers, concentrations generally remain within baseline ranges at all of the study lakes. Potential increasing trends were noted for chromium at WTS and KAN/MAM. Despite this, trigger exceedances for chromium were marginal at KAN/MAM and concentrations at WTS ranged well above the trigger value during baseline sampling. Mean copper concentrations exceeded the trigger at A20, however, this is likely attributed to spatial heterogeneity rather than mining activities. These potential changes in arsenic, chromium, and copper will be monitored in 2024.

TOC proportions, while naturally differing across the study lakes, have remained stable within each lake. These findings show that mining activity has not caused an increase in TOC. **The next sediment coring program will be conducted in August 2026 to review trends in chemistry. In 2024, grab samples will be collected for chemistry and to support the benthic invertebrate community sampling program.**

Benthos Community

Benthic invertebrate (benthos) community structure (taxa richness) and function (abundance) in the Whale Tail study area lakes is typical of northern headwaters lakes in the region (i.e., relatively low abundance and few taxa). Significant increases in abundance occurred at KAN/MAM and NEM across all time periods, as well as WTS in 2022-23. Significant increases in richness were also found at A20 in 2022-23, 2021-23, and 2020-23 as well as DS1 in 2022-23. These increases may be occurring due to an enrichment effect; however, there are a number of factors not related to mining activities (e.g., water temperature) that could have an important influence on the Whale Tail benthos community. Further, the densities observed in 2021, under a similar nutrient and primary production regime, were among the lowest observed across the Whale Tail impact lakes since 2015. Additional monitoring data should help understand the cause of the increased densities observed in 2023. **Benthos community monitoring will be conducted in 2024 according to the CREMP Plan.**

Baker Lake

CREMP monitoring at Baker Lake started in 2008. Important mine-related activities in Baker Lake include barge/shipping traffic and general land-based activities associated with the tank farm area. Water quality sampling was conducted at two NF areas (BBD, BPJ) and one reference area (BAP) in Baker Lake in July, August, and September 2023. As 2023 was a sediment coring year, sediment and benthos sampling occurred at the NF (BBD, BPJ) and reference area (BAP) mentioned above, and at an additional reference area (Baker Lake East Shore [BES]) to better characterize sediment and benthos conditions.

The number of barge shipments in 2023 were down from 2021 and 2022 which reported the highest shipments since monitoring began in 2008. On June 3rd 2023, a turbid water runoff release to Baker Lake was identified. Efforts were made to divert the runoff and remedial steps were taken including installing silt fences, wood-chip booms, and maritime curtains to contain the TSS plume in the receiving environment. There were no elevated TSS concentrations observed in the Baker Lake sampling areas in subsequent sampling events.

Water Quality

The mean concentrations for dissolved organic carbon (DOC) exceeded their respective triggers in 2023 at all three areas (BBD, BPJ, and BAP). Additionally, for the first time since monitoring began, pH (field measured) dropped below the lower trigger threshold at reference location BAP. The BACI showed no statistically significant increase above baseline/reference for BBD or BPJ. There was no evidence of any barge-related impacts to water quality at *impact* areas in Baker Lake. **Monitoring in 2024 will follow the scope and schedule of the CREMP Plan.**

Phytoplankton Community

There was an apparent increase in total biomass at NF areas BPJ and BBD along with richness at BBD, however this may be attributed to the decrease observed at reference area BAP. Overall, the phytoplankton community in Baker Lake was similar to previous years and has not exhibited any changes attributable to Agnico Eagle's activities in Baker Lake. **Monitoring in 2024 will follow the scope and schedule of the CREMP Plan.**

Sediment Chemistry

The mean sediment core concentration of arsenic exceeded the trigger at BPJ in 2023, however this exceedance was not found to be statistically significant when compared to baseline conditions using the BA statistical model. No evidence was found to suggest that Agnico Eagle's activities are influencing sediment quality at Baker Lake. **The next sediment coring program will be conducted in August 2026 to review trends in chemistry.**

Benthic Community

There was an apparent increase in both abundance and richness at BBD and BPJ across all years since 2020. However, none of these results were found to be significant in the BACI analysis except for richness at BBD in 2023 and 2021-23 time periods. There has been a general decline in both abundance and richness at BAP and BES since 2020. The apparent increases at BBD and BPJ may reflect the declines occurring at the reference locations. There is no indication that Agnico Eagle's activities are influencing the benthic community at Baker Lake. **The next benthic sampling program will be conducted in August 2026.**

Table ES-1. Summary of key findings from the 2023 Meadowbank CREMP.

Notes:
1. Temporal and spatial trends are outlined for monitoring components and variables that exceeded trigger or effects-based thresholds (i.e., apparent change from baseline).
2. Spatial scale ratings are: localized = small area within the lake/area; widespread = basin to whole lake.
3. Causality ratings are: low = no evidence of a mine-related source; moderate = some likelihood of a mine-related source; high = the source of the change is likely mine-related.

Monitoring Component (and report section)	**Variable**	**Summary**	**Temporal and Spatial Trend Assessment**[1, 2, 3]	**Annual CREMP Results Compared to FEIS Predictions** (Cumberland, 2005)
Limnology Section 4.2	Temperature and Dissolved Oxygen	The limnology profiles collected in 2023 indicated dissolved oxygen and readings were consistent with range of conditions typical of previous monitoring cycles. Temperature readings in lakes with larger basins were at the upper end of typical range, however, maximum temperatures at SP in 2023 exceeded the historical maximum by around 3°C.	There is no evidence to suggest seasonal fluctuation in dissolved oxygen and temperature among the NF study area lakes is attributed to mining or site-related activities.	No predictions in the FEIS.
	Conductivity	The observations of minor stratification in early year monitoring events followed the pattern from previous years of being well mixed and unstratified by July.	The spatial and temporal trends appear to be consistent with previous years.	No predictions in the FEIS.
Water Chemistry Section 4.3	Conventional Parameters and Major Ions	Conductivity, hardness, TDS, alkalinity, and major cations exceeded their trigger values at one or more NF areas in 2023. These results are consistent with recent years. The trigger value for these parameters is set at the 95th percentile of concentrations measured during the baseline period. There are no effects-based thresholds for most of these parameters.	**Spatial scale – widespread**; concentrations have increased lake-wide in Third Portage from TPE to TPN and between lakes (SP and WAL). **Temporal trend – stable**; concentrations are elevated relative to the baseline period according to the BACI analysis, no evidence of-year-over-year increases (i.e., concentrations in 2023 are similar to 2022, 2021, 2020, etc.) **Causality – high**; the spatial pattern and temporal trend of increasing concentrations in the *after* period is plausibly attributed to activities at the mine, though concentrations are consistently below effects-based thresholds for the few parameters with thresholds (**Figure 4-7**, **Figure 4-8**).	Water quality constituents without effects-based CCME thresholds were not incorporated in the magnitude ratings for assigning effects in the FEIS; however, following the intent of the FEIS magnitude ratings, constituents exceeding baseline but below concentrations associated with adverse effects were considered consistent with a *low* magnitude rating.
	Nutrients	Minor trigger exceedance of TKN at TPE and reactive silica at WAL, concentrations of nutrients are similar to baseline.	**Spatial scale – localized**; TKN and reactive silica are only elevated at TPE and WAL. **Temporal trend – none**. **Causality – low**; no evidence of mine-related source.	*Low* (i.e., < CCME water quality guidelines).
	Metals	The yearly mean for total and dissolved silicon exceeded the trigger value at SP, similar to 2022 and 2021 as well as a marginal trigger exceedance for total silicon at WAL. There are no *before* data to use in the BACI statistical analysis of changes over time for silicon, but concentrations appear stable throughout the monitoring period. All other metals concentrations (total and dissolved) were consistently low or below their respective MDLs at the NF, MF, and FF locations in 2023.	**Spatial scale – localized, silicon (Si)**; Si is elevated at WAL only. **Temporal trend – stable (Si)**; 2023 Si concentrations appear to be unchanged over all sample years in WAL. **Causality – low (Si)**; the long-term stability and the monthly stability in 2023 of Si concentrations in WAL suggest conditions are not mine related.	Recent temporal water quality analysis for areas in Third Portage Lake (TPE and TPN), Second Portage Lake, and Wally Lake indicates the results conform with the *low* effect rating predicted in the FEIS. This conclusion is corroborated by the phytoplankton and benthos community results, which show relatively diverse, abundant, and stable communities at the NF areas relative to baseline/reference conditions.
Phytoplankton Section 4.4	Chlorophyll-a	There is no trigger for chlorophyll-a for the CREMP. For reference area PDL and NF areas, chlorophyll-a concentrations remained below 1 µg/L in 2023.	Concentrations in the reference area samples typically range between 0.2 and 0.9 µg/L in summer months, reflecting the oligotrophic, nutrient poor condition of these lakes; a trend that has not changed over time.	No predictions in the FEIS.

Monitoring Component (and report section)	**Variable**	**Summary**	**Temporal and Spatial Trend Assessment**[1, 2, 3]	**Annual CREMP Results Compared to FEIS Predictions** (Cumberland, 2005)
Phytoplankton (cont'd) Section 4.4	Total Biomass	Increases in phytoplankton biomass were detected at NF areas in 2023 relative to baseline/reference conditions but were not confirmed by the time-series plots. The magnitude of the BACI analysis increase ranged up to 54% at WAL, however no increases were significant (**Table 4-7**). Nutrient concentrations (i.e., nitrogen and total phosphorus) were similar to baseline (**Section 4.3**).	**Spatial scale – localized**; phytoplankton biomass increased in the BACI analysis at NF areas relative to baseline/reference conditions in 2023, though the increases were not significant. **Temporal trend – stable**; historical biomass and richness levels for the NF areas do not show obvious visual signs of temporal trends for individual NF study areas (**Figure 4-14**). **Causality – low**; SP was the only NF area that received effluent discharge in 2023. The magnitude of the change in biomass at the NF areas TPN, SP, and WAL suggests the observed pattern of increase/decrease in phytoplankton biomass/richness is likely annual variability in the community rather than mine-related.	The absolute biomass values at the NF are comparable to their historical values. Taking into consideration all the lines of evidence (BACI and absolute values plotted over time), there is no evidence to suggest mining operations are increasing primary productivity in the NF areas.
	Taxa Richness	Based on the BACI analysis, the estimated changes in NF areas relative to baseline/reference were small (< 20% effect size) and changes were statistically significant solely at TPE (**Table 4-7**).	**Spatial scale – localized**; slight reductions in taxa richness relative to reference/baseline conditions at TPN, TPE, SP, and WAL. **Temporal trend – stable**; richness has remained stable during the *after* period (**Figure 4-17**). **Causality – low**; there is no indication that mine activities are influencing taxa richness.	Taxa richness for the phytoplankton communities has been stable throughout the 'after' period (i.e., no apparent loss of community diversity).
Sediment Chemistry Section 4.5	Metals	Core samples for sediment chemistry were collected at NF and reference areas in 2023 as part of the coring cycle (i.e., every 3 years with EEM). The results were compared to triggers/thresholds. Parameters with mean concentrations exceeding the trigger value were formally tested using a before-after (BA) statistical model to assess whether concentrations are increasing over time. The mean sediment concentrations exceeded the trigger for chromium at TPE. These increases were all statistically significant. Grab samples were collected alongside benthic invertebrate samples. Grab sample results were analyzed for grain size, moisture, and TOC. Grab sample results are used to support benthic invertebrate interpretation.	**Spatial scale – localized**; The only trigger exceedance was for chromium at TPE. **Temporal trend – stable;** Chromium concentrations at TPE consistently trended higher from 2009-2013 (i.e., onset of the mine development) (**Figure 4-23**). The pattern since 2013 has been variable, but appears to have been decreasing since 2017. **Causality – high (Cr)**; increasing concentrations of Cr in sediment at TPE were likely related to use of ultramafic rock for dike construction.	The FEIS noted that release of effluent (i.e., settling of TSS and altered sediment chemistry) *may impact benthos.*
	Hydrocarbons	Sediment hydrocarbon concentrations in grab samples were below detection for all sampling areas in 2023.	Hydrocarbons are not contaminants of potential concern for the CREMP based on recent and historical results. There have been no instances of measured concentrations attributable to site-related activities during the monitoring period.	No predictions in the FEIS.

Monitoring Component (and report section)	Variable	Summary	Temporal and Spatial Trend Assessment[1, 2, 3]	Annual CREMP Results Compared to FEIS Predictions (Cumberland, 2005)
Benthos Section 4.6	Total Abundance	Benthic invertebrate communities at the NF areas were monitored in 2023. Decreased abundance at TPE, TPN, and WAL relative to reference/baseline conditions in 2023. No statistically significant differences were reported in the BACI. Abundance at TPE and TPN showed reductions in annual comparisons back to 2020, however variability was consistent with baseline sampling results.	**Spatial scale – localized**; lower abundance (based on the BACI analysis) observed at TPE, TPN, and WAL. Changes exceed 20% effect size, but were not significant. **Temporal trend – stable**; abundance (absolute values) at TPE, TPN, and WAL was lower in 2023 compared to the last three years but was consistent with the range observed in baseline (**Figure 4-28**). **Causality – low**; the 'apparent' reduction in abundance in the BACI analysis was not significant.	The identification of potential mine-related impacts generally involves visually examining the data for spatial/temporal patterns that matched mine-related events. An apparent reduction in total abundance was identified in the BACI analyses in 2023, but the results were not significant in the BACI analysis (**Figure 4-28**).
	Total Richness	Apparent increases above the 20% effect size at SP in all time periods back to 2020 and at TPN for periods from 2022-23. The only change that was statistically significant was the 2020-23 time period at SP. Taxa richness in 2023 at the NF areas are still within the range of baseline.	Richness continues to track higher for most areas. The benthic communities are dominated by chironomids, and the relative proportion of major taxa remains stable at all areas.	No predictions in the FEIS.

Table ES-2. Summary of key findings from the 2023 Whale Tail CREMP.

Notes:
1. Temporal and spatial trends are outlined for monitoring components and variables that exceeded trigger or effects-based thresholds (i.e., apparent change from baseline).
2. Spatial scale ratings are: localized = small area within the lake/area; widespread = basin to whole lake.
3. Causality ratings are: low = no evidence of a mine-related source; moderate = some likelihood of a mine-related source; high = the source of the change is likely mine-related.

Monitoring Component (and report Section)	**Variable**	**Summary**	**Temporal and Spatial Trend Assessment**[1, 2, 3]	**Monitoring Results Compared to FEIS Predictions (Golder, 2019) and AMP Thresholds**
Limnology Section 5.2	Temperature and Dissolved Oxygen	The limnology profiles collected in 2023 show dissolved oxygen readings are consistent with range of conditions observed in previous monitoring cycles (2015 –2022). The maximum reported temperatures in 2023 were elevated at all of the study lakes, including reference. The shallower headwater lakes surrounding Whale Tail (e.g., WTS and KAN/MAM) generally demonstrated the highest increases compared to previous year, while the larger, deeper reference lakes showed muted increases.	For dissolved oxygen, spatial and temporal trends were stable in 2023. In 2023, the maximum reported temperatures in 2023 were elevated at all of the study lakes, including reference.	No predictions in the FEIS.
	Field Measured Conductivity	WTS, KAN/MAM, A20, A76, and NEM all demonstrated conductivity profiles elevated above baseline conditions. The 2023 conductivity profiles for WTS were comparable to 2022 with highest conductivities during discharge periods (i.e., March and May). The conductivity in KAN/MAM indicated a spatial trend with higher conductivity readings in the east basin compared to the west basin. Conductivity readings in KAN/MAM increased from a range of 100-225 to 155-231 µS/cm in 2022 and 2023 respectively. Conductivity in the MF lakes and NEM were comparable to 2022.	**Spatial scale – localized**; Slight spatial trend observed within KAN/MAM (east basin elevated compared to west basin), which appeared to become more well mixed by July. The spatial trend extended to Lake A76, though not to further downstream area DS1. NEM is within a separate watershed and there is no spatial trend to review. **Temporal trend – increasing (WTS, KAN/MAM); stable (A20, A76, NEM, DS1);** similar to 2022, conductivity in WTS appeared to trend upwards during the ice-covered months and during discharge. Apparent increase in conductivity observed in KAN/MAM since late 2018 with conductivities increasing slightly in 2023. Conductivities at NEM, the MF lakes, and DS1 appear to be stable in 2023. **Causality – high (WTS, KAN/MAM);** Spatial and temporal trends at WTS and KAN/MAM suggest mine activities are influencing conductivity. While laboratory conductivity measurements at WTS and KAN/MAM exceeded the trigger in 2023, there is no effects-based threshold for this parameter (**Figure 5-9**).	No predictions in the FEIS.
Water Chemistry Section 5.3	Major Ions and Conventional Parameters	Statistically significant increases above trigger values were observed at all NF areas for TDS, the cations Ca, Mg, K, Na as well as the HCO_3 anion (alkalinity). The effects-based triggers for the remaining anions (Cl, SO_4) were not exceeded, though concentrations track with increases in the other major ions. Statistically significant increases extended to MF areas A20 and A76 for all these parameters.	**Spatial scale – widespread**; the 2023 results indicated changes to WTS and KAN/MAM and to a lesser extent A20 and A76 as well as NEM which is located in a separate watershed. **Temporal trend – increasing (WTS, KAN/MAM); stable (NEM, A20, A76, DS1);** Conditions at WTS have been increasing most markedly, at KAN/MAM increases occurred but were mostly muted. Conditions at NEM have remained stable since 2019. Conditions at A20 and A76 have generally remained stable in 2023 compared to 2022. **Causality – high**; these parameters have increased in the Meadowbank study area lakes and it seems likely that the apparent increase observed in the Whale Tail study area lakes in 2023 follows a similar trend and with more samples in the *after* period, it is easier to assign causality.	Water quality constituents without effects-based CCME thresholds were not incorporated in the magnitude ratings for assigning effects in the FEIS; however, following the intent of the FEIS magnitude ratings, constituents exceeding baseline but below concentrations associated with adverse effects were considered consistent with a *low* magnitude rating. FEIS predictions are for Kangislulik Lake and Whale Tail South. Monthly mean concentrations for several parameters exceeded FEIS predictions but all conform with the *low* effect rating predicted in the FEIS.

Monitoring Component (and report Section)	Variable	Summary	Temporal and Spatial Trend Assessment[1, 2, 3]	Monitoring Results Compared to FEIS Predictions (Golder, 2019) and AMP Thresholds
Water Chemistry (cont'd) Section 5.3	Nutrients	Statistically significant increases above trigger values were observed at WTS, KAN/MAM, and A20 for TKN. Statistically significant increases of total phosphorus occurred at WTS and A20.	**Spatial scale – widespread**; the 2023 results indicated changes at NF and MF locations. **Temporal trend – variable**; Comparing 2022 to 2023, TKN and total phosphorus was increasing at WTS and stable at KAN/MAM and A20. **Causality – moderate**; the changes in TKN and total phosphorus concentrations were restricted to NF and MF areas of the Whale Tail study area lakes, which suggests the apparent changes may be due to mine activities in 2023.	The yearly mean for total phosphorus at WTS and KAN/MAM fell below the FEIS predictions. The AMP Level 0 is in effect for both WTS and KAN/MAM. The full suite of CREMP water sampling is scheduled for 2024.
	TOC and DOC	The yearly mean for TOC and DOC exceeded the trigger in WTS, KAN/MAM, A20, and DS1 in 2023. The BACI analysis indicated that the increases were significant at each of the lakes except for at DS1.	**Spatial scale – widespread**; TOC and DOC were over the trigger at NF (WTS and KAN/MAM), MF (A20), and FF (DS1) areas. **Temporal trend – increasing**; there were apparent increases in TOC and DOC at WTS, KAN/MAM, A20, and DS1 in 2023. **Causality – moderate**; while mining activity and flooded terrestrial areas may be responsible in part for changes in TOC and DOC at the NF and MF lakes, reference locations (INUG and PDL) also indicate an increasing trend in 2023. This trend is also visible in the Meadowbank and Baker Lake study areas. Natural regional factors may be at play in addition to the spatially isolated effects of mining at WTS, KAN/MAM, and A20.	No predictions in the FEIS. The observed trends may be in part due to natural variability. These parameters will be monitored in 2024.
	Metals	Statistically significant increases of total and dissolved lithium were observed at the NF areas WTS and KAN/MAM. These were the only metals where mean annual concentrations exceeded triggers with the exception of dissolved silicon at DS1. Arsenic has not exceeded its trigger value since sampling began, however it has trended upwards in recent years. This parameter is monitored in the receiving environment on a monthly basis under the AMP (**Section 5.3.4**) and also in effluent via the MDMER and Water Licence limits (**Section 5.1**).	**Spatial scale – localized**; mean lithium concentrations exceeded the trigger value at KAN/MAM and WTS, but elevated concentrations did not extend to Lakes A20 or A76. **Temporal trend – decreasing or stable**; lithium concentrations appear to be relatively stable in 2023 relative to 2022. **Causality (Figure 5-12):** **Lithium – high**; the exceedances of lithium have historically occurred at both NF locations (KAN/MAM and WTS). There is a marked increase in this parameter following the start of mining activity in 2018.	*Low* (i.e., < CCME water quality guidelines). For total arsenic, the AMP Level 0 is in effect for WTS and KAN/MAM.
Phytoplankton Section 5.4	Chlorophyll-a	There is no trigger for chlorophyll-a for the CREMP. Chlorophyll-a concentrations varied in 2023 with larger seasonal fluctuations at the NF and MF lakes. Mean annual concentrations at the NF and MF lakes were higher relative to reference.	**Spatial scale – localized**; chlorophyll-a appeared to have increased in WTS and A20 in 2023. There was no formal BACI analysis on this parameter. **Temporal trend – Increase (WTS, A20), variable (KAN/MAM, A76)**; The 2023 mean annual concentration of chlorophyll-a at WTS and A20 exceeded 1 µg/L which is considered characteristic of oligotrophic systems. **Causality – moderate (WTS, KAN/MAM, A20)**; A spatial trend did extend into MF lake A20. Correspondence exists between elevated nutrients and chlorophyll-a at the WTS and A20, though large seasonal fluctuations make interpreting temporal trends challenging.	No predictions in the FEIS. Chlorophyll-a appears to have increased at WTS and A20 in 2023. An increase in productivity is normally indicative of an increase in nutrient concentrations. Nutrients are discussed above with increases also influenced by natural variability in 2023. Nutrients and primary productivity in the water column will be monitored in 2024.

Monitoring Component (and report Section)	**Variable**	**Summary**	**Temporal and Spatial Trend Assessment**[1, 2, 3]	**Monitoring Results Compared to FEIS Predictions (Golder, 2019) and AMP Thresholds**
	Total Biomass	WTS, KAN/MAM, A20, and NEM results showed an increase in biomass compared to baseline conditions. The BACI analysis showed significant increases at WTS and A20 with effect sizes of 102% to 243% respectively.	**Spatial scale – localized**; an increase in phytoplankton biomass was observed at WTS, KAN/MAM, A20, and NEM. **Temporal trend – increase/variable**; statistical analysis indicated a significant increase in biomass at WTS and A20 over baseline/control with signs of increase since 2021. **Causality – moderate**; the increases in biomass were only observed at NF and MF area lakes where mining activities would likely be an influence. An increase in nutrients as shown by the water chemistry data may have influenced phytoplankton growth. The trends observed were similar in terms of seasonal variability but the magnitude of change appeared to be greater at the NF and MF area lakes compared to the reference areas PDL and INUG a further indication of mining influence.	No predictions in the FEIS. The increase in total biomass at NF and MF area lakes but not FF and corresponding increases in nutrient concentrations in water suggest the changes may be attributed to mining activities. Biomass and nutrient patterns will be re-examined in 2024.
	Taxa Richness	Slight decreases in taxa richness were observed at the study lakes, though the changes were not statistically significant (**Table 5-11**).	**Spatial scale – localized**; Though slight decreases were observed relative to baseline/reference, the changes were small and not statistically significant. **Temporal trend – variable**; richness has been variable during the *after* period (**Figure 5-18**). The apparent decreased in richness relative to baseline/reference conditions may be attributed to natural variability due to similar observed trends at reference areas INUG and PDL. **Causality – low**; the decrease in richness relative to baseline suggests there may be influences from mine activities. However, there is uncertainty due the lack of significance.	No predictions in the FEIS. Taxa richness for the phytoplankton communities has been variable throughout the *after* period, however it appears there may be a slight loss in community diversity compared to the baseline period.
Sediment Chemistry Section 5.5	Metals	Core samples for sediment chemistry were collected at WTS, KAN/MAM, NEM, A20, A76 and DS1 in 2023 as part of the coring cycle (i.e., every 3 years with EEM). The results were compared to triggers/thresholds. Parameters with mean concentrations exceeding the trigger value were formally tested using a before-after (BA) statistical model to assess whether concentrations are increasing over time. The mean sediment concentrations exceeded the trigger for arsenic and chromium at WTS, KAN/MAM, and A20, and for copper at A20. These increases were all statistically significant. Grab samples were collected alongside benthic invertebrate samples and analysed for grain size to support interpretation of benthos results.	**(1.) Spatial scale – localized, arsenic (As)**; As concentrations exceeded the trigger at WTS, KAN/MAM, and A20 in 2023. As appears to be higher than in 2020. **Temporal trend – increasing (As)**; Though results are highly variable within years due to spatial heterogeneity, As appears to be higher at WTS, KAN/MAM, and A20 in 2023 compared to 2020 (**Figure 5-22**). **Causality – moderate (As)**; Apparent increases in As in sediment at WTS, KAN/MAM, and A20 in 2023 may be attributed to mining activities. The elevated As concentrations were not seen at lakes further from the mining activities or at reference lakes. Note that arsenic is not demonstrating increasing trend in water chemistry at the Whale Tail lakes. **(2.) Spatial scale – localized, chromium (Cr)**; Cr is elevated at A20, A76 and DS1. **Temporal trend– increasing (Cr)**; mean Cr concentrations at WTS and KAN/MAM may be trending higher since baseline (**Figure 5-24**). At A20, the Cr concentrations were still within baseline. **Causality – moderate (Cr)**; apparent increases in Cr in sediment at WTS, KAN/MAM, and A20 in 2023 may be attributed to mining activities. The elevated Cr concentrations were not seen at lakes further from the mining activities or at reference lakes. **(3.) Spatial scale – localized, copper (Cu)**; Cu is elevated at A20. **Temporal trend – stable (Cu)**; there is an apparent slight increasing trend in Cu at A20. Concentrations in 2023 were within the range of baseline Cu concentrations (**Figure 5-25**).	No predictions in the FEIS for grab sample chemistry.

Monitoring Component (and report Section)	**Variable**	**Summary**	**Temporal and Spatial Trend Assessment**[1, 2, 3]	**Monitoring Results Compared to FEIS Predictions (Golder, 2019) and AMP Thresholds**
			Causality – low (Cu); it appears that the observed pattern of sediment Cu at A20 is due to natural spatial heterogeneity.	
	Hydrocarbons	Sediment hydrocarbon concentrations were below detection for all parameters except mineral oil and grease at A76. There are no ISQG or PEL screening values for this parameter.	Hydrocarbons are not contaminants of potential concern for the CREMP based on recent and historical results. There have been no instances of measured concentrations attributable to site-related activities during the monitoring period.	No predictions in the FEIS for grab sample chemistry.
Benthos Section 5.6	Total Abundance	Benthic abundance was highly variable between replicates and was variable between areas. The BACI showed significant increases for KAN/MAM and NEM across all time periods and significant increases for WTS only in the 2022-23 time period.	**Spatial scale – localized**; in 2023 higher abundance observed at NF and MF locations. **Temporal trend – increasing**; abundance at the NF and MF lakes increased markedly in 2023, though this increase was only significant relative to baseline conditions at KAN/MAM and NEM (**Figure 5-29**). **Causality – moderate**; increases were observed across the NF and MF study lakes in 2023, however this does not necessarily indicate a response to mining. Increases in mine derived nutrients could have a cascading effect on phytoplankton and in turn benthic communities, however natural limnological factors or population cycles can also influence results. Abundance will be monitored in 2024 for sustained increases at the NF and MF lakes.	No predictions in the FEIS.
	Total Richness	The BACI analysis indicated a statistically significant increases at KAN/MAM and NEM in all time-periods. A20 significant in 2022-23, 2021-23 and 2020-23. DS1 significant in 2022-23 only.	**Spatial scale – localized**; significant increases in taxa richness only observed at KAN/MAM, NEM, and A20. **Temporal trend – variable;** taxa richness has been highly variable since the baseline period, though there appears to be an upward trend at KAN/MAM and NEM. **Causality – low;** the benthic communities are dominated by chironomids, and the relative proportion of major taxa remains stable at all areas. There is also little correspondence across the NF study lakes (no significant increasing trends at WTS).	No predictions in the FEIS.

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ACKNOWLEDGEMENTS

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ACRONYMS

AEMP	Aquatic effects monitoring program
AMP	Adaptive management plan
AIC	Akaike information criterion
ANOVA	Analysis of variance
AWAR	All weather access road
BACI	Before/after control/impact
BACIP	Before/after control/impact paired
BAER	Baseline aquatic ecosystem report (for Meadowbank)
BAP	Baker Lake – Akilahaarjuk Point
BBD	Baker Lake – barge dock
BES	Baker Lake – east shore
BPJ	Baker Lake – proposed jetty
CCME	Canadian Council of Ministers of the Environment
COC	Chain of custody
COPC	Contaminant of potential concern
CREMP	Core receiving environment monitoring program
CRM	Certified reference material
DFO	Fisheries and Oceans Canada
DI	Deionized blank
DOC	Dissolved organic carbon
DQO	Data quality objective
DW	Dry weight
EAS	Effects assessment strategy
EB	Equipment blank
EEM	Environmental effects monitoring
EIA	Environmental impact assessment
FEIS	Final environmental impact statement
FF	Far-field
FWAL	Freshwater aquatic life guidelines (e.g., CCME)
GPS	Global positioning system
HCF	Habitat compensation feature
HCMP	Habitat compensation monitoring program
HEPH	Heavy extractable petroleum hydrocarbons

ICP-MS	Inductively coupled plasma mass spectrometry
INUG	Inuggugayualik Lake
ISQG	Interim sediment quality guidelines
KAN	Kangislulik Lake ([KAN]; formerly Mammoth Lake [MAM]; referred to as KAN or MAM)
LCS	Laboratory control sample
LEPH	Light extractable petroleum hydrocarbons
MDL	Method detection limit
MDMER	Metal and Diamond Mining Effluent Regulations
MF	Mid-field area
NEM	Nemo Lake
NF	Near-field
NWB	Nunavut Water Board
PAG	Potentially acid generating
PAHs	Polycyclic aromatic hydrocarbons
PDL	Pipedream Lake
PEL	Probable effect level
QA/QC	Quality assurance / quality control
REF	Reference
RPD	Relative percent difference
SEP	Sequential extraction procedure
SOP	Standard operating procedure
SP	Second Portage Lake
SQG	Sediment quality guidelines
SSD	Species sensitive distribution
SSWQO	Site specific water quality objective
TDS	Total dissolved solids
TE, TEFF	Tehek Lake sampling areas
TIA	Tailings impoundment area
TKN	Total Kjeldahl nitrogen
TOC	Total organic carbon
TP	Total phosphorus
TPE, TPN, TPS	Third Portage Lake sampling areas
TSF	Tailings Storage Facility (North and South Cells)
TSS	Total suspended solids
UTM	Universal Transverse Mercator

WAL	Wally Lake
WOE	Weight of evidence
WQG	Water quality guideline
WRSF	Waste rock storage facility
WTN, WTS	Whale Tail Lake – North and South basins

REPORT ORGANIZATION

The 2023 Core Receiving Environment Monitoring Program (CREMP) report is organized into a main document and six appendices (A through F). An overview of the various sections of the report is provided to help guide the reader as they navigate the document.

Executive Summary provides a high-level summary of the monitoring results by study area (Meadowbank, Whale Tail, and Baker Lake).

Section 1 introduces the CREMP with overview of the environmental setting for the project. The pace and scope of mining development is also outlined to catalogue how the CREMP has been implemented to monitor changes in the aquatic receiving environment.

Section 2 outlines elements of the CREMP study design including sampling areas, a description of the routine monitoring components, details regarding any targeted studies conducted for a given cycle, and the statistical framework used to assess spatial and temporal changes in chemistry (water and sediment) and biological communities (phytoplankton and benthic invertebrates).

Section 3 summarizes results of the detailed quality assurance and quality control assessment (QA/QC) presented in **Appendix A**.

Section 4 (Meadowbank), **Section 5** (Whale Tail), and **Section 6** (Baker Lake) are stand-alone chapters detailing the results of the spatial and temporal trends in water quality, sediment chemistry, and biological community health (phytoplankton and benthos) specific to each study area. Figures and Tables are included at the end of each section.

Section 7 provides recommendations for the scope of the 2024 CREMP for Meadowbank, Whale Tail, and Baker Lake study areas.

1 INTRODUCTION

This CREMP report documents the methods and results of aquatic receiving environment monitoring activities completed at Meadowbank, Whale Tail, and Baker Lake study areas in 2023. As in previous years, this report integrates historical data to identify changes in limnology or water chemistry parameters, sediment chemistry, phytoplankton biomass and benthic community structure associated with mine-related activities at Meadowbank (since 2006), Whale Tail (since 2018), or in Baker Lake (since 2008).

1.1 Development of the Aquatic Monitoring Program

Agnico Eagle Mines Ltd.'s (Agnico Eagle) Meadowbank Complex is situated approximately 75 km north of the hamlet of Baker Lake, Nunavut. The aquatic monitoring program has evolved since its inception in 2005; terms and acronyms used to describe the aquatic monitoring programs for the Meadowbank Complex are described below:

AEMP

The AEMP acronym was first used in the 2005 report *(Aquatic Effects Management Program*[3]; Azimuth, 2005a). The AEMP was developed to address issues identified during the Environmental Impact Assessment (EIA) process that could potentially impact the aquatic receiving environments surrounding the development. The scope of the original AEMP described the rationale, framework, strategy, methods, and scope of receiving environment monitoring for the Meadowbank mine. Receiving environment monitoring conducted in 2006 and 2007 use the term *AEMP* in the annual report titles[4].

Agnico Eagle has several monitoring programs (e.g., effluent monitoring, ground water monitoring, air quality monitoring) relevant to tracking potential changes to the aquatic receiving environment surrounding the Meadowbank mine. A restructuring of the AEMP was completed in 2012 (Azimuth, 2012c) to broaden the scope of the AEMP to serve as the overarching 'umbrella' strategy that provides an opportunity to integrate results of individual, but related, monitoring programs (e.g., construction, groundwater, water quality and flow, air quality) in accordance with the original Nunavut Water Board (NWB) Type A Water Licence requirements. On an annual basis, the restructured AEMP brings in the results of the individual monitoring programs, assesses them using a site-specific conceptual model

[3] The 2005 AEMP refers to the original AEMP document that served as the blueprint for the CREMP until the CREMP Design Document 2012 (Azimuth, 2012d) was completed.

[4] The Nunavut Water Board Type A License, issued in 2008 and renewed in 2015, defines the "AEMP" as the *Aquatic Effects Monitoring Program*; annual receiving environment monitoring reports since 2008 reflect this subtle change.

framework and recommends specific management actions to address potential issues. Previously, the term *AEMP* was essentially synonymous with receiving environment monitoring. Given the AEMP's broadened scope, more specific terminology (i.e., CREMP; see below for more details) was developed when referring to aquatic receiving environment monitoring for the Meadowbank mine. The AEMP Plan was updated in 2022 (Version 5). The report was included in Agnico Eagle's Annual Report for review by the NWB.

CREMP

CREMP is the acronym for Core Receiving Environment Monitoring Program. This term, which is synonymous with *core monitoring program* was first used for the 2009 annual report. It encompasses the core receiving environment monitoring program dating back to 2006. The study design for the CREMP was reviewed and formalized in 2012 (*Core Receiving Environment Monitoring Program (CREMP): Design Document 2012*; Azimuth, 2012d), but has its origins in the AEMP (Azimuth, 2005a). The 2012 design document reviewed all historic monitoring CREMP data, presented the trigger/threshold derivation process (see **Section 1.5** for description of triggers/thresholds), determined trigger/threshold values for individual parameters, and established the experimental design to optimize the program. The resulting triggers/thresholds and experimental design changes have been integrated into the CREMP since 2012.

The *CREMP Plan*, which is the "how-to" manual for conducting aquatic receiving environment monitoring at the Meadowbank Complex, is updated from time to time to adapt the program to reflect the state of development of the site. The 2022 update (*CREMP: 2022 Plan Update*; Azimuth, 2022b) involved integrating the 2015 version of the *CREMP Plan* (Azimuth, 2015b) with an addendum that focused on the Whale Tail Expansion Project. The only notable technical change in the 2022 version of the *CREMP Plan* is in the frequency of benthic invertebrate and sediment chemistry monitoring in Baker Lake, which moved to a three-year cycle rather than annually, coinciding with the sediment coring program starting in August 2023. This change is supported by the long-term data that clearly shows the benthic invertebrate communities are stable relative to baseline and reference conditions.

1.2 Environmental Setting

1.2.1 Meadowbank and Whale Tail Study Areas

The Meadowbank and Whale Tail mines (collectively termed the Meadowbank Complex) are situated in the barren-ground central Arctic region of Nunavut within an area of continuous permafrost known as the Wager Bay Plateau (Campbell et al., 2012). These are headwater, ultra-oligotrophic/oligotrophic (nutrient poor and unproductive) lakes, situated on the watershed boundary that separates two main drainages – the Arctic and Hudson Bay drainages. Only a few hundred meters to the north of Second and

Third Portage lakes is the divide between water that flows north to the Arctic Ocean (via the Meadowbank and Back River system) or to Chesterfield Inlet and Hudson Bay (via the Quoich River system). Lakes near the Meadowbank mine (i.e., Third Portage, Second Portage, and Tehek) flow into the Quoich River system, while CREMP reference lakes (Tasirjuaraajuk Lake; aka Pipedream Lake [PDL] and Inuggugayualik [INUG]) and lakes in the vicinity of Whale Tail flow north via the Meadowbank and Back River system (**Figure 1-1**).

The local landscape around Meadowbank and Whale Tail consists of rolling hills and relief with low-growing vegetative cover and poor soil development. Numerous lakes are interspersed among boulder fields, eskers and bedrock outcrops, with indistinct and complex drainages. As is common of headwater lakes, all the project lakes have small drainage areas relative to the surface area of the lakes themselves. Local inflow from surrounding terrain is the predominant influence on water movement within the system. Small channels connect the project area lakes, although there is little flow between lakes except during freshet and possibly none during winter months. Movement by fish between lakes is also rare, as populations remain quite isolated from one another. The ice-free season on these lakes is short, with ice break-up typically in late-June to mid-July and ice-up beginning in late September or early October. Maximum ice thickness is often 2 m thick or more by March or April.

The Meadowbank and Whale Tail area lakes support healthy communities of plankton, benthos, and fish that are typical of oligotrophic Arctic lakes (Azimuth, 2005b). Biological productivity of the lakes is limited by nutrient availability, cold water, and a short growing season.

1.2.2 Baker Lake

Baker Lake receives drainage from three major river systems that drain much of the central Arctic: the Thelon River, the Kazan River, and the Dubawnt River (Hutchinson et al., 2018). Baker Lake is the fifth largest lake in Nunavut with a surface area of approximately 1,900 km^2 and 90 km from the mouth of the Thelon River to the narrows at the eastern end of the lake (Nunami, 2007). Water quality in Baker Lake is indicative of a nutrient poor, low alkalinity, soft water Arctic Lake (Hutchinson et al., 2018). Analysis of surface water for metals analysis indicate dilute concentrations throughout Baker Lake with no reported exceedances of human health or freshwater quality guidelines. Water quality in Baker Lake is strongly influenced by freshwater inputs during freshet; results from the lake-wide survey completed by Hutchinson et al. (2018) show only weak spatial and seasonal patterns in water quality except for conductivity.

Specific conductivity measurements collected throughout the monitoring period occasionally detect the influence of the deep marine-water influence in Baker Lake. A report by Johnson (1965) suggested three scenarios to explain saline conditions in Baker Lake: 1) ancient seawater trapped during isostatic rebound following glacial retreat, 2) seawater seeping into Baker Lake near the outlet, and 3) seawater entering Baker Lake driven by tides and storm events. Data generated from a more recent 3-year limnological study in Baker Lake between 2015 and 2017 suggest scenario 3 is the most likely explanation for saline water in Baker Lake. The channel or sill separating Baker Lake from marine influence is shallow and strong tidal currents and higher tidal amplitude at Chesterfield Inlet compared to other regions in Hudson Bay could contribute saltwater to Baker Lake (Hutchinson et al., 2018). Conductivity readings over 1,000 µS/cm were recorded at depths between 10 and 20 m at locations further away from the influence of freshwater from the Thelon River (Hutchinson et al., 2018). Spring freshet is postulated as a key factor that prevents saline water from accumulating in Baker Lake year-over-year.

1.3 Mine Development and Operation

An overview of the mine development for the Meadowbank Complex is provided below. A list of within-year site activities and a summary of previous CREMP results dating back to 2008 are provided in **Table 1-1**.

1.3.1 Meadowbank

The construction phase of the Meadowbank mine officially started in June 2008, upon receipt of the NWB A Water Licence (2AM-MEA0815; renewed to 2AM-MEA1525 in 2015, amended to 2AM-MEA1526 in 2018 and to 2AM-MEA1530 in 2020) for the project. The Fisheries and Oceans Canada (DFO) Fisheries Act Authorization (NU-03-0191) for the project was issued on July 30, 2008, thus allowing the start of in-water construction activities. Dike construction at Second Portage (East Dike) and Third Portage Lake (Bay-Goose Dike) between 2008 and 2010 allowed development of the open pit deposits. The mine officially opened on February 27, 2010, marking the start of the operations period. Five deposits were mined in the 10 years of operations: North Portage, South Portage, Bay-Goose, Vault Phaser, and BB Phaser. Mining operation ceased in 2019 at Meadowbank Site but the mill is still in operation and processes the ore from Whale Tail mine. In addition to mill operations, key ongoing activities involve reclaim water use and tailings discharge, monitoring for seepage into Portage, as well as management of East Dike seepage.

1.3.2 Whale Tail

The Whale Tail mine is situated within the Amaruq property, a 408 km^2 exploration area on Inuit and federal crown land. The Whale Tail mine is located approximately 50 km northwest of the Meadowbank mine and is connected by a 64 km all-weather access road that was completed in 2018. The Whale Tail mine is permitted under a separate NWB license, 2AM-WTP1830, with ore being trucked to Meadowbank to take advantage of the existing infrastructure (e.g., mill, tailings storage, air strip). The Whale Tail mine is made up of three locations of active ore extraction. These include the Whale Tail Pit, IVR Pit, and the underground mine. Major in-water construction activities at Whale Tail from 2018 to 2023 included:

- Dike construction in Whale Tail Lake
- Mammoth Dike Construction
- Fishout of the isolated north basin of Whale Tail Lake
- Road construction around Kangislulik Lake (KAN/MAM)[5]
- Dewatering and surface water management at Whale Tail Lake (South Basin; WTS) and KAN
- Construction and completion of the diversion channel between WTS and KAN
- Dewatering and fishout of lakes in the footprint of the IVR Pit and IVR WRSF and the future attenuation pond
- Completion of the IVR diversion channel
- Construction of Whale Tail Dike Thermal Berm in 2023.

1.3.3 Baker Lake

The hamlet of Qamani'tuaq (aka Baker Lake) located on the northwest shore of Baker Lake is the point of entry for fuel, equipment, and goods arriving by barge. Open-water access to the hamlet from Chesterfield Inlet on Hudson Bay is limited to approximately 2.5 months from the end of July through to mid-October, depending on annual ice conditions. Goods and fuel typically travel from Quebec, around Labrador, and through Hudson Straight. Cargo and fuel tanker vessels moor in Chesterfield Inlet and shallow draft ships or barges pulled by tugs are used to navigate the channel that connects Baker Lake with Chesterfield Inlet (Agnico Eagle, 2018). Dry goods are transferred at a floating dock facility to the east of the hamlet (CREMP area BPJ is the closest sampling area). Fuel is transferred from the barges to an 80-million-liter capacity tank farm located upgradient from the floating dock. Equipment, goods, and fuel are trucked year-round from the hamlet to Meadowbank via 110 km all-weather access road (AWAR) completed by Agnico Eagle in 2008.

Monitoring at Baker Lake began in 2008, coinciding with the first barge season. The number of barge trips for fuel and goods dating back to 2008 are shown in **Figure 6-2**.

1.4 CREMP Objectives

The CREMP focuses on identifying changes in limnological parameters, water and sediment chemistry, and in primary (phytoplankton) and secondary (benthic invertebrate community) aquatic producers that

[5] Kangislulik Lake (KAN) was previously referred to as Mammoth Lake (MAM).

may be associated with mine development activities. This is accomplished through the application of a temporal/spatial trend assessment that includes the application of quantitative decision criteria (i.e., early warning *triggers* and action *thresholds*) to facilitate immediate and objective decision-making regarding appropriate management actions. This information is integrated annually into the Aquatic Ecosystem Monitoring Program (AEMP) for holistic environmental management and decision making.

The 2005 AEMP framework (Azimuth, 2005a) presented a receiving environment monitoring strategy consisting of two components:

Core Receiving Environment Monitoring Program – was designed based on our understanding of mine construction, operation, and infrastructure (e.g., dikes, effluents, stream crossings, roads, etc.) and has been developed to detect mine-related effects at temporal and spatial scales that are ecologically relevant. The program was expanded to include Baker Lake in 2008 and Whale Tail in 2018. The program was updated based on the recommendations of the *CREMP: Design Document 2012* (Azimuth, 2012d) and more recently, described in detail in the *CREMP Plan* (Azimuth, 2015b) and *Whale Tail Pit Addendum* (Azimuth, 2018b), and the *CREMP Plan Update* (Azimuth, 2022b). The study design is based on a before-after-control-impact (BACI) approach, but has also incorporated the concept of gradients in exposure (e.g., by incorporating near-field, mid-field, and far-field areas in addition to reference areas).

Targeted Studies – are designed to address specific questions related to mine development during construction or operation and typically have narrower temporal or spatial bounds. These results are integrated with and complementary to the routine CREMP. Examples include dike construction monitoring (e.g., Azimuth, 2009a) and the total suspended solids (TSS) effects assessment studies (EAS) (e.g., Azimuth, 2009b). Recently, targeted studies have been carried out to determine the toxicity and bioavailability of metals in sediments at TPE (Azimuth, 2016; Azimuth, 2020a).

1.5 CREMP Strategy

CREMP reporting for the Meadowbank and Baker Lake study areas changed substantially starting in 2011 with a stronger focus on assessing potential temporal and spatial trends in the data related to mining activity. Greater emphasis is now placed on identifying changes to support the AEMP (**Section 1.1**) and ultimately the environmental management process, rather than on providing a detailed description of the annual results in isolation. To that end, this CREMP report applies numerical decision criteria (i.e., triggers and thresholds) to assess the magnitude of change in CREMP monitoring variables (e.g., water quality, sediment chemistry, lower trophic level communities [i.e., phytoplankton and benthos]). The same approach has been applied at the Whale Tail study area for 2023; in 2019 this study area transitioned from the baseline 'before' period to the 'after' period.

The 2012 AEMP (Azimuth, 2012c) with updates in 2022 (Azimuth, 2022b) described a two-tiered approach (**Figure 2-2**) for evaluating changes in the monitoring components (e.g., water quality, benthos community) based on 'trigger' and 'threshold' level changes:

- **Trigger values** are typically lower or more conservative than threshold values. They serve as early warning criteria that might lead to action. Exceedance of a trigger value does not necessarily imply that an adverse effect may be expected. The triggers may be based on absolute numbers (e.g., an increase half-way from baseline to an identified effects-based threshold) or statistical criteria (e.g., statistically significant trend that predicts exceedances of a threshold within 3 years).
- **Effects-based thresholds** are legal requirements, regulatory guidelines (e.g., CCME), or other discrete benchmarks, below which unacceptable adverse effects are not expected and above which adverse effects may occur. If effects-based thresholds do not exist or are not warranted for a variable, then early warning triggers will be developed without thresholds. In such cases, if triggers are exceeded then the implications of such exceedances can only be understood through the integration of results from other AEMP monitoring programs, or, if important information gaps still exist, through focused studies (e.g., risk assessment).

Comparison of the data to trigger values is the initial analytical focus. If trigger values are exceeded, the data are then compared to the applicable effects-based thresholds (if available[6]). Details regarding the derivation of trigger and threshold values for the CREMP are presented in the *CREMP: Design Document 2012* (Azimuth, 2012d).

In addition to triggers and effects-based thresholds, the results are also compared to water quality predictions developed as part of the Federal Environmental Impact Statement (FEIS) process (see **Section 2.3.1** for more details). The FEIS predictions provide context for whether any observed changes in water quality are consistent with expectations for the approved projects at two levels:

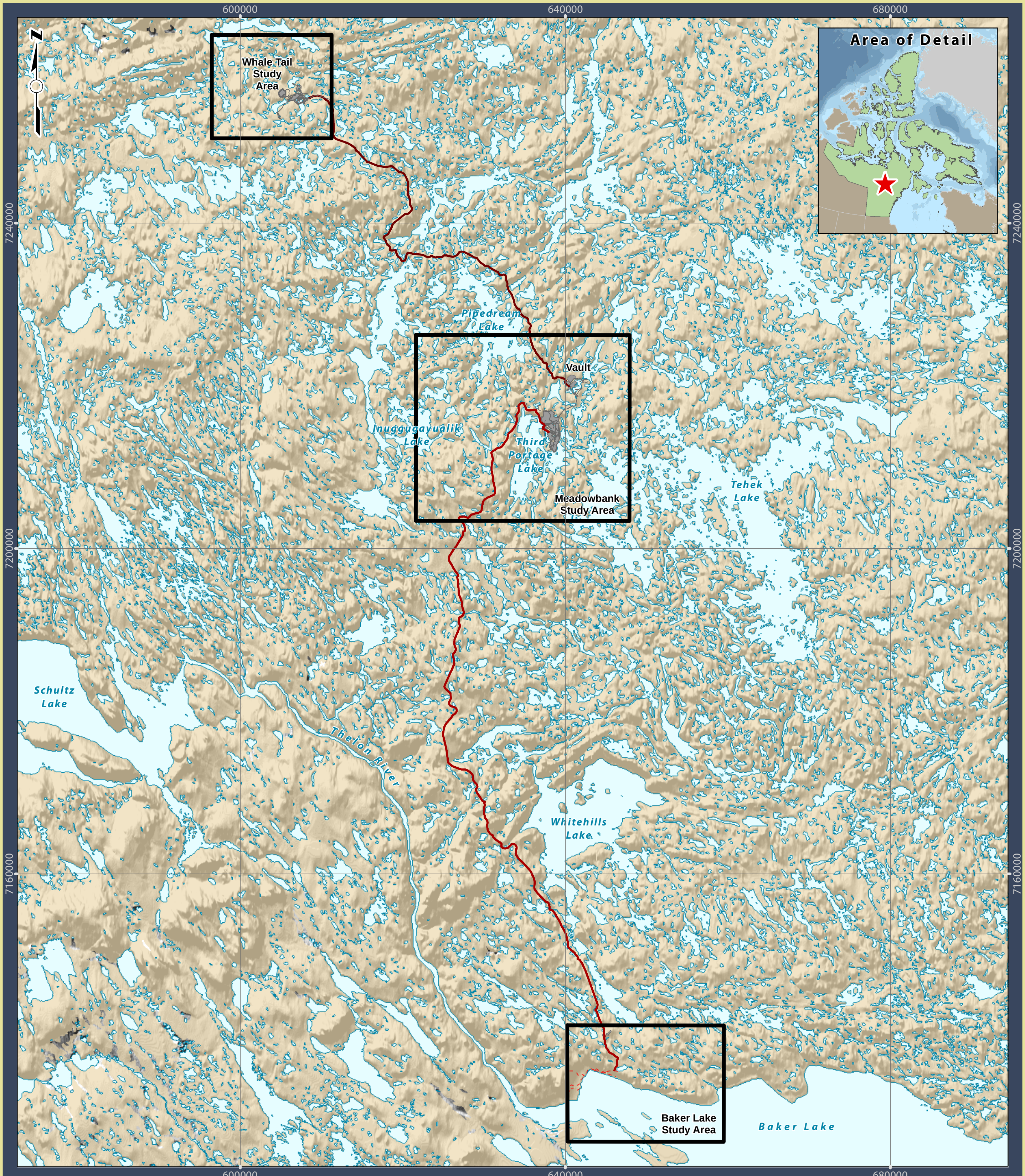
1. Numerical predictions – the actual concentrations predicted to occur for a suite of parameters. Given the uncertainties associated with water quality model development, these predictions are provided as a guide only.
2. Narrative predictions – these were categorical predictions used to classify the expected magnitude of change, typically relative to baseline conditions and water quality guidelines (see **Section 2.3.1**).

[6] For water and sediment quality, effects-based thresholds were generally set to existing environmental quality guidelines. Thresholds were not derived in cases where guidelines were unavailable or when baseline concentrations naturally exceeded existing guidelines (e.g., some metals in sediment).

The application of trigger and effects-based threshold values complements the spatial-temporal trends assessment initiated in the 2011 CREMP (Azimuth, 2012a), which used trend plots (each showing monitoring results since 2006) to identify patterns of change consistent with one or more of the mining activities described in **Section 1.3**.

The general rationale for conducting the trend assessment followed these principles:

- **Establish Expected Conditions** – Control data, i.e., combination of baseline [i.e., pre-mining] data from impact areas and data from remote reference or control areas) were examined to set expectations for a parameter (e.g., water or sediment metal concentration) in the absence of mining activity (see **Table 2-3**). Baseline data were used to infer relative spatial differences (e.g., between a NF and Ref area) and reference data were used to infer regional temporal changes (e.g., the regional decrease in benthic community abundance between 2009 and 2010).
- **Compare Patterns of Change** – With expected conditions in mind, impact data (i.e., data collected at NF and MF areas after the onset of mining-related activity in proximity to an area; see **Table 1-1**) were assessed visually for spatial-temporal patterns (e.g., short-term [in any year] spikes [rapid rises that return to baseline] or longer-term trends [gradual or rapid increases that persist]) matching mining activity (e.g., rise in TSS concentrations at SP in August 2008). Where observed, the spatial and temporal extent and magnitude of the changes were characterized (i.e., do they extend to MF or FF areas, and if so, at what magnitude/duration?).
- **Provide Context for Magnitude of Change** – As discussed above, site-specific triggers and effects-based thresholds and FEIS predictions were used to provide some context for observed changes to CREMP monitoring parameters. In addition, where applicable and available, results of target studies (e.g., TSS EAS studies) were used to help interpret changes in biological parameters and endpoints.
- **Identify Parameters for Management** – Identify parameters requiring management action on one of two levels: continued trend monitoring (i.e., to follow low magnitude or weak trends), or active follow-up with more detailed quantitative assessment (i.e., a targeted study to address a potential concern). This process will emphasize issues or concerns present in this year's CREMP results.



Legend

- Figure Extents
- Mine Sites
- All-Weather Access Road
- Whale Tail Haul Road
- River
- Lake

0 5 10 15 20

Kilometres

Projection: UTM Zone 14 NAD83

Data Sources:
Natural Resources Canada, GeoBase®
National Topographic Database
Agnico-Eagle Mines Limited.
Azimuth Consulting Group Inc.

Figure 1-1. Meadowbank – Complex Study Area Overview

Meadowbank Gold Project

Prepared for: AGNICO EAGLE

By: CASLYS CONSULTING

February 2024

Table 1-1. Chronology of major mine development and operational activities, along with corresponding receiving environment findings since 2008.

Note: The summary provided here pertains to Meadowbank (since 2008) and Whale Tail (since 2018) study areas.

Year	Major Mine-Related Activities	Receiving Environment Overview
2008	• Major in-water construction activities included the East Dike (located in Second Portage Lake) and the Western Channel Dike (located between Third Portage Lake and Second Portage Lake); the closest CREMP sampling area to these activities was the Second Portage Lake area (SP). • Other site-related activities included rock crushing, road building, pit blasting, ground preparation, and infrastructure construction. • Barge traffic increases in Baker Lake to support construction.	• As described in detail elsewhere (Azimuth, 2009a; 2009b), East Dike construction led to a sedimentation event that extended through Second Portage Lake (SP) to Tehek Lake (TE). The potential impact of construction-related sediment releases to the aquatic environment was the focus of the four-year EAS study (Azimuth, 2009b, 2010d, 2011a, 2012c).
2009	• Dewatering discharges (i.e., impounded Second Portage Lake water with TSS) were directed primarily into the north basin of Third Portage Lake (TPN), but also into Second Portage Lake (March to July and Oct to Dec, 2009). • Bay-Goose Dike construction started in late July 2009. • Most of the site preparation and road infrastructure was completed in 2009. • North Portage Pit was the primary focus of blasting and mine operations. • Barge traffic increases in Baker Lake.	• Despite several precautions, storm winds broke the Bay-Goose Dike turbidity barrier containment system, leading to another sedimentation event in late August. • Elevated TSS (and other parameters) was primarily restricted to east basin of Third Portage Lake (TPE) and to a minor extent into SP and TE. The implications of the release were assessed in the EAS study (see above).
2010	• Bay-Goose Dike construction completed using additional mitigation measures. • Mine officially opened on 27 Feb 2010, marking the start of the operations period. • Pit development focused on North Portage and South Portage pits • Waste rock to rock storage facility (RSF). Tailings to impoundment area (TIA). Contact water from operations not discharged to receiving environment. • Dewatering of SP impoundment to TPN continued, with discharge now subject to MMER • Barge traffic increases in Baker Lake.	• Bay-Goose Dike construction leads to less-pronounced sedimentation event in TPE and extends through SP to TE; EAS studies continue. • TPN (dewatering) TSS concentrations generally consistent with baseline conditions.
2011	• Mining operations focus on North Portage and South Portage pits. • Waste rock to rock storage facility (RSF). Tailings to impoundment area (TIA). • Construction activities limited to mine footprint. • Dewatering of SP and TPE to TPN continued, with treatment added to reduce fine sediment and turbidity. • Barge traffic stabilizes in Baker Lake.	• TPN focus of routine EEM study - no mine-related effects detected (Azimuth, 2012e). • TPN TSS concentrations consistent with baseline. • The TSS EAS targeting dike construction sedimentation events completed.
2012	• SP and TPE dewatering discharges to TPN finished by spring. Diffuser installed and effluent (mix of residual Bay-Goose water, contact water, East Dike seepage and run-off) discharge to TPN commences; treatment (for fine sediment, turbidity) continues. • North cell non-contact water diversion ditches completed in August (intercepting run-off prior to the tailings and waste rock areas and diverting to NP2 and Dogleg ponds). • Vault access road constructed and site preparation activities for the Vault Pit and Vault Dike commence. • Barge traffic remains stable in Baker Lake; 200-L diesel spill occurs, but cleaned up successfully.	• TPN TSS concentrations generally consistent with baseline. • Minor mine-related trends identified for several water chemistry parameters at near-field areas: conductivity, sulphate and total dissolved solids. • Spill-related monitoring shows no traces of hydrocarbons in Baker Lake.
2013	• Effluent discharge to TPN continued. • Fishout activity in Vault lake was completed. • Vault lake was dewatered into Wally Lake (ongoing) and did not require TSS treatment. • Minor construction modifications to north cell diversion ditches completed. • Completion of the Airstrip extension (18m) into Third Portage Lake in March. • Seepage from Rock Storage Facility (ST-16) through the road into NP2 identified (additional monitoring in NP2 to evaluate near-shore water quality).	• TPN TSS concentrations consistent with baseline. • Minor mine-related trends identified for several water chemistry parameters at near-field areas: alkalinity, conductivity, calcium and total dissolved solids. • TPE sediment chromium concentrations were elevated above trigger value; better spatial coverage needed to reduce uncertainty in 2014.

Year	Major Mine-Related Activities	Receiving Environment Overview
2014	• Effluent discharge to TPN from the Portage Attenuation Pond occurred only from June 10 to July 5. Discharge to TPN is now complete. The former Portage Attenuation Pond has now become the South Cell for tailings deposition. • EEM Cycle 2 Study Design was conducted at the end of August through the beginning of September (no TPN discharge at this time). • Vault Dewatering into Wally Lake from June 20 to 29 (now complete); discharge from Vault Attenuation Pond into Wally Lake from July 24 to August 14. No TSS treatment for Vault Discharge. • New discharge into Second Portage Lake during all of 2014 (except from May 3 to July 28): two seepage collection points (North and South) are situated on west side of the East Dike to collect seepage through dike from SP. Water is pumped from both collection points, which are connected together before discharging back into Second Portage Lake through a diffuser. No TSS treatment for East Dike Discharge. • No seepage water from Rock Storage Facility (ST-16) reaching the NP2 Lake in 2014. • Commercial mining in Vault Pit started at the beginning of 2014. No major construction or modifications in 2014.	• Minor mine-related trends identified for a number of water chemistry parameters at near-field areas: conductivity, hardness, Ca/Mg/K/Na and total dissolved solids. • Temporal trend in TPE sediment chromium confirmed in coring study; targeted study recommended for 2015.
2015	• No discharge to TPN in 2015. • Vault discharge to Wally from July 7 to September 10. No TSS treatment needed. • East dike (North-South) discharge to SP all year except from June 16 to August 10. Discharge was stopped for increasing TSS levels as no treatment is available for this location. The discharge from East Dike that was not directed to 2PL was discharged in the Portage Pit and then pumped to the South Cell TSF (Tailings Storage Facility). • No seepage water from Rock Storage Facility to NP-2. Monitoring ongoing. • HCMP work completed for TP, SP and Dogleg lakes and at water crossing R02 along the AWAR. • One incident of elevated TSS from Vault road culverts to NP-1, early June, during freshet. Barriers installed. No impacts observed to Dogleg Lake.	• Minor mine-related trends identified for a number of water chemistry parameters at near-field areas: conductivity, hardness, Ca/Mg/K/Na and total dissolved solids. Parameters with effects-based thresholds (e.g., CCME water quality criteria) were below their respective trigger values in 2016. • Targeted sediment bioavailability and toxicity testing was completed at TPE. Toxicity test results on *Chironomus dilutus* and *Hyalella azteca*, combined with sequential extraction tests on the sediment, indicated current chromium concentrations at TPE are unlike to adversely affect the benthic invertebrate community. Continued monitoring was recommended for 2016, but addition target studies were not recommended for 2016. • Phytoplankton and benthic invertebrate community results for the impact areas were within the range of reference/baseline conditions.
2016	• Vault discharge to Wally from June to September. No TSS treatment needed. • East dike (North-South) discharge to SP all year. • No seepage water from Rock Storage Facility to NP-2. Monitoring ongoing. • Phaser lake dewatering - August 26 to September 10 and September 15 to October 4. • Phaser Lake fishout from August 13 to 31 and September 10 to 25. • No Goose Pit reflooding activities. • Pit E and pushback assessment. • Mining focused on Vault Pit and Pit A. • Amaruq exploration road construction (km 25 at end of 2016).	• Minor mine-related trends identified for a number of water chemistry parameters at near-field areas: conductivity, hardness, Ca/Mg/K/Na and total dissolved solids. • Similar trend of elevated chromium in sediment grab samples from TPE, but the concentrations appear stable relative to those measured in 2015. • Phytoplankton and benthic invertebrate community results for the impact areas were within the range of reference/baseline conditions.
2017	• Vault discharge to Wally from June to October. No TSS treatment needed. • East dike (North-South) discharge to SP all year except from May 12 to September 5. Discharge was also stopped from September 23 to October 29. Discharge was stopped for increasing TSS levels as no treatment is available for this location. The discharge from East Dike that was not directed to SP was discharged in the Portage Pit and then pumped to the South Cell TSF (Tailings Storage Facility). • No seepage water from Rock Storage Facility to NP-2. Monitoring ongoing. • No Goose Pit reflooding activities. • Mining focused on Vault Pit and Pit A, Pit E, and Phaser Pit. • Amaruq exploration road completed. • Phaser Pit started in November. • HCMP work completed for TP, SP and Dogleg lakes and at water crossing R02 along the AWAR. • One incident of elevated TSS from Vault road to NP-1, early June, during freshet. Barriers installed. No impacts observed to Dogleg Lake.	• Minor mine-related trends identified for a number of water chemistry parameters at near-field areas: conductivity, hardness, Ca/Mg/K/Na and total dissolved solids. Parameters with effects-based thresholds (e.g., CCME water quality criteria) were below their respective trigger values in 2017. • Phytoplankton and benthic invertebrate community results for the impact areas were within the range of reference/baseline conditions. • Core chemistry was analyzed for all study areas in 2017. Chromium in TPE and Arsenic in WAL were flagged for follow-up assessment in 2018 based on BACI results.

Year	Major Mine-Related Activities	Receiving Environment Overview
2018	*Meadowbank* • East dike (North-South) discharge to SP all year except from June 4 to August 21. Discharge was stopped for increasing TSS levels as no treatment is available for this location. The discharge from East Dike that was not directed to SP was discharged in the Portage Pit and then pumped to the South Cell TSF (Tailings Storage Facility). • No seepage water from Rock Storage Facility to NP-2; monitoring ongoing. • No Goose Pit reflooding activities. • Mining focused on Vault Pit and Pit A, Pit E and Phaser Pit. • No discharge to Wally in 2018.	• Minor mine-related trends identified for a number of water chemistry parameters at near-field areas: conductivity, hardness, Ca/Mg/K/Na and total dissolved solids. Parameters with effects-based thresholds (e.g., CCME water quality criteria) were below their respective trigger values in 2018. • Phytoplankton and benthic invertebrate community results for the impact areas were within the range of reference/baseline conditions. • Core chemistry was collected for TPE and WAL to follow-up on 2017 results. The 2018 results showed an overall improvement though concentrations for Chromium in TPE and Arsenic in WAL remain slightly above background concentrations.
	Whale Tail • Whale Tail Dike Construction began on July 27. • Whale Tail Pit commencement of Quarry 2 began in September. • Freshwater intake from Nemo Lake started on October 28. • Whale Tail North fishout August 13 - September 28. • Newterra Wastewater treatment system at AMQ operational in March. • Crusher activities started on the waste rock storage facility (WRSF) on October 21. • Quarry 2 overburden stripping. • Snow removal in preparation of dike construction near Kangislulike Lake (WRSF dike and Kangislulik Dike).	• 2018 was a transition year for the Whale Tail Mine study area. Only WTS was considered *impact* from August onwards and impacts to water quality, sediments, and biota were not found for 2018.
2019	*Meadowbank* • East dike (North-South) discharge to SP was stopped on March 30. Restarted on November 13. • No seepage water from Rock Storage Facility to NP-2; monitoring ongoing. • Goose Pit water transfer from South Cell to Goose started on June 11. • In-pit disposal started at Bay-Goose in July. • End of mine production at Phaser Pit, BB Phaser Pit, Vault (Q1), and Pit E (Q4). • No discharge to Wally in 2019. • Addition of tank infrastructure at Baker Lake (1 tank, containment for 2).	• Study focused on monitoring changes in the near field study areas in TPE, SP and WAL. • Targeted bioavailability studies conducted at TPE. • Limnology results were consistent with previous years. • Minor mine-related trends identified for a number of water chemistry parameters at near-field areas: conductivity, hardness, Ca/Mg/K/Na, total silicon and total dissolved solids. • Phytoplankton community results for the impact areas showed an increase in biomass and taxa richness in 2019 compared to 2018. • Benthic invertebrate community results for the impact areas were within the range of reference/baseline conditions. • Core chemistry was collected for TPE to follow-up on 2018 results. Results were comparable to 2018 with concentrations of chromium in TPE still slightly above background concentrations. In 2019, concentrations of zinc in one core sample exceeded the trigger and threshold values.
	Whale Tail • Mining from the Whale Tail Pit (WTP) began in 2019. • Dewatering/Diversion pumping into Whale Tail Lake South Basin (WTS) started April 1 and is ongoing. • Dewatering of Whale Tail Lake North Basin (WTN) to WTS occurred from April 1 to April 9, May 3 to May 17 and again from May 24 to May 29. • Dewatering/Diversion pumping into Kangislulik Lake (KAN/MAM) started June 22 and ended November 18. • Higher than expected precipitation in June and July required additional water management. • NE Dike impoundment pumped to AP5 and through to Nemo watershed June 21 to September 27. • Dewatering of WTN to KAN/MAM occurred from June 22 to June 30 and August 1 to October 26. • Water transfer from Quarry 1 pond to KAN/MAM August 26 to October 23. • Water seep from WTS through dike pumped back into WTS from October 4 to November 2, and November 7 to 16. • Dewatering of WTN to WTS through WTP November 7 is ongoing. • Whale Tail Dike Grouting project started on November 14 is ongoing. • Pumping from WTS to KAN/MAM occurred October 24 to December 9. • Lake A45 dewatering to the tundra near KAN/MAM shoreline occurred from November 25 to November 27. • Construction in the South Whale Tail Channel (SWTC) between A20 and KAN/MAM began around December 1.	• 2019 was a transition year for the Whale Tail study area when most lakes switched designation from *control* to *impact*. • Minor mine-related trends identified for 16 water chemistry parameters at WTS. • Phytoplankton community results for WTS and KAN/MAM showed an increase in biomass in 2019 compared to 2018. • Benthic invertebrate community results for the impact areas were within the range of baseline conditions. • Sediment chemistry results for 2019 were generally consistent with previous years and showed no indications of construction-related changes.

Year	Major Mine-Related Activities	Receiving Environment Overview
2020	*Meadowbank* • East Dike seepage discharge to SP was stopped on June 5 and restarted on October 23. • No seepage water from Portage RSF to NP2; monitoring ongoing. • Tailings discharge to Goose Pit up to July 2020 and the in-pit deposition started at Pit E started in August. • Reclaim water set up in Pit A completed in October. • No discharge to Wally in 2020.	• Study focused on monitoring changes in the near field study areas in TPN, TPE, SP and WAL. • Limnology results were consistent with previous years. • Minor mine-related trends identified for a number of water chemistry parameters at near-field areas: conductivity, hardness, Ca/Mg, TDS, and alkalinity. Other minor trends were identified for reactive silica, total & dissolved silicon, and dissolved zinc which were not mine-related. • Phytoplankton community results for the impact areas showed a slight decrease in biomass and an increase in taxa richness in 2020 compared to 2019. • The sediment coring program focused on NF and reference areas only. The mean sediment concentrations exceeded the trigger for arsenic at WAL, for chromium at TPE, and for zinc at SP and TPE. Concentrations were similar or less than those in 2019. • Benthic invertebrate community data for impact areas were within the range of reference/baseline conditions.
	Whale Tail • South Whale Tail Channel (SWTC) Construction between Lake A20 and Kangislulik Lake is completed. • Whale Tail Dike Remedial Grouting Project January 11 to March 25. • WRSF Dike Mitigation Work from April 8 to April 28. • NE Dike dismantling occurred in September. • IVR Diversion construction. • Temporary diffuser installation in WTS occurred in October. • Fishout occurred from August 1 to September 8. • Dewatering of fishout lakes and installation of dewatering line from July to September. • Construction of IVR Ring Road and IVR Waste Dump in September. • Mining from IVR Pit began September 20. • IVR Attenuation Pond jetty occurred in October. • Dewatering completed and WTN became attenuation pond on May 20. • Water transfer from WTN to WTS from January 1 to January 26, February 11 to February 23, February 29 to March 8, March 15 to March 22, March 30 to April 3, April 15 to April 20, April 25 to April 30, and May 7 to May 15. • Water transfer from Quarry 1 to KAN/MAM from April 13 to April 15 and April 25 to April 29. • Water transfer from attenuation pond to KAN/MAM from May 20 to May 28, June 14 to July 5, July 7 to July 22, July 25 to August 5, August 7 to September 20, September 15 to October 7. • Water transfer from attenuation pond to WTS from May 28 to June 16 and October 12 to November 1, November 6 to December 2, December 5 to December 14, December 27 to December 31.	• All Whale Tail study area lakes designated as *impact* in 2020. • Minor mine-related trends identified for about 18 water chemistry parameters at WTS and KAN/MAM, about 10 parameters at NEM, and 2-7 parameters at the MF/FF areas. • Phytoplankton community results for WTS and KAN/MAM showed a decrease in biomass and total species in 2020 compared to 2019. • Sediment chemistry results showed exceedances of As, Cr and Cu in 2020; however, it is uncertain whether these changes are related to mining activities. • Benthic invertebrate community results for the impact areas were within the range of baseline conditions.
2021	*Meadowbank* • East Dike seepage discharge to SPL (MMER-3) stopped on May 6 and restarted on December 9. • No seepage water from Portage RSF to NP2; monitoring ongoing. • Tailings discharge to Pit E all year long, with a hiatus in July and August when tailings were discharged in the North Cell. • Reclaim water from Pit A all year. • Reclaim water from Pit E ongoing November to December. • Aerial application of dust suppression on the Tailings Storage Facility in August. • No discharge to Wally Lake or Third Portage Lake in 2021.	• Overall, results from NF areas were consistent with the previous 5 years demonstrating stabilization since mine activities ceased. • Minor water chemistry trigger exceedances identified for physical/ionic parameters (conductivity, hardness, TDS, alkalinity Ca/Mg/K) at NF areas TPN, TPE, SP, and WAL. Minor trigger exceedances for Si and reactive silica at SP and WAL respectively. • Long-term trend analysis on physical/ionic parameters supported the hypothesis that concentrations had increased during mine activity (2009-2013) and have now stabilized since 2014. • Phytoplankton community results for the impact areas showed a slight increase in biomass and taxa richness in 2021 compared to 2020. • Only sediment grabs were collected in 2021. A laboratory error resulted in a subset of the grab samples that were collected in 2021 to be discarded prior to analysis. Sediment chemistry results for samples that were analyzed showed no mining related temporal and spatial patterns. Sediment concentrations for a few replicates at TPE and SP exceeded the trigger for Cr (TPE only) and Zn. Concentrations were similar to 2020. • Benthic invertebrate community data for impact areas were within the range of reference/baseline conditions.

Year	Major Mine-Related Activities	Receiving Environment Overview
	Whale Tail • First year of operation - IVR diversion ditch. • Construction of IVR Dike D1. • Commissioning of IVR attenuation pond. • Excavation IVR West Pit began October 22. • Start of IVR WRSF. • Discharge to WTS through MDMER-5 between March 1 and June 8. • Discharge to WTS through MDMER-11 between January 1 to February 13, June 6 to June 17 and October 2 to November 23. • Discharge to KAN/MAM through MDMER-7 between June 9 and September 28. • Discharge to KAN/MAM through MDMER-8 between June 18 and August 26.	• Greatest magnitude of exceedances at NF area KAN/MAM where physical/ionic parameters (conductivity, hardness, TDS, alkalinity Ca/Mg/K), anions/nutrients (TKN, reactive silica), metals (Li and Si), and TOC/DOC exceeded triggers. • Increasing mine influence on MF areas A76 (down gradient of KAN/MAM) and A20 (inundated in summer 2019 and now connected to NF area WTS) where physical/ionic and TOC/DOC trigger exceedances occur, in addition to a threshold exceedance for P. • Phytoplankton community results for KAN/MAM, A76, and A20 showed an increase in biomass in 2021 compared to 2020. Taxa richness was similar to 2020. • A laboratory oversight upon sample receipt resulted in a subset of the grab samples that were collected in 2021 to be discarded prior to analysis. Sediment chemistry results for samples that were analyzed showed trigger exceedances in individual replicates for As, Cr, Cu, and Zn in 2021. Formal statistical assessment is planned for the next coring event in 2023. • Benthic invertebrate community results for the impact areas were within the range of baseline conditions.
2022	*Meadowbank* • Construction of additional 3.3ML fuel tank, completed in January 2023. • All Weather Access Road bridge repair/ maintenance ongoing (at KM 62 and 69). • East Dike seepage discharge to SPL (MMER-3) from January 1 to January 25, from April 7 to April 30, and from November 20 until the end of the year. • Reclaim water from Pit A from January 1 to mid-April. • Reclaim water from Pit E from mid-April until the end of 2022. • Aerial application of dust suppression on the Tailings Storage Facility in August. • Tailings discharge to Pit E all year long. • No discharge to Wally or Third Portage Lake in 2022.	• Overall, results from NF areas were consistent with the previous six years demonstrating stabilization since mine activities ceased. • Minor water chemistry trigger exceedances were identified for physical/ionic parameters (conductivity, alkalinity, hardness, TDS, Ca/Mg/K) at one or more NF areas TPN, TPE, SP, and WAL. Minor trigger exceedances identified for reactive silica at WAL and total and dissolved silicon at SP. • Phytoplankton community results for the impact areas in 2022 showed that total biomass was higher than reference/baseline conditions, though results were not statistically significant. Only slight changes reported for taxa richness compared to baseline/reference. • Sediment grabs were collected in 2022 and analyzed for grain size, and TOC. Remaining sediment was archived for chemistry analysis. The next sediment coring program to review trends in chemistry is planned for August 2023. • Benthic invertebrate community data for impact areas were within the range of reference/baseline conditions except for taxa richness at SP in the 2019-2022 time period which showed an apparent increase relative to reference/baseline conditions.
	Whale Tail • Commercial production from the underground mine began in 2022. • Landfarm construction completed on September 30. • Discharge to WTS through MDMER-11: sporadic in January, February and April, from May 22 to June 16, and from October 3 to October 29. • Discharge to KAN/MAM through MDMER-8 between June 16 and September 20. • Construction of a thermal berm at the West abutment of Whale Tail Dike (upstream) from September 24 to September 30.	• Greatest magnitude of exceedances at MF area A20 where physical/ionic parameters (conductivity, hardness, TDS, alkalinity, Ca/Mg/K/Na), anions/nutrients (TKN, total phosphorus), and TOC/DOC exceeded triggers. Only metals that exceeded the trigger in 2022 were lithium at NF area KAN/MAM and titanium at WTS. Total phosphorus, a parameter with an effects-based threshold exceeded the trigger at WTS, KAN/MAM, and A20. • Increasing mine influence on MF areas A76 (downgradient of KAN/MAM) and A20 (inundated in summer 2019 and now connected to NF area WTS). • Phytoplankton community results for WTS, KAN/MAM, A20, and A76 showed an increase in biomass in 2022 compared to reference/baseline, but results were not significant. Taxa richness was similar to 2021. • Sediment chemistry results for samples that were analyzed showed trigger exceedances in individual replicates for As, Cu, Cd, and Zn in 2022. Formal statistical assessment is planned for the next coring event in 2023. • Benthic invertebrate abundance and taxa richness increased at KAN/MAM and NEM compared to baseline/reference. Taxa richness also increased compared to baseline/reference at A20, however only in some of the time periods assessed.
2023	*Meadowbank* • All Weather Access Road bridge repair from March 31 to April 11 at KM 8 and bridge repair at KM 69 ongoing. • Tailings discharge to Pit E all year except in August and September when it was discharged to South Cell. • Pit A discharge to Goose Pit from September 22 to October 6 and from October 15 to November 7. • East Dike seepage discharge to SPL (MMER-3) from January 1 to April 29. • Reclaim water from Pit E from January to mid-June and from mid-September to December. • Reclaim water from Pit A from mid-June to mid-September. • Resurfacing Airstrip from July 7 to 14.	• Overall, results from NF areas were consistent with the previous seven years demonstrating stabilization since mine activities ceased. • Minor water chemistry trigger exceedances were identified for physical/ionic parameters (conductivity, alkalinity, hardness, TDS, Ca/Mg) at one or more NF areas TPN, TPE, SP, and WAL. Minor trigger exceedance for TKN at TPE and for total and dissolved silicon at SP. Minor trigger exceedances identified for reactive silica and total silicon at WAL. • Phytoplankton community results for the impact areas showed that total biomass was higher than reference/baseline conditions, though results were not statistically significant. Only slight changes reported for

Year	Major Mine-Related Activities	Receiving Environment Overview
	• Resurfacing SD1/SD2, East Dike, and Goose Dike in 2023. • Ditch capping at RF1 and RF2. • No seepage water from Portage RSF to NP2; monitoring ongoing. • No discharge to Wally Lake in 2023.	taxa richness compared to baseline/reference. Small reduction at TPE was found to be statistically significant though taxa richness still within range of baseline/reference. • The sediment coring program focused on NF and reference areas only. The mean sediment concentrations exceeded the trigger for chromium at TPE. Concentrations were less than those in 2020. • Benthic invertebrate community data for impact areas were within the range of reference/baseline conditions except for taxa richness at SP in the 2020-2023 time period which showed an apparent increase relative to reference/baseline conditions.
	Whale Tail • Effluent water sent to IVR-1 Pit from October to December. • Landfarm became operational in 2023. • Discharge to WTS through MDMER-11: sporadic from January 8 to 15, February 20 to 27, March 19 to 24, April 10 to 15, April 24, April 26 to 29, May 10 to 22, September 18 and19, and October 8 to 11. • Discharge to Kangislulik Lake MDMER-8 from June 4 to July 7, July 16 to 18, July 21 to 22, August 6 to 18 and September 3 to 14. • Discharge to Kangislulik Lake MDMER-7 from June 11 to 28. • Whale Tail Dike Thermal Berm construction upstream from April 12 to 17.	• Greatest magnitude of exceedances at MF area A20 where physical/ionic parameters (conductivity, hardness, TDS, alkalinity, Ca/Mg/K/Na), anions/nutrients (TKN, total phosphorus), and TOC/DOC exceeded triggers. Only metals that exceeded the trigger in 2023 were lithium at NF areas KAN/MAM and WTS and dissolved silicon at FF area DS1. • Increasing mine influence on MF areas A76 (downgradient of KAN/MAM) and A20 (inundated in summer 2019 and now connected to NF area WTS). • Phytoplankton community results for WTS, KAN/MAM, A20, and NEM showed an increase in biomass in 2023 compared to reference/baseline with statistically significant results at WTS and A20. Taxa richness showed slight decreases at all areas in 2023. • Sediment chemistry results showed exceedances of As and Cr at WTS, KAN/MAM, and A20 in 2023. Copper exceeded the trigger slightly at A20 in 2023. • Benthic invertebrate abundance increased at KAN/MAM and NEM compared to baseline/reference in all time periods assessed. Benthos abundance increased at WTS in the 2022-2023 time period. Taxa richness also increased compared to baseline/reference at KAN/MAM, A20, and NEM in most time periods assessed. Taxa richness increased at DS1 compared to baseline/reference in the 2022-2023 time period.

2 CREMP STUDY DESIGN

2.1 Overview

To streamline the annual report and reduce redundancy, aspects of the CREMP study design presented in the *CREMP Plan* are not repeated herein. Readers looking for detailed information on the aspects of the study design such as sampling methods, QA/QC protocols and procedures, and data evaluation criteria are referred to Azimuth (2022b). A summary of the CREMP study design is included to guide the reader.

Normally the CREMP includes five sampling events at Meadowbank and Whale Tail, however, the May sampling event in 2023 was canceled due to unsafe ice conditions on the lakes. An abbreviated sampling event took place in November at Whale Tail area lakes KAN/MAM and WTS. A full sampling event was not recommended because 1) preliminary results from the first four sampling events in 2023 suggested the water quality in the NF areas was within the range of previous months and 2) no discharge was planned after September and the water quality was therefore not expected to change significantly between September and December. The number of sampling events in 2023 were in accordance with the *CREMP Plan Update*, i.e., the Meadowbank and Whale Tail CREMP is conducted up to five times per year at reference and exposure areas (Azimuth, 2022b).

2.2 Routine CREMP Sampling

2.2.1 Sampling Areas

The CREMP is designed to detect spatial and temporal changes in water quality, sediment chemistry, or biological communities (phytoplankton and benthos) at the scale of the lake or basin, in the case of large lakes such as Third Portage Lake. A common element for the Meadowbank and Whale Tail study designs is the use of near-field (NF), mid-field (MF), and far-field (FF) areas to provide spatial context when interpreting potential changes year-over-year. Near-field areas provide the first line of early-warning for introductions of stressors into the receiving environment. These areas are situated closest to the development near dikes, dewatering discharge points, and proposed effluent sources. MF and FF areas are located farther downstream from the NF monitoring areas and provide insights into the spatial extent of any observed changes in chemistry or biological communities closer to the source. Brief descriptions of the Meadowbank, Whale Tail, and Baker Lake study areas are provided below.

Meadowbank

There are nine sampling areas included in the Meadowbank CREMP. Third Portage Lake East Basin and North Basin (TPE and TPN), Second Portage Lake (SP), and Wally Lake (WAL) are the NF areas monitored annually for changes related to operations at the Meadowbank mine and mill. Starting in 2023, MF areas Tehek Lake (TE), the South Basin of Third Portage Lake (TPS), and FF area Tehek Lake far-field (TEFF) are monitored only if *moderate changes*[7] are detected upstream at the NF locations consistent with the strategy outline in **Section 2.2.3** (Azimuth, 2022b). Two reference areas are shared for the Meadowbank and Whale Tail programs: Inuggugayualik Lake (INUG) and Tasirjuaraajuk Lake (aka Pipedream Lake [PDL]). INUG has been the core reference area since formal monitoring began in 2006. PDL was added to the Meadowbank CREMP in 2009; while the absence of data at this area from 2006 to 2008 make its utility limited in the BACI statistical analyses, it provides insights into the strength of regional patterns (i.e., how well it matches INUG).

The 2023 sampling areas for the Meadowbank CREMP are shown in **Figure 4-1** (water and phytoplankton) and **Figure 4-2** (sediment and benthos).

Whale Tail

There are six lakes currently included in the Whale Tail CREMP study design. Whale Tail Lake South Basin (WTS) and Kangislulik Lake[8] (KAN/MAM) are NF areas designed to detect changes related to dike construction in Whale Tail Lake and Kangislulik Lake and discharge of treated water during operations. Nemo Lake (NEM) is also considered a NF area because of its proximity to the site, even though it is situated in a different watershed. MF areas are Lake A20 (upstream from WTS, but joined to WTS after flooding) and Lake A76 located downstream from KAN/MAM. Lake A76 is situated at the junction of the two flow paths leading to Lake DS1. Given its morphology and location, it represents an ideal MF exposure area for both flow paths. Lake DS1 is the FF location to provide additional context for characterizing spatial extent of effects.

The 2023 sampling areas for the Whale Tail CREMP are shown in **Figure 5-1** (water and phytoplankton) and **Figure 5-2** (sediment and benthos).

Baker Lake

There are two NF areas for the Baker Lake CREMP, one targeting the hamlet's barge landing area (Baker Barge Dock [BBD]) and the other Agnico's fuel storage facility (Baker Proposed Jetty[9] [BPJ]). The primary reference area for Baker Lake is located approximately 10 kilometers east of the hamlet along the north shore of the lake (Baker Akilahaarjuk Point [BAP]). A second reference area on the East Shore of Baker

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[7] *Moderate changes* in water quality are defined as statistically significant increases exceeding the early warning trigger for parameters with effects-based thresholds (i.e., CCME FWAL).

[8] Kangislulik Lake (KAN) was previously referred to as Mammoth Lake (MAM).

[9] Note that while a jetty was initially considered, the idea was abandoned in favour of continued use of the existing barge landing.

Lake (BES) between BAP and BPJ was added in 2011 to provide additional context for interpreting sediment chemistry and benthic invertebrate data.

The 2023 sampling areas for the Baker Lake CREMP are shown in **Figure 6-1.**

2.2.2 Monitoring Components

Water quality, sediment quality, phytoplankton community, and benthic invertebrate community were monitored in the core 2023 program. Sampling was undertaken according to SOPs provided in the *CREMP Plan* (Azimuth, 2022b). Locations for water, limnology, and phytoplankton were selected randomly for the Meadowbank and Baker lakes areas from within their respective lake basins. The Whale Tail study area lakes are smaller and more variable in depth compared to the Meadowbank project lakes. Fixed water quality monitoring locations are used for the Whale Tail study area lakes to avoid selecting locations in less than 5 m of water. Two fixed locations were randomly selected for water quality and phytoplankton community monitoring in each full event. Water sampling was completed in March, July, August, and September as per the study design[10]. A single limnology profile is taken at the NF areas during the remaining winter months, when travel on ice is safe, to verify water quality is within the range of expected conditions. In 2023, limnology only monitoring occurred in January, February, April, November, and December[11].

Sediment for chemistry and benthic invertebrate community analyses were collected from the established areas (i.e., depositional zones between 6.5 m and 9 m) in each basin/lake.

Table 2-1 lists the monitoring components sampled at the various study areas in 2023. Global Positioning System (GPS) Universal Transverse Mercator (UTM) coordinates (in NAD 83) are shown in **Table 2-2** for all CREMP study areas.

Samples from the 2023 CREMP were sent to the laboratories listed below for analysis:

- Water and bulk sediment chemistry – ALS Laboratories (Burnaby, BC)
- Phytoplankton taxonomy – Plankton R Us Inc. (Winnipeg, MB)
- Benthic invertebrate taxonomy – ZEAS Inc. (Nobleton, ON)

2.2.3 Sampling Effort

A results-driven sampling strategy for the Meadowbank study lakes was developed as part of the *CREMP Plan* (Azimuth, 2015b) which was then updated in 2022 (Azimuth, 2022b). Minor revisions were made to

[10] The May sampling event was cancelled due to unsafe ice conditions. After reviewing the results of the first four sampling events, an abbreviated event took place in November at WTS and KAN.

[11] Limnology only profiles are collected at a subset of the areas.

the *CREMP Plan* in 2023 (Azimuth, 2022b). The strategy was developed to increase the efficiency of the CREMP by focusing resources on monitoring in the areas most likely to be affected by mining-related activities. The decision framework outlines when the frequency of monitoring at MF and FF areas can safely be reduced. The annual decision framework presented in the *CREMP Plan Update* applies to MF and FF areas at Meadowbank (Azimuth, 2022b; **Figure 2-1** [below]). More specifically, the framework applies to MF area TE (which is paired with upstream NF areas TPE, SP, and WAL), MF area TPS (which is paired with NF area TPN), and to FF area TEFF (which is paired with upstream MF area TE). The same strategy may eventually be implemented at Whale Tail as more years of 'after' data become available. For the time being, monitoring at Whale Tail MF and FF areas will continue at the same frequency as the NF areas (i.e., five water chemistry/phytoplankton planned sampling events).

As per the normal Meadowbank CREMP data analysis process, NF results are evaluated on an annual basis (i.e., with CREMP reporting due at the end of March following each monitoring year), with the NF results (i.e., for *Year*) dictating the monitoring requirements for the MF area in the subsequent year (i.e., *Year +1*). The Year +1 NF and MF results are used as the basis to determine the MF and FF monitoring requirements for Year +2, and so on. While the full CREMP program will be conducted at each NF area each year, the specific monitoring requirements for the MF and FF areas vary based on the NF and MF results, respectively. Below are the various outcomes of the CREMP data analysis and associated program requirements for MF and FF areas in the following year (see Azimuth, 2022b for more details):

- No changes identified – no statistical changes above any trigger values. No further sampling required.
- Minor changes identified – statistically significant changes exceeding the early warning trigger values for parameters without effects-based threshold values (i.e., trigger values are based on the 95th percentile of the baseline distribution). No further sampling required at MF and FF areas unless moderate changes (see below) are identified in NF areas.
- Moderate changes identified – statistically significant changes exceeding the early warning trigger values for parameters with effects-based thresholds (e.g., CCME water quality guidelines for water chemistry parameters). Full CREMP water sampling (all events) is required to determine if changes extend to MF area (or to FF if such changes are seen at an MF area).
- Major changes identified – statistically significant changes exceeding the effects-based threshold values. Full CREMP program including sediment and biological components is required to determine if changes extend to MF area (or to FF if such changes are seen at an MF area).

Minor changes to water quality parameters without toxicologically-derived effects-based thresholds were identified in the 2022 CREMP (Azimuth, 2023a). Following the strategy outlined above, these results meant there was no sampling required at MF (TPS and TE) and FF (TEFF) areas in 2023.

Table 2-1. CREMP sampling summary, 2023.

Sampling Month	Sampling Crew	Conditions	Components[2]	Meadowbank Areas									Baker Lake Areas				Whale Tail Areas					
				INUG	PDL	TPN	SP	TPE	WAL	TPS	TE	TEFF	BAP	BES	BBD	BPJ	WTS	KAN/ MAM	NEM	A20	A76	DS1
				REF	REF	NF	NF	NF	NF	MF	MF	FF	REF	REF	NF	NF	NF	NF	NF	MF	MF	FF
January	Agnico	Ice	L			✓	✓	✓	✓								✓	✓	✓	✓		
February	Agnico	Ice	L			✓	✓	✓	✓								✓	✓	✓	✓		
March	Agnico	Ice	L,W,P	✓	✓	✓	✓	✓	✓								✓	✓	✓	✓	✓	✓
April	Agnico	Ice	L			✓	✓	✓	✓								✓	✓	✓	✓		
May [1]	Agnico	Ice	L,W,P	***Ice not safe***																		
June	***Ice not safe***																					
July	Agnico	Open-water	L,W,P	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓	✓	✓	✓	✓	✓
August	Azimuth	Open-water	L,W,P	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓	✓	✓	✓	✓	✓
			B,S	✓	✓	✓	✓	✓	✓								✓	✓	✓	✓	✓	✓
September	Agnico	Open-water	L,W,P	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓	✓	✓	✓	✓	✓
October	***Ice not safe***																					
November [1]	Agnico	Ice	L, W			✓	✓	✓	✓								✓	✓	✓	✓		
December	Agnico	Ice	L			✓	✓	✓	✓								✓	✓	✓	✓		

Notes:

Components: L=Limnology; W=Water chemistry; P=Phytoplankton; B=Benthic invertebrates; S=Sediment grab chemistry.

✓ = monitoring components were collected.

Area designations: C=Control; I=Impact; REF=reference (in grey shading); NF=near-field (in blue shading); MF=mid-field (in pink shading); FF=far-field (in teal shading)

Area IDs: Meadowbank and Whale Tail Reference areas: INUG = Inuggugayualik Lake; PDL = Pipedream Lake. Meadowbank areas: TPN, TPE, TPS = Third Portage Lake – North, East, South basins; SP = Second Portage Lake; WAL = Wally Lake; TE, TEFF = Tehek Lake (Mid-field and Far-field). Baker Lake areas: BAP, BES, BBD, BPJ=Baker Lake – Akilahaarjuk Point, East Shore, Barge Dock, Proposed Jetty. Whale Tail areas: WTS = Whale Tail Lake South Basin; KAN/MAM = Kangislulik Lake; NEM = Nemo Lake; A20 = Lake A20; A76 = Lake A76; DS1 = Lake DS1.

[1] Monitoring in May was cancelled due to unsafe ice conditions. Abbreviated sampling event took place in November at WTS and KAN/MAM.

2 Phytoplankton samples collected at Meadowbank lakes in winter months (March and May) are archived as per the *CREMP Plan Update*.

Table 2-2. CREMP sampling coordinates for Meadowbank, Whale Tail, and Baker Lake study areas, 2023.

Area[1]	Area Type[2]	Area-Replicate	Water & Phytoplankton (Monthly)					Benthos & Sediment Chemistry (August)					
			Month	Depth (m)	Zone	Easting	Northing	Area-Replicate	Sample Type[3]	Depth (m)	Zone	Easting	Northing
Meadowbank													
TPE	NF	TPE-limno	January	9.7	14W	638115	7211665	TPE-1	B & C	7.5	14W	639058	7211518
		TPE-limno	February	11.9	14W	639286	7211733	TPE-2	B & C	8.2	14W	639089	7211537
		TPE-limno	April	5.4	14W	638488	7211649	TPE-3	B & C	7.6	14W	639114	7211558
		TPE-limno	November	17.7	14W	638005	7214099	TPE-4	B & C	6.5	14W	639113	7211743
		TPE-limno	December	>20	14W	639100	7212159	TPE-5	B & C	6.6	14W	639144	7211710
		TPE-160	March	15.4	14W	638729	7210194	TPE-COMP	C	-	-	-	-
		TPE-161	March	16.8	14W	637811	7211609	TPE-SC-1	C	9.2	14W	639066	7211492
		TPE-162	July	6.2	14W	639689	7211639	TPE-SC-2	C	8.2	14W	639059	7211500
		TPE-163	July	7.5	14W	637558	7210921	TPE-SC-3	C	8.3	14W	639091	7211534
		TPE-164	August	14.0	14W	639140	7211825	TPE-SC-4	C	8.2	14W	639091	7211537
		TPE-165	August	6.9	14W	638987	7210897	TPE-SC-5	C	7.9	14W	639107	7211551
		TPE-166	September	18.0	14W	639180	7211607	TPE-SC-6	C	7.8	14W	639114	7211560
		TPE-167	September	10.8	14W	639912	7211662	TPE-SC-7	C	7.4	14W	639138	7211735
								TPE-SC-8	C	7.3	14W	639138	7211743
								TPE-SC-9	C	7.3	14W	639148	7211632
								TPE-SC-10	C	6.8	14W	639148	7211630
TPN	NF	TPN-limno	January	9.8	14W	636234	7213420	TPN-1	B & C	9.5	14W	636347	7215513
		TPN-limno	February	>20	14W	636458	7213307	TPN-2	B & C	8.6	14W	636350	7215527
		TPN-limno	April	14.9	14W	636560	7213687	TPN-3	B & C	7.5	14W	636407	7215535
		TPN-limno	November	18.9	14W	636941	7213414	TPN-4	B & C	7.7	14W	636422	7215519
		TPN-limno	December	>20	14W	636750	7213160	TPN-5	B & C	9.1	14W	636372	7215531
		TPN-160	March	6.5	14W	635857	7215527	TPN-COMP	C	-	-	-	-
		TPN-161	March	18.4	14W	636540	7214965	TPN-SC-1	C	9.5	14W	636343	7215516
		TPN-162	July	11.7	14W	636060	7213547	TPN-SC-2	C	9.5	14W	636349	7215516
		TPN-163	July	21.3	14W	636485	7214251	TPN-SC-3	C	8.5	14W	636348	7215526
		TPN-164	August	8.8	14W	634783	7214815	TPN-SC-4	C	8.6	14W	636344	7215528

Area[1]	Area Type[2]	Area-Replicate	Water & Phytoplankton (Monthly)					Benthos & Sediment Chemistry (August)					
			Month	Depth (m)	Zone	Easting	Northing	Area-Replicate	Sample Type[3]	Depth (m)	Zone	Easting	Northing
TPN	NF	TPN-165	August	21.5	14W	635899	7215417	TPN-SC-5	C	7	14W	636406	7215540
		TPN-166	September	10.5	14W	635320	7213182	TPN-SC-6	C	7.3	14W	636404	7215537
		TPN-167	September	5.6	14W	636487	7213921	TPN-SC-7	C	8	14W	636424	7215518
								TPN-SC-8	C	7.7	14W	636426	7215517
								TPN-SC-9	C	9.3	14W	636377	7215533
								TPN-SC-10	C	9.1	14W	636377	7215536
SP	NF	SP-limno	January	12.4	14W	639711	7214076	SP-1	B & C	9.3	14W	640014	7214087
		SP-limno	February	9.2	14W	639530	7213685	SP-2	B & C	8.3	14W	640042	7214115
		SP-limno	April	11.5	14W	640075	7213701	SP-3	B & C	7	14W	640050	7214151
		SP-limno	November	7.5	14W	639728	7214072	SP-4	B & C	7.7	14W	640066	7214181
		SP-limno	December	13.1	14W	639720	7214015	SP-5	B & C	9.3	14W	640081	7214196
		SP-160	March	8.5	14W	639706	7214142	SP-COMP	C	-	-	-	-
		SP-161	March	9.2	14W	640412	7213511	SP-SC-1	C	8.6	14W	640012	7214090
		SP-162	July	10.0	14W	640096	7214009	SP-SC-2	C	8.7	14W	640002	7214088
		SP-163	July	10.9	14W	640766	7213386	SP-SC-3	C	7.1	14W	640032	7214126
		SP-164	August	7.1	14W	640699	7213143	SP-SC-4	C	7.6	14W	640034	7214117
		SP-165	August	7.3	14W	639964	7212945	SP-SC-5	C	8.5	14W	640066	7214155
		SP-166	September	7.5	14W	640286	7212785	SP-SC-6	C	7.6	14W	640057	7214151
		SP-167	September	9.6	14W	640144	7214297	SP-SC-7	C	7.5	14W	640071	7214181
								SP-SC-8	C	7.4	14W	640067	7214184
								SP-SC-9	C	8.9	14W	640079	7214202
								SP-SC-10	C	8.9	14W	640078	7214195
WAL	NF	WAL-limno	January	8.8	15W	360906	7220520	WAL-1	B & C	7.9	15W	360957	7220392
		WAL-limno	February	10.6	15W	360853	7220706	WAL-2	B & C	9.5	15W	360927	7220458
		WAL-limno	April	6.9	15W	361477	7222326	WAL-3	B & C	8.8	15W	360905	7220478
		WAL-limno	November	10.0	15W	360855	7220696	WAL-4	B & C	7.5	15W	360884	7220476
		WAL-limno	December	7.5	15W	360449	7221522	WAL-5	B & C	7.1	15W	360895	7220522
		WAL-129	March	7.2	15W	361739	7222782	WAL-COMP	C	-	-	-	-
		WAL-130	March	6.1	15W	360993	7221919	WAL-SC-1	C	7.6	15W	360953	7220383

Area[1]	Area Type[2]	Area-Replicate	Water & Phytoplankton (Monthly)					Benthos & Sediment Chemistry (August)					
			Month	Depth (m)	Zone	Easting	Northing	Area-Replicate	Sample Type[3]	Depth (m)	Zone	Easting	Northing
WAL	NF	WAL-131	July	5.5	15W	360980	7222482	WAL-SC-2	C	7.4	15W	360956	7220384
		WAL-132	July	11.5	15W	360862	7220723	WAL-SC-3	C	9.3	15W	360925	7220449
		WAL-133	August	5.0	15W	360859	7221790	WAL-SC-4	C	9.5	15W	360933	7220453
		WAL-134	August	6.0	15W	361775	7222872	WAL-SC-5	C	8.4	15W	360901	7220470
		WAL-135	September	5.2	14W	360585	7221358	WAL-SC-6	C	9.1	15W	360908	7220472
		WAL-136	September	5.5	14W	360747	7221223	WAL-SC-7	C	7.5	15W	360881	7220479
								WAL-SC-8	C	7.8	15W	360886	7220479
								WAL-SC-9	C	7	15W	360891	7220528
								WAL-SC-10	C	7.1	15W	360897	7220527
INUG	Ref	INUG-148	March	6.7	14W	622805	7216273	INUG-1	B & C	7.8	14W	622826	7216811
		INUG-149	March	14.9	14W	622199	7214963	INUG-2	B & C	8	14W	622780	7216793
		INUG-150	July	7.5	14W	622088	7215966	INUG-3	B & C	8	14W	622754	7216784
		INUG-151	July	5.6	14W	621873	7216651	INUG-4	B & C	8.4	14W	622710	7216793
		INUG-152	August	17.2	14W	622321	7215739	INUG-5	B & C	7.5	14W	622761	7216764
		INUG-153	August	11.2	14W	622635	7216219	INUG-COMP	C	-	-	-	-
		INUG-154	September	13.5	14W	622303	7215864	INUG-SC-1	C	9.1	14W	622833	7216788
		INUG-155	September	11.2	14W	622635	7214637	INUG-SC-2	C	8	14W	622828	7216788
								INUG-SC-3	C	8.2	14W	622792	7216779
								INUG-SC-4	C	7.6	14W	622776	7216800
								INUG-SC-5	C	8	14W	622757	7216794
								INUG-SC-6	C	8.1	14W	622747	7216793
								INUG-SC-7	C	8.5	14W	622718	7216797
								INUG-SC-8	C	8.4	14W	622702	7216797
								INUG-SC-9	C	8.5	14W	622778	7216756
								INUG-SC-10	C	8	14W	622765	7216758
PDL	Ref	PDL-113	March	11.9	14W	629786	7225081	PDL-1	B & C	8.6	14W	630738	7223076
		PDL-114	March	>20	14W	631975	7225233	PDL-2	B & C	9	14W	630752	7223001
		PDL-115	July	13.7	14W	631723	7224108	PDL-3	B & C	8.5	14W	630762	7222974

Area[1]	Area Type[2]	Area-Replicate	Water & Phytoplankton (Monthly)					Benthos & Sediment Chemistry (August)					
			Month	Depth (m)	Zone	Easting	Northing	Area-Replicate	Sample Type[3]	Depth (m)	Zone	Easting	Northing
PDL	Ref	PDL-116	July	16.9	14W	629837	7224004	PDL-4	B & C	8.9	14W	630764	7222949
		PDL-117	August	11.5	14W	632733	7224737	PDL-5	B & C	8.8	14W	630775	7222933
		PDL-118	August	21.8	14W	631206	7225225	PDL-COMP	C	-	-	-	-
		PDL-119	September	13.5	14W	632818	7224165	PDL-SC-1	C	8.5	14W	630740	7223079
		PDL-120	September	14.5	14W	630055	7223533	PDL-SC-2	C	8.4	14W	630738	7223080
								PDL-SC-3	C	8.8	14W	630753	7223004
								PDL-SC-4	C	8.1	14W	630757	7223002
								PDL-SC-5	C	9.3	14W	630757	7222972
								PDL-SC-6	C	8.1	14W	630765	7222971
								PDL-SC-7	C	8.8	14W	630770	7222944
								PDL-SC-8	C	7.9	14W	630772	7222954
								PDL-SC-9	C	7.8	14W	630780	7222933
								PDL-SC-10	C	7.9	14W	630779	7222939
Baker Lake													
BBD	NF	BBD-85	July	16.6	14W	644620	7134168	BBD-1	B & C	8.4	14W	644601	7135284
		BBD-86	July	12.0	14W	643904	7135247	BBD-2	B & C	7.9	14W	644577	7135293
		BBD-87	August	9.0	14W	644005	7135333	BBD-3	B & C	8.5	14W	644540	7135308
		BBD-88	August	9.4	14W	644731	7135236	BBD-4	B & C	8.2	14W	644494	7135316
		BBD-89	September	9.2	14W	644367	7135336	BBD-5	B & C	8.4	14W	644431	7135345
		BBD-90	September	12.5	14W	644785	7135131	BBD-COMP	C	-	-	-	-
								BBD-SC-1	C	8.6	14W	644516	7135274
								BBD-SC-2	C	8.6	14W	644601	7135288
								BBD-SC-3	C	8.2	14W	644579	7135298
								BBD-SC-4	C	7.9	14W	644581	7135305
								BBD-SC-5	C	8	14W	644536	7135313
								BBD-SC-6	C	9	14W	644535	7135303
								BBD-SC-7	C	8.3	14W	644508	7135325
								BBD-SC-8	C	8.5	14W	644509	7135314

Area[1]	Area Type[2]	Area-Replicate	Water & Phytoplankton (Monthly)					Benthos & Sediment Chemistry (August)					
			Month	Depth (m)	Zone	Easting	Northing	Area-Replicate	Sample Type[3]	Depth (m)	Zone	Easting	Northing
BBD	NF							BBD-SC-9	C	7.6	14W	644437	7135352
								BBD-SC-10	C	8.3	14W	644439	7135351
BPJ	NF	BPJ-85	July	>20	15W	356696	7134054	BPJ-1	B & C	8.2	15W	357188	7134152
		BPJ-86	July	13.0	15W	357390	7133940	BPJ-2	B & C	8.2	15W	357231	7134124
		BPJ-87	August	19.2	15W	356725	7134197	BPJ-3	B & C	7.4	15W	357065	7134220
		BPJ-88	August	14.5	15W	357300	7133955	BPJ-4	B & C	8.8	15W	357017	7134218
		BPJ-89	September	17.6	15W	356871	7134082	BPJ-5	B & C	7.9	15W	357281	7134101
		BPJ-90	September	12.9	15W	357456	7133919	BPJ-COMP	C	-	-	-	-
								BPJ-SC-1	C	7.8	15W	357189	7134163
								BPJ-SC-2	C	7.3	15W	357198	7134164
								BPJ-SC-3	C	7.8	15W	357241	7134124
								BPJ-SC-4	C	8.2	15W	357227	7134124
								BPJ-SC-5	C	7.9	15W	357053	7134216
								BPJ-SC-6	C	7.8	15W	357047	7134215
								BPJ-SC-7	C	8.5	15W	357015	7134221
								BPJ-SC-8	C	7.1	15W	357023	7134235
								BPJ-SC-9	C	8.4	15W	357281	7134092
								BPJ-SC-10	C	7.7	15W	357287	7134101
BAP	Ref	BAP-85	July	10.2	15W	364437	7130901	BAP-1	B & C	6.9	15W	363995	7131224
		BAP-86	July	12.5	15W	363875	7131157	BAP-2	B & C	7.5	15W	364039	7131190
		BAP-87	August	9.2	15W	362921	7131482	BAP-3	B & C	7.9	15W	364075	7131159
		BAP-88	August	14.3	15W	364149	7130958	BAP-4	B & C	9.1	15W	364126	7131125
		BAP-89	September	>20	15W	356871	7134082	BAP-5	B & C	8.9	15W	364142	7131049
		BAP-90	September	7.5	15W	363782	7313223	BAP-COMP	C	-	-	-	-
								BAP-SC-1	C	6.5	15W	364001	7131223
								BAP-SC-2	C	7.1	15W	363991	7131219
								BAP-SC-3	C	7.2	15W	364040	7131186
								BAP-SC-4	C	7.7	15W	364034	7131191

Area[1]	Area Type[2]	Area-Replicate	Water & Phytoplankton (Monthly)					Benthos & Sediment Chemistry (August)					
			Month	Depth (m)	Zone	Easting	Northing	Area-Replicate	Sample Type[3]	Depth (m)	Zone	Easting	Northing
BAP	Ref							BAP-SC-5	C	8	15W	364070	7131164
								BAP-SC-6	C	7.8	15W	364071	7131161
								BAP-SC-7	C	8.9	15W	364130	7131120
								BAP-SC-8	C	8.9	15W	364131	7131125
								BAP-SC-9	C	8.3	15W	364150	7131045
								BAP-SC-10	C	8.8	15W	364145	7131050
BES	Ref							BES-1	B & C	7.4	15W	361226	7132391
								BES-2	B & C	9.4	15W	361245	7132371
								BES-3	B & C	8.5	15W	361305	7132359
								BES-4	B & C	8.5	15W	361372	7132326
								BES-5	B & C	8.7	15W	361439	7132289
								BES-COMP	C	-	-	-	-
								BES-SC-1	C	8.5	15W	361231	7132394
								BES-SC-2	C	7.8	15W	361225	7132402
								BES-SC-3	C	9.5	15W	361266	7132368
								BES-SC-4	C	9.6	15W	361256	7132369
								BES-SC-5	C	8.1	15W	361301	7132361
								BES-SC-6	C	8.5	15W	361310	7132355
								BES-SC-7	C	8	15W	361369	7132330
								BES-SC-8	C	8.2	15W	361359	7132330
								BES-SC-9	C	8	15W	361433	7132296
								BES-SC-10	C	7.6	15W	361441	7132302
Whale Tail													
WTS	NF	WTS-limno	January	5.2	14W	607730	7254309	WTS-1	B & C	9	14W	607142	7253550
		WTS-limno	February	9.4	14W	607564	7254153	WTS-2	B & C	8.9	14W	607183	7253510
		WTS-limno	April	5.4	14W	607734	7254285	WTS-3	B & C	8.7	14W	607071	7253588
		WTS-limno	December	7.6	14W	607535	7254373	WTS-4	B & C	8.7	14W	607097	7253662
		WTS-77	March	8.7	14W	607686	7254010	WTS-5	B & C	9.3	14W	607168	7253664

Area[1]	Area Type[2]	Area-Replicate	Water & Phytoplankton (Monthly)					Benthos & Sediment Chemistry (August)					
			Month	Depth (m)	Zone	Easting	Northing	Area-Replicate	Sample Type[3]	Depth (m)	Zone	Easting	Northing
WTS	NF	WTS-78	March	10.9	14W	607163	7253609	WTS-COMP	C	-	-	-	-
		WTS-79	July	8.7	14W	607686	7254012	WTS-SC-1	C	9	14W	607139	7253546
		WTS-80	July	9.8	14W	607116	7253595	WTS-SC-2	C	9	14W	607141	7253544
		WTS-81	August	11.9	14W	607197	7253626	WTS-SC-3	C	8.3	14W	607182	7253506
		WTS-82	August	13.2	14W	607489	7254164	WTS-SC-4	C	8.7	14W	607184	7253506
		WTS-83	September	7.3	14W	607540	7254403	WTS-SC-5	C	8.9	14W	607067	7253590
		WTS-84	September	15.4	14W	607241	7253710	WTS-SC-6	C	8.7	14W	607066	7253591
		WTS-85	November	7.9	14W	607170	7253393	WTS-SC-7	C	8.2	14W	607091	7253661
		WTS-86	November	9.9	14W	607686	7254018	WTS-SC-8	C	8.4	14W	607094	7253663
								WTS-SC-9	C	9.3	14W	607158	7253664
								WTS-SC-10	C	9.3	14W	607162	7253662
KAN/MAM	NF	MAM-limno	January	9.2	14W	605035	7254845	MAM-1	B & C	7.9	14W	605071	7254877
		MAM-limno	February	12.1	14W	604072	7254464	MAM-2	B & C	7.5	14W	605041	7254891
		MAM-limno	April	5.0	14W	604392	7254204	MAM-3	B & C	7.6	14W	605019	7254884
		MAM-limno	December	5.8	14W	604931	7254744	MAM-4	B & C	7.9	14W	604973	7254889
		MAM-77	March	8.9	14W	605076	7254879	MAM-5	B & C	8.9	14W	605025	7254860
		MAM-78	March	13.7	14W	604032	7254411	MAM-COMP	C	-	-	-	-
		MAM-79	July	5.5	14W	605290	7254935	MAM-SC-1	C	7.6	14W	605060	7254887
		MAM-80	July	7.1	14W	604137	7254410	MAM-SC-2	C	7.5	14W	605066	7254883
		MAM-81	August	7.0	14W	604185	7253849	MAM-SC-3	C	7.2	14W	605035	7254895
		MAM-82	August	8.5	14W	605379	7255108	MAM-SC-4	C	7.4	14W	605042	7254885
		MAM-83	September	7.5	14W	605377	7255079	MAM-SC-5	C	7.8	14W	605021	7254880
		MAM-84	September	5.0	14W	604144	7254320	MAM-SC-6	C	7.9	14W	605023	7254877
		MAM-85	November	5.3	14W	605211	7254891	MAM-SC-7	C	7.8	14W	604970	7254892
		MAM-86	November	5.9	14W	604068	7254478	MAM-SC-8	C	8.2	14W	604974	7254878
								MAM-SC-9	C	9.2	14W	605023	7254847
								MAM-SC-10	C	9.2	14W	605033	7254839
NEM	NF	NEM-limno	January	9.3	14W	606412	7257118	NEM-1	B & C	9	14W	606560	7257375

Area[1]	Area Type[2]	Area-Replicate	Water & Phytoplankton (Monthly)					Benthos & Sediment Chemistry (August)					
			Month	Depth (m)	Zone	Easting	Northing	Area-Replicate	Sample Type[3]	Depth (m)	Zone	Easting	Northing
NEM	NF	NEM-limno	February	7.3	14W	606628	7257648	NEM-2	B & C	9.2	14W	606542	7257375
		NEM-limno	April	5.1	14W	606586	7257353	NEM-3	B & C	9	14W	606525	7257300
		NEM-limno	November	10.8	14W	606533	7257483	NEM-4	B & C	7.4	14W	606561	7257331
		NEM-limno	December	10.1	14W	606412	7257135	NEM-5	B & C	8	14W	606556	7257344
		NEM-77	March	11.9	14W	606617	7257602	NEM-COMP	C	-	-	-	-
		NEM-78	March	10.1	14W	606408	7257020	NEM-SC-1	C	8.5	14W	606560	7257369
		NEM-79	July	13.2	14W	606166	7257529	NEM-SC-2	C	9	14W	606558	7257367
		NEM-80	July	14.6	14W	606695	7257682	NEM-SC-3	C	9.5	14W	606539	7257365
		NEM-81	August	18.5	14W	606800	7257682	NEM-SC-4	C	9.5	14W	606541	7257369
		NEM-82	August	9.5	14W	606133	7257405	NEM-SC-5	C	9.2	14W	606527	7257308
		NEM-83	September	13.5	14W	606202	7257451	NEM-SC-6	C	9.2	14W	606526	7257303
		NEM-84	September	>20	14W	606823	7257733	NEM-SC-7	C	7.2	14W	606557	7257323
								NEM-SC-8	C	6.9	14W	606558	7257318
								NEM-SC-9	C	6.5	14W	606572	7257344
								NEM-SC-10	C	7	14W	606570	7257351
A20	MF	A20-limno	January	17.6	14W	604597	7252624.13	A20-1	B & C	8.6	14W	604605	7252542
		A20-limno	February	18.4	14W	604452	7252590	A20-2	B & C	8	14W	604652	7252550
		A20-limno	April	18.7	14W	604535	7252616	A20-3	B & C	7.7	14W	604613	7252501
		A20-limno	November	6.8	14W	604085	7252544	A20-4	B & C	8.4	14W	604669	7252521
		A20-limno	December	5.3	14W	604389	7252534	A20-5	B & C	8.2	14W	604611	7252561
		A20-71	March	6.7	14W	605222	7252786	A20-COMP	C	-	-	-	-
		A20-72	March	>20	14W	604376	7252620	A20-SC-1	C	7.9	14W	604601	7252545
		A20-73	July	5.3	14W	605270	7252769	A20-SC-2	C	8.8	14W	604604	7252547
		A20-74	July	9.4	14W	604136	7252591	A20-SC-3	C	8.4	14W	604652	7252555
		A20-75	August	5.8	14W	605234	7252752	A20-SC-4	C	8.6	14W	604647	7252540
		A20-76	August	5.3	14W	604657	7252413	A20-SC-5	C	7.7	14W	604611	7252502
		A20-77	September	5.3	14W	605165	7252752	A20-SC-6	C	7.9	14W	604614	7252508
		A20-78	September	6.7	14W	604541	7252533	A20-SC-7	C	8.4	14W	604669	7252516

Area[1]	Area Type[2]	Area-Replicate	Water & Phytoplankton (Monthly)					Benthos & Sediment Chemistry (August)					
			Month	Depth (m)	Zone	Easting	Northing	Area-Replicate	Sample Type[3]	Depth (m)	Zone	Easting	Northing
A20	NF							A20-SC-8	C	8.7	14W	604669	7252514
								A20-SC-9	C	8.3	14W	604604	7252562
								A20-SC-10	C	8.5	14W	604607	7252559
A76	MF	A76-69	March	13.9	14W	602555	7257139	A76-1	B & C	9	14W	602274	7256914
		A76-70	March	9.9	14W	601682	7256840	A76-2	B & C	8	14W	602223	7256920
		A76-71	July	10.9	14W	601789	7256745	A76-3	B & C	8.2	14W	602277	7256944
		A76-72	July	13.3	14W	602477	7257147	A76-4	B & C	8	14W	602289	7256969
		A76-73	August	9.8	14W	602617	7257218	A76-5	B & C	8	14W	602237	7256975
		A76-74	August	4.2	14W	601794	7257012	A76-COMP	C	-	-	-	-
		A76-75	September	8.9	14W	601819	7256882	A76-SC-1	C	8.9	14W	602277	7256914
		A76-76	September	7.4	14W	602345	7257028	A76-SC-2	C	8.9	14W	602272	7256919
								A76-SC-3	C	8	14W	602227	7256923
								A76-SC-4	C	8	14W	602222	7256928
								A76-SC-5	C	7.8	14W	602271	7256948
								A76-SC-6	C	7.8	14W	602275	7256947
								A76-SC-7	C	8	14W	602297	7256969
								A76-SC-8	C	7.9	14W	602293	7256976
								A76-SC-9	C	7.8	14W	602223	7256957
								A76-SC-10	C	8	14W	602226	7256966
DS1	FF	DS1-67	March	19.8	14W	597582	7260651	DS1-1	B & C	6.8	14W	598005	7262009
		DS1-68	March	10.1	14W	598035	7258247	DS1-2	B & C	7.9	14W	598078	7262011
		DS1-69	July	9.1	14W	598032	7258282	DS1-3	B & C	9.5	14W	598112	7262065
		DS1-70	July	7.8	14W	597598	7261080	DS1-4	B & C	9.5	14W	598129	7262018
		DS1-71	August	9.4	14W	597424	7261005	DS1-5	B & C	8.4	14W	598128	7262002
		DS1-72	August	9.3	14W	598034	7258279	DS1-COMP	C	-	-	-	-
		DS1-73	September	>20	15W	597494	7260475	DS1-SC-1	C	7.1	14W	598013	7262008
		DS1-74	September	5.7	15W	598001	7258251	DS1-SC-2	C	7.2	14W	598012	7262006
								DS1-SC-3	C	7.1	14W	598086	7262012

Area[1]	Area Type[2]	Area-Replicate	Water & Phytoplankton (Monthly)					Benthos & Sediment Chemistry (August)					
			Month	Depth (m)	Zone	Easting	Northing	Area-Replicate	Sample Type[3]	Depth (m)	Zone	Easting	Northing
DS1	FF							DS1-SC-4	C	7.3	14W	598081	7262010
								DS1-SC-5	C	9	14W	598109	7262010
								DS1-SC-6	C	9	14W	598115	7262010
								DS1-SC-7	C	9.2	14W	598123	7262019
								DS1-SC-8	C	9.5	14W	598128	7262021
								DS1-SC-9	C	7.5	14W	598118	7261990
								DS1-SC-10	C	7.5	14W	598122	7261998

Notes:

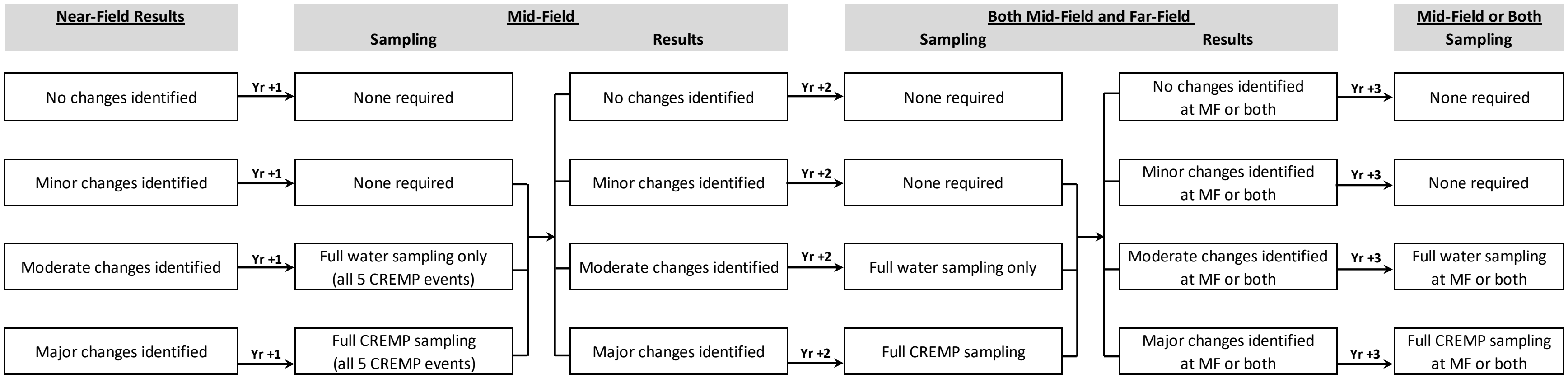
1. Area IDs are as follows: TPE, TPN, TPS=Third Portage Lake - East, North, South basins; SP=Second Portage Lake; TE, TEFF=Tehek Lake - Farfield; INUG=Inuggugayualik Lake; WAL=Wally Lake; PDL=Pipedream Lake; BBD, BPJ, BES, BAP=Baker Lake - Barge Dock, Proposed Jetty, East Shore, Akilahaarjuk Point. WTS = Whale Tail Lake – South Basin; KAN/MAM = Kangislulik Lake (previously Mammoth Lake); NEM = Nemo Lake.
2. Area types: NF=near-field; MF=mid-field; FF=far-field; Ref=reference.
3. Sample types: B=Benthos; C=chemistry; Comp = composite sample of all 5 replicate samples from each area (no coordinates).
4. Comp = composite sample of all 5 replicate samples from each area (no coordinates).

Note that water sampling at BES and sediment/benthic invertebrate sampling at TPS, TE, or TEFF was not completed as per the study design (Azimuth, 2022b).

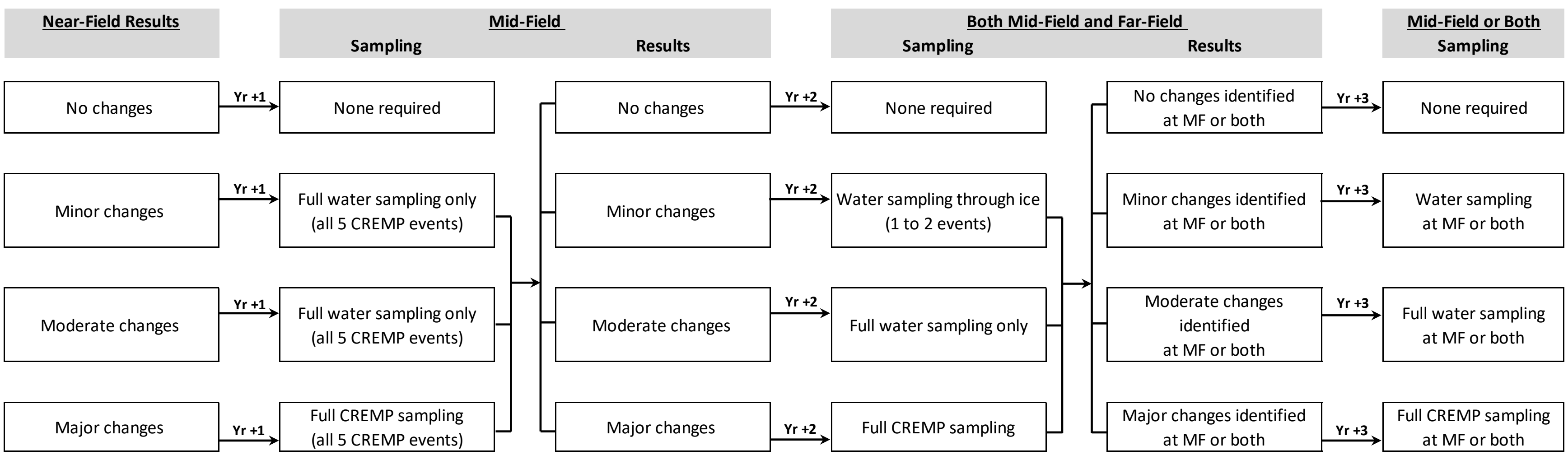
N/R = depth not recorded (no limnology data for this sample).

Figure 2-1. Annual results-based sampling strategy rules for mid-field and far-field sampling areas.

Meadowbank Study Area Lakes



Whale Tail Study Area Lakes



2.3 Data Evaluation Criteria

The specific methods used to apply triggers/thresholds in the evaluation of CREMP monitoring parameters varied by study component; details are presented in the following sections. The evaluation process focused on comparisons to early warning triggers; only when triggers were exceeded were monitoring results compared to effects-based thresholds. Consequently, methods for applying numerical decision criteria focus on triggers only, but apply equally to threshold values.

2.3.1 Water Chemistry

An iterative process was utilized to identify water chemistry parameters of primary concern at the Meadowbank, Whale Tail, and Baker Lake project areas. For each water chemistry parameter analyzed, the yearly mean concentration for each lake or basin was compared to its respective trigger value. Parameters where the yearly mean was equal to or exceeded the trigger value were formally tested using the Before-After-Control-Impact (BACI) statistical model. In addition to BACI analysis, a trigger screening assessment was conducted to evaluate the extent of changes in water quality as a guide for decision making (See **Section 2.2.3**). Finally, a conservative three-step assessment process was used to identify parameters to include in the formal trend assessment to streamline the interpretation process. In this assessment, water chemistry trends were examined broadly for all parameters meeting detection limits (> 10% of samples > method detection limit [MDL]), control-impact, and mine-related criteria outlined below.

Trigger Evaluation

Water quality data collected in 2023 were evaluated against triggers and effects-based thresholds consistent with the two-tiered approach outlined in **Section 1.5**. Formal comparison of the water quality data for decision-making purposes was done by comparing the yearly mean[12] parameter concentrations to the trigger values developed separately for the Meadowbank area lakes, Wally Lake[13], Baker Lake areas, and the Whale Tail area lakes[14]. The derivation methods and a full list of triggers and effects-based thresholds for each study area are provided in the *CREMP Plan*[15] (Azimuth, 2022b).

Parameters where the yearly mean was equal to, or exceeded the trigger value were formally tested using a one-tailed test of the null hypothesis[16] (significance level of p=0.05) using the Before-After-

[12] Yearly means were calculated by first calculating the monthly mean for each parameter per area, then calculating the yearly mean on an area-specific basis. Values that were less than the MDL were conservatively set to the MDL.

[13] Separate water quality triggers were developed for Wally Lake from the other Meadowbank areas when mining activities transitioned from the North and South Portage Pits (discharge to TPN) to the Vault Lake area (discharge to WAL) in 2013.

[14] Water quality triggers specific to the Whale Tail study area lakes were developed in 2019 (Azimuth, 2020a).

[15] The CREMP plan was revised in April 2022 and was formally implemented in August 2022.

[16] The null hypothesis is that "test" area concentrations either did not change or decreased. The alternative hypothesis is that they increased.

Control-Impact (BACI) statistical model. The BACI model is *paired* (i.e., BACIP) when multiple *before* and *after* events are available. Across each of the study areas, the following BACI components were included in the analysis:

- **Meadowbank Study Area Lakes and Wally Lake**: In the BACI model, INUG was used as the reference (*control*) area[17], with the other areas tested as exposure (*impact*) areas. True *pre-impact* data, when both INUG and the test area had *control* ("C") status, were used for the *before* data (see **Table 2-3**). Only events when both INUG and the test area were sampled in 2023 were used as the *after* data.
- **Whale Tail**: BACI analysis followed the approaches outlined for Meadowbank including INUG as the reference (*control*) area.
- **Baker Lake:** Baker Lake areas were designated as control (BAP) or impact (BPJ and BBD) when sampling started in 2008 (i.e., there was no detailed baseline sampling conducted for Baker Lake; see **Table 2-3**), so there are no true pre-impact or before data. While a spatial CI design could be used to test for differences between reference control and exposure impact areas, the design does not allow for distinguishing natural differences between areas from development-related changes. Given that no development-related changes had been identified to date, all years of data up to and including 2019 were considered in the before period, while the results since 2020 were considered after period data (i.e., allowing the more robust BACI analysis). The BACI analyses specifically looked at changes in 2023 at the two impact areas relative to previous years.

In addition to BACI analysis, a trigger screening assessment was conducted to evaluate the extent of changes in water quality as a guide for decision making. This approach falls into the framework outlined in **Section 2.2.3** and involved evaluating the extent and magnitude of trigger exceedances to direct the level of sampling intensity in proceeding years.

Parameter Assessment

Given the number of parameters routinely below laboratory MDLs (i.e., thus providing little insight for assessing mine-related changes to water quality), a conservative three-step assessment process was used to identify parameters to include in the formal trend assessment to streamline the interpretation process (the results are summarized in **Table 4-2**):

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[17] PDL and TEFF are excluded as control areas in the BACI analysis because neither area was sampled in the before period between 2006 and 2008 (i.e., limiting their utility as reference areas in the BACI model, but both providing valuable context for interpreting the strength and consistency of regional trends seen at INUG).

- **Overall Detection Frequency** – Only those water quality parameters that exceeded MDLs in at least 10% of the samples are included for this discussion. Because the project lakes are ultra-oligotrophic, it is normal for many parameters to be below MDLs. The temporal (and spatial) trend assessment includes data from all study years. In 2023, over half the parameters exceeded MDLs at least 10% of the time in Meadowbank lakes (54%), Whale Tail (71%), and Baker Lake (64%) study areas. These parameters are included in this discussion. Overall, there were no changes in detection frequency between 2022 and 2023.
- **Control-Impact Detection Frequency Comparison** – To avoid screening out infrequently detected parameters that were detected more often in association with mining activities, the proportion of samples exceeding MDLs between *control* and *impact* samples was compared. The intent was to identify parameters with <10% detection frequency (i.e., those screened out above) for which the proportion of detected values increased by 0.1 or more. Based on this second screening, no parameters were added back into the trend assessment.
- **Apparent Detection Pattern Matching Mining Activity** – As a further step to avoid screening out potentially important parameters at Meadowbank and Whale Tail study area lakes, trend plots for infrequently detected parameters were used to visually identify parameters with measured values associated with periods/locations of known mining activities (see **Table 1-1**). Where such patterns were observed or where parameters were measured at greater than five times the MDL at near-field sampling areas in at least one event, these parameters were added back into the trend assessment process.

FEIS Model Comparisons

In addition to the trigger/threshold BACI evaluation, the 2023 CREMP water quality data at Meadowbank and Whale Tail study area lakes were compared to water quality predictions developed as part of the FEIS process introduced in **Section 1.5**.

- **Meadowbank Study Area Lakes and Wally Lake** – Annual Meadowbank CREMP water quality data were also compared to the maximum whole-lake average water quality modelling predictions for Third Portage, Second Portage, and Wally Lakes made during the environmental assessment process (Cumberland, 2005).
- **Whale Tail** – Monthly Whale Tail CREMP water quality data for Whale Tail Lake (South Basin) and Kangislulik Lake were compared to their respective water quality monthly modeled predictions presented in the revised FEIS for the Expansion Project (see Golder, 2019).

While direct comparisons were made, the difference in spatial focus (i.e., the CREMP at the basin scale and the water quality model at the whole-lake scale) warrants caution interpreting any differences. To that end, the assessment criteria outlined in the Final Environmental Impact Statement (FEIS;

Cumberland, 2005) for defining the predicted magnitude of impacts to water quality will be used to provide the appropriate context for interpreting the screening results as follows:

- **Negligible**: water quality concentrations are similar to baseline
- **Low**: concentrations are < 1x the CCME Water quality guideline (WQG)
- **Medium**: concentrations are between 1 and 10-times the CCME guidelines
- **High**: concentrations are less than MDMER but greater than 10-times the CCME guidelines
- **Very High**: concentrations exceed MDMER standards.

Adaptive Management Strategy

Agnico Eagle developed an adaptive management strategy in 2021 to guide water management decisions at KAN/MAM and WTS[18] for two key contaminants of potential concern (COPCs): arsenic and phosphorus (Agnico Eagle, 2021). The strategy uses 'Levels' linked to specific criteria for total phosphorus and arsenic, and each Level has prescribed management actions. The Levels range from 0 (normal operating conditions) to 4 (emergency situation). The 'Level' for each lake is based on the concentration of total phosphorus and arsenic relative to predictions in the FEIS (Golder, 2019) and relative to the CCME water quality guidelines (WQG) of 0.01 mg/L for total phosphorus and the site-specific water quality objective (SSWQO) of 0.025 mg/L for arsenic. The adaptive management thresholds and corresponding adaptive management levels and strategies are summarized in **Table 2-4**. A detailed description of the adaptive management thresholds and management strategies is provided in Table 3 of the Adaptive Management Plan (AMP; Agnico Eagle, 2021).

Water quality data collected as part of the annual CREMP are used in the assessment. Results of the water quality comparison to AMP thresholds are provided in **Section 5.3.4**.

2.3.2 Sediment Chemistry

Sediment grab samples at Meadowbank and Whale Tail lakes are collected annually with the benthic invertebrate samples (2023[19]). In addition to characterizing physical conditions (e.g., grain size and organic carbon content), samples provide information on temporal changes in concentrations of metals and organics in sediment. Sediment chemistry core sampling for the CREMP is completed every three years at the same time as Environmental Effects Monitoring (EEM) sampling. The intent of the coring program is to monitor long-term trends in metals concentrations in the top layer of sediment (1.5 cm

[18] Mitigation measures include but are not limited to targeted studies, implementing activities to prevent, stabilize or reverse a change in environmental conditions or to protect the receiving environment.

[19] The frequency of benthic invertebrate and sediment chemistry monitoring was reduced from annually to once every three years in the 2022 *CREMP Plan Update* (Azimuth, 2022b).

[approximately]). In sediment coring years, metals analyses from the core samples replaces metals analyses from the grab samples. Sediment cores were collected in 2023, the next full coring program is scheduled for 2026 (coinciding with the EEM program).

Trends in sediment chemistry are evaluated by comparing the yearly mean parameter concentrations in the core samples to the trigger[20] values applicable to the Meadowbank study area lakes, Wally Lake, and the Whale Tail study area lakes (see discussion below). Those parameters where the yearly mean was equal to or exceeded triggers were formally tested using a before-after (BA) statistical model[21]. Sediment chemistry can be quite variable over a small spatial scale within a given basin, but natural seasonal variability in sediment chemistry is assumed to be low given the low rates of natural sediment deposition in Arctic lakes (Azimuth, 2012d). The BA statistical model assumes that, in absence of mining-related inputs, annual variability in sediment chemistry is negligible.

The naturally high sediment concentrations in the Whale Tail lakes necessitated triggers that were lake specific, similar to the approach that was used to develop triggers for Wally Lake. The derivation of these triggers was completed in 2019 and included in the analysis of grab sediment chemistry. The statistical analysis of sediment in the Whale Tail study lakes was implemented for the 2023 sediment coring program that took place August 2023 (see **Section 5.5**). Evaluation of the data followed the same approach used for Meadowbank by comparing the yearly mean concentrations to new trigger values and BA statistical analysis of temporal changes for parameters that exceeded their respective triggers. Triggers were developed using the baseline sediment core chemistry data collected in 2017 and the statistical approach described in Azimuth (2012d). CCME sediment quality guidelines were set as the thresholds when applicable (i.e., for those parameters with CCME sediment quality guidelines). Triggers were set to the maximum of one of three methods for the Whale Tail lakes:

- Method A: the value halfway between the baseline median and the effects-based threshold (CCME ISQG),
- Method B: the 90th percentile of the baseline data, or
- Method C: the value corresponding to a 20% increase above the median value.

2.3.3 Phytoplankton and Benthos Community Variables

Trigger and threshold value development for phytoplankton and benthos communities was presented in detail in the original *CREMP Design Document* (Azimuth, 2012d). Unlike water or sediment, where environmental quality guidelines can be used to develop triggers or thresholds, there are no universal

[20] The trigger values for the Meadowbank project lakes were updated in the 2017 CREMP report (Azimuth, 2018c).

[21] One-tailed test of the null hypothesis that concentrations are not different (or lower) in the after period relative to the before period (significance level of p=0.05); the alternate hypothesis is that concentrations have increased in relation to mining.

benchmarks for biological variables such as abundance, biomass or diversity. Rather, the magnitude of change or difference relative to expected conditions must be used to establish *critical effect sizes* (CES) for biological variables. Effect sizes of 20% and 50% were established as the *trigge*r and *threshold* for assessing changes in biological variables. Importantly, the terms *threshold* and *trigge*r for biological variables are not used as strictly as for water and sediment chemistry parameters for two reasons:

1. Statistical Power – For most biological variables, natural variability can make it difficult to statistically detect effect sizes as low as 20%. It is more realistic to detect larger effect sizes such as 50%.
2. Causality – Regardless of effect size, even if statistically-significant changes are documented the cause of the change needs to be understood in order to effectively manage the situation. For the Meadowbank biological data, effect sizes exceeding 50% have been observed due to natural variability in the baseline data.

Phytoplankton Taxonomy

Total phytoplankton biomass and taxa richness are the metrics used to assess changes in the phytoplankton community using the BACI framework. The BACI analysis compares paired monthly sampling events at control area (INUG or BAP) and impact areas (i.e., NF or MF areas) over two periods (before and after), with months as the unit for temporal replication. Phytoplankton triggers and thresholds are set to relative changes of 20% and 50%, respectively. The evaluation procedure was analogous to that used for water chemistry, except that yearly area means were not directly comparable to triggers (i.e., since the triggers/thresholds are based on the relative change over time in a parameter rather than on a finite value), so the process started with the BACI testing. Two-tailed tests of the null hypothesis (i.e., that test areas experienced no relative change up or down) were conducted with a significance level of p=0.1.

Benthos Taxonomy

For benthos, trigger and threshold values are set to relative changes (increases or decreases of 20% and 50%) in total biomass and species richness at test areas using the BACI framework. The CREMP uses percent change rather than standard deviations which are used in EEM, to maintain a transparent (fixed) effect size that is more likely to be ecologically relevant. Statistical power increases with consideration of more *after* period years; consequently, BACI analyses for the Meadowbank lakes were conducted on four *after* data period lengths: one year (2023 only), two years (2022–2023), three years (2021–2023), and four years (2020–2023) and for the Whale Tail lakes for either one year (2023 only) or for WTS and KAN/MAM both one year and two years (2022–2023). Two-tailed tests of the null hypothesis were conducted with a significance level of p=0.1. Failure to reject the null hypothesis implies the endpoint (i.e., total abundance or species richness) did not change. The alternative hypothesis is that the endpoint increased or decreased. A p-value of 0.1 or less was considered significant to help improve statistical power for the benthic invertebrate endpoints.

Benthic invertebrate community monitoring was completed at Baker Lake in 2023 as outlined in the *CREMP Plan Update* (Azimuth, 2022b). No baseline benthic community data are available for Baker Lake, so there is no true *pre-impact* or *before* data. While a spatial *CI* design could be used to test for differences between reference *control* and exposure *impact* areas, the design does not allow for distinguishing natural differences between areas from development-related changes. Rather, since no development-related changes had been identified to date, BACI analyses for Baker Lake benthos are conducted using a series of four temporal scenarios using all years of data (i.e., 2023 compared to 2008–2022; 2022/2023 compared to 2008–2021 and so on). These series of comparisons are a more robust method for identifying temporal changes due to mining-related activities in Baker Lake without needing to assume that sampling areas should have identical communities (i.e., like the *CI* design).

Figure 2-2. Management response plan for the Meadowbank Mine Aquatic Environment Monitoring Program (AEMP).

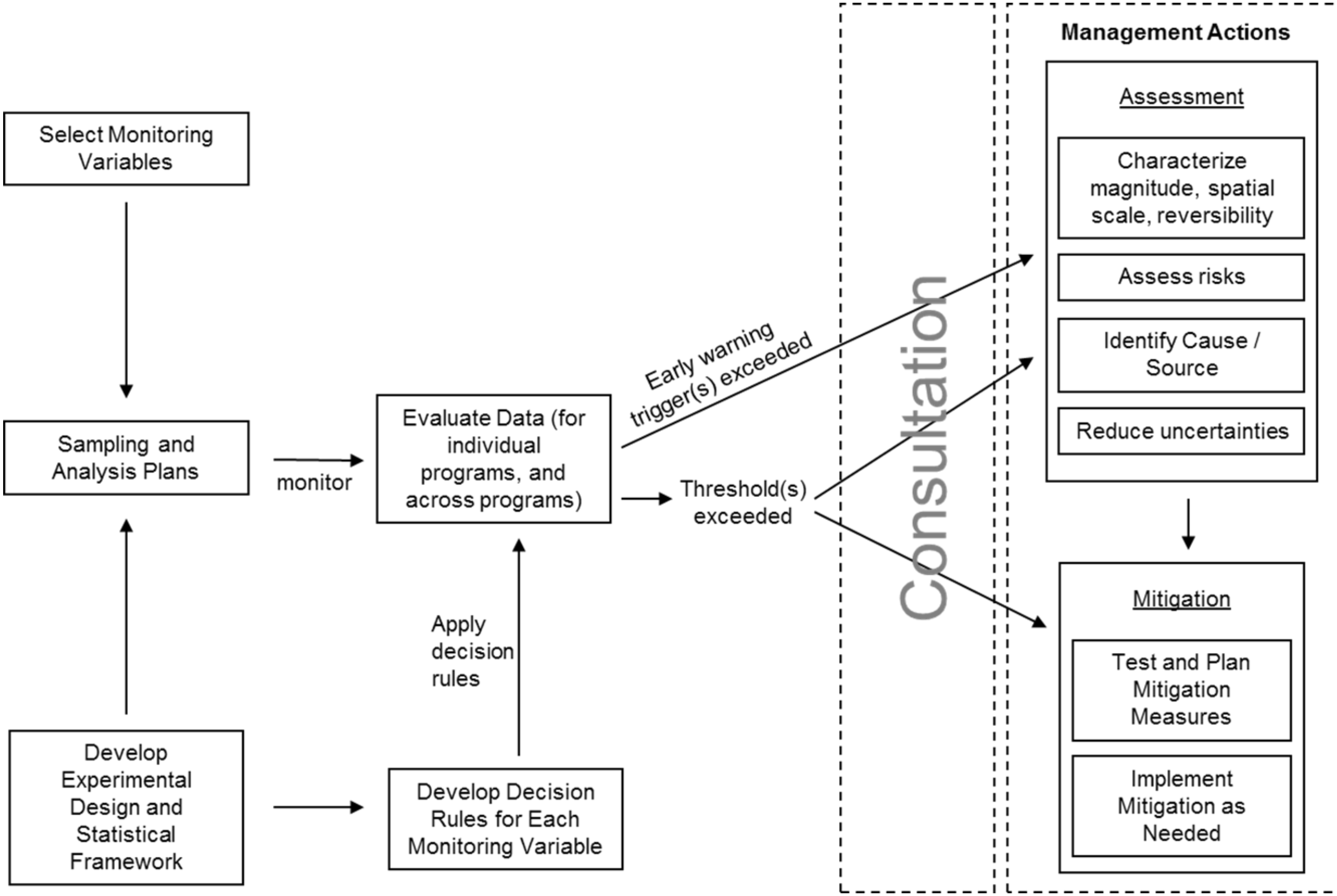

Table 2-3. Status of all CREMP sampling areas since the beginning of monitoring.

	Meadowbank Areas									Baker Lake Areas				Whale Tail Areas					
Designation	**REF**	**REF**	**NF**	**NF**	**NF**	**NF**	**MF**	**MF**	**FF**	**REF**	**REF**	**NF**	**NF**	**NF**	**NF**	**NF**	**MF**	**MF**	**FF**
Area	**INUG**	**PDL**	**TPN**	**SP**	**TPE**	**WAL**	**TPS**	**TE**	**TEFF**	**BAP**	**BES**	**BBD**	**BPJ**	**WTS**	**KAN/MAM**	**NEM**	**A20**	**A76**	**DS1**
2006	C		C	C	C	C	C	C											
2007	C		C	C	C	C	C	C											
2008	C		C	I (Aug)	C	C	C	I (Aug)		C		I	I						
2009	C	C	I (Mar)	I	I (Aug)	C	C	I	C	C		I	I						
2010	C	C	I	I	I	C	C	I	C	C		I	I						
2011	C	C	I	I	I	C	C	I	C	C	C	I	I						
2012	C	C	I	I	I	C	C	I	C	C	C	I	I						
2013	C	C	I	I	I	I (Jul)	C	I	C	C	C	I	I						
2014	C	C	I	I	I	I	C	I	C	C	C	I	I	C	C	C			
2015	C	C	I	I	I	I	C	I	C	C	C	I	I	C	C	C			
2016	C	C	I	I	I	I	C	I	C	C	C	I	I	C	C	C	C	C	C
2017	C	C	I	I	I	I	C	I	C	C	C	I	I	C	C	C	C	C	C
2018	C	C	I	I	I	I	C	I	C	C	C	I	I	I (Aug)	I (Nov)	C	C	C	C
2019	C	C	I	I	I	I	C	I	C	C	C	I	I	I	I	I (Aug)	I	I	I
2020	C	C	I	I	I	I	C	I	C	C	C	I	I	I	I	I	I	I	I
2021	C	C	I	I	I	I	C	I	C	C	C	I	I	I	I	I	I	I	I
2022	C	C	I	I	I	I	C	I	C	C	C	I	I	I	I	I	I	I	I
2023	C	C	I	I	I	I	C	I	C	C	C	I	I	I	I	I	I	I	I

Notes:

<u>Area designations:</u>

C=Control; I=Impact; REF=reference (in grey shading); NF=near-field (in blue shading); MF=mid-field (in pink shading); FF=far-field (in teal shading).

Blank cells indicate the area was not part of the monitoring program that year.

<u>Area IDs:</u>

Meadowbank and Whale Tail Reference areas: INUG = Inuggugayualik Lake; PDL = Pipedream Lake.

Meadowbank: TPN, TPE, TPS = Third Portage Lake – North, East, South basins; SP = Second Portage Lake; WAL = Wally Lake; TE, TEFF = Tehek Lake (Mid-and Far-field).

Baker Lake areas: BAP, BES, BBD, BPJ=Baker Lake – Akilahaarjuk Point, East Shore, Barge Dock, Proposed Jetty.

Whale Tail areas: WTS = Whale Tail Lake South Basin; KAN/MAM = Kangislulik Lake (previously Mammoth Lake); NEM = Nemo Lake; A20 = Lake A20; A76 = Lake A76; DS1 = Lake DS1.

Table 2-4. Adaptive Management Strategy for contaminants of potential concern (COPCs) in water from Whale Tail Lake (South Basin) and Kangislulik Lake.

Adaptive Management Level*	Threshold (Total Phosphorus and Arsenic)	Management Strategy[1]
Level 0 (Normal operating condition)	Within 20% of FEIS predicted concentrations.	No changes – continue with CREMP monitoring plan.
Level 1 (Area of concern)	Concentrations equal to or greater than 20% FEIS predicted concentrations AND less than 80% of the WQG or SSWQO.	Continue with Level 0 management strategy. Analyze site wide water quantity and quality data to identify and assess cause(s) of the difference(s) and reported to the NWB. Report results of data review in annual reporting to the NWB including implications on the Water Management Plan and evaluation of potential mitigation strategies (e.g., enhance water treatment plant efficiency and reduce maximum effluent discharge concentration by 10%).
Level 2 (Area of concern)	Concentrations equal to or greater than 20% FEIS predicted concentrations AND between 80% and 100% of the WQG or SSWQO.	Continue with Level 1 management strategy. Report results of data review to the NWB in the Annual Report, including implications on the Water Management Plan and the evaluation of potential mitigation strategies (e.g., enhance water treatment plant efficiency and reduce maximum effluent discharge concentration by 20%). Move discharge location to KAN/MAM or WTS. Assess potential discharge in lakes D1 or D5 in case level 3 is reached, with approval from the NWB as per NIRB Project Certificate Conditions.
Level 3 (High risk situation)	Concentrations equal to or greater than 20% FEIS predicted concentrations AND between 100% and 120% of the WQG or SSWQO.	Continue Level 2 management strategy. Report results of data review in the Annual Report to the NWB including implications on the Water management plan and the evaluation of potential mitigation strategies (e.g., review overall water management strategy to stay within assimilative capacity of the receivers). Continue monitoring in the original receiving area to evaluate if they recover and define threshold to restart using them.
Level 4 (Emergency situation)	Concentrations equal to or greater than 20% FEIS predicted concentrations AND greater than 120% of the WQG or SSWQO.	Continue Level 3 management strategy. Report results of detailed data review in the Annual Report to the NWB, including implications on the Water management plan and the evaluation of potential mitigation strategies (e.g., move discharge location to an approved location). Continue monitoring in the original receiving area to evaluate if they recover and define thresholds to restart using them. Evaluate potential new discharge location to resume operation.

Notes:

* Agnico Eagle will consult with the NWB on the required approval process, execution, and implementation prior to initiating the adaptive management strategy items for Adaptive Management Levels 3 and 4.

[1] See Table 3 in the Adaptive Management Plan for more details on management strategies for each Adaptive Management Level (Agnico Eagle, 2021).

Acronyms

FEIS = Final environmental impact statement.

SSWQO = Site-specific water quality objective.

WQG = Water quality guideline.

3 QUALITY ASSURANCE / QUALITY CONTROL

3.1 Overview of CREMP QA/QC

The objective of quality assurance/quality control (QA/QC) is to assure that the chemical and biological data collected are representative of the material or populations being sampled, are of known quality, have sufficient laboratory precision to be highly repeatable, are properly documented, and are scientifically defensible. Data quality was assured throughout the sample collection and analysis using specified standardized operating procedures, by using laboratories that have been certified for all applicable methods, and by staffing the program with experienced technicians.

The framework of the QA/QC program is outlined in *CREMP Plan* (Azimuth, 2022b), which includes a description of the established SOPs. The plan update document is the foundation for assessing data quality for each routine component of the CREMP (e.g., water, sediment) and was adopted for the Whale Tail mine baseline sampling program (Azimuth, 2018b). Detailed analysis of the data quality for each component of the CREMP is provided in **Appendix A**. A summary of the key messages from the 2023 QA/QC program is provided in the subsections below.

3.2 Sample Shipping and Handling

Sample shipping and handling concerns documented in earlier CREMP reports have largely been rectified in recent years. ALS's QA/QC summary results from each laboratory report are integrated into **Appendix A**.

The sample shipping and handling QA/QC for 2023 was comparable to 2022. There were a few discrepancies between samples submitted and the COCs, but most were rectified without impacting the analytical results. The logistics, distances, and general challenges of collecting and shipping samples from a remote mine in Nunavut meant that hold times were exceeded for several parameters/analytes, but the impact on results is considered negligible.

3.3 Water Chemistry

Briefly, the standard QA procedures for the water chemistry program include thoroughly flushing the flexible tubing and pump to prevent cross-contamination between areas. Field QC procedures include collection and/or analysis of field duplicates and blanks (travel, equipment, and deionized water blanks). The laboratory QC program includes duplicate analysis, blanks, and analysis of spike samples and reference material to verify the accuracy and precision of the analytical method.

The objectives and methods for surface water QA/QC are outlined in detail in **Appendix A**. The field and laboratory QA/QC results for water chemistry for 2023 were very good and were comparable to the results from the previous year:

1. Sample integrity was very good in 2023. No samples were lost from breakage or mislabeling, which was an improvement over 2022. Sample temperatures received at the laboratory were variable depending on season and reflect the challenges with shipping from a remote mine site. Holding times were routinely exceeded for alkalinity, turbidity, laboratory pH, nitrate, nitrite, total dissolved solids (TDS), TSS, and dissolved orthophosphate (as P). Very occasionally hold times were exceeded for cyanides (free and total), total Kjeldahl nitrogen (TKN), ammonia, total mercury, and chlorophyll-a. These hold-time exceedances are not considered likely to impact data analysis and interpretation.
2. Travel, deionized (DI) water, and equipment (EB) blank results for 2023 were similar to 2022 and indicated reliable sample handling and that systematic cross-contamination related to sampling equipment is unlikely. The DI blanks and travel blanks did not warrant flagging any parameters as unreliable in the 2023 analyses.
3. The implication of possible cross-contamination (i.e., where analytes were detected in the EBs) on interpretation of the 2023 water quality data was evaluated by comparing the sample concentrations with the EB results from the same event. Sample results were given a cautionary flag (shown in tables using underlining; e.g., 0.001) when the measured concentration was less than 5-times the concentration detected in the EB. Several analytes were occasionally given cautionary flags, including ammonia, aluminum, copper, lead, and manganese. None of the results had concentrations were > 10 times the DL. Sample results, including results with cautionary flags, are reported in **Appendix B1** (Meadowbank), **Appendix B2** (Whale Tail), and **Appendix B3** (Baker Lake).
4. It should be noted that isolated instances of trigger exceedances for individual water chemistry parameters do not necessarily indicate a trend or even real conditions. The QA/QC program provides an added layer of context to data interpretation by highlighting those variables for which the results appear to be influenced by laboratory anomalies or cross-contamination rather than by mining activities. Overall, potential cross-contamination is considered unlikely to bias interpretation of the 2023 water quality analysis.
5. There were a few cases where planned method detection limits (MDL) were not met by the laboratory. The MDL for chromium was adjusted by the laboratory from 0.0001 to 0.0005 mg/L in May 2021 and for beryllium in 2018 from 0.00002 to 0.00001 mg/L due to method re-validation (Pers. Comm. Brent Mack, ALS November 28, 2022). For both parameters, the revised MDLs still meet the lowest available Canadian quality guidelines (0.1 µg/L for beryllium, 0.5 µg/L for

chromium; Pers. Comm. Brent Mack, ALS November 28, 2022). Beryllium has consistently remained below MDL since baseline and is not a parameter of concern for the Site. Furthermore, the revised MDL is below the trigger and threshold values for the Meadowbank, Whale Tail, and Baker Lake study areas. As such, the revised MDL is sufficient to detect changes in concentrations of beryllium at the Site. There is no lower MDL analysis available for beryllium. For chromium, concentrations above MDL have been detected during operations and the revised MDL was higher than those detected concentrations. Starting in 2023, low-level chromium (DL = 0.1 µg/L) was analyzed in order to ensure any potential changes in chromium concentrations due to mining activities are detected. The 2023 results for beryllium were less than the revised DL. There were a few samples above the revised MDL for chromium at NF areas and reference areas (INUG and PDL).

6. The 2023 field duplicate results were very good, with <1% of the calculated RPDs not meeting DQOs. There was one field duplicate collected in September for chlorophyll-a that did not meet the RPD DQO with a concentration greater than 10 times the DL. The other samples collected during the same sampling event do were not affected.
7. Laboratory QC results for water chemistry were also very good in 2023, with very few laboratory data quality qualifiers and none that were deemed likely to impact data interpretation.
8. Two QC screening steps comparing total to dissolved fractions and examining disparities between paired sample results were also utilized. The first analysis compared the total and dissolved concentrations for a given parameter in each sample. Samples for which dissolved concentrations were greater than total concentrations and which had a relative percent difference (RPD) of more than 30% were flagged for review. The second analysis compared parameter concentrations of samples collected within a given area in each sampling event; parameters within a given area and sampling event that had concentrations that differed by more than a factor of 5 (or a factor of 10, if at least one of the samples was within a factor of 10 from the MDL) were flagged for review. All samples that were flagged for further validation are summarized by sampling event in **Appendix A**. Based on these screening steps, a few of the 2023 water quality results were removed from the analysis due to data quality issues (i.e., *unreliable* flags). For transparency, the results are shown in the water quality tables provided in **Appendix B**.

Unless discussed as unreliable above, the water quality QA/QC assessment verified that data are reliable for analysis and interpretation of spatial and temporal trends.

3.4 Sediment Chemistry

The sediment chemistry QA/QC assessment is comprised of field and laboratory duplicates, filter swipes for cross-contamination, and the QC report from ALS for sediment grab samples submitted in 2023. Key results of the sediment chemistry QA/QC, presented in **Appendix A**, are as follows:

- For the sediment QA/QC samples, there were no sample integrity concerns.
- Several analytes were detected in the sediment grab equipment filter swipes. However, none were estimated to affect sediment chemistry results by more than 0.01%, suggesting negligible cross contamination.
- There were nine grab and 15 core sample field duplicates collected in 2023. Out of the RPDs calculated, 97% met the DQOs for sediment cores and 91% met the DQOs for sediment grabs. For the composite sample duplicates, all RPDs met the DQOs for hydrocarbon/PAHs in sediment. Overall, field duplicate results indicate good field collection methods and a high degree of replicability in sampling.
- The laboratory QC results show a high degree of precision for the laboratory analysis and laboratory processing and analytical methods were consistent between sub-samples. The only qualifiers assigned to the sediment grab chemistry results were for polycyclic aromatic hydrocarbon (PAH) detection limits in composite samples due to high moisture content, however these results are unlikely to impact data interpretation.

3.5 Phytoplankton Taxonomy

Field duplicates are collected for phytoplankton during each sampling event in coordination with water sample duplicates and are taken in order to assess sampling variability and sample homogeneity. An RPD of 50% for total density and total biomass concentrations is considered acceptable. As a measure of laboratory QA/QC on the enumeration method, replicate counts are performed on 10% of the samples. Replicate samples are chosen at random and processed at different times from the original analysis to reduce biases.

Detailed analysis of the phytoplankton data quality is included in **Appendix A**. Phytoplankton QA/QC for both field and laboratory components in 2023 was good, indicating reproducible results across both sampling and taxonomic analysis process. Except for a few RPDs that exceeded DQOs in the field duplicates, the majority of phytoplankton taxonomy results for 2023 met project DQOs and are considered reliable for data analysis and interpretation of spatial and temporal trends.

3.6 Benthos Taxonomy

Quality assurance measures in the field involved adherence to the standardized method for collecting, sieving, and preserving samples for taxonomic identification (see Appendix B in Azimuth, 2015b). While field duplicates are not collected, inferences regarding within-area variability are gained by directly looking at results across replicate samples (see **Section 4.6** and **Section 5.6**). The laboratory (ZEAS) QA/QC procedures include re-sorting and re-counting 10% of the samples targeting a DQO of > 90% recovery. Details of the benthos taxonomy data quality assessment is included in **Appendix A**. Percent recovery was above 95% in all re-sorted samples, with an average percent recovery of 97.4%.

The 2023 benthos taxonomy metrics met DQOs and are considered reliable for data analysis and interpretation of spatial and temporal trends.

4 MEADOWBANK

4.1 Overview of the Meadowbank CREMP

This section summarizes the 2023 CREMP results for monitoring water quality, sediment chemistry, phytoplankton community, and benthic invertebrate communities at the Meadowbank study area lakes. Relevant figures and tables are included at the end of the section.

The CREMP monitoring plan for routine CREMP sampling years is outlined in **Section 2.2**. The 2023 CREMP focused on monitoring changes in the NF study areas in Third Portage Lake (East Basin [TPE] and North Basin [TPN]), Second Portage Lake (SP) and Wally Lake (WAL). Reference area sampling at INUG and PDL was completed concurrently with sampling at the NF areas. Beginning in 2022, routine water sampling was suspended at TE, TEFF, and TPS unless results in NF areas showed moderate changes (Azimuth, 2022b). Based on the results of the 2022 CREMP[22] , no routine water sampling, sediment chemistry, or benthic invertebrate community sampling was required at the MF (TE, TPS) and FF (TEFF) stations (Azimuth, 2023a). CREMP sampling locations for water and sediment/benthos are shown in **Figure 4-1** and **Figure 4-2**, respectively.

4.2 Limnology

Limnology data, when compared to previous monitoring data, provide an initial assessment of whether conditions are changing within a sampling area and may require additional investigation. At least one depth profile was conducted monthly for temperature, dissolved oxygen, and conductivity from NF areas except when ice conditions were unsafe[23] (June and October). Two profiles were completed along with water sampling for chemistry and phytoplankton taxonomy in March, July, August, and September. No samples were collected at Meadowbank area lakes in May due to unsafe ice conditions. Limnology profiles, without paired water chemistry or phytoplankton sampling, were also collected in January, February, April, November, and December. Qualitative evaluation of the limnology data was completed using plots of the deepest sample within each lake for a given event. Samples used for plotting and interpreting the 2023 limnology data are specified in **Table 4-1**.

[22] There were no trigger exceedances for parameters with effects-based thresholds at the NF areas in 2022 (Azimuth, 2023a). Consistent with the adaptive monitoring strategy implemented in 2015 (summarized in Azimuth, 2022b), sediment chemistry or benthic invertebrate community sampling was not required at MF and FF areas in 2023.

[23] In 2023, the May sampling event was cancelled due to unsafe ice conditions.

Table 4-1. Samples included in the limnology profiles in 2023.

Area[1]	Jan	Feb	Mar	Apr	May[2]	Jun	Jul	Aug	Sep	Oct	Nov	Dec
INUG			INUG-149		Ice not safe for travel	Ice not safe for travel	INUG-151	INUG-152	INUG-155	Ice not safe for travel		
PDL			PDL-114				PDL-116	PDL-118	PDL-119			
TPN	☑	☑	TPN-161	☑			TPN-163	TPN-165	TPN-167		☑	☑
TPE	☑	☑	TPE-161	☑			TPE-163	TPE-164	TPE-167		☑	☑
SP	☑	☑	SP-160	☑			SP-162	SP-164	SP-167		☑	☑
WAL	☑	☑	WAL-129	☑			WAL-132	WAL-133	WAL-136		☑	☑
TPS												
TE												
TEFF												

Notes:
Empty cells indicate no limnology profiles were collected, consistent with the study design.
☑ = One profile is collected from the near-field areas (and occasionally one mid-field area) in months where water sampling is not completed.
The sample IDs shown represent the deeper of the two locations sampled each month.
1. Routine water sampling at TPS, TE, and TEFF was not completed in 2023 as per the *CREMP Plan Update* (Azimuth, 2022b).
2. The May sampling event was cancelled due to unsafe ice conditions.

4.2.1 General Observations

The ice-free season on the Meadowbank study area lakes is very short. Ice break-up usually occurs during mid- to late-June, and ice begins to form again beginning in late September or early October, with complete ice cover by late October. Maximum ice thickness is about 2 m and occurs in March/April, increasing the concentration of some ions, such as chloride, in the water near the ice-water interface. This occurs due to cryo-concentration, where ice formation excludes certain ions and increases their concentration in the water column (Wetzel, 1983). Because the lakes are ice-covered for most of the year, gas exchange with the atmosphere is limited, although oxygen concentrations usually remain high under the ice because of the low rates of biological activity and organic decomposition (processes that consume oxygen from the water). Historically, there is typically a slight negative thermal stratification in the winter with water temperatures of 0°C near the ice-water interface and increasing to between 3°C and 5 °C at depth.

The maximum temperature measured during the open-water sampling events in 2023 was 17.34 °C at SP in mid-August, which was approximately 3°C warmer than in 2022 and the highest reported since sampling began in 2006. During open-water events, maximum water temperatures may typically reach 15°C in the summer with little evidence of thermal stratification, except for brief periods (days) when there is typically only a 4°C to 5°C temperature difference. High winds maintain uniform temperature and high oxygen profiles in the water column due to vertical mixing.

4.2.2 Temporal and Spatial Trends

Temperature and Dissolved Oxygen

Water temperatures and oxygen concentrations in the Meadowbank study area lakes in 2023 followed similar patterns of seasonal change compared to previous monitoring cycles. Surface water (3 m) temperatures in 2023 showed substantial differences between winter and summer events, like previous years (**Figure 4-3**).

Winter temperature profiles for the through-ice sampling events show a slight negative thermal stratification with water temperatures near 0°C at the ice-water interface, typically increasing to between 2°C and 3.5°C at depth (**Figure 4-4**). Oxygen concentrations in winter generally decrease slightly with increasing depth, with occasional values measured above theoretical limits of air saturation[24] (14.6 mg/L at 0°C; **Figure 4-5**). Oxygen concentrations in all basins are greater than 5 mg/L, and usually greater than 10 mg/L at even the lowest depths, despite nearly nine months of ice cover.

The study area lakes typically turn over by mid-July, leading to a well-mixed water column with uniform temperature and high oxygen concentrations. Water temperatures warm rapidly to reach maximum temperatures of around 15°C by late July and into August. Deeper lakes and basins, such as TPN and INUG, are typically 2°C to 3°C colder than the shallower locations, Wally Lake (WAL) and Second Portage Lake (SP). Temperatures in the 2023 depth profiles were mostly typical of historical temperature patterns aside from slightly warmer temperature profiles reported in August at TPE and SP (**Figure 4-4**). There was slight stratification at INUG, SP, and WAL in July, and at PDL, TPN, and TPE in August. There was no evidence of vertical stratification from July through September in the other lakes and basins. In November, the study lakes froze and became slightly stratified, with surface waters near 0°C and bottom waters ranging up to 2.2°C at TPN. With vertical mixing, oxygen concentrations were high, and the water was fully saturated in November and December (**Figure 4-5**).

Temperature and oxygen concentrations in 2023 were mostly consistent with previous years, and the seasonal patterns were typical of this Arctic area. There were no differences in these patterns between the control lakes (INUG and PDL) and the NF and MF monitoring areas, aside from slightly warmer temperatures in TPE and SP in August compared to previous years.

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[24] Photosynthesis occurring under ice can lead to DO results exceeding theoretical air saturation limits. This is due to photosynthesis producing pure oxygen, as opposed to the approximate oxygen content of 21% in air.

Conductivity

Field conductivity[25] is an indicator of stratification in the water column and is an effective way of assessing changes in water quality that may be related to mining activities such as the discharge of treated water and seeps. From a monitoring perspective, uniform conductivity provides confidence that the water column is well-mixed and that a water sample collected at a discrete depth represents conditions from the surface to near the bottom of the lake. In contrast, variable conductivity in areas close to mining activity may indicate the presence of water with different chemical properties. Surface water sampling is done at 3 m below the surface, but conductivity profiles can help identify if additional samples should be collected at other depth intervals. Conductivity of oligotrophic systems with low concentrations of dissolved solids is typically less than 50 µS/cm and uniform from top to bottom in any given month, with minor seasonal fluctuations. While the overall range in conductivity is similar between ice-on (10–50 µS/cm) and ice-off (10–40 µS/cm) months, the conductivities in ice-off months are generally lower, which is consistent with cryo-concentration during progressive ice formation in winter.

Field-measured conductivity was unstratified for most of the 2023 limnology profiles. Minor fluctuations in conductivity were evident during some of the winter sampling events due to cryo-concentration (see **Figure 4-6**).

Conductivity at SP in 2023 was generally within the range of historical values dating back to 2009. Field collected conductivity at SP was typically between 20 µS/cm and 30 µS/cm prior to 2014. More recent results from 2014–2022 have trended between 30 µS/cm and 50 µS/cm. The change in laboratory reported conductivity at SP was identified in the water chemistry BACI analysis but has not been linked to any adverse effects to the biological community (see **Section 4.3** and **Figure 4-7** for more details).

Conductivity at WAL was within the range observed in previous years. WAL had higher conductivity observed in the winter months (between 40 and 50 µS/cm) compared to the summer months (between 30 and 40 µS/cm). Baseline results for WAL during the open-water period were between 30 and 40 µS/cm. As with SP, laboratory reported conductivity at WAL has been identified in the BACI analysis but has not been linked to any adverse effects to the biological community (see **Section 4.3** and **Figure 4-7** for more details).

4.3 Water Chemistry

Tabulated water quality data for 2023 are presented in **Appendix B1**. Water chemistry samples were collected simultaneously with limnology samples in March, July, August, and September (see **Section 4.2**

[25] Throughout this report, any discussion of *conductivity* refers to specific conductance, which is conductivity normalized to 25°C.

for limnology results). In May, the sampling event was cancelled due to unsafe ice conditions (see **Section 2.1** for details).

4.3.1 Key Findings from the 2023 Water Chemistry Monitoring Program

- There are no major mining activities taking place at Meadowbank and effluent discharge only occurred at SP from January to April in 2023.
- There were no trigger exceedances for parameters with effect-based thresholds. Water quality in the Meadowbank study area lakes is safe for aquatic life.
- Mining activities have contributed to higher concentrations of dissolved solids and some major ions in the Meadowbank area lakes.

4.3.2 Temporal and Spatial Trends

Annual mean concentrations for each parameter were compared to triggers and effects-based thresholds according to the approach outlined in **Section 2.3.1**. If the annual mean concentration for a given parameter exceeds the trigger, BACI statistical comparisons to baseline conditions and reference location INUG were conducted.

Given the number of parameters routinely below laboratory MDLs, a conservative three-step assessment process was used to identify parameters to include in the formal trend assessment to streamline the interpretation of the results. Details of the three-step assessment process are provided in **Section 2.3.1** and the results are summarized in **Table 4-2**. The results of the water chemistry parameter assessment process are presented in **Table 4-2**; shaded parameters were retained for further analysis. Monitoring results showing spatial (all NF, MF, FF, and REF areas) and temporal (all monitoring years) trends for surface water (samples collected from a depth of 3 meters) for retained parameters are shown in **Figure 4-7** to **Figure 4-11**. The red dashed line is the trigger value specific to the parameter and area. Blue dashed lines have been added for TPN, TPE, SP, and WAL for parameters that have FEIS model predictions (see **Section 2.3.1**). Parameters with no clear spatial or temporal trends related to mining activities or natural variability were excluded from further consideration (see **Table 4-2**). For completeness and transparency, water chemistry plots for all parameters are included in **Appendix B1**.

Parameters for which the 2023 yearly mean exceeded the trigger values in NF areas are shown in **Table 4-3**. Parameter/area trigger exceedances were similar to 2022 and included measures and indicators of conductivity, hardness, alkalinity, major ions, and silicon. The results of BACI analyses for exceeding parameter/area combinations are provided in **Table 4-4**. BACI analysis results in 2023 were largely the same as last year, with statistically significant increases relative to baseline/reference conditions ($p < 0.05$) in conductivity, hardness, major ions, and other non-threshold parameters for at least one NF lake.

A literature review was completed in 2019 focusing on toxicity studies for major ions and other parameters that have routinely exceeded the 95th percentile of baseline concentrations during the operations phase. That summary report was prepared as a technical appendix in the 2020 CREMP report (Azimuth, 2021). Water chemistry results for parameters that exceeded their respective trigger values are discussed in the sections that follow.

Conventional Parameters (Conductivity, Hardness, and Alkalinity)

Conductivity and Hardness – Conductivity is a composite variable that increases in response to higher concentrations of ionic compounds such as chlorides, sulphates, carbonates, sodium, magnesium, calcium, potassium, and metallic ions. Conductivity and hardness at all areas were slightly lower than 2022. At TPE, TPN, and WAL these parameters appear to be stable which is consistent with results from previous years and expected, given that discharge to these lakes stopped in 2014 at TPE and TPN, and 2017 at WAL. In 2023, conductivity and hardness were elevated at TPN, TPE, SP, and WAL (hardness only) relative to baseline/reference conditions (**Figure 4-7**).

Alkalinity – The concentrations of bicarbonate and total alkalinity were elevated in SP in 2023 relative to baseline/reference conditions. Bicarbonate (HCO_3-) comprised 100% of the total alkalinity fraction, typical of surface water with pH in the range of 6.5 to 9. The trigger value for both bicarbonate and total alkalinity is 8.7 mg/L. Bicarbonate alkalinity at SP has consistently exceeded the trigger since 2011 and in 2023 the mean concentration at SP was .10.9 mg/L (as $CaCO_3$), which is within the range of around 11 to 13 mg/L observed in 2016–2022. No other areas exceeded triggers for mean bicarbonate concentrations.

From a potential-effects perspective, alkalinity measures the buffering capacity of water (i.e., how much acid can be added without changing pH) and low values are typically of concern for aquatic life. For example, the working water quality guidelines for British Columbia (BC MOE, 2017) have three categories of sensitivity to acid inputs based on alkalinity: highly sensitive (<10 mg/L), moderately sensitive (10 to 20 mg/L) and low sensitivity (>20 mg/L). Consequently, the temporal trend of slightly increasing alkalinity relative to baseline/reference conditions is unlikely to adversely affect biota at TPE or SP and would decrease the potential sensitivity of TPE and SP to acidic inputs (e.g., low pH snow melt and rain).

Total Dissolved Solids and Major Ions

Total Dissolved Solids – Concentrations of total dissolved solids (TDS) were elevated at SP, TPE, and WAL in 2023 relative to baseline/reference conditions but have been stable for the past several years (**Figure 4-8**). In a review of TDS toxicity to aquatic life, Weber-Scannell and Duffy (2007) recommended deriving ion-specific limits for aquatic life (i.e., rather than for TDS). However, none of the literature studies they compiled showed effects to aquatic life at TDS concentrations less than 250 mg/L and they reported the average TDS in the world's rivers was approximately 120 mg/L. There are no federal water quality guidelines for TDS in Canada. In Alaska, TDS concentrations may not exceed 500 mg/L without a special permit and may not exceed 1,000 mg/L at any time (ADEC, 2012). A site-specific TDS aquatic receiving environment benchmark of 500 mg/L was adopted at Diavik (WLWB, 2013). The TDS concentrations measured at SP, TPE, and WAL ranging from around 22 to 28 mg/L are, therefore, very low and unlikely to pose risks to aquatic receptors.

Major Ions – Similar to 2022, concentrations of the major ions calcium and magnesium were elevated relative to baseline/reference conditions at Meadowbank study area lakes in 2023 (**Table 4-3**, **Table 4-4**, and **Figure 4-8**). Concentrations appeared to be stable and were consistent with the ranges observed in 2022. At the NF areas TPN, TPE, and SP, mean 2023 concentrations were similar to 2022, with calcium ranging from 2.5 to 4.0 mg/L, and magnesium ranging from 0.98 to 1.3 mg/L. In 2023, the mean concentration of TKN exceeded the trigger value of 0.17 mg/L at TPE, whereas concentrations at SP and TPN were below the trigger. The BACI result showed an increase in TKN at TPE, however, this was not significant (p-value > 0.05).

Slight increases of these cations above triggers in the Meadowbank study lakes for the *after* period are unlikely to adversely affect biota. These major cations are essential elements, and all species of aquatic life, from algae to fish, have evolved to actively regulate their osmotic, ionic, and acid-base balance by taking up ions from their surrounding environment (Martemyanov and Mavrin, 2012). Furthermore, adverse effects on primary producers and secondary consumers (e.g., zooplankton) are more commonly associated with deficiency rather than enrichment of major cations in oligotrophic freshwater lake environments (Alstad et al., 1999). Calcium deficient waters are defined for some species of algae at concentrations < 10 mg Ca/L (Wetzel, 1983) and effects on zooplankton communities are more common in freshwater lakes that are calcium-depleted because of acidification and logging (Arnott et al., 2017).

Metals

Silicon – In absence of *control* data and a threshold, an early warning trigger for silicon was derived for the Meadowbank study area lakes in 2019 based on data from all lakes (except WAL). There is evidence of temporal trends in silicon concentrations across all Meadowbank study area lakes, (i.e., peak concentrations in 2012 followed by a decrease through 2017 and then have remained stable since then) including reference areas that suggest regional influence. There also appears to be differences in concentrations among lakes. This is clear at SP where concentrations have always been relatively high compared to reference area INUG yet the temporal patterns are very similar between the two areas (**Figure 4-10**). Given the similar trends observed in reference area INUG and distinct difference in concentrations among lakes, it is unlikely that elevated silicon concentrations compared to the trigger are related to mining activities. In 2023, the BACI result showed a statistically significant increase in total silicon at WAL (p-value > 0.05) with the yearly mean concentration of 0.67 mg/L marginally exceeding the 0.65-mg/L trigger value.

Other metals – Concentrations of other metals (total and dissolved) were consistently low or below their respective MDLs at the NF locations in 2023 (**Appendix B1**). None of these parameters have exceeded trigger or effects-based threshold values in the formal BACI analysis. In 2023, the same metals were measured above laboratory detection limits (MDLs) as in previous years. This is important to note in relation to ongoing discharge from dike seepage from the East Dike to Second Portage Lake.

In 2020, dissolved zinc[26] showed unusual annual mean trigger exceedances in TPN, TPE, and SP, however, the annual mean has been below the trigger in the years since. In 2023, dissolved zinc showed two discrete samples slightly exceeding the trigger in March at TPE and SP (**Figure 4-11**). This parameter will continue to be monitored in 2024.

Reactive Silica

The first trigger exceedance for reactive silica occurred in 2020 at WAL. The yearly mean concentrations of reactive silica have exceeded the trigger since then (**Figure 4-9**). Given that the mean concentration of reactive silica at WAL (1.4 mg/L) in 2023 was only slightly over the trigger value (1.08 mg/L) and that the exceedance occurred in a NF area that was not exposed to any mining activity since 2020, it is unlikely mine-related and will continue to be monitored in 2024.

Long-term Trend Analysis

In addition to the routine BACI analysis, a more detailed statistical analysis of temporal changes for key physical/ionic parameters in NF areas was completed in 2021 (Azimuth, 2022a). The assessment used a mixed-effects modelling approach to compare three different long-term patterns in conductivity, hardness, calcium, magnesium, total alkalinity, and TDS, which have consistently exceeded triggers and/or FEIS predictions. The BACI analysis is designed to test for changes in parameters for a particular year relative to baseline/reference conditions; it is not designed to test for longer-term trends in key parameters over time. The mixed-effects trend analysis was conducted to provide a statistically supported understanding of long-term trends in key water chemistry parameters. While we will continue to implement the BACI analysis each year to test for changes relative to baseline/reference conditions, the mixed-effects analysis will only be repeated periodically to address specific concerns.

The analysis specifically looked at relative differences between NF areas TPN, TPE, and SP and the reference lake INUG for each of the analytes. The three patterns tested were: (1) a constant linear trend

[26] It is worth noting that the trigger for dissolved zinc is uncertain and perhaps overly conservative because the hardness levels used to calculate the WQG for trigger development are often much lower than the data range used to develop the long-term WQG (CCME, 2018; see Appendix I in Azimuth, 2020a).

over time (*Trend* model), (2) variable, year-specific differences without an increasing trend (*Year* model), or (3) an increasing, but variable, trend during operations to a peak followed by stabilized conditions since 2014 (*Stable* model). The *Stable* model fit the data best for nearly all area-analyte combinations; the except for total alkalinity at TPN where the *Trend* model showed a slightly better fit. These results indicate that concentrations of conductivity, hardness, calcium, magnesium, total alkalinity, and TDS have generally been stable from 2014 to 2021. A full description of the long-term trend analysis and results was included in the *2021 CREMP report* (Azimuth, 2022a).

4.3.3 Comparison to FEIS Model Predictions

The CREMP continues to detect changes in some general water quality parameters related to mining activities. These changes are also reflected in higher concentrations of some parameters when compared to the model predictions in the FEIS (Cumberland, 2005). The FEIS water quality predictions are estimates of water quality changes in Third Portage Lake, Second Portage Lake, and Wally Lake, assuming different mixing scenarios and loading estimates from water releases and dike leaching:

- **Third Portage Lake** – the model for Third Portage Lake includes treated water released from the project in years 1 to 4 and long-term loading of metals from the Bay-Goose dike material. Two mixing scenarios (upper range [169 Mm^3] and mid-range [92 Mm^3] mixing) are evaluated for Third Portage Lake with and without dike leaching.
- **Second Portage Lake** – The Second Portage Lake water quality model includes loading of parameters from the Third Portage and East dikes and inflow from Third Portage and Wally lakes. Changes in water quality in Second Portage Lake were modelled for the two different mixing scenarios for water released into Third Portage Lake listed above.
- **Wally Lake** – The water quality model for Wally incorporates long-term loadings from the Vault dike and effluent releases from the Vault Attenuation Pond.

As discussed in the 2019 report, the assessment of Meadowbank water chemistry results against FEIS predictions only includes comparison to mean concentrations (Azimuth, 2020a). The full screening results are for Third Portage Lake, Second Portage Lake, and Wally Lake and are summarized in **Appendix B1**. For perspective, the screening results against mean concentrations are provided in **Table 4-6**.

Overall, the same list of parameters that exceed the Meadowbank trigger values typically exceed the concentrations predicted in the FEIS, namely hardness, total alkalinity, and ionic compounds (calcium and magnesium; **Appendix B1**). Concentrations for most metals are below the predictions for Third Portage Lake, Second Portage Lake, and Wally Lake, except for total silicon at SP and WAL. Constituents such as silicon that were not reported in the 2003 baseline dataset were assumed to not be present in the receiving environment in the FEIS mixing models (V. Bertrand, pers comm, March 30, 2020). The full suite of analytes currently included in the CREMP water quality analysis were not available in the early stages of the program, hence, the absence of concentration data for silicon during the baseline phase. As a result, the predicted silicon concentrations are an underestimate of the actual baseline concentrations. Silicon is therefore not suitable for evaluating the accuracy of the FEIS predictions (see Azimuth, 2020a).

At the time the FEIS was issued in 2005, the freshwater aquatic life guideline for cadmium was lower than the MDL for the baseline data. A thorough review of the ecological significance of the predicted cadmium concentrations was presented in the FEIS, and the probability of cadmium causing toxicity was considered *extremely low* (Cumberland, 2005). Arsenic was also predicted to exceed the freshwater aquatic life guideline in Wally Lake (0.006 mg/L in the FEIS). Similar to cadmium, the MDL for arsenic was equal to the guideline (i.e., 0.005 mg/L) in 2005. The models were considered conservative because the MDLs were used as the baseline concentrations. The MDLs for arsenic and cadmium in the 2023 data are 0.0001 mg/L and 0.000005 mg/L, respectively. All the samples collected in 2023 from Meadowbank study area lakes were below the MDL for cadmium, except one sample collected at TPE in March which was reported at twice the MDL (**Appendix B1**). In the case of arsenic, the concentrations are below the trigger values for the Meadowbank study area lakes, and at least an order of magnitude lower than the CCME water quality guideline of 0.005 mg/L in all samples.

Overall, the FEIS predicted the magnitude of potential effect on water quality in each of the lakes as *low* (see **Section 2.3.1** for more details on the decision criteria for effect magnitude). It is important to note that none of the parameters that exceeded trigger values or FEIS model predictions in 2023 had trigger values set in the context of effects-based threshold values (e.g., CCME water quality guidelines). Thus, CREMP water quality results are consistent with the *low* significance (i.e., <1x CCME WQG) rating applied to model predictions in the FEIS (Cumberland, 2005).

4.3.4 Summary and Recommendations

Water quality results were evaluated according to the decision criteria outlined in **Section 2.2.3** to determine the effort level and sampling frequency required at the MF and FF areas in 2024. The assessment strategy interprets the water quality assessment results from the NF areas in the current year (in this case 2023) to inform sampling at MF and FF areas the following year (i.e., 2024) (**Figure 4-12**).

Trigger screening results for the Meadowbank study areas are presented in **Table 4-5** according to the degree of change interpretation framework:

- no trigger exceedance,
- minor changes = trigger exceeded for parameters without effects-based thresholds,

- moderate changes = trigger exceeded for parameters with effects-based thresholds, or
- major changes = exceedance of the effects-based threshold.

The 2023 water quality results from Meadowbank area lakes do not require additional management actions as per the *CREMP Plan Update* (Azimuth, 2022b). The outcome of the assessment for sampling at NF, MF, and FF areas[27] in 2023 is summarized below.

Reference Areas (INUG, PDL)

- Trigger exceedances of the mean concentrations were documented for total and dissolved silicon at INUG and for hardness, calcium, total silicon, and magnesium at PDL. INUG and PDL are reference areas located beyond the influence of activities at the Mine.
- The full CREMP program will be completed at reference areas in 2024.

Near-field (TPE, TPN, SP, and WAL)

- Trigger exceedances were documented for parameters without effects-based thresholds (i.e., conductivity, hardness, TDS, alkalinity, and cations).
- The mean reactive silica concentration exceeded the trigger in WAL.
- The mean total and dissolved silicon concentrations exceeded the trigger in SP.
- The full CREMP program will be completed at the NF areas in 2024.

Mid-field and Far-field (TE, TPS, and TEFF)

- No sampling was conducted at MF and FF areas TPS, TE, and TEFF in 2023 based on the results of the 2022 CREMP and as per the *CREMP Plan Update* (Azimuth, 2023a and 2022b).
- Given there were no trigger exceedances for parameters with effects-based thresholds at the NF areas in 2023, no sampling is required at the MF and FF areas in 2024. No other sampling (e.g., sediment chemistry or benthic invertebrate community) is required at MF and FF areas in 2024.

4.4 Phytoplankton Community

In 2023, phytoplankton samples collected during winter sampling events[28] were archived as per the *CREMP Plan Update* (Azimuth, 2022b). Results of the open-water season are discussed below and did not warrant analysis of the winter phytoplankton samples (see text for more details).

[27] No samples were collected at MF and FF areas TPS, TE, and TEFF as per the *CREMP Plan Update* (Azimuth, 2022b).

[28] Phytoplankton samples were not collected in May due to unsafe ice conditions.

4.4.1 Key Findings from the 2023 Phytoplankton Monitoring Program

- Chlorophyll-a concentrations at the NF areas were consistent with baseline and reference, generally remaining less than 1 µg/L.
- Increases in phytoplankton biomass were observed at NF areas TPE, TPN and WAL compared to reference area INUG, however, increases in 2023 are likely due to environmental variability as biomass at the NF areas is consistent with historical results.
- Phytoplankton taxa richness at the NF areas in 2023 was similar to previous years and to reference areas. There were small reductions in taxa richness at all NF areas which is likely attributed to environmental variability rather than mining activities, particularly since effluent discharge at the Meadowbank site only occurred in Second Portage Lake in 2023 where there was no significant decrease in richness.

4.4.2 General Observations

The diversity in types and sizes of phytoplankton in the study lakes is large and their abundance is great. In summer, abundance typically exceeds 1 million individuals per liter with a total biomass of approximately 200 mg/m^3. Six major taxonomic groups of phytoplankton are present in the study lakes, namely blue-green algae (Cyanophyta), green algae (Chlorophyta), golden-brown algae (Chrysophyta), Diatoms, Cryptophytes, and Dinoflagellates.

Chrysophytes (golden-brown algae) are small, usually unicellular phytoplankton that are consistently the most abundant taxonomic group in the Meadowbank study area lakes. Chrysophytes also dominate phytoplankton biomass in all study area lakes, typically representing 65% or more of total phytoplankton biomass in summer samples, with smaller proportions (usually < 10% each) from the other five major groups. The dominant chrysophyte genera for the Meadowbank study area lakes are *Chrysococcus, Kephyrion, Chrysochromulina, Dinobryon,* and *Chrysolkos*. Dominant genera for the other groups are *Oocystis* for chlorophytes, *Planktolyngbya* for cyanophytes, *Cyclotella* for diatoms, *Rhodomonas* and *Cryptomonas* for cryptophytes, and *Gymnodinium* and *Peridinium* for dinoflagellates (Azimuth, 2012a, 2011b, 2010a, 2009c, 2008a, and 2008b).

Mean phytoplankton biomass in the Meadowbank study area lakes typically ranges from 100 to 250 mg/m^3 during summer with diminishing biomass in fall through winter. This range in biomass is typical for oligotrophic, central Arctic Canadian lakes. Biomass estimates from lakes sampled in the 1980s in the Kivalliq Region generally ranged between 100 and 300 mg/m^3 (McKee et al., 1989). Other studies on arctic lake phytoplankton communities have reported similar ranges of phytoplankton biomass at Snap Lake (266 mg/m^3; De Beers, 2002), Char Lake (166 mg/m^3, Kalff et al., 1975), and Spring Lake (120 mg/m^3, Welch et al., 1989).

4.4.3 Temporal and Spatial Trend Interpretation

The approach for identifying potential mine-related impacts involved visually searching for temporal-spatial patterns that might be associated with mine-related activities (see **Table 1-1** for details), augmented by statistical analyses of annual data to test for changes relative to baseline/reference conditions using the BACI model (see **Section 2.3.3** for details). Both methods look for evidence of temporal-spatial patterns that might be associated with the mine-related activities.

The primary metrics used in the assessment were chlorophyll-a concentration (a surrogate for overall primary productivity), total biomass (mg/m^3), relative biomass of major taxonomic groups, and species richness (total # species). Biomass, not abundance, was examined because biomass and abundance tend to be reasonably well correlated and, ultimately, biomass is a much better approximation of actual lake productivity or food availability for zooplankton. The BACI statistical testing focused on total biomass and species richness because these reflect ecologically relevant information about the phytoplankton community (i.e., total mass of community and community composition, respectively). The trigger and threshold effect sizes for total biomass and species richness are 20% and 50%.

Expected response patterns in phytoplankton biomass and species richness are dictated by the nature of the physical and/or chemical changes caused by mine-related activities. For example, dike construction or dewatering may introduce turbidity, leading to a reduction in phytoplankton biomass/diversity. In contrast, introducing other substances, such as nitrogen associated with blasting by-products, could increase primary production. We therefore look for both reductions and increases (i.e., two-tailed statistical tests) in phytoplankton-related metrics coinciding with mining activities (i.e., focusing primarily on data for NF areas SP, TPE, TPN, and WAL).

An important consideration when working with phytoplankton data is the naturally high variability of control data. This potentially confounding *noise* effect can make it difficult to identify mining-related influences or *signals* at impact areas, unless the signals are quite large.

Density and biomass results for phytoplankton samples collected from the Meadowbank study lakes are provided in **Appendix D1**. The 2012 CREMP (Azimuth, 2013) provided a detailed description of historical trends in phytoplankton-related metrics. The current report emphasizes results for 2023, but retains the historical context by showing the results of all monitoring years. Trend data for chlorophyll-a, total biomass, major taxa composition, and species richness are presented from **Figure 4-13** to **Figure 4-17**. Plots for all other phytoplankton metrics are presented in **Appendix D1**. The BACI statistical test results of changes in the phytoplankton community in 2023 compared to baseline/reference conditions are provided in **Table 4-7**; key results are described below.

Key Results for the Visual and BACI Analyses

Chlorophyll-a

Concentrations in the reference area samples typically range between 0.11 and 0.72 µg/L in summer months, reflecting the oligotrophic, nutrient poor condition of these lakes. Temporal patterns at the reference areas INUG and PDL have been fairly consistent, with some inter-annual variability but no apparent trends. This suggests a lack of regional changes in this metric.

Chlorophyll-a concentrations at the NF exposure areas TPN, TPE, SP, and WAL show no evidence of abnormal seasonal or longer-term temporal trends (**Figure 4-13**) and generally remain less than 1 µg/L, which is consistent with oligotrophic conditions (Kasprzak et al. 2008). The 2023 results are consistent with this conclusion.

Total Biomass

The total phytoplankton biomass results for 2023 were very similar to 2017–2022. Starting in 2023 chlorophyll-a collected in the winter is only analyzed depending on the results from the summer month (July to September; Azimuth, 2022b). Biomass results for the summer months were similar to 2022:

- For reference lakes, summer biomass estimates at INUG in 2023 ranged from 74 to 290 mg/m^3, which were lower than in 2022 while still within the range observed historically. The peak biomass at PDL was 190 mg/m^3 in July, which was similar to 2022. Overall, these results are consistent with the range of total biomass observed in previous years for the reference areas (**Figure 4-14**).
- Peak total biomass in 2023 for NF areas TPE, TPN, and WAL ranged lower than in 2022. For all NF areas, total biomass was largely within the range observed historically.
- BACI analysis demonstrated apparent increases ranging from 19% to 54% at the NF areas in 2023 relative to reference area INUG. The increases in total biomass exceeded the trigger (> 20% effect size) at TPN (49%) and WAL (54%). None of the observed increases at NF areas were statistically significant (**Table 4-7**). As the results are similar to previous years, the increases in 2023 are likely due to natural variability as biomass at the NF areas is consistent with historical results.

Major Taxa Composition

Chrysophytes tend to dominate in the study lakes in all open-water months, a pattern that has been consistent since monitoring began in 2006 (**Figure 4-15**). The continued dominance of chrysophytes provides an additional line of evidence suggesting any *potential* incremental increase in nutrients or changes in water quality has not resulted in major structural changes to the community. Among the major taxa, chlorophytes are typically the first to respond to nutrient enrichment in freshwater systems (Holmgren, 1984). The direct positive effect of nutrient enrichment on chlorophytes has been shown to have an indirect negative effect on chrysophytes, which compete with chlorophytes for nutrients (Klug and Cottingham, 2001). In the same study by Klug and Cottingham, chrysophytes were among the dominant taxa prior to artificial fertilization of the study lakes. These observations from the primary literature substantiate findings from the CREMP that the structure of the phytoplankton community is consistent with pre-development oligotrophic conditions (**Figure 4-16**).

Taxa Richness

Taxa richness was similar to previous years for the open-water season in 2023[29] (**Appendix D1**). The taxa richness at the exposure areas was similar to the reference areas and consistent with previous years (**Figure 4-17**). The estimated changes relative to baseline/reference conditions showed small reductions (< 20% effect size) and only results from TPE were found to be significant (p-values < 0.1; **Table 4-7**). Taxa richness appeared to be similar to historical results at all NF areas.

4.4.4 Summary and Recommendations

The phytoplankton community taxa biomass and taxa richness data from 2023 are generally similar to previous years and largely appear within the range of historical baseline/reference conditions.

Total biomass was significantly higher at NF areas TPN, TPE and WAL, while total richness showed only minor decreases relative to historical baseline/reference conditions. Results for 2023 for NF areas were within the historical range for both metrics. It is difficult to determine in a single year whether these changes are related to mining but when compared to the trends observed over the years, but natural variability is considered to be the most likely driver. Notwithstanding, monitoring will continue in 2024 to verify whether future patterns are consistent with observed patterns or whether they provide stronger evidence of mine-related causality.

4.5 Sediment Chemistry

4.5.1 Key Findings from the 2023 Sediment Chemistry Monitoring Program

- Chromium exceeded the trigger at TPE in 2023. Chromium concentrations have been stable since 2017. Current conditions do not pose risks to the benthos at TPE.

4.5.2 General Observations

Natural sedimentation rates in the Meadowbank study lakes are considered low, due to the headwater nature of the watersheds and the lack of any substantial riverine or tributary inflow. Thus, very little sediment is carried into the lakes other than what erodes off the nearby tundra during spring run-off or

[29] Samples collected during the winter months were archived as per the CREMP Plan Update (Azimuth, 2022b).

heavy rain events, or from dust deposition. The only site discharge in 2023 was from East Dike seepage into Second Portage Lake (**Table 1-1**).

Based on historical bulk sampling of sediment using grab samples, we have observed reasonably large, within-basin or within-lake differences in surface sediment (i.e., top 3–5 cm) concentrations for various metals, indicating natural spatial heterogeneity driven by localized mineralization. Several processes can affect the pattern of metals distribution to sediments, including differential deposition of different grain size materials according to wind direction and speed, water depth, water currents, basin morphometry, bioturbation (i.e., vertical mixing of sediment by burrowing insect larvae), and patchy, heterogeneous distribution of metals in mineralized areas. Metals concentrations are highly dependent on grain size, with coarse grain size (i.e., sandier) typically correlating with lower metals concentrations. Therefore, our sediment programs target low energy, depositional areas that are dominated by silt/clay sediment in areas of similar water depth (6–10 m), where grain size tends to be finer and more consistent.

Sediment chemistry samples are collected using grab samplers (targeting top 3–5 cm) or coring devices (targeting top 1.5 cm). Grab samples are used to characterize the chemical and physical conditions of sediments paired with the benthic invertebrate community samples. While grab samples can provide insights into temporal changes in sediment chemistry, core samples are more sensitive and are used in the CREMP to formally test for changes in sediment chemistry related to mining. Core samples are collected every three years to match the timing of EEM studies required under the Metal and Diamond Mining Effluent Regulations (MDMER).

In 2023, sediment grab and core sampling were completed at the NF and reference areas. Samples were spaced throughout each basin (**Figure 4-2**). Grabs for sediment chemistry and habitat characteristics and benthic invertebrates were collected at the same locations. Core samples were opportunistically collected from some of the grab sampling locations. The remaining replicates were spaced throughout the basin in areas with the targeted depth and substrate composition. Sediment grab samples for habitat characteristics were analyzed for moisture, total organic carbon (TOC), and grain size; composite grab samples for chemistry were analyzed for aggregate organics, hydrocarbons, and polycyclic aromatic hydrocarbons (PAHs). Core samples were analyzed for moisture, pH, and total metals.

Grain size and organic content (TOC) are important sediment analytes relevant for benthic invertebrate community habitat characteristics. Results from this year's CREMP are provided in **Appendix C1**. Grain size results were similar to previous years, with generally finer-grained sediment often dominated by the silt fraction (**Figure 4-19**). There is an apparent difference in TOC across Meadowbank study lakes (**Figure 4-18**). WAL consistently has the highest proportions of TOC (approximately 5 to 10 %), while TPN has the lowest (< 5% TOC). These results reflect differences in productivity levels across the lakes, with shallow, lower-volume lakes tending to be more productive relative to deeper, high-volume lakes. In

2023, TOC concentrations across Meadowbank study area lakes were similar to previous results, with most areas having < 5 % TOC except WAL (4.6 to 11 % in 2023).

The results for organic compounds analyzed in grab composite samples are provided in **Appendix C1**. There were no detectable concentrations of organic compounds in 2023.

An overview of the various sediment sampling programs at Meadowbank dating back to baseline sampling in 2008 is provided in **Appendix C1**.

4.5.3 Temporal and Spatial Trend Interpretation

The 2023 sediment core chemistry and grab particle size and moisture content results for Meadowbank, screened relative to the lake-specific trigger values, are presented in **Appendix C1**.

To help interpret long-term temporal and spatial trends, concentrations of individual metals have been plotted in **Figure 4-20** to **Figure 4-27**. Metals concentrations are shown by area/basin for the different sampling methods (grab [data points] vs core samples [box and whisker plots]). The red dashed line in each of sediment metals figure is the trigger value specific to the parameter and area (i.e., Meadowbank lakes and Wally Lake each have their own trigger values as of 2017). The box and whisker plots illustrate the statistical distribution of core samples within each area.

2023 Trigger Exceedances and Effects Assessment

Sediment core metals for which the 2023 mean exceeded the trigger value at the NF areas are shown in **Table 4-8**. Results of the statistical before-after (BA) analysis for metals that exceeded their respective trigger values are provided in **Table 4-9**.

Chromium

- The mean sediment chromium concentration at TPE exceeded the trigger value in 2023 (mean value = 136 mg/kg dw; trigger value = 135 mg/kg dw). This is lower than the 2017–2020 means of 193 mg/kg dw and which ranged from 150 to 205 mg/kg dw (**Figure 4-23**). The observed increase in sediment chromium concentration in 2023 compared to the 'before' period at TPE was statistically significant and represents a proportional increase of just under 2 times (**Table 4-9**).
- Other sediment chromium trigger exceedances were observed at WAL in 2023, but only for individual replicates and not for overall area means: 2 replicate exceedances at WAL (ranging from 63 and 64 mg/kg dw; note the trigger at WAL is 61 mg/kg dw).
- Sediment chromium levels at TPE have been elevated in past coring programs and were further investigated in 2018 and 2019 (Azimuth, 2019a and 2020a). These studies concluded that while concentrations of chromium have increased relative to the baseline period and have continued to exceed the trigger, chromium concentrations at TPE appear to have stabilized relative to the

increasing temporal trend that was apparent prior to approximately 2013. It is likely that increasing concentrations of chromium in sediment at TPE were related to the use of ultramafic rock for dike construction. The 2018 and 2019 studies also concluded that current conditions do not pose risks to the benthos at TPE. These conclusions were confirmed in the 2020 study (Azimuth, 2021a).

In addition to chromium, there were single trigger exceedances for arsenic, cadmium, and zinc at one or more NF areas. These exceedances were generally reflective of natural spatial variability rather than mining-related changes as supported by the lack of temporal changes relative to baseline conditions, the lack of a corresponding change in water quality, and by the lack of co-located mine discharges (except at SP). Core sampling results, except for chromium at TPE, showed no mining-related temporal or spatial patterns. Grab sampling results for organics analysis did not identify detectable concentrations of any chemicals. Confirmation of the observed trends using sediment grabs will be conducted in 2024.

4.6 Benthos Community

4.6.1 Key Findings from the 2023 Benthos Community Monitoring Program

- In 2023, there were decreases in abundance at all Meadowbank areas, though none of the changes were statistically significant.
- Taxa richness increased at SP in the 2020-23 time period. No differences were observed at the other Meadowbank area lakes.
- Overall, taxa richness and abundance remain within the range of baseline/reference.

4.6.2 General Observations

The abundance and species composition of benthic invertebrates are influenced by water depth, substrate grain size, and organic carbon. Other physical factors, such as water temperature, can influence larval development rates and, ultimately, timing of hatching for insect larvae. Consequently, even if sampling can be conducted simultaneously in all lakes (which is not practical), this would still not overcome differential timing of hatching of particular species between lakes. This is partly overcome in the CREMP by sampling during August, after most groups have emerged, but it is still a source of some variability.

Benthic invertebrate communities in the Meadowbank study lakes are characterized by relatively few taxa and low abundance. Abundance is generally less than 2,000 organisms/m^2 and is often less than 1,000 organisms/m^2 at reference and exposure areas (e.g., **Table 4-10** and **Figure 4-28**). Despite abundance generally being low at the study area lakes, values above 5,000 organisms/m^2 are not uncommon, and on occasion abundance has exceeded 10,000 organisms/m^2. Relatively large total benthic invertebrate abundance values were periodically observed in samples collected prior to mine development (e.g., one replicate had 26,000 organism/m^2 at WAL in 2006) and in more recent sampling events (e.g., one replicate had 31,000 organism/m^2 at WAL in 2016). The high variability in total abundance within an area has also recently been observed at lakes sampled for the Whale Tail mine during the baseline period (i.e., the *before* period). Total abundance at Lake A76 in 2017 was between 3,000 and >24,000 organisms/m^2 (Azimuth, 2018a). Whale Tail Lake – South Basin also showed comparatively large variance in abundance in 2017, ranging from 1,800 to over 10,000 organisms/m^2. Abundance data for the Meadowbank study lakes between 2006 and 2022, as well as more recent baseline data from the Whale Tail program, demonstrates that benthos abundance is naturally variable, both spatially (i.e., among areas) and temporally (i.e., between years).

Taxa richness typically ranged from 8–12 for most area-year combinations (**Figure 4-31**). Typical of most Arctic lakes, the benthic invertebrate community has been dominated by the aquatic larval stages of insects, especially chironomids (Family Chironomidae), both in terms of abundance and taxa richness (e.g., **Figure 4-29** and **Figure 4-32**). The next most abundant group was Mollusca (clams), particularly *Cyclocalyx* / *Neopisidium* genera of the family Sphaeriidae (fingernail clams). Oligochaete worms were also relatively common in the lake sediments; generally, at least one oligochaete taxon was present at most area-year combinations.

4.6.3 Temporal and Spatial Trend Interpretation

Benthic invertebrate abundance and richness results from the reference (INUG and PDL) and NF (TPE, TPN, SP, and WAL) Meadowbank study lakes in 2023 are provided in **Appendix E1**, by major taxonomic group (i.e., Insecta, Mollusca, Oligochaeta, and other taxa). Geometric means of total abundance and total richness for the entire data set dating back to 2006 are provided in **Table 4-10**.

Time-series plots showing abundance and richness endpoints are presented in **Figure 4-28** to **Figure 4-33**. Below are descriptions of the endpoints, based on Environment Canada EEM guidance (2012):

- Total abundance – the number of individual organisms per m^2. This metric is a measure of community density.
- Total richness – the number of different taxa (identified to the lowest practical taxonomic level, usually species) per grab.
- Abundance of major taxa (absolute and relative abundance of each major taxon).
- Richness of major taxa (absolute and proportional richness of each major taxon).

Other benthic invertebrate community results presented in **Appendix E1**, but not discussed in detail, include time-series plots of abundance and richness within each major taxon, Simpson's Diversity, and Bray-Curtis Index values.

Identifying potential mine-related impacts generally involved visually examining the data for spatial/temporal patterns that matched mine-related events. This was followed up with formal statistical analyses of the data to test for changes relative to baseline/reference conditions using the BACI model (see **Section 2.3.3** for details). The BACI comparisons involved testing for single-year (i.e., 2023) and multi-year (i.e., up to four years) trends and focused on benthic invertebrate total abundance and taxa richness. This report focuses on the 2023 results and discusses temporal and spatial trends over the last four years (i.e., dating back to 2020). As discussed in **Section 2.2.3**, MF (TPS and TE) and FF (TEFF) areas were not sampled in 2023. BACI model results for benthic invertebrate abundance and richness are presented in **Table 4-11** and **Table 4-12**. Key results are described below.

Total Abundance

Total abundance at INUG was higher in 2023 compared to 2022. INUG is the main reference area used for the BACI comparisons, so it is noteworthy that total abundance has been generally higher for INUG from 2015 to 2023 compared to earlier years (**Table 4-10**). However, the range in abundance since monitoring began is generally lower at INUG relative to the NF areas, with maximum abundance of 2,100 organisms/m^2 (2016) relative to SP (2,796 in 2014), TPN (3,025 in 2015), TPE (5,556 in 2008), and WAL (14,253 in 2016).

Yearly total abundance is plotted in **Figure 4-28**. Visually, the plots suggest slightly lower abundance at TPN and WAL and similar abundance at TPE and SP compared to 2022. Overall, the BACI results in **Table 4-11** show negative effect sizes (i.e., reduction) in abundances for all NF sampling areas (i.e., TPN, TPE, SP, and WAL) compared to reference area INUG in 2023, although none of the changes are statistically significant ($p > 0.1$). The observed effect sizes exceeded the 20% trigger at TPN (62%), TPE (65%), and WAL (27%), but not at SP (-8%); the 50% threshold was also exceeded at TPN and TPE. These results appear to be influenced by natural inter-annual variability rather than mining activities.

Interpreting the BACI analysis results can be challenging for two reasons: 1) because natural variability exists between years and areas and 2) because there is heterogeneity within areas. For example, total abundance at TPE continues to be fairly stable with relatively minor variability between years (**Figure 4-28**). However, the 2023 BACI results for total abundance at TPE in each time period assessed over the past four years showed a relative reduction ranging from 42% to 65% compared to INUG, though none of these changes was statistically significant (**Table 4-11**). These results are driven by a number of years with higher abundance at INUG rather than on any actual reduction in abundance at TPE.

A further challenge is accounting for heterogeneity within sites and the influence that differing abundance in replicates can have on the yearly mean for an area. For example, in 2023, abundance at replicate TPE-4 had a low total abundance of 630 organisms/m^2 compared to replicate TPE-3 which had a high abundance of 2,848 organisms/m^2. An even larger difference between replicates was observed in 2020, where the lowest total abundance was 2,065 organisms/m^2 at replicate WAL-4 compared to the highest total abundance of 24,261 organisms/m^2 at replicate WAL-5.

In recent years, estimated effect sizes have fluctuated but generally remained small for total abundance at the Meadowbank study area lakes. In 2023, effect sizes were often > 20% (reduced abundance), though not statistically significant for all *after* periods up to four years except for TPE in the 2020-2023 time period (i.e., reduced abundance, see **Table 4-11**). As discussed previously, the apparent reductions in abundance are not supported by the temporal trends for total benthic abundance for TPE shown in **Figure 4-28**. The time-series plots highlight that abundance at TPE has remained fairly consistent over the last seven years and is similar to baseline results. The apparent reduction in abundance at TPE in the BACI analysis is related to the combined effect of two factors: 1) high abundance at TPE during the baseline period and 2) increased abundance at INUG in recent years (relative to baseline). In this context, the BACI results for TPE are interpreted strictly as a *relative* reduction in abundance compared to INUG rather than an absolute reduction in benthos abundance. The BACI results, while important for identifying potential temporal changes in benthos metrics, need to be interpreted in the broader context of the absolute change in the benthos community over time. Overall, the abundance data do not suggest that there are changes to benthic invertebrate abundance in the NF areas that are attributable to mining activity.

Major Taxa Abundance

Insects were the dominant taxon with generally over 60% relative abundance followed by molluscs with roughly between 10–25% relative abundance (**Figure 4-29** and **Figure 4-30**). While there were no apparent trends in composition changes related to mining at most areas, it is notable that most peaks or valleys in total abundance over the years appear to be driven by changes in abundance of insects, predominantly chironomids. Notable examples are WAL in 2020 and 2022, or TPE in 2008. Given the large inter-annual changes in total abundance, it is not unexpected to see a change in the relative dominance of major taxa groups.

Taxa Richness

Taxa richness in 2023 was generally within the range of other sampling years (**Figure 4-31**). Mean taxa values at the reference areas were 11.7 at INUG and 8.5 at PDL, which were around the mid-range of reported number of taxa since monitoring began in 2006 (INUG) and 2009 (PDL) (**Table 4-10**). Results of 2023 BACI suggested there was an apparent increase in taxa richness at all areas and in all time periods, except for WAL in 2023 with a slight reduction (-3%). These changes were not statistically significant p-value > 0.1), except for SP during the 2020-23 period. At SP and TPN the 20% effect size was exceeded in all time periods, except TPN in 2023 (**Table 4-12**). Overall, taxa richness was within the range observed across all sampling years. Despite some within-year variability in taxa richness, the NF areas show either stable or increasing taxa richness.

Major Taxa Richness

Insects were dominant in terms of absolute and proportional richness (generally from 6 to 8 taxa), followed by molluscs (~ 2 taxa) (**Figure 4-32** and **Figure 4-33**). The 2023 results are similar to previous years and show that there were no apparent trends in composition related to mining.

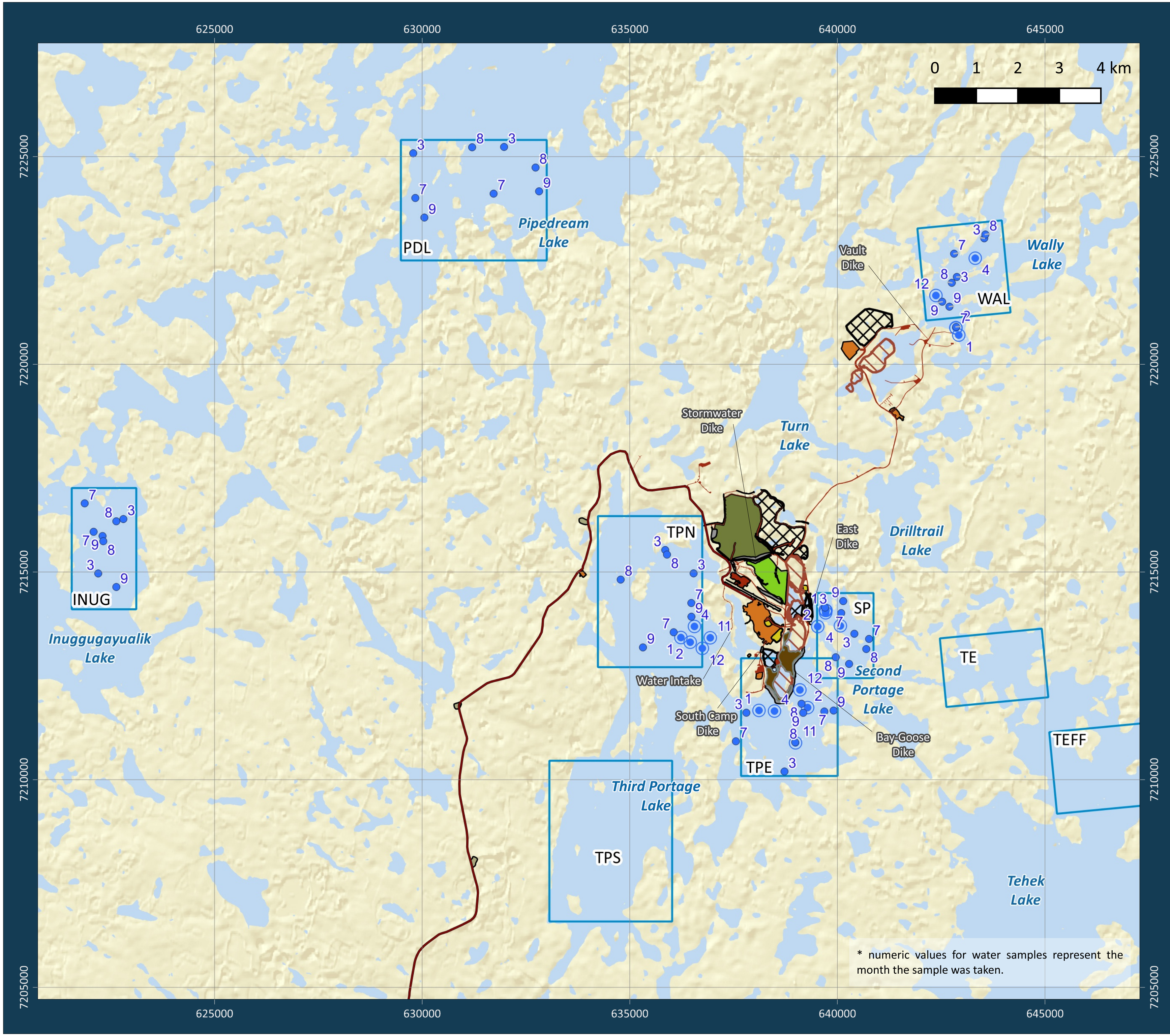
4.6.4 Summary and Recommendations

The benthic invertebrate metrics (total abundance and taxa richness) for the NF and reference areas were generally within the range reported for previous years. Furthermore, other than an apparent increase in richness at SP in the 2020-23 time period, the BACI analysis did not detect any significant changes in abundance or taxa richness in 2023, nor in the three longer-term time periods assessed (i.e., 2022-23, 2021-23, and 2020-23). There were apparent reductions in abundance at TPN, TPE, and WAL relative to INUG, however, the reductions were not statistically significant. Total abundance at TPE has been remarkably stable over the past 11 years. Importantly, the richness of the benthic invertebrate community at TPE is consistent with previous CREMP years, indicating the benthic community at TPE remains functionally diverse. In summary, the apparent changes in benthic community observed in 2023 are likely due to natural variability rather than to mining activities, and will continue to be monitored in 2024.

4.7 Meadowbank Tables and Figures

The tables and figures for the Meadowbank CREMP are provided in this section, except for the large tabulated datasets and figures for parameters not included in the detailed analysis (see in-text references to appropriate Appendices). Subsections are provided for each of the CREMP components (e.g., limnology, water chemistry, phytoplankton, sediment chemistry, and benthic invertebrates).

Figure 4-1. Meadowbank Study Area - 2023 Water Quality Sampling Stations



Legend

- Water *
- Limno
- Water Sampling Areas
- Regional Watersheds
- All Weather Access Road
- Haul Road
- Facilities
- Road
- Dike
- Diversion Ditch
- WasteDump
- Pit
- Dewatered Lake
- South Cell Tailings Storage Facility
- North Cell Tailings Storage Facility

Client	Agnico Eagle Mines Limited Meadowbank Division
Project	CREMP 2023 Meadowbank Complex
Date: Datum: Scale: Software:	March 19, 2024 NAD 83 UTM Zone 14N 1:120,000 QGIS Version 3.22.11-Białowieża

REFERENCES:
1. Basemap imagery from ESRI.
2. Mine plan and sub-watershed boundary layers from Agnico Eagle.
3. Watershed boundaries and watercourse from NRCan.

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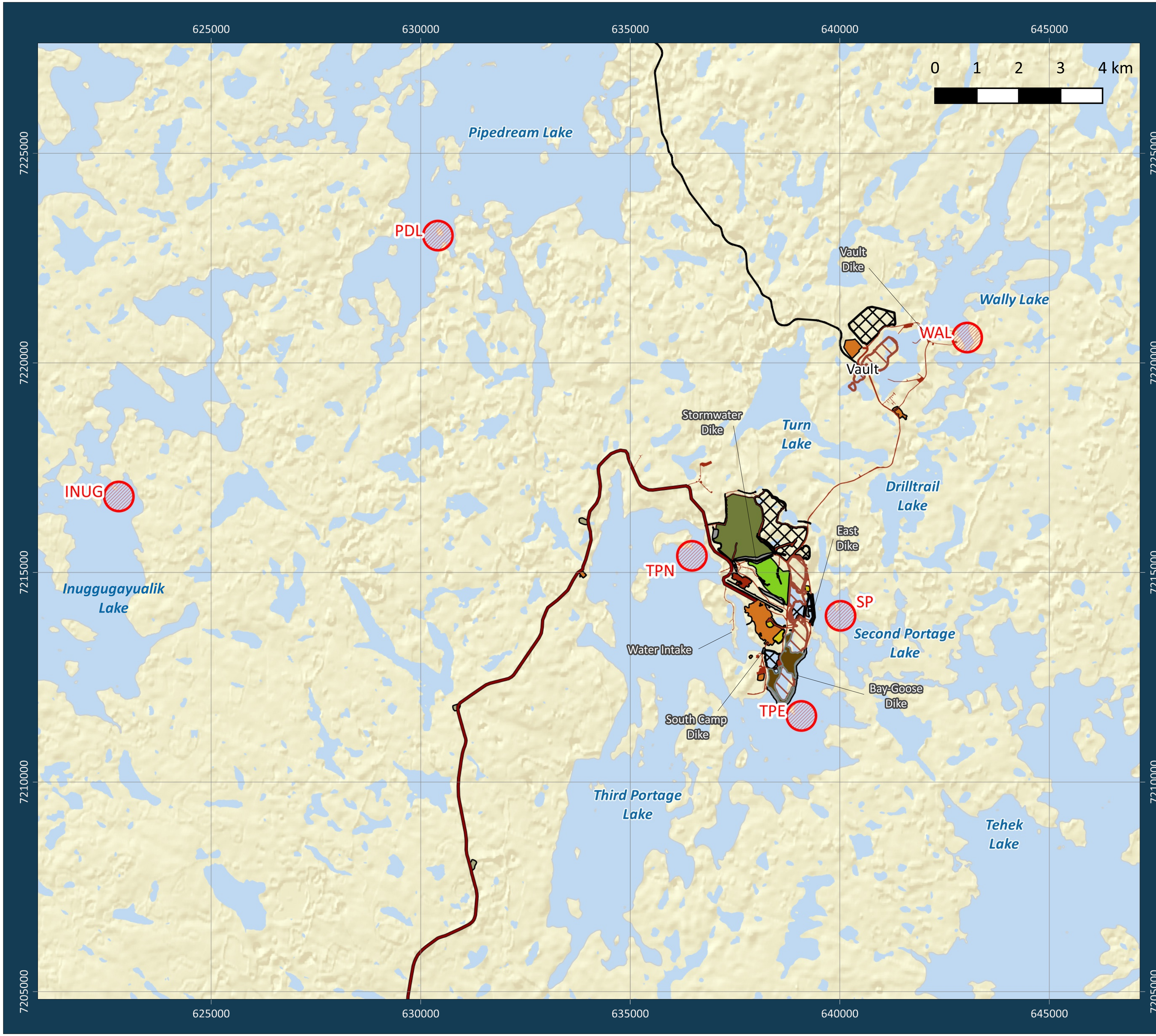

Figure 4-2.
Meadowbank Study Area - 2023 Sediment and Benthic Invertebrate Monitoring Areas

- Benthic Invertebrate & Sediment Chemistry Sampling Areas
- Regional Watersheds
- All Weather Access Road
- Haul Road
- Facilities
- Road
- Dike
- Diversion Ditch
- WasteDump
- Pit
- Dewatered Lake
- South Cell Tailings Storage Facility
- North Cell Tailings Storage Facility

Client	Agnico Eagle Mines Limited Meadowbank Division
Project	CREMP 2023 Meadowbank Complex
Date: Datum: Scale: Software:	March 19, 2024 NAD 83 UTM Zone 14N 1:120,000 QGIS Version 3.22.11-Białowieża

REFERENCES:
1. Basemap imagery from ESRI.
2. Mine plan and sub-watershed boundary layers from Agnico Eagle.
3. Watershed boundaries and watercourse from NRCan.

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Limnology Tables and Figures

Figure 4-3. Mean monthly field-measured temperature (°C) at 3 m depth since 2006, Meadowbank study area lakes.

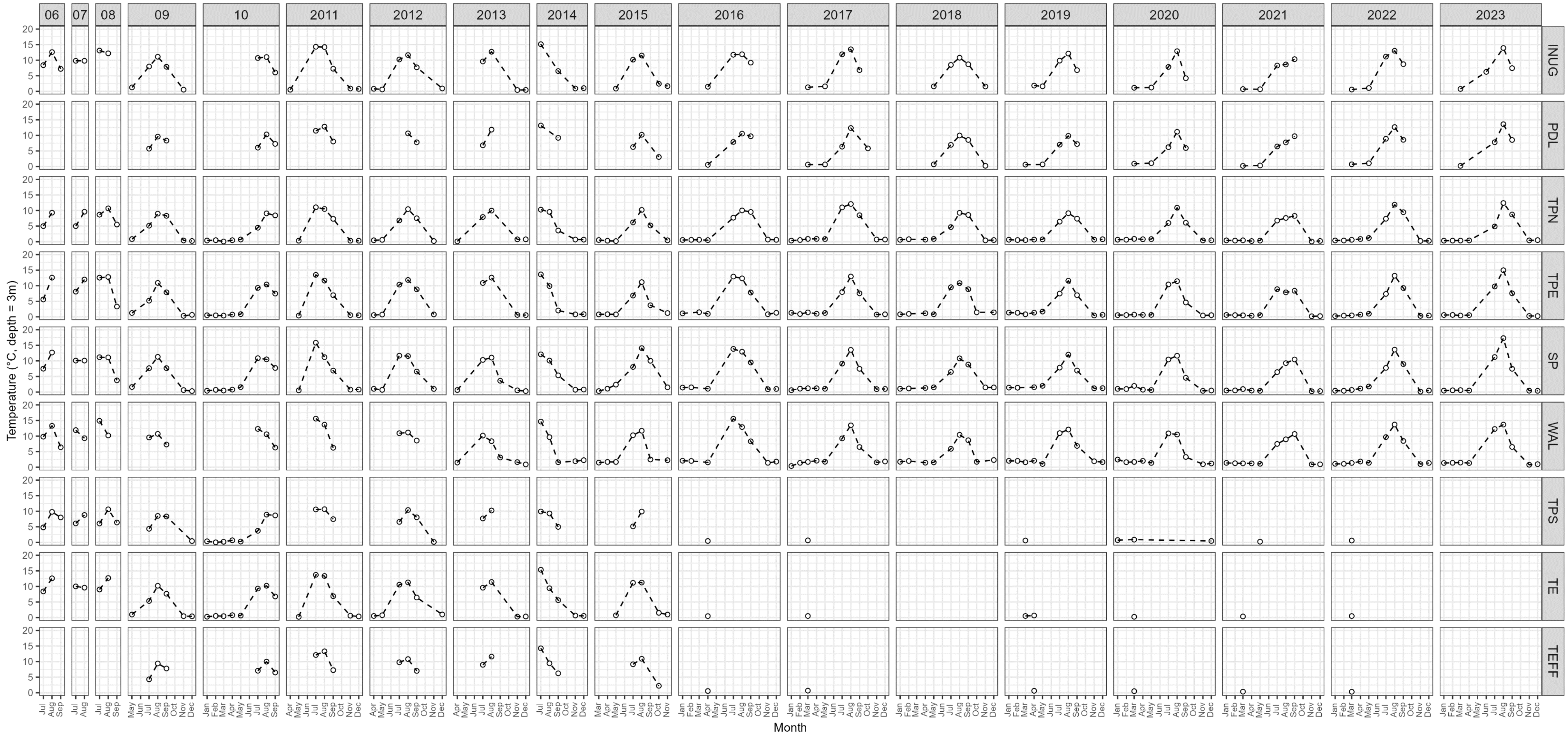


Figure 4-4. Meadowbank – Field-measured temperature profiles, 2023.

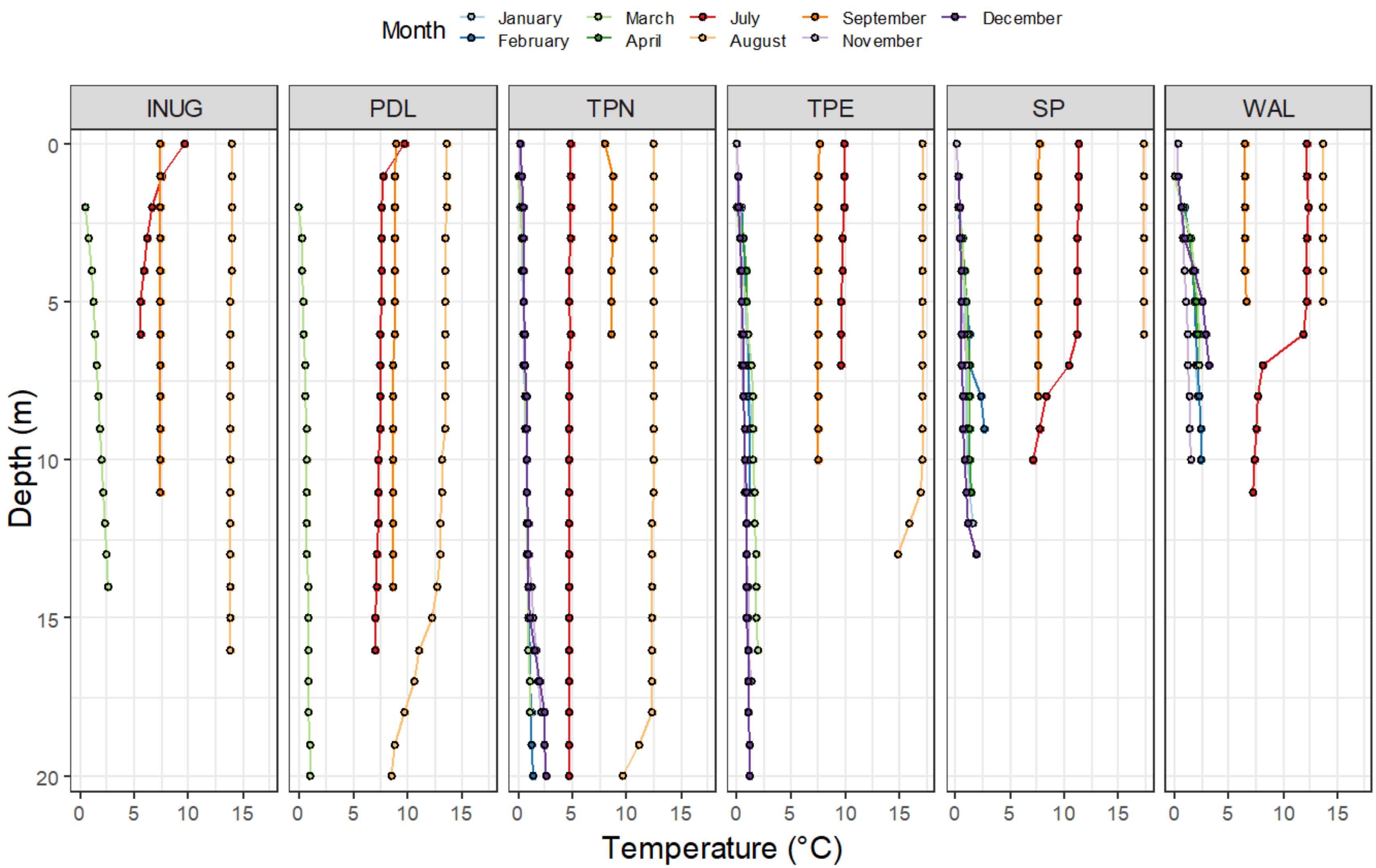


Figure 4-5. Meadowbank – Field-measured dissolved oxygen profiles, 2023.

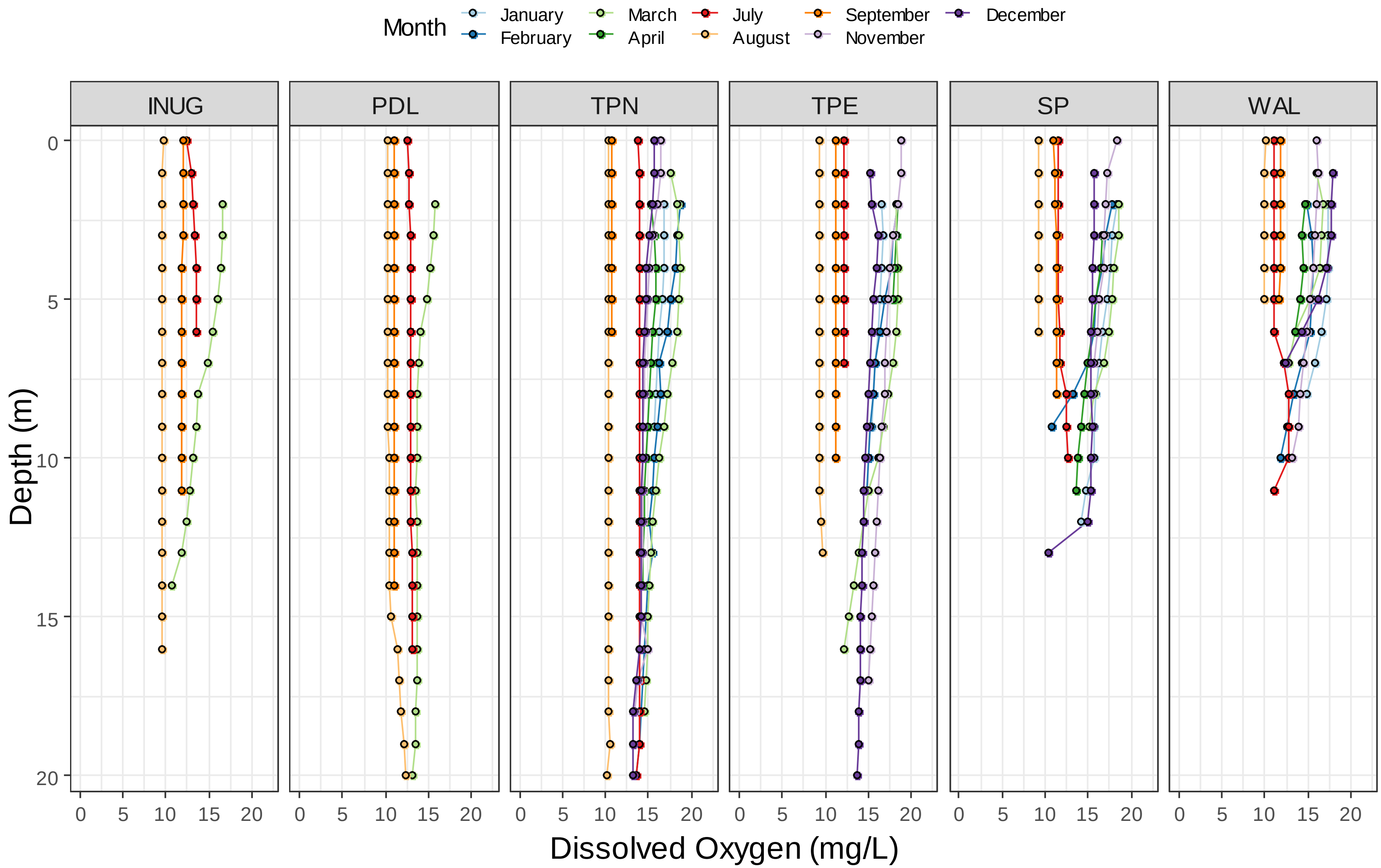
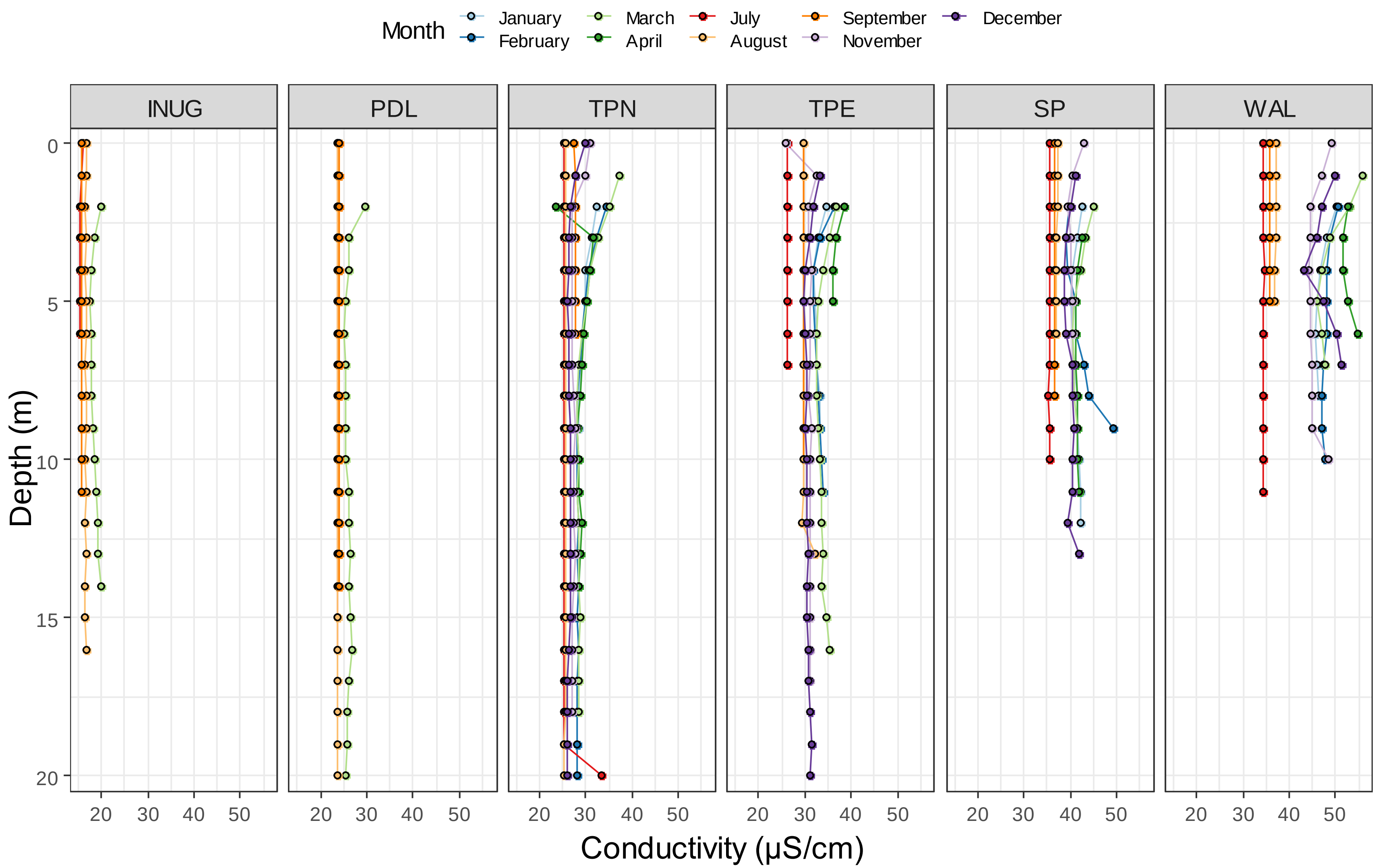


Figure 4-6. Meadowbank – Field-measured conductivity profiles, 2023.



Water Chemistry Tables and Figures

Table 4-2. Assessment process for water quality parameters, Meadowbank study area lakes, 2023.

Parameters	Trigger Exceedance[2]	Screening Level and Rule[1] 1: >DL ≥ 10% Frequency	2: C-I > 0.1 Frequency	3: Pattern = Activity
CONVENTIONALS				
Conductivity	All stations except INUG	**Yes**		
TSS	-	**Yes**		
Hardness	All stations except INUG	**Yes**		
T-Alkalinity	All stations except INUG and TPN	**Yes**		
B-Alkalinity	All stations except INUG and TPN	**Yes**		
C-Alkalinity	-	No	No	No
pH -Field	All stations	**Yes**		
pH -Lab	-	**Yes**		
TDS & MAJOR IONS				
TDS	All stations	**Yes**		
Calcium	All stations except INUG	**Yes**		
Chloride	-	**Yes**		
Fluoride	SP, TPE, TPN	**Yes**		
Magnesium	All stations except INUG	**Yes**		
Potassium	All stations except INUG and PDL	**Yes**		
Sodium	All stations except INUG and PDL	**Yes**		
Sulphate	-	**Yes**		
NUTRIENTS & OTHERS				
Ammonia-N	-	**Yes**		
Nitrate-N	-	**Yes**		
Nitrite-N	-	No	No	No
TKN	PDL	**Yes**		
T-phosphorus	WAL	**Yes**		
Ortho-phosphate	-	No	No	No
DOC	INUG, PDL, SP	**Yes**		
TOC	-	**Yes**		
Reactive silica	WAL	**Yes**		
T-Cyanide	-	No	No	No
Free Cyanide	-	No	No	No

Parameters	Trigger Exceedance[2]	Screening Level and Rule[1] 1: >DL ≥ 10% Frequency	2: C-I > 0.1 Frequency	3: Pattern = Activity
TOTAL METALS				
Aluminum	-	**Yes**		
Antimony	-	No	No	No
Arsenic	-	**Yes**		
Barium	-	**Yes**		
Beryllium	-	No	No	No
Boron	-	No	No	No
Cadmium	-	No	No	No
Chromium	-	**Yes**		
Copper	-	**Yes**		
Iron	-	**Yes**		
Lead	WAL	No	No	No
Lithium	-	No	No	No
Manganese	-	**Yes**		
Mercury	-	No	No	No
Molybdenum	-	**Yes**		
Nickel	-	**Yes**		
Selenium	-	No	No	No
Silicon	INUG, PDL, SP, WAL	**Yes**		
Silver	-	No	No	No
Strontium	-	**Yes**		
Thallium	-	No	No	No
Tin	-	No	No	No
Titanium	-	No	No	No
Uranium	-	**Yes**		
Vanadium	-	No	No	No
Zinc	-	No	No	No

Parameters	Trigger Exceedance[2]	Screening Level and Rule[1] 1: >DL ≥ 10% Frequency	2: C-I > 0.1 Frequency	3: Pattern = Activity
DISSOLVED METALS				
Aluminum	-	**Yes**		
Antimony	-	No	No	No
Arsenic	-	**Yes**		
Barium	-	**Yes**		
Beryllium	-	No	No	No
Boron	-	No	No	No
Cadmium	-	No	No	No
Chromium	-	No	No	No
Copper	-	**Yes**		
Iron	-	No	No	No
Lead	-	No	No	No
Lithium	-	No	No	No
Manganese	-	**Yes**		
Mercury	-	No	No	No
Molybdenum	-	**Yes**		
Nickel	-	**Yes**		
Selenium	-	No	No	No
Silicon	INUG, SP, WAL	**Yes**		
Silver	-	No	No	No
Strontium	-	**Yes**		
Thallium	-	No	No	No
Tin	-	No	No	No
Titanium	-	No	No	No
Uranium	-	**Yes**		
Vanadium	-	No	No	No
Zinc	TPE and SP	No	No	No

Notes:

1. A three-step assessment process was used to identify parameters to include in the formal temporal and spatial trend assessment (**Section 2.3.1** and **Section 4.3.2**).
   Parameters were assigned a "Yes" if the following assessment was true:

(1) **>DL ≥ 10% Frequency**: parameters that exceeded MDLs in at least 10% of the samples.
(2) **C-I > 0.1 Frequency**: parameters that were detected more often in impact areas and the proportion of detected values increased by 0.1 or more.
(3) **Pattern = Activity**: additional step to avoid screening out potentially important parameters. Based on the trend plots, is there a trend for infrequently detected parameters and/or are there values > 5 x DL in at least one sampling event at NF areas?

2. Indicates that a trigger exceedance occurred at the listed Whale Tail study area lakes in one or more sampling event.

Shaded parameters are included in the temporal and spatial trend assessment.

Plots for all individual parameters are presented in **Appendix B1.**

Table 4-3. Water quality variables at the Meadowbank study areas for which the 2023 mean concentration exceeded the trigger.

Meadowbank Study Areas

Parameter	Trigger	2023 Mean		
		TPN	TPE	SP
		NF	NF	NF
Conductivity	27.4	28.8	31.4	38.4
Hardness	9.5	10.1	11.2	15.3
TDS	19.0	-	21.8	26.4
Total alkalinity	8.7	-	-	10.9
HCO_3 alkalinity	9	-	-	10.9
Calcium	2.39	2.5	2.8	4.0
Magnesium	0.93	0.98	1.1	1.3
TKN	0.17	-	0.26	-
T. Silicon	0.2	-	-	0.34
D. Silicon	0.180	-	-	0.30

Wally Lake

Parameter	Trigger	2023 Mean
Conductivity	36.6	41.6
Hardness	16.7	17.2
TDS	25.3	28.1
Magnesium	1.36	1.4
Reactive silica	1.08	1.4
T. Silicon	0.65	0.67

Notes:

"-" indicates no threshold available, and/or mean annual concentration was < the trigger value.
Reported mean values are all in units of mg/L except for conductivity (µS/cm).

Table 4-4. Results of BACI tests for selected water variables at Meadowbank study areas in 2023.

Parameter	Test Area	n(B)	n(A)	Estimate	SE	P-value[1]	Proportional change		
							exp(Est)	LCI	UCI
Conductivity	TPN	6	4	0.48	0.012	**< 0.001**	1.6	1.6	1.7
	TPE	8	4	0.54	0.048	**< 0.001**	1.7	1.6	1.9
	SP	5	4	0.34	0.029	**< 0.001**	1.4	1.3	1.5
	WAL	18	4	0.088	0.071	0.12	1.1	0.94	1.3
Hardness	TPN	6	4	0.47	0.024	**< 0.001**	1.6	1.5	1.7
	TPE	8	4	0.55	0.048	**< 0.001**	1.7	1.6	1.9
	SP	5	4	0.35	0.024	**< 0.001**	1.4	1.3	1.5
	WAL	18	4	0.13	0.063	**0.024**	1.1	1.0	1.3
Bicarbonate alkalinity	SP	5	4	0.28	0.058	**< 0.001**	1.3	1.2	1.5
Total alkalinity	SP	5	4	0.28	0.058	**< 0.001**	1.3	1.2	1.5
TDS	TPE	8	4	0.28	0.082	**0.0040**	1.3	1.1	1.6
	SP	5	4	0.39	0.15	**0.016**	1.5	1.1	2.1
	WAL	18	4	-0.038	0.16	0.59	0.96	0.69	1.3
Calcium	TPN	6	4	0.53	0.024	**< 0.001**	1.7	1.6	1.8
	TPE	8	4	0.61	0.050	**< 0.001**	1.8	1.6	2.1
	SP	5	4	0.37	0.030	**< 0.001**	1.5	1.4	1.6
Magnesium	TPN	6	4	0.40	0.028	**< 0.001**	1.5	1.4	1.6
	TPE	8	4	0.46	0.048	**< 0.001**	1.6	1.4	1.8
	SP	5	4	0.32	0.020	**< 0.001**	1.4	1.3	1.5
	WAL	18	4	0.13	0.036	**< 0.001**	1.1	1.1	1.2
TKN	TPE	8	4	0.27	0.31	0.21	1.3	0.65	2.6
T. Silicon	WAL	6	4	0.34	0.12	**0.012**	1.4	1.1	1.9
Reactive silica	WAL	16	4	0.66	0.25	**0.0080**	1.9	1.1	3.3

Notes:
1. Bolded P-values are statistically significant ($p < 0.05$).
Test area = area compared to control (INUG).
N(B) = number of paired months in the *before* period.
N(A) = number of paired months in the *after* period (i.e., in 2023).
Estimate = BACI model estimate of the 2023 change in mean for log-transformed data.
SE = standard error of the estimate.
DF = degrees of freedom.
P-value = one-tailed test of the null hypothesis (no change or a decrease in mean [opposite for lower pH trigger]).
Exp(Est.) = estimated proportional change.
LCI = lower 95% confidence interval; UCI = upper 95% confidence interval.

Table 4-5. Sampling effort and frequency assessment results for the Meadowbank study area lakes, 2023.

Areas	Area Designation	Triggers Exceeded?	Minor Changes [1]		Moderate Changes [2]		Major Changes [3]		Plan for 2024
		Yes/No	Yes/No	Parameters	Yes/No	Parameters	Yes/No	Parameters	
Sampling Strategy for Reference Areas									
INUG	Ref	Yes	Yes	T.&D. Silicon	No	-	No	-	Full CREMP (reference area)
PDL	Ref	Yes	Yes	Hard., Ca, Mg, T. Silicon	No		No	-	Full CREMP (reference area)
Sampling Strategy for Near-field Areas									
TPE	NF	Yes	Yes	TKN, Cond., Hard., Ca, Mg, TDS	No	-	No	-	Full CREMP (near-field area)
TPN	NF	Yes	Yes	Cond., Hard., Ca, Mg	No	-	No	-	Full CREMP (near-field area)
SP	NF	Yes	Yes	Cond., Hard., TDS, Alkalinity (HCO_3 & Total), Ca, Mg, T.&D. Silicon	No	-	No	-	Full CREMP (near-field area)
WAL	NF	Yes	Yes	Cond., Hard., TDS, Mg, Reactive silica, T. Silicon	No	-	No	-	Full CREMP (near-field area)
Sampling Strategy for Mid-field and Far-field Areas									
TE	MF	NA	NA	-	NA	-	NA	-	Sampling suspended
TEFF	FF	NA	NA	-	NA	-	NA	-	Sampling suspended
TPS	MF	NA	NA	-	NA	-	NA	-	Sampling suspended

Notes:
1. Minor = exceedance of the early warning trigger values for parameters without effects-based threshold values.
2. Moderate = exceedance of the early warning trigger values for parameters with effects-based thresholds.
3. Major = exceedance of the effects-based threshold values.

NA = Routine water sampling at MF and FF areas was suspended in 2023. Sampling will be conducted at MF and FF areas if monitoring data from the NF areas suggest there are "moderate" changes in water quality. See *CREMP Plan Update* for details (Azimuth, 2022b).

Table 4-6. Meadowbank study area FEIS screening predictions compared to 2023 mean concentrations.

Parameter	Meadowbank Study Area							
	FEIS Screening Prediction				2023 Annual Mean			
	TPN	TPE	SP	WAL	TPN	TPE	SP	WAL
Hardness	5.7	5.7	8.9	17.2	10.1	11.2	15.3	17.2
Total Alkalinity	4.1	4.1	7.0	13.2	-	-	10.9	-
Calcium	1.3	1.3	2.3	4.7	2.5	2.8	4.0	-
Magnesium	0.60	0.60	0.80	1.3	0.98	1.1	1.3	1.4
Silicon (T)	0.010	0.010	0.010	0.040	-	-	0.34	0.67

Notes:
Reported mean concentrations are all in units of mg/L.
"-" indicates mean annual concentration was < the trigger value.

Figure 4-7. Conventional parameters in water samples from Meadowbank study area lakes since 2006.

Note: Conductivity data from 2014 should be interpreted with caution (See Azimuth [2015c] for more details).

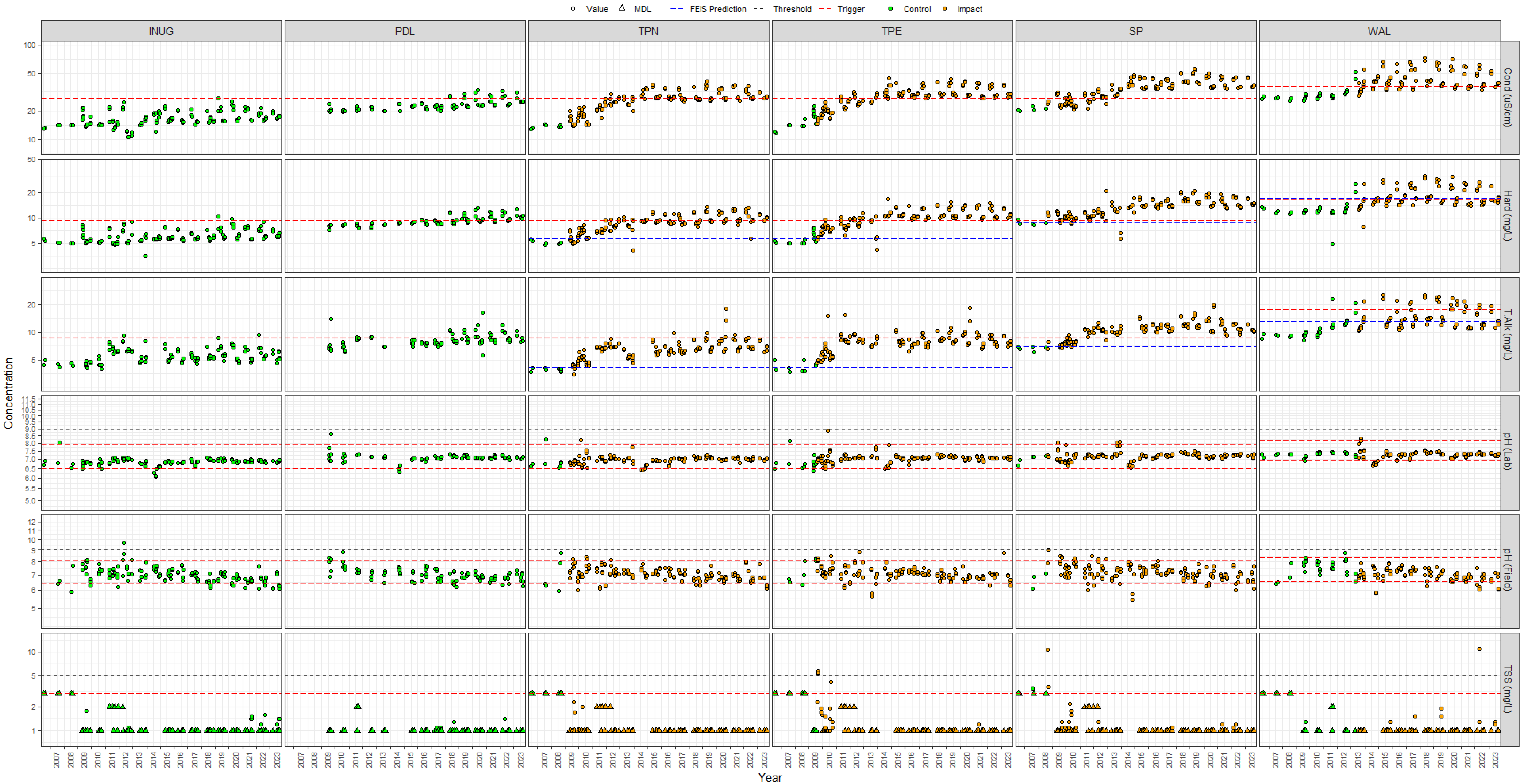


Figure 4-8. Major ions in water samples from Meadowbank study area lakes since 2006.

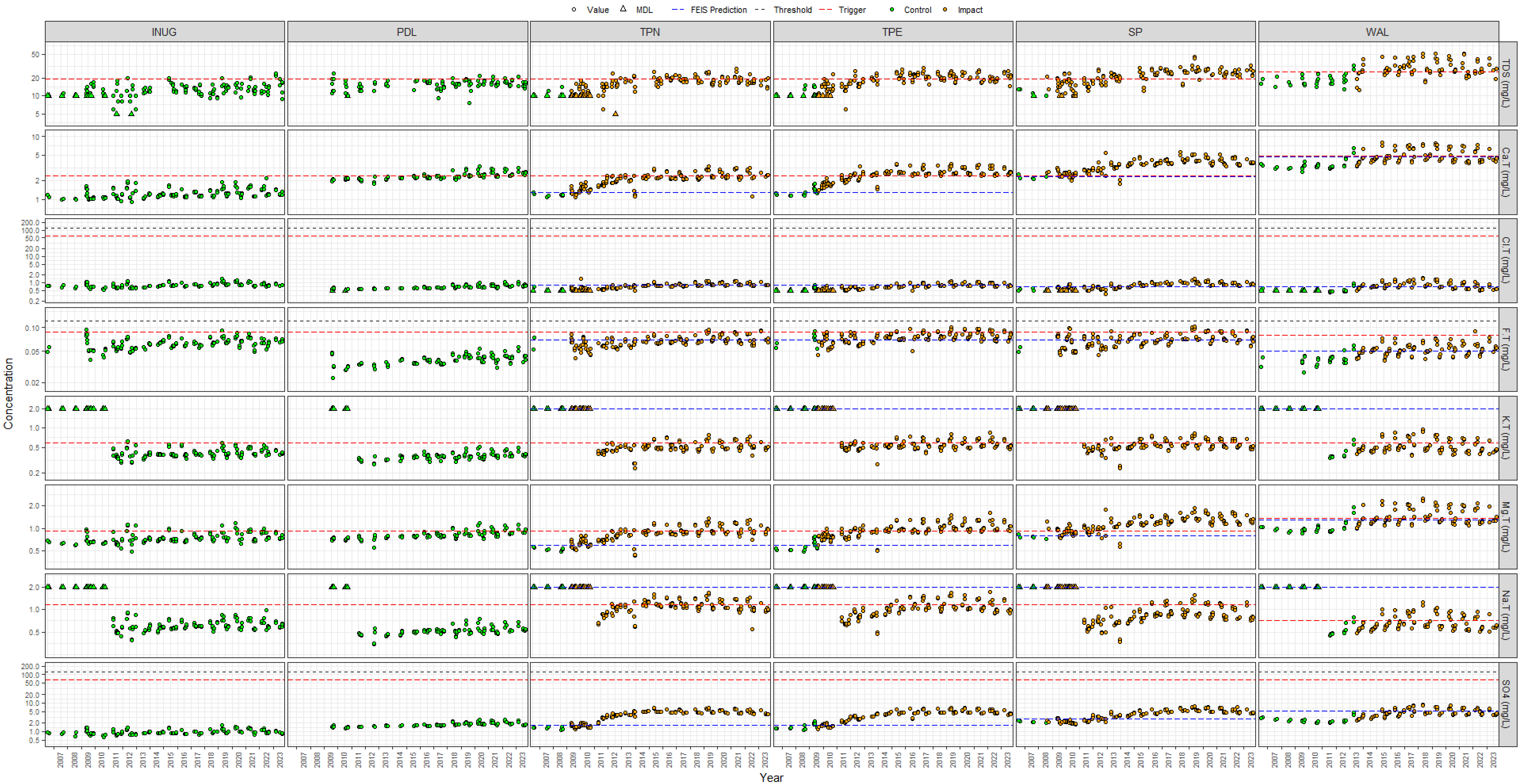


Figure 4-9. Nutrients in water samples from Meadowbank study area lakes since 2006.

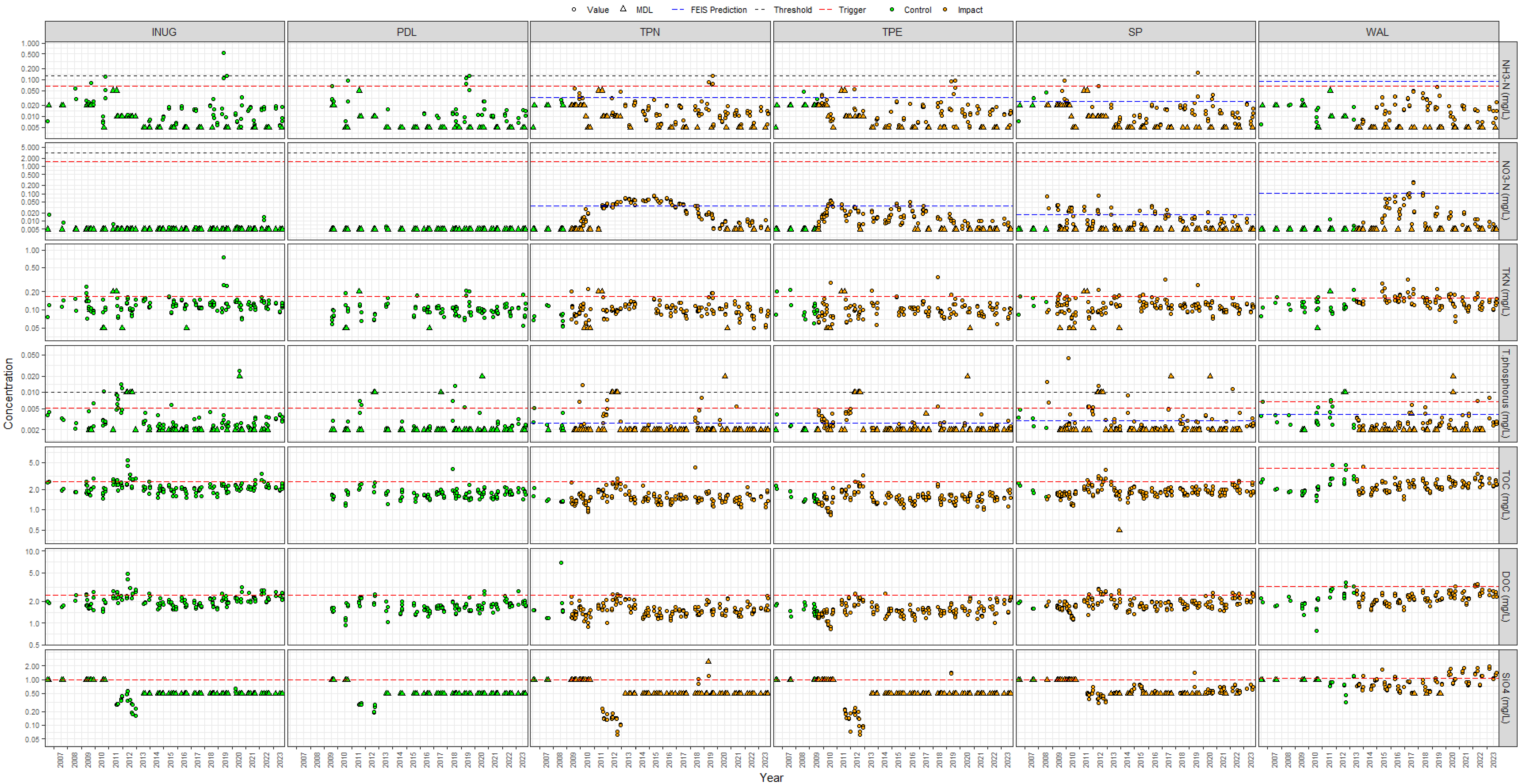


Figure 4-10. Metals in water samples from Meadowbank study area lakes since 2006.

Note: The FEIS prediction is equal to the threshold value for total arsenic at WAL.

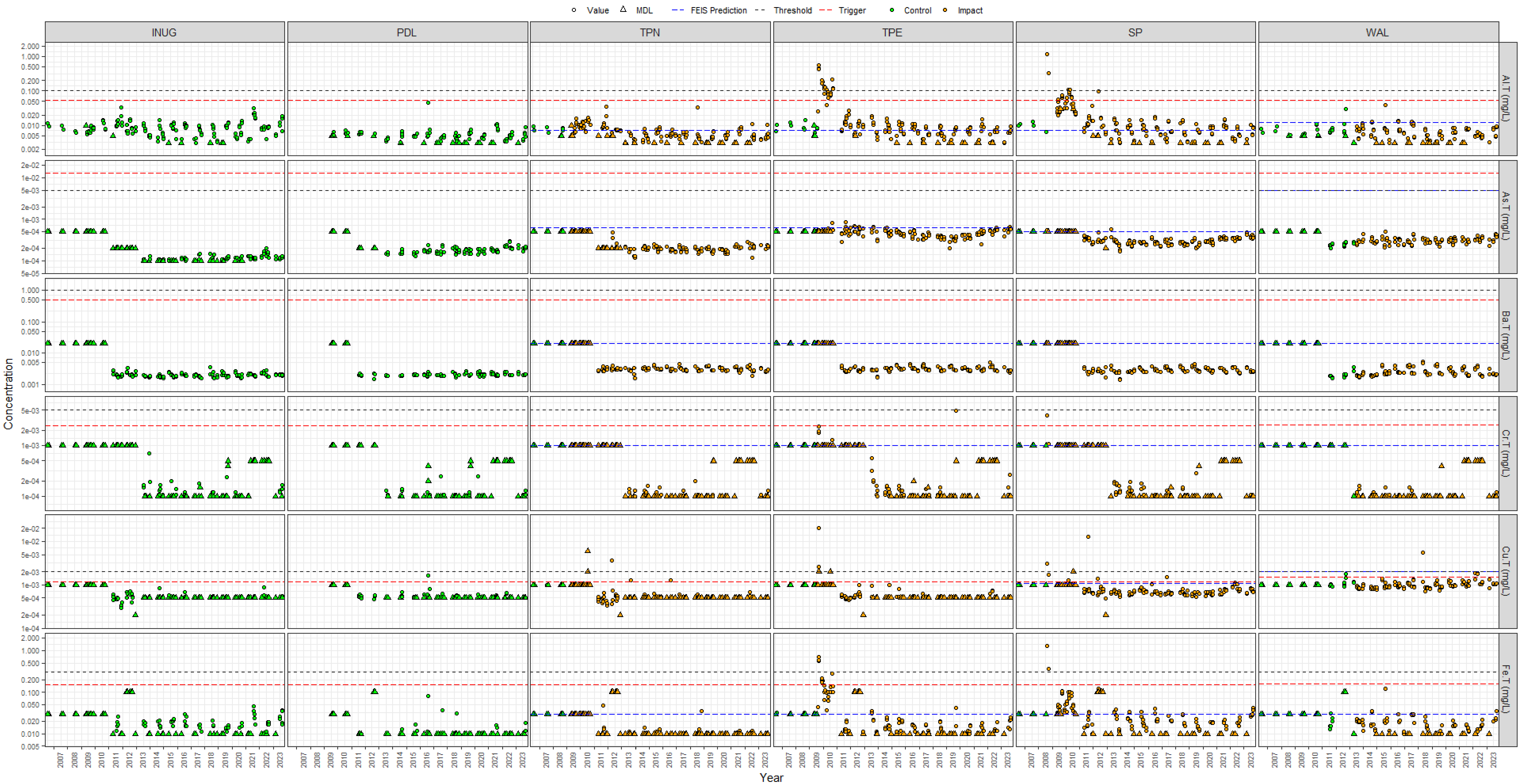


Figure 4-11. Metals in water samples from Meadowbank study lakes since 2006.

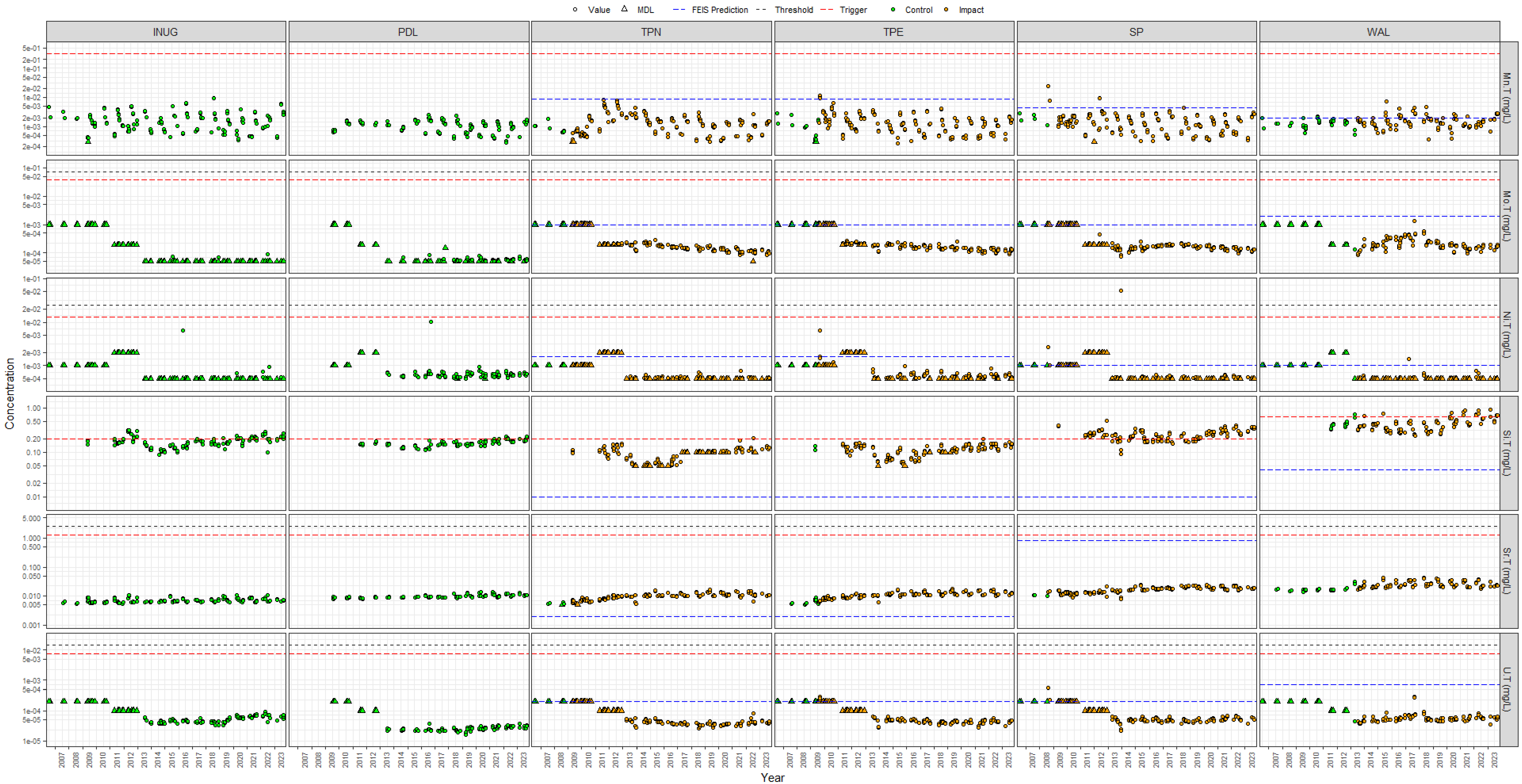
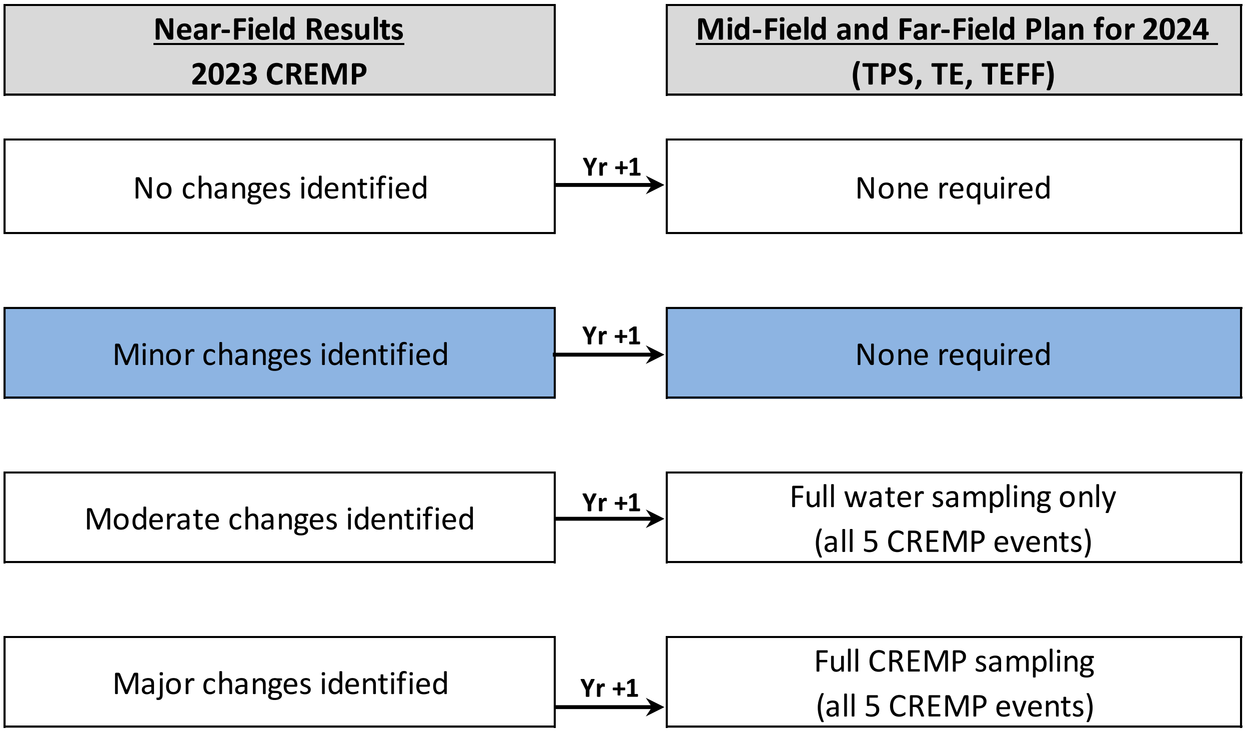


Figure 4-12. Flow chart showing sampling effort and frequency plan for mid-field and far-field sampling in 2024.

Note: Blue-shaded cells show the linkage between 2023 CREMP results and the sampling effort and frequency for mid-field and far-field sampling in 2024. *Minor changes* refer to statistically significant increased concentrations for parameters without effects-based threshold values that exceed the early warning trigger values. Refer to **Section 2.2.3** for more information.



Phytoplankton Tables and Figures

Table 4-7. Results of the BACI test for phytoplankton variables at Meadowbank areas, 2023.

Parameter Measured	Test Area	n(B)	n(A)	Estimate	SE	P-value*	Effect size (%)		
							ES	LCI	UCI
Total Biomass	TPN	7	2	0.66	0.29	**0.054**	94	-1	282
	TPE	8	2	0.44	0.20	**0.062**	56	-3	150
	SP	6	2	0.38	0.33	0.295	46	-35	230
	WAL	19	2	0.62	0.30	**0.050**	86	0	248
Taxa Richness	TPN	7	2	-0.09	0.12	0.471	-9	-31	21
	TPE	8	2	-0.07	0.06	0.290	-7	-19	7
	SP	6	2	-0.07	0.12	0.581	-7	-30	24
	WAL	19	2	-0.03	0.09	0.726	-3	-20	17

Notes:

* **Bolded** values are P-values < 0.1.

Shaded cells indicate positive (increased) or negative (reduced) effect sizes of 20% or more.

Test area = area compared to control (INUG).

n(B) = number of months in the "before" period.

n(A) = number of months in the "after" period (i.e., in 2023).

Estimate = BACI model estimate of the 2023 change in mean for log-transformed data.

SE = standard error of the estimate.

P-value = two-tailed test of the null hypothesis of no change.

ES = estimated effect size (i.e., 100%*(exp[Estimate]-1)).

LCI = lower 95% confidence interval; UCI = upper 95% confidence interval.

Figure 4-13. Chlorophyll-a (µg/L) in water samples from Meadowbank study area lakes since 2006.

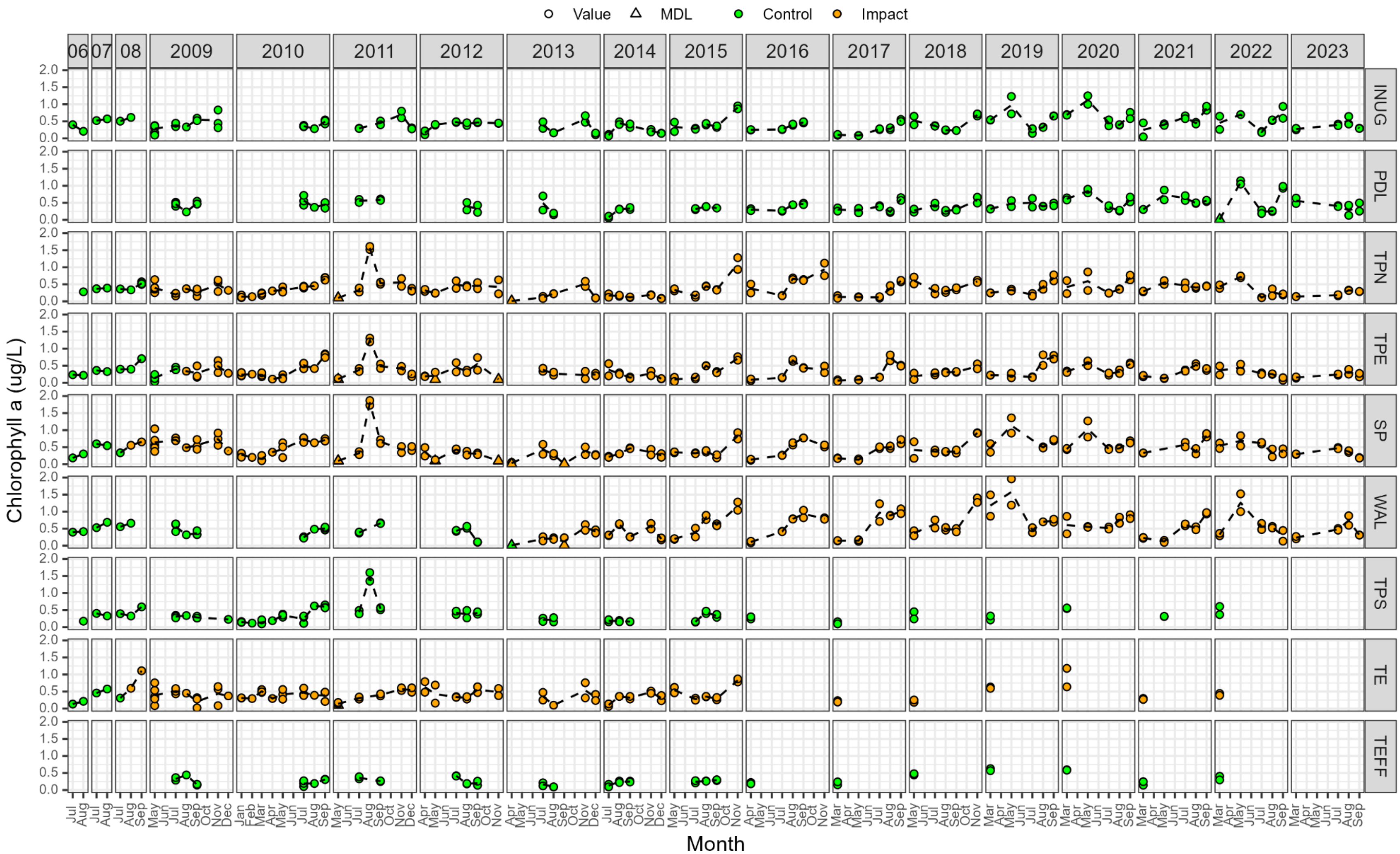


Figure 4-14. Total phytoplankton biomass (mg/m^3) from Meadowbank study area lakes since 2006.

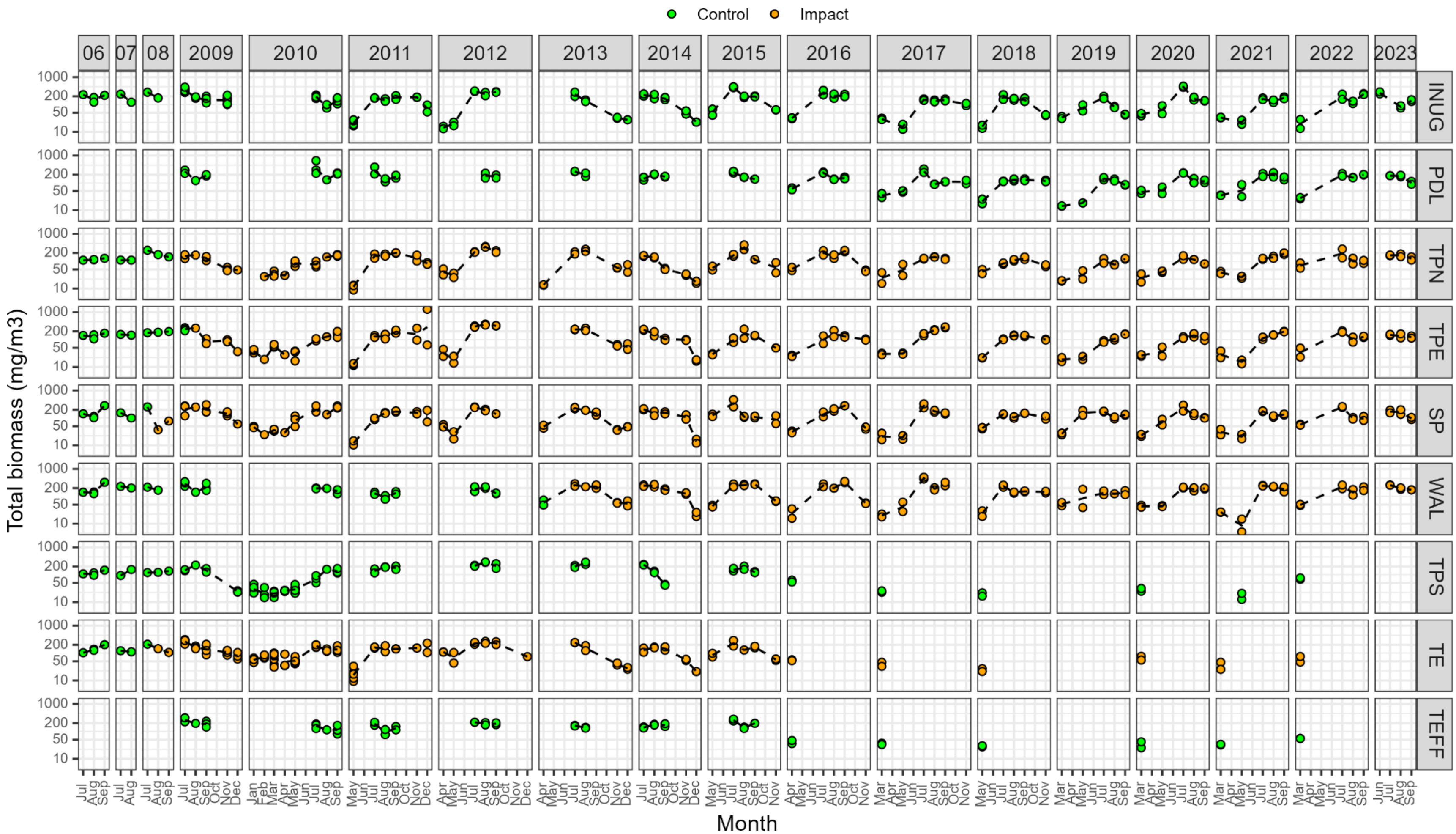


Figure 4-15. Phytoplankton biomass (mg/m³) by major taxa from Meadowbank study area lakes since 2006.

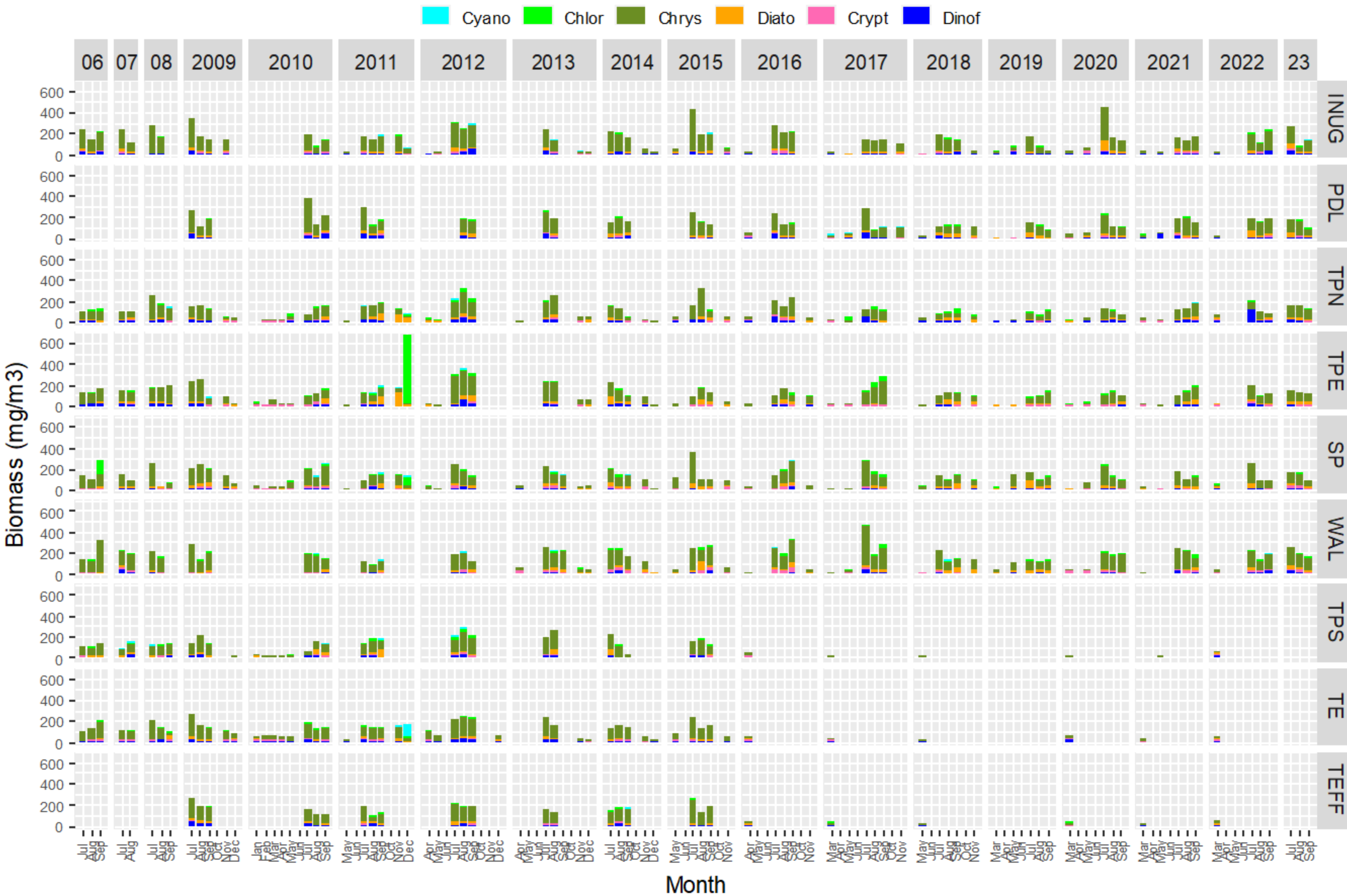


Figure 4-16. Relative phytoplankton biomass by major taxa group from Meadowbank study area lakes since 2006.

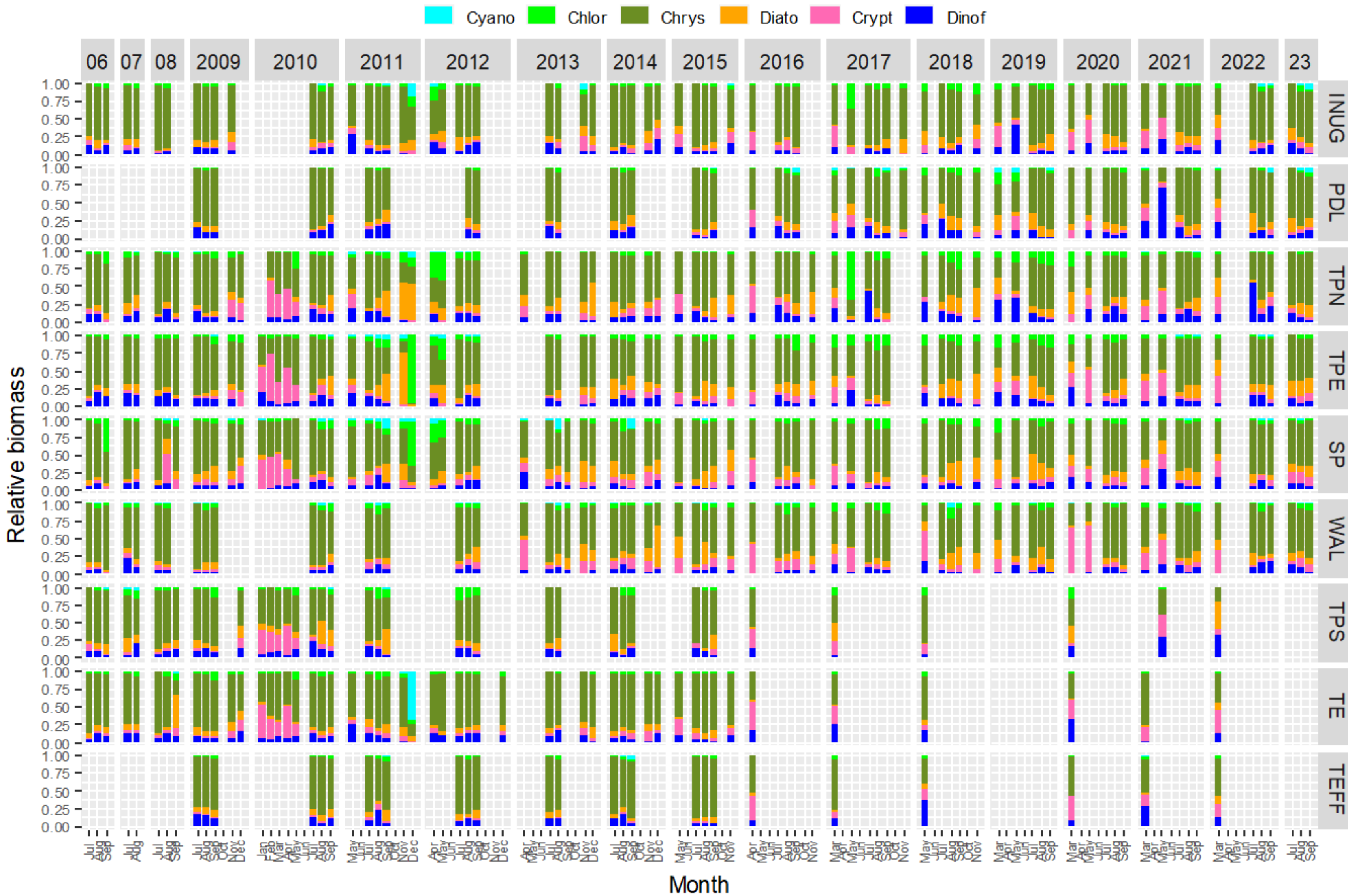
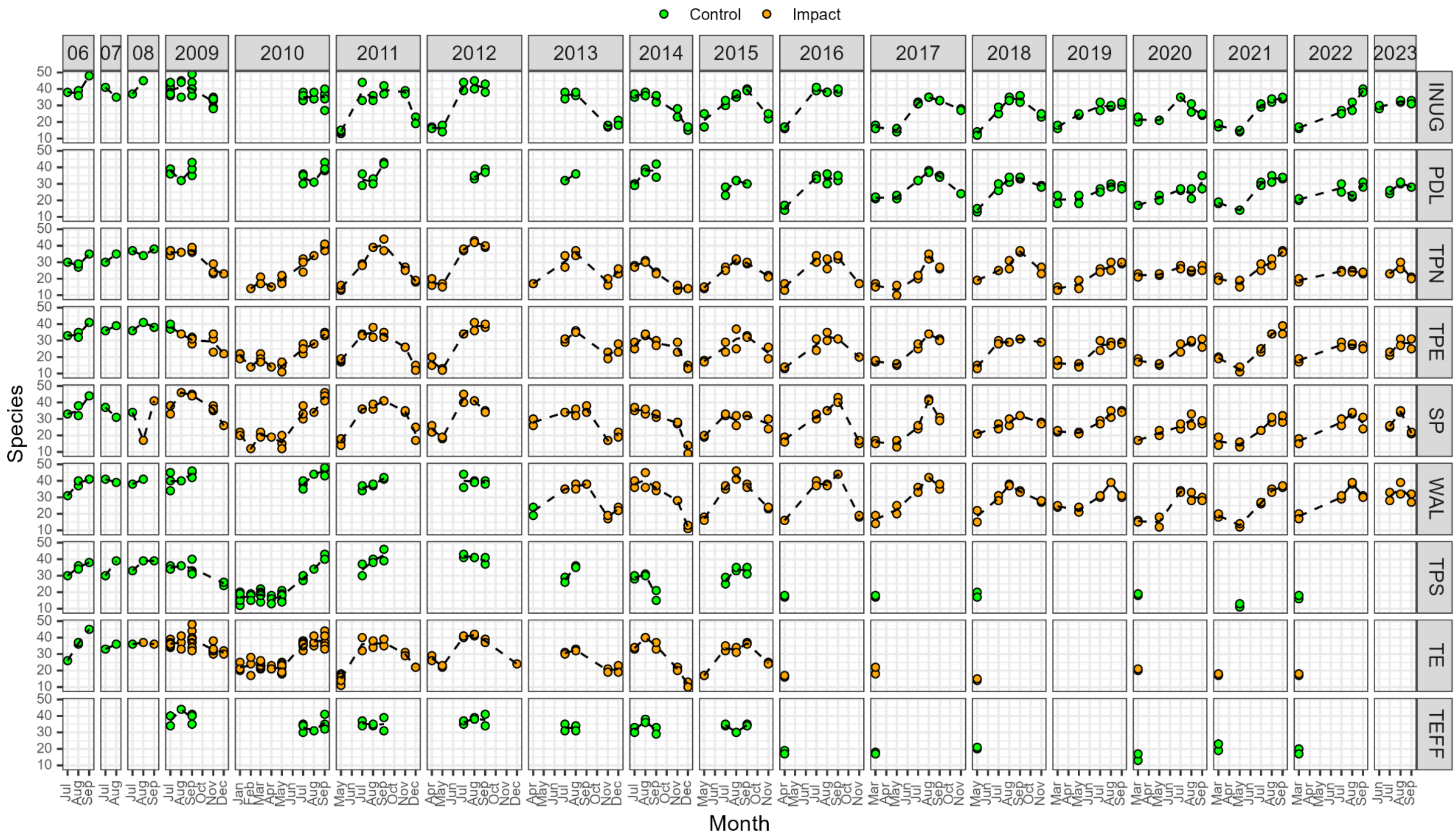


Figure 4-17. Phytoplankton species richness from Meadowbank study area lakes since 2006.



Sediment Chemistry Tables and Figures

Table 4-8. Sediment core metals at the Meadowbank study area lakes for which the 2023 mean concentration exceeded the trigger.

Meadowbank Study Areas [1]

Parameter	Trigger	2023 Mean		
		TPN	TPE	SP
		NF	NF	NF
Arsenic	121	-	-	-
Cadmium	1.1	-	-	-
Chromium	135	-	136	-
Copper	83	-	-	-
Lead	25	-	-	-
Mercury	0.10	-	-	-
Zinc	114	-	-	-

Wally Lake

Parameter	Trigger	2023 Mean
Arsenic	45	-
Cadmium	0.66	-
Chromium	61	-
Copper	257	-
Lead	37	-
Mercury	0.12	-
Zinc	142	-

Notes:

"-" indicates mean annual concentration was < the trigger value.

Reported mean values are all in units of mg/kg dw (mean of 10 replicate sediment core samples).

Table 4-9. Results of the before-after statistical analysis of sediment core chemistry data at the Meadowbank study area lakes, 2023.

								Proportional change		
Parameter	**Test Area**	**n(B)**	**n(A)**	**Estimate**	**SE**	**P-value[1]**	**DF**	**exp(Est)**	**LCI**	**UCI**
Chromium	TPE	30	10	0.45	0.073	**<0.001**	38	1.6	1.4	1.8

Notes:

1. **Bolded** values are p-values < 0.05.

Test area in 2023 compared to the “before" period.

n(B) = number of paired months in the “before” period.

n(A) = number of paired months in the “after” period (i.e., in 2023).

Estimate = BA model estimate of the 2023 change in mean for log-transformed data.

SE = standard error of the estimate.

P-value = one-tailed test of the null hypothesis of no change or a decrease in mean concentration.

Exp(Est.) = estimated proportional change in 2023 relative to the *before* period.

DF = degrees of freedom.

LCI = lower 95% confidence interval; UCI = upper 95% confidence interval.

Figure 4-18. TOC (%) in sediment from Meadowbank study lakes since 2007.

Notes: In 2021, a batch of sediment samples were not analyzed due to a sample receipt error by the laboratory. Missing results in 2021 correspond to samples that were discarded prior to analysis. No TOC was analyzed for INUG and PDL in 2022 due to high moisture content in the samples.

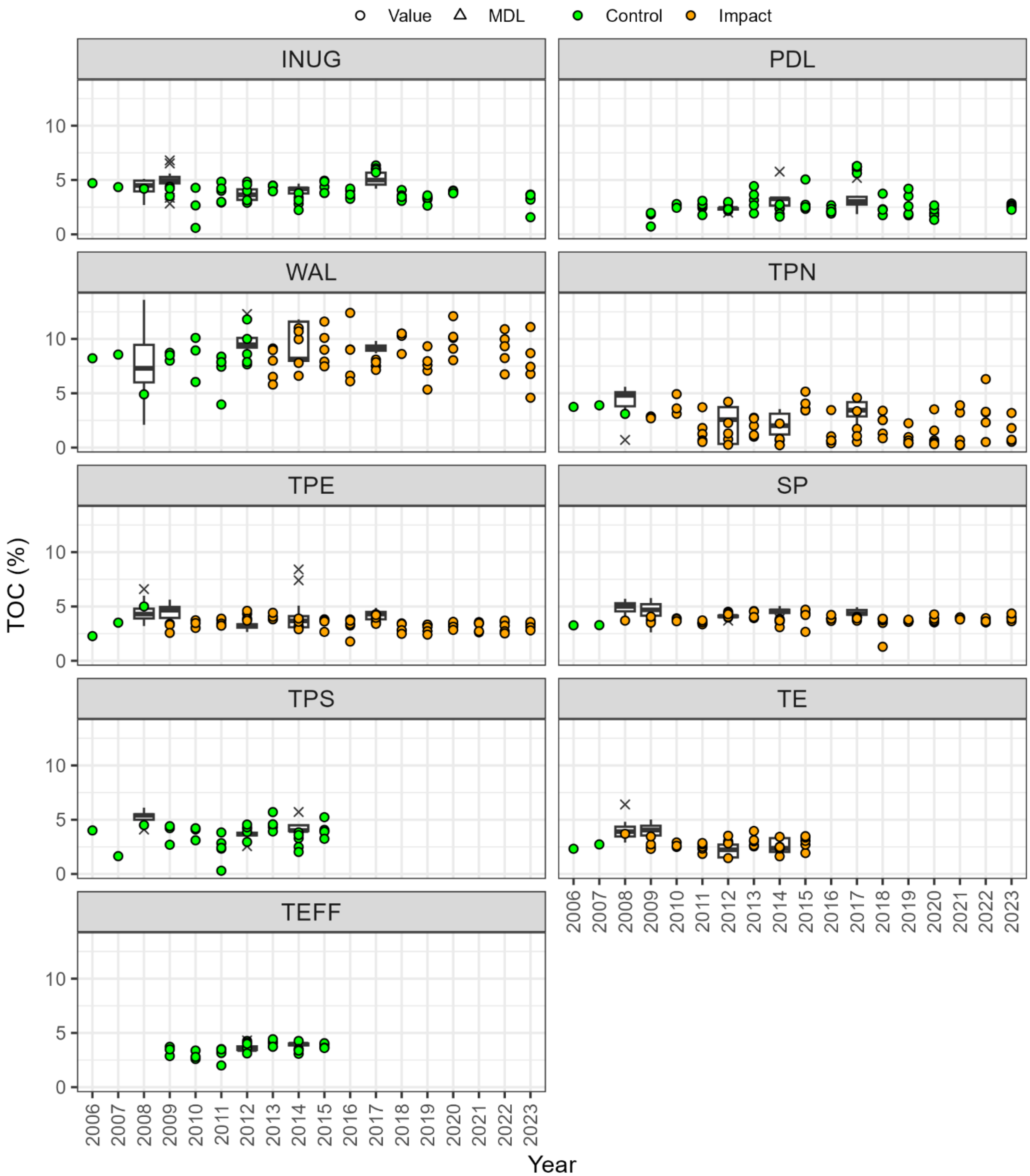


Figure 4-19. Sediment grain size in sediment samples from Meadowbank study lakes since 2007.

Notes: No grain size was analyzed for INUG and PDL in 2022 due to high moisture content in the samples. Grain size was not analyzed in WAL in 2021 as the sediment was discarded prior to analysis (see **Appendix A2** in Azimuth, 2023a).

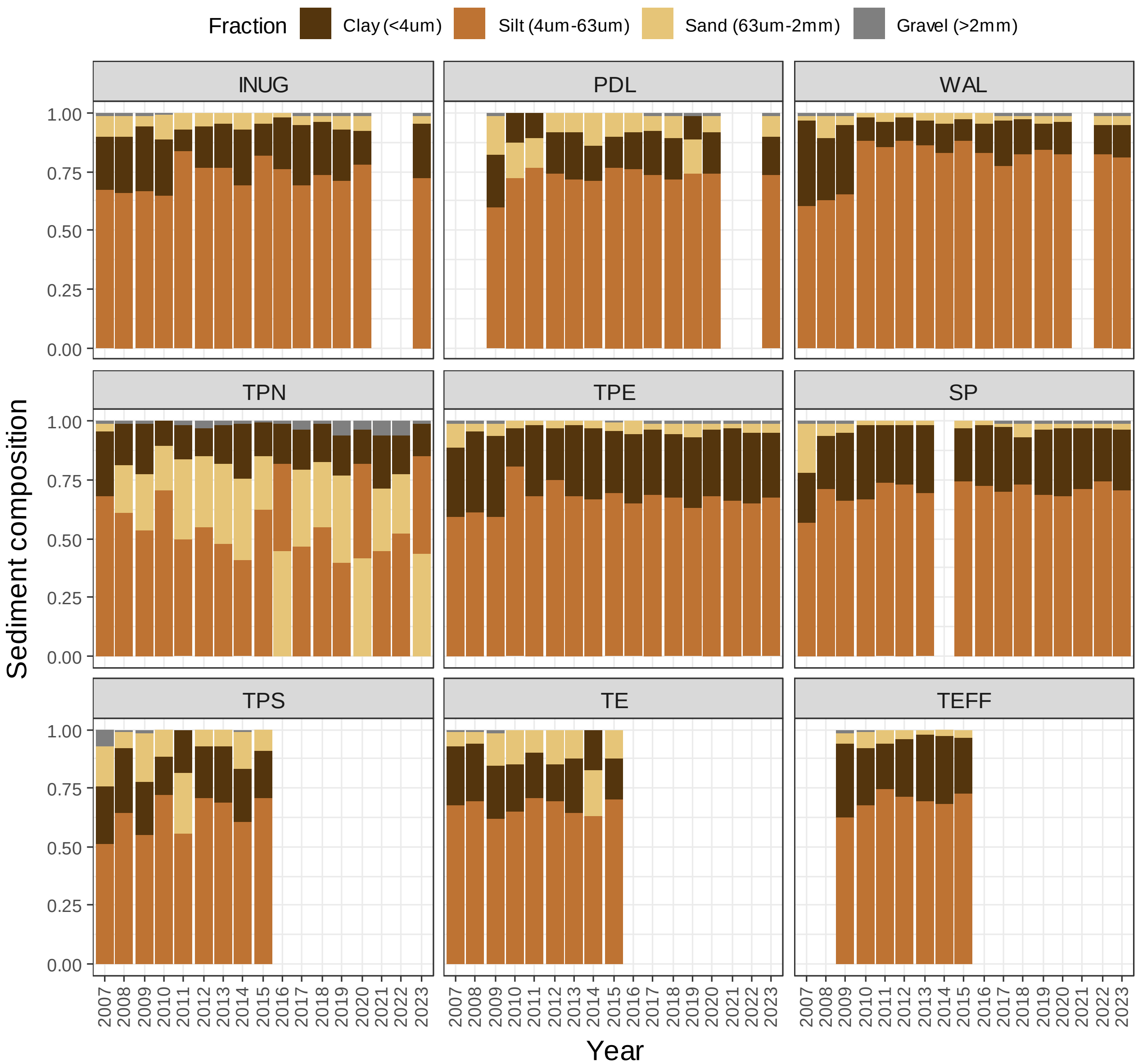


Figure 4-20. Total aluminum (mg/kg dw) in sediment samples (grabs & cores) from Meadowbank study area lakes since 2006.

Note: Cores samples = box and whisker. Box and whisker plots are interpreted as follows: horizontal line in the box = median concentration, upper and lower margins = upper (75th) and lower (25th) percentile concentrations or the interquartile range, vertical lines are maximum and/or minimum concentrations, ‘x’s beyond vertical lines are outlier concentrations.

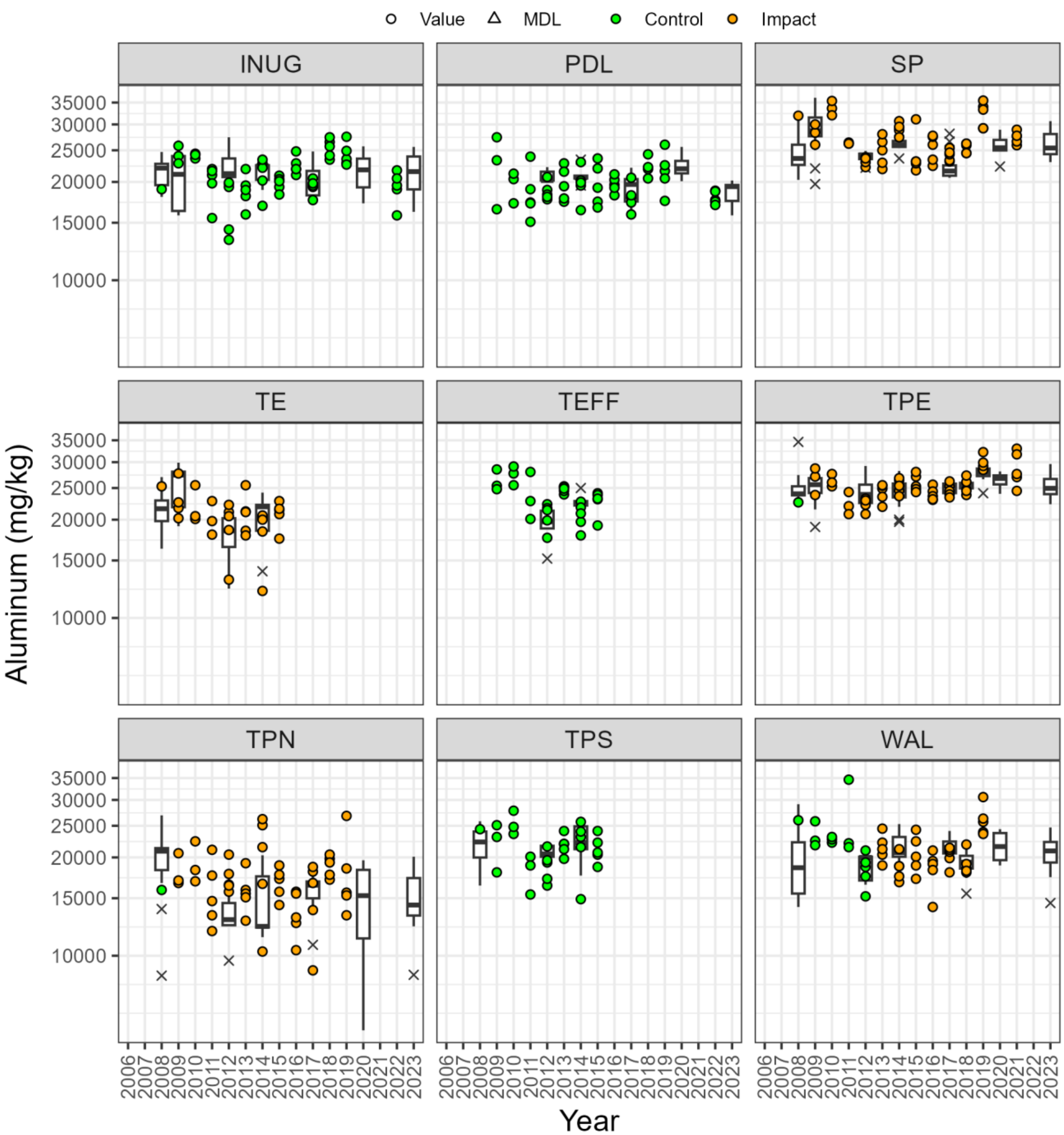


Figure 4-21. Total arsenic (mg/kg dw) in sediment samples (grabs & cores) from Meadowbank study area lakes since 2006.

Note: The red dashed line = trigger value. Cores samples = box and whisker. Box and whisker plots are interpreted as follows: horizontal line in the box = median concentration, upper and lower margins = upper (75th) and lower (25th) percentile concentrations or the interquartile range, vertical lines are maximum and/or minimum concentrations, 'x's beyond vertical lines are outlier concentrations.

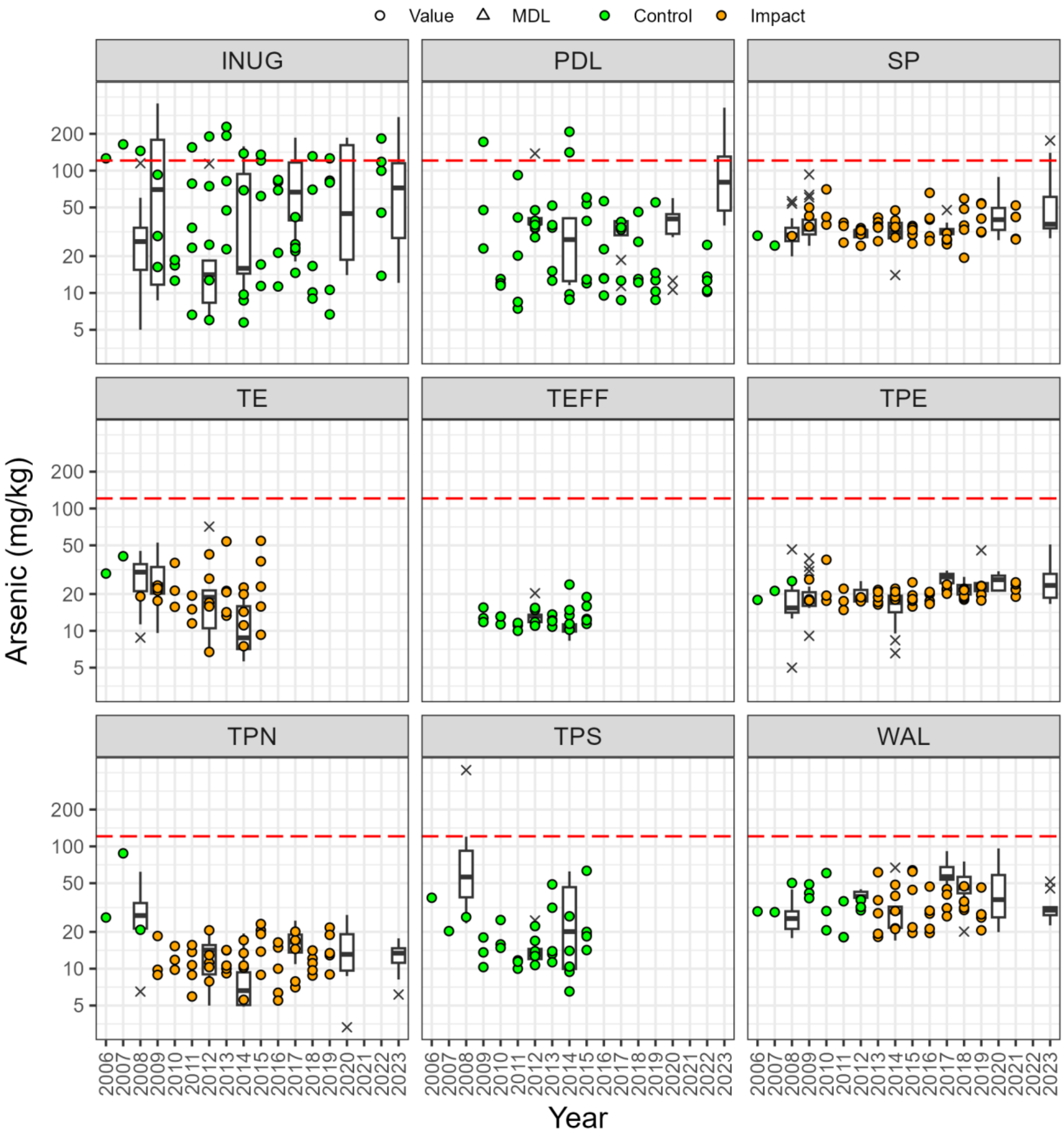


Figure 4-22. Total cadmium (mg/kg dw) in sediment samples (grabs & cores) from Meadowbank study area lakes since 2006.

Note: The red dashed line = trigger value. Cores samples = box and whisker. Box and whisker plots are interpreted as follows: horizontal line in the box = median concentration, upper and lower margins = upper (75th) and lower (25th) percentile concentrations or the interquartile range, vertical lines are maximum and/or minimum concentrations, 'x's beyond vertical lines are outlier concentrations.

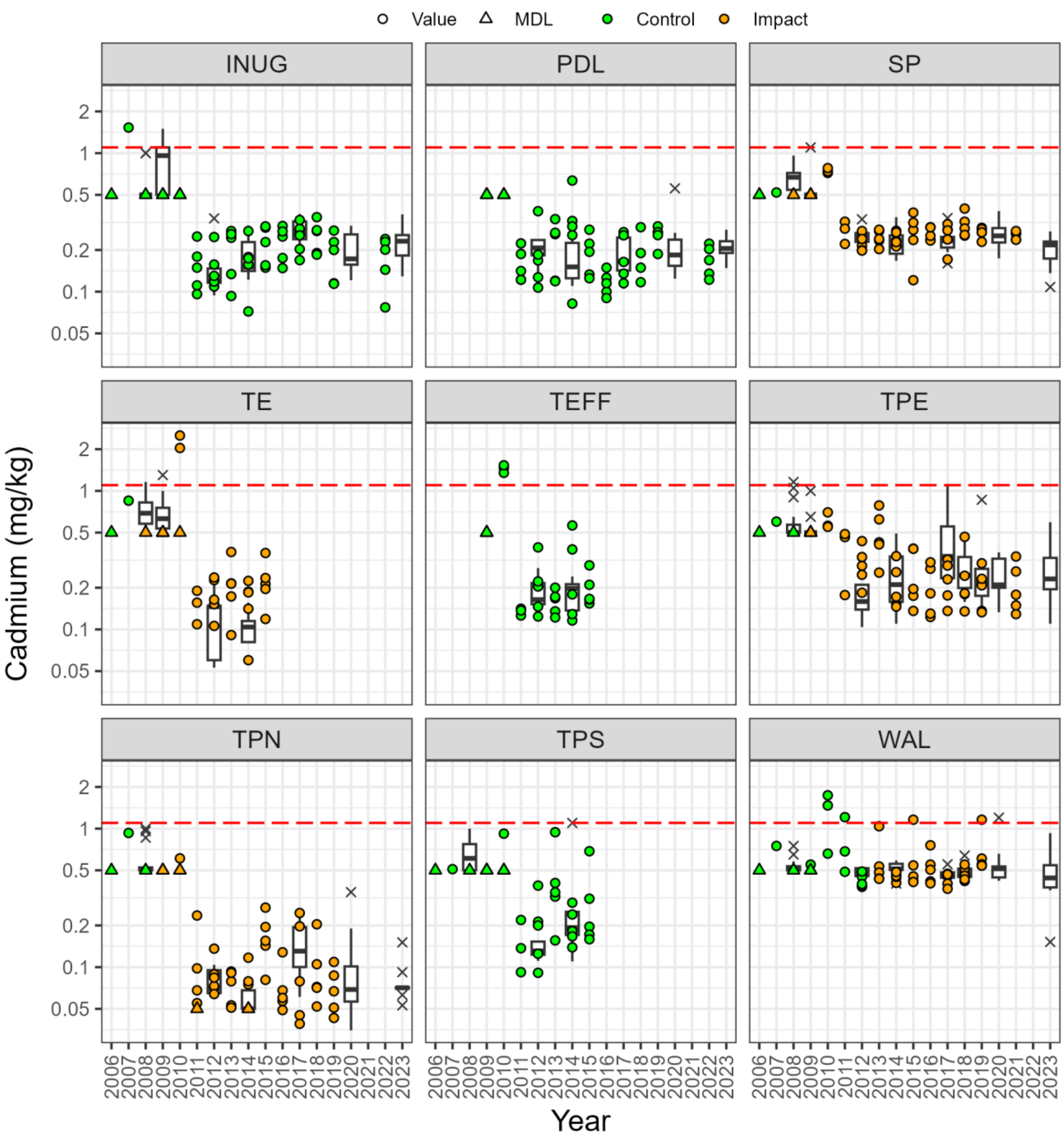


Figure 4-23. Total chromium (mg/kg dw) in sediment samples (grabs & cores) from Meadowbank study area lakes since 2006.

Note: The red dashed line = trigger value. Cores samples = box and whisker. Box and whisker plots are interpreted as follows: horizontal line in the box = median concentration, upper and lower margins = upper (75th) and lower (25th) percentile concentrations or the interquartile range, vertical lines are maximum and/or minimum concentrations, 'x's beyond vertical lines are outlier concentrations.

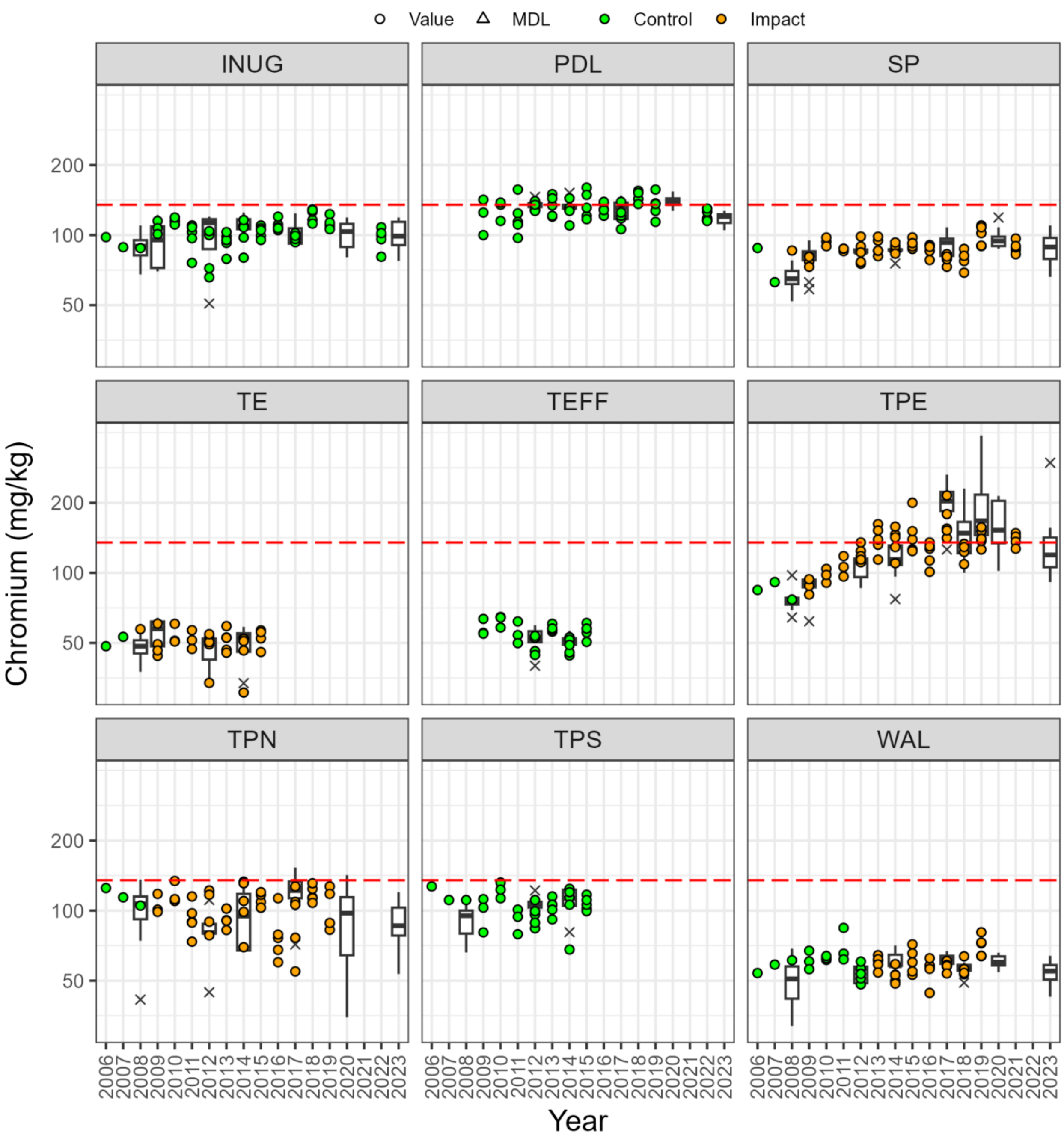


Figure 4-24. Total copper (mg/kg dw) in sediment samples (grabs & cores) from Meadowbank study area lakes since 2006.

Note: The red dashed line = trigger value. Cores samples = box and whisker. Box and whisker plots are interpreted as follows: horizontal line in the box = median concentration, upper and lower margins = upper (75th) and lower (25th) percentile concentrations or the interquartile range, vertical lines are maximum and/or minimum concentrations, 'x's beyond vertical lines are outlier concentrations.

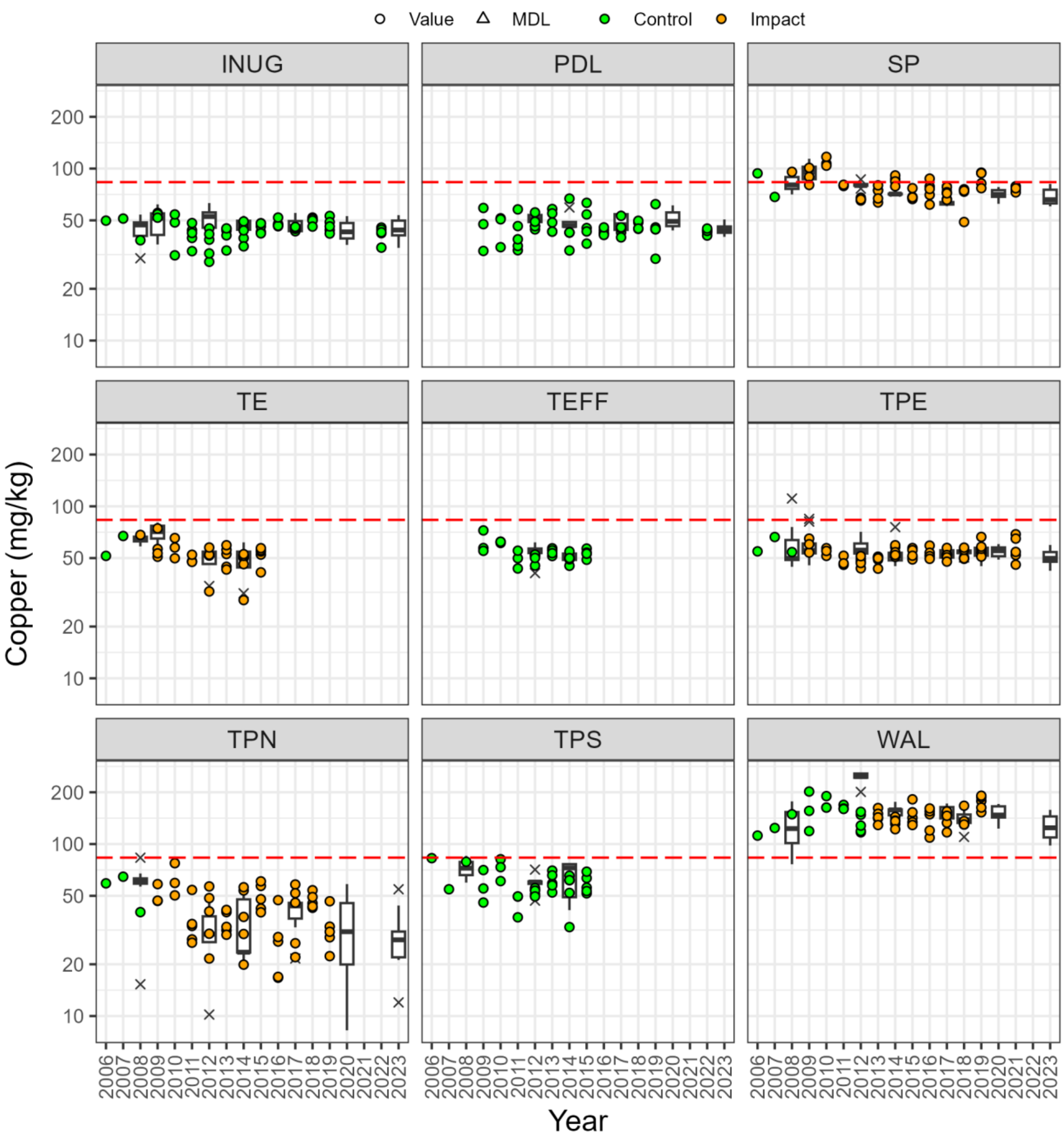


Figure 4-25. Total lead (mg/kg dw) in sediment samples (grabs & cores) from Meadowbank study area lakes since 2006.

Note: The red dashed line = trigger value. Cores samples = box and whisker. Box and whisker plots are interpreted as follows: horizontal line in the box = median concentration, upper and lower margins = upper (75th) and lower (25th) percentile concentrations or the interquartile range, vertical lines are maximum and/or minimum concentrations, 'x's beyond vertical lines are outlier concentrations.

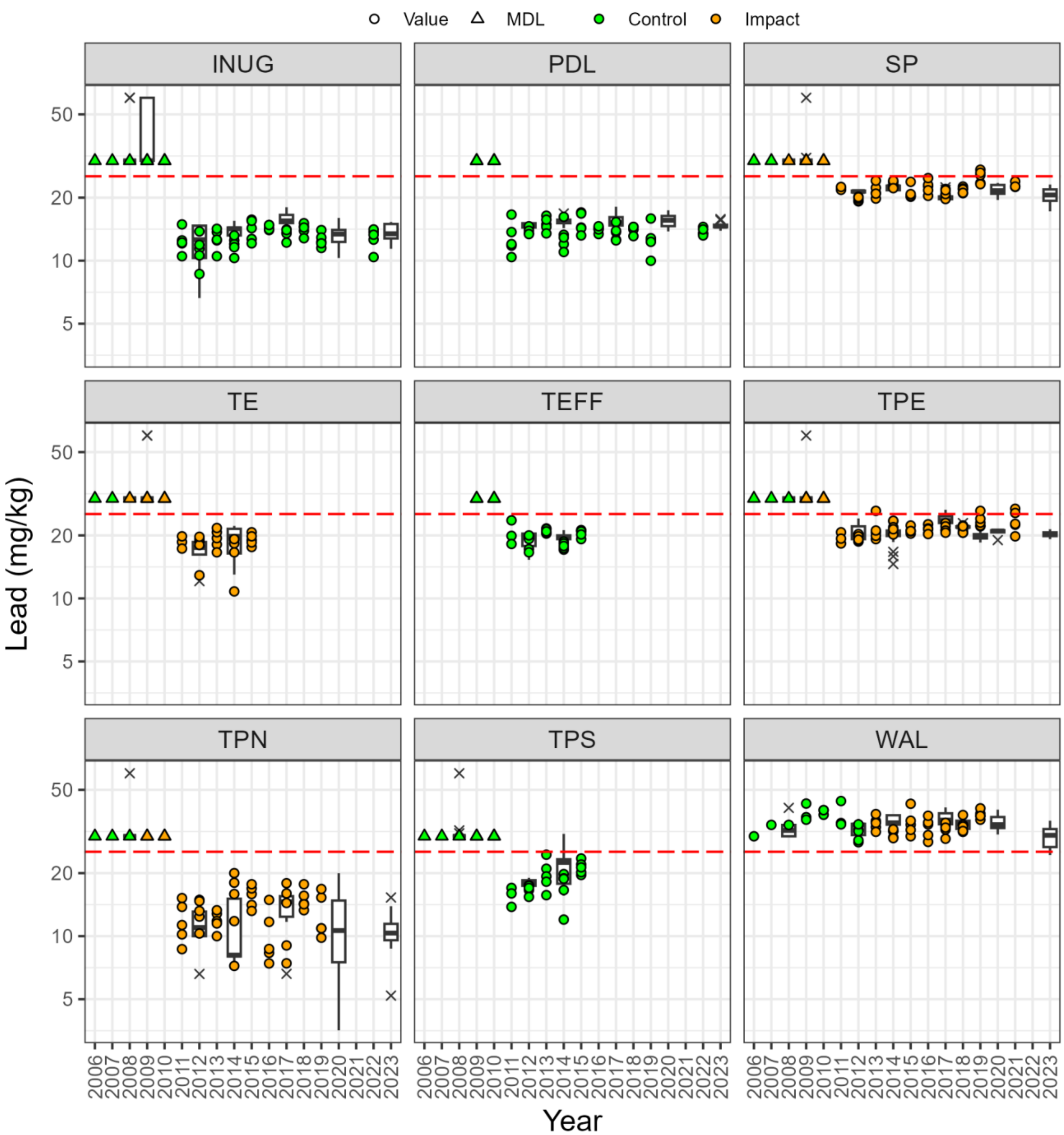


Figure 4-26. Total mercury (mg/kg dw) in sediment samples (grabs & cores) from Meadowbank study area lakes since 2006.

Note: The red dashed line = trigger value. Cores samples = box and whisker. Box and whisker plots are interpreted as follows: horizontal line in the box = median concentration, upper and lower margins = upper (75th) and lower (25th) percentile concentrations or the interquartile range, vertical lines are maximum and/or minimum concentrations, 'x's beyond vertical lines are outlier concentrations. The detection limit for mercury was adjusted in 2019 from 0.005 mg/L to 0.05 mg/L. These changes are notable on this plot for all study areas if mercury concentrations are below 0.05 mg/L. This adjustment does not impact trigger screening.

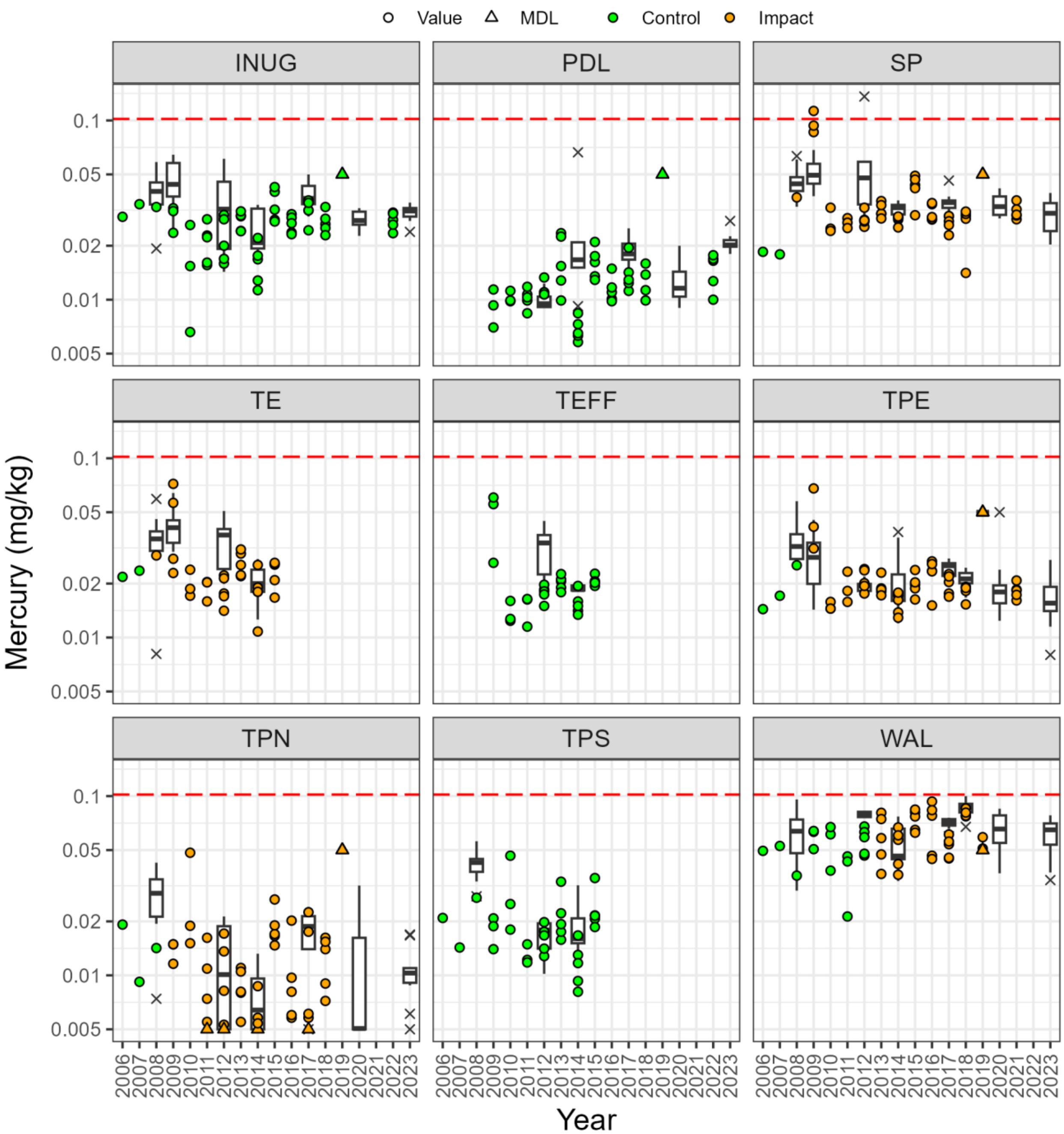
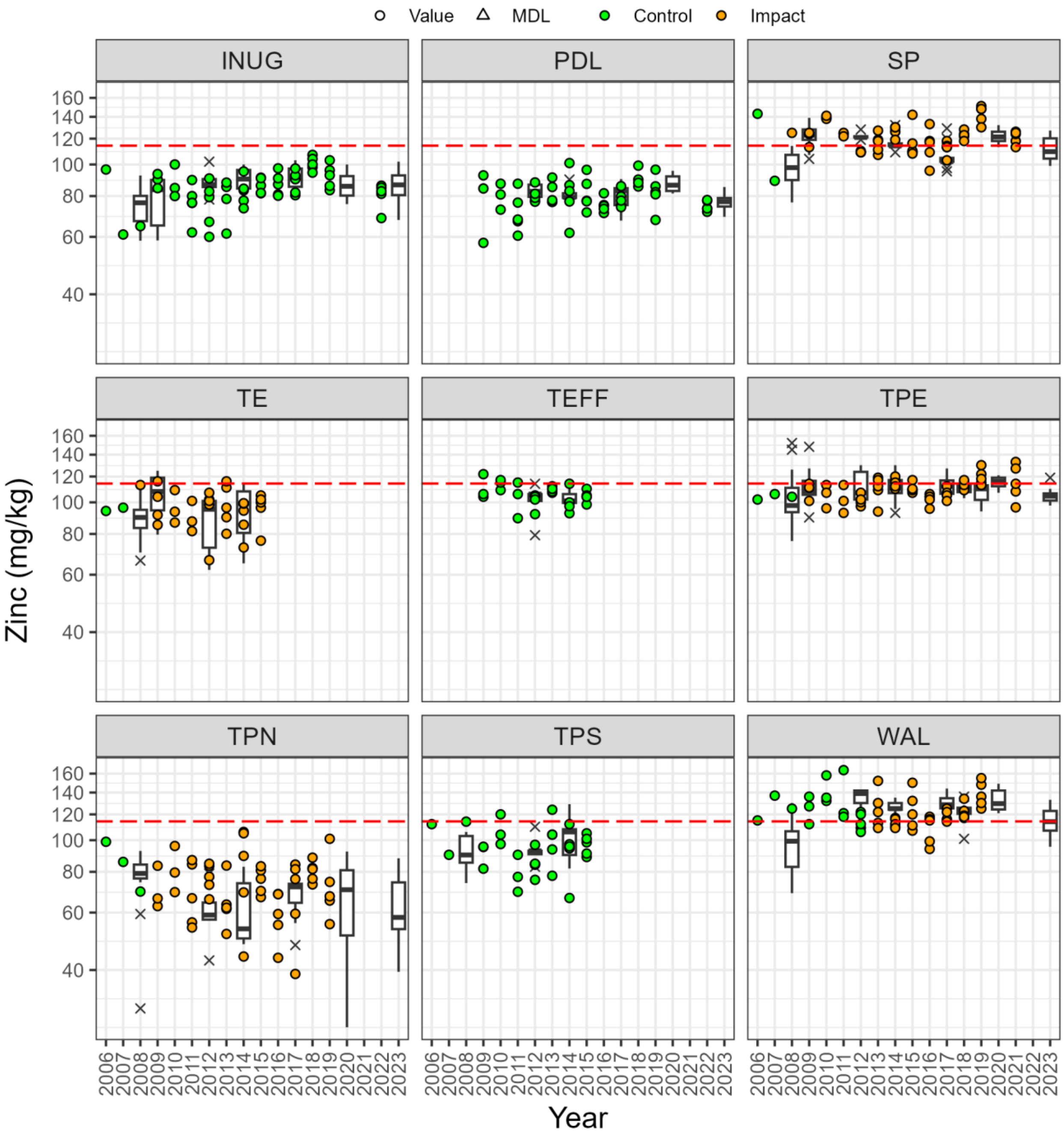


Figure 4-27. Total zinc (mg/kg dw) in sediment samples (grabs & cores) from Meadowbank study area lakes since 2006.

Note: The red dashed line = trigger value. Cores samples = box and whisker. Box and whisker plots are interpreted as follows: horizontal line in the box = median concentration, upper and lower margins = upper (75th) and lower (25th) percentile concentrations or the interquartile range, vertical lines are maximum and/or minimum concentrations, 'x's beyond vertical lines are outlier concentrations.



Benthic Invertebrate Tables and Figures

Table 4-10. Geometric means for total abundance and total richness, Meadowbank study lakes.

Geometric means for total abundance[1]																		
Test Area	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
INUG	731 (16)	975 (14)	1300 (10)	1129 (11)	628 (17)	881 (15)	1042 (13)	1975 (3)	621 (18)	1648 (6)	2100 (1)	1712 (4)	1497 (7)	1452 (8)	2055 (2)	1398 (9)	1070 (12)	1656 (5)
PDL	NA	NA	NA	1522 (1)	776 (13)	927 (10)	942 (9)	1279 (3)	473 (15)	1127 (4)	1373 (2)	748 (14)	779 (12)	990 (6)	951 (8)	829 (11)	963 (7)	1045 (5)
WAL	12894 (2)	4357 (6)	1057 (17)	1834 (11)	1727 (13)	800 (18)	1874 (10)	1445 (16)	2222 (9)	1568 (14)	14253 (1)	4942 (5)	12035 (3)	1761 (12)	6117 (4)	1524 (15)	4065 (7)	2798 (8)
TPN	NA	1359 (6)	864 (13)	1214 (8)	1029 (11)	498 (16)	1141 (9)	1407 (5)	373 (17)	3025 (1)	1696 (4)	1309 (7)	2051 (3)	594 (15)	1075 (10)	2283 (2)	917 (12)	610 (14)
TPE	3220 (6)	1563 (17)	5556 (1)	1663 (15)	1126 (18)	1584 (16)	3915 (2)	2244 (13)	2827 (8)	2765 (10)	2787 (9)	3147 (7)	2485 (11)	3490 (4)	3224 (5)	3505 (3)	2379 (12)	1767 (14)
SP	619 (15)	842 (12)	395 (17)	771 (14)	241 (18)	563 (16)	1169 (10)	2279 (2)	2796 (1)	1927 (4)	1420 (6)	2058 (3)	1298 (8)	842 (13)	1631 (5)	1222 (9)	1055 (11)	1299 (7)
TPS	935 (9)	1597 (4)	1501 (6)	1714 (3)	1130 (8)	932 (10)	1932 (2)	1581 (5)	1217 (7)	5939 (1)	NA	NA	NA	NA	NA	NA	NA	NA
TE	913 (4)	930 (3)	743 (8)	757 (6)	517 (10)	725 (9)	747 (7)	819 (5)	1158 (2)	1548 (1)	NA	NA	NA	NA	NA	NA	NA	NA
TEFF	NA	NA	NA	1215 (1)	886 (5)	615 (7)	921 (3)	955 (2)	891 (4)	816 (6)	NA	NA	NA	NA	NA	NA	NA	NA

Geometric means for total richness																		
Test Area	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
INUG	11 (16)	12 (12)	14 (6)	14 (7)	9 (18)	11 (15)	11 (14)	16 (3)	10 (17)	13 (10)	16 (2)	14 (5)	15 (4)	14 (8)	17 (1)	13 (9)	13 (11)	12 (13)
PDL	NA	NA	NA	11 (1)	9 (9)	10 (5)	8 (12)	10 (3)	5 (15)	9 (6)	11 (2)	10 (4)	6 (14)	9 (10)	9 (11)	8 (13)	9 (7)	9 (8)
WAL	12 (7)	14 (4)	8 (17)	11 (12)	11 (15)	7 (18)	12 (8)	11 (13)	11 (11)	11 (16)	15 (3)	14 (4)	15 (2)	12 (10)	16 (1)	12 (9)	14 (6)	11 (14)
TPN	NA	10 (10)	8 (16)	9 (12)	11 (8)	8 (15)	11 (9)	13 (3)	6 (17)	11 (7)	13 (3)	13 (5)	13 (2)	9 (13)	10 (11)	15 (1)	12 (6)	9 (14)
TPE	9 (18)	11 (15)	15 (4)	12 (13)	10 (16)	10 (17)	13 (10)	14 (6)	11 (14)	15 (5)	14 (7)	13 (10)	13 (9)	16 (1)	16 (2)	15 (3)	13 (8)	13 (12)
SP	7 (17)	10 (14)	8 (16)	8 (15)	5 (18)	11 (13)	13 (6)	12 (7)	14 (4)	13 (5)	16 (1)	12 (8)	11 (10)	11 (12)	15 (2)	14 (3)	11 (11)	12 (9)
TPS	11 (5)	10 (8)	11 (3)	11 (3)	9 (9)	8 (10)	11 (6)	11 (7)	11 (2)	17 (1)	NA	NA	NA	NA	NA	NA	NA	NA
TE	5 (10)	9 (5)	10 (2)	8 (7)	6 (9)	6 (8)	9 (4)	8 (6)	9 (3)	13 (1)	NA	NA	NA	NA	NA	NA	NA	NA
TEFF	NA	NA	NA	11 (3)	11 (2)	9 (6)	9 (7)	10 (5)	11 (3)	12 (1)	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

1. Total abundance in organisms/m^2.

Rank order of abundance and richness shown in parentheses.

Red vertical lines mark the year that area designations switched from *control* to *impact.*

NA = Benthic invertebrate sampling was not completed for the given area/year.

Table 4-11. Results of the BACI tests for benthic invertebrate abundance at Meadowbank study lakes.

After Period	Test Area	n(B)	n(A)	Estimate	SE	P-value*	Effect size (%)		
							ES	LCI	UCI
2023	TPN	2	1	-0.96	0.47	0.29	-62	-100	14,048
	TPE	3	1	-1.05	0.67	0.26	-65	-98	517
	SP	2	1	-0.09	0.30	0.82	-8	-98	3,939
	WAL	7	1	-0.32	0.98	0.76	-27	-93	700
2022-23	TPN	2	2	-0.54	0.40	0.31	-42	-90	229
	TPE	3	2	-0.68	0.51	0.28	-50	-90	159
	SP	2	2	0.03	0.26	0.93	3	-66	212
	WAL	7	2	0.09	0.69	0.90	9	-79	457
2021-23	TPN	2	3	-0.18	0.57	0.77	-17	-86	405
	TPE	3	3	-0.52	0.43	0.30	-40	-82	98
	SP	2	3	0.02	0.24	0.93	2	-52	120
	WAL	7	3	-0.19	0.58	0.75	-18	-78	212
2020-23	TPN	2	4	-0.29	0.49	0.59	-25	-81	193
	TPE	3	4	-0.55	0.36	0.19	-42	-77	47
	SP	2	4	0.00	0.22	0.99	0	-45	82
	WAL	7	4	-0.08	0.52	0.88	-8	-72	201

Notes:

* **Bolded & underlined** values are P-values < 0.1.

Shaded cells indicate positive (increased) or negative (reduced) effect sizes of 20% or more.

Test area = area compared to control (INUG).

n(B) = number of years in the "before" period.

n(A) = number of years in the "after" period.

Estimate = BACI model estimate of the after-period change in mean for log-transformed data.

SE = standard error of the estimate.

P-value = two-tailed test of the null hypothesis of no change.

ES = estimated effect size (i.e., 100%*(exp[Estimate]-1)).

LCI = lower 95% confidence interval; UCI = upper 95% confidence interval.

Table 4-12. Results of the BACI tests for benthic invertebrate taxa richness at Meadowbank study area lakes.

After Period	Test Area	n(B)	n(A)	Estimate	SE	P-value*	Effect size (%)		
							ES	LCI	UCI
2023	TPN	2	1	0.10	0.25	0.76	10	-95	2,469
	TPE	3	1	0.12	0.15	0.51	13	-41	117
	SP	2	1	0.32	0.21	0.37	38	-91	1,913
	WAL	7	1	-0.03	0.31	0.94	-3	-54	107
2022-23	TPN	2	2	0.23	0.19	0.36	26	-45	188
	TPE	3	2	0.14	0.12	0.34	14	-22	68
	SP	2	2	0.27	0.16	0.23	31	-34	159
	WAL	7	2	0.07	0.22	0.75	7	-36	80
2021-23	TPN	2	3	0.33	0.21	0.21	39	-28	171
	TPE	3	3	0.16	0.11	0.22	17	-13	57
	SP	2	3	0.31	0.14	0.12	37	-13	116
	WAL	7	3	0.03	0.18	0.89	3	-32	55
2020-23	TPN	2	4	0.21	0.23	0.42	23	-35	132
	TPE	3	4	0.13	0.09	0.24	13	-11	44
	SP	2	4	0.29	0.13	**0.08**	34	-5	91
	WAL	7	4	0.03	0.16	0.85	3	-28	47

Notes:

* **Bolded & underlined** values are P-values < 0.1.

Shaded cells indicate positive (increased) or negative (reduced) effect sizes of 20% or more.

Test area = area compared to control (INUG).

n(B) = number of years in the "before" period.

n(A) = number of years in the "after" period.

Estimate = BACI model estimate of the after-period change in mean for log-transformed data.

SE = standard error of the estimate.

P-value = two-tailed test of the null hypothesis of no change.

ES = estimated effect size (i.e., 100%*(exp[Estimate]-1)).

LCI = lower 95% confidence interval; UCI = upper 95% confidence interval.

Figure 4-28. Benthic invertebrate total abundance (#/m²) from Meadowbank study area lakes since 2006.

Notes: Meadowbank areas TPS, TE, and TEFF have not been sampled since 2015. For results from these areas from 2006 to 2015 see Azimuth 2021.

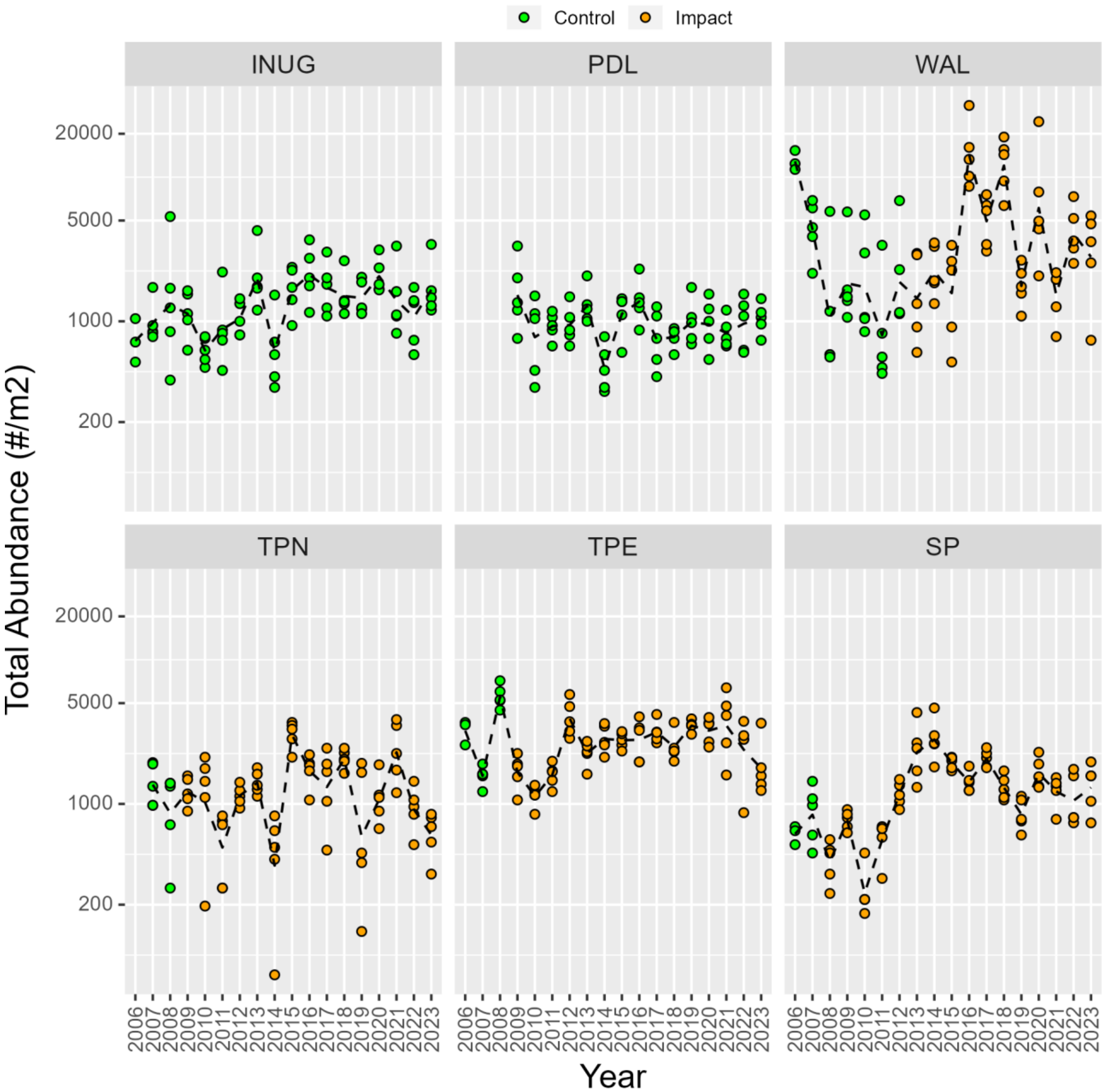


Figure 4-29. Benthic invertebrate abundance (#/m²) by major taxa from Meadowbank study area lakes since 2006.

Notes: Meadowbank areas TPS, TE, and TEFF have not been sampled since 2015. For results from these areas from 2006 to 2015 see Azimuth 2021.

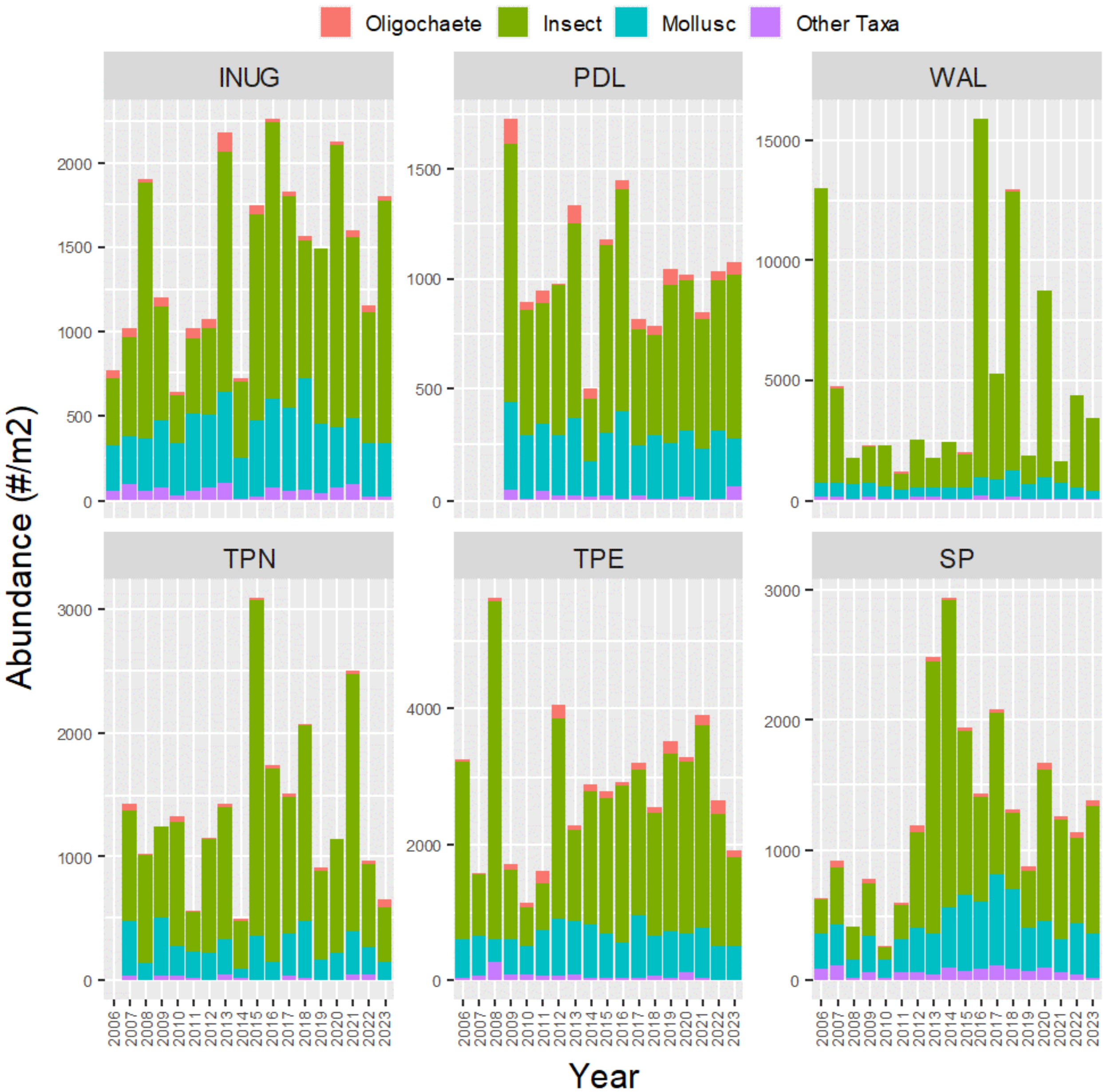


Figure 4-30. Benthic invertebrate relative abundance by major taxa from Meadowbank study area lakes since 2006.

Notes: Meadowbank areas TPS, TE, and TEFF have not been sampled since 2015. For results from these areas from 2006 to 2015 see Azimuth 2021.

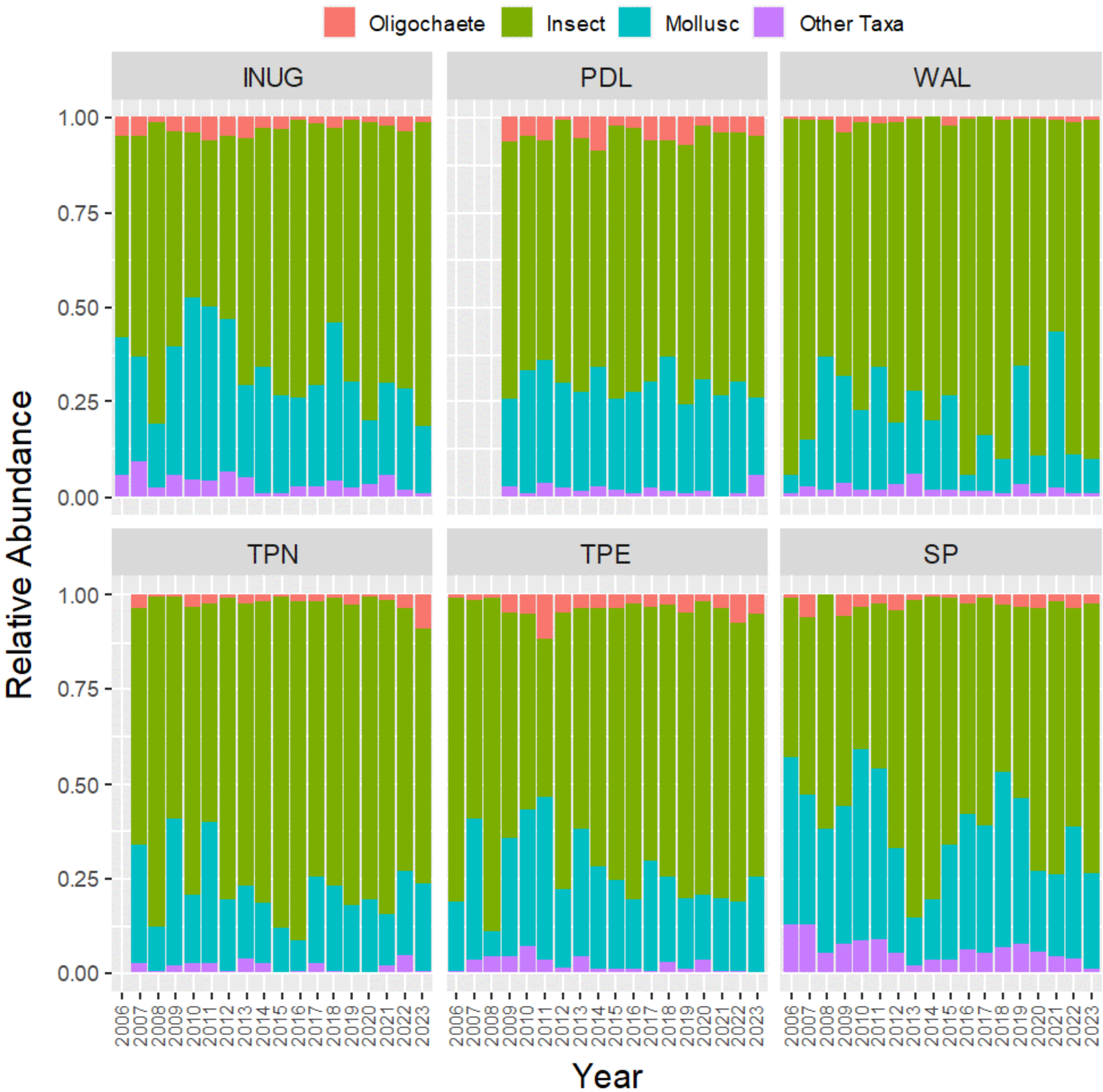


Figure 4-31. Benthic invertebrate total richness (# taxa) from Meadowbank study area lakes since 2006.

Notes: Meadowbank areas TPS, TE, and TEFF have not been sampled since 2015. For results from these areas from 2006 to 2015 see Azimuth 2021.

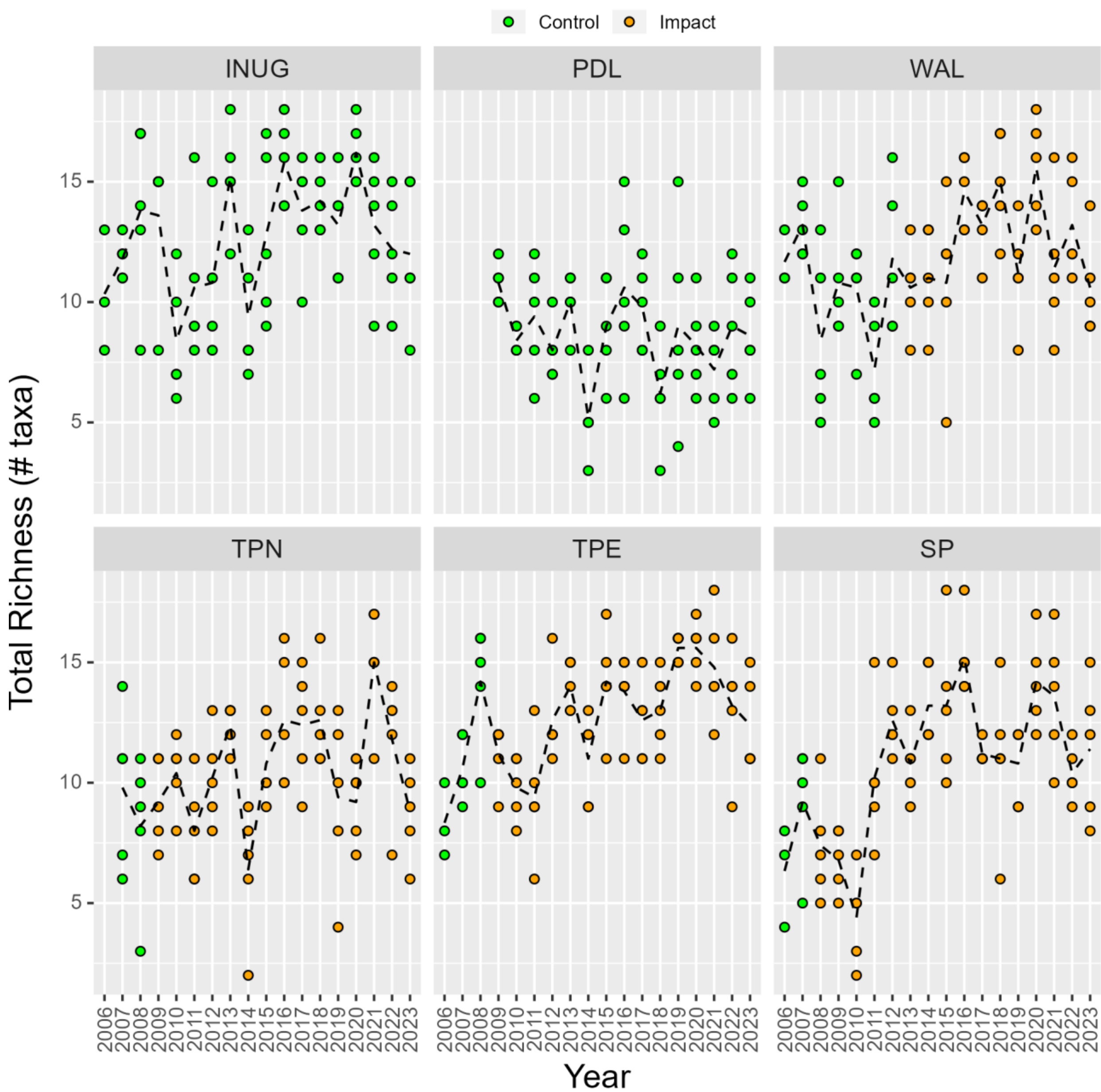


Figure 4-32. Benthic invertebrate richness (# taxa) by major taxa from Meadowbank study area lakes since 2006.

Notes: Meadowbank areas TPS, TE, and TEFF have not been sampled since 2015. For results from these areas from 2006 to 2015 see Azimuth 2021.

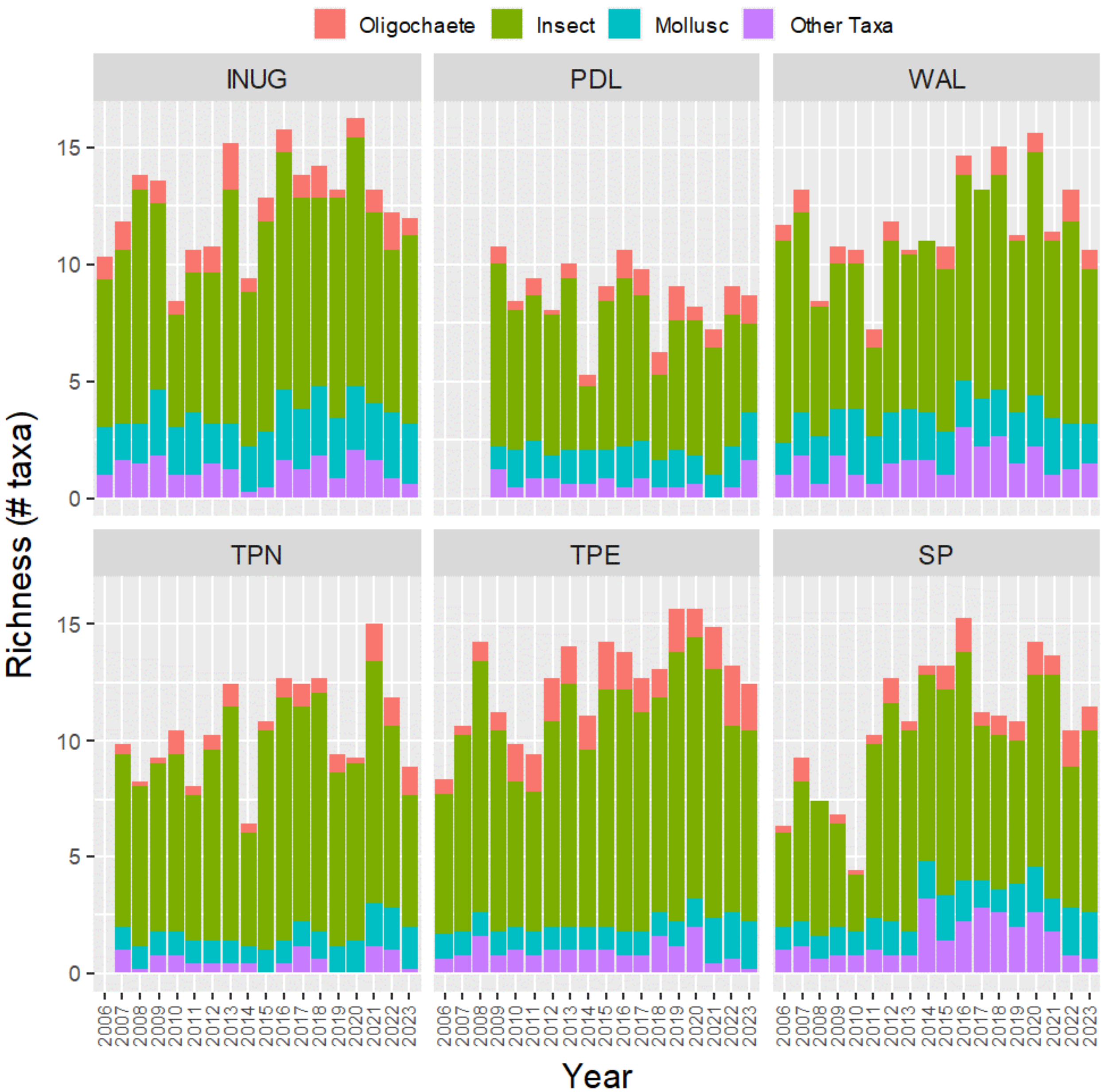
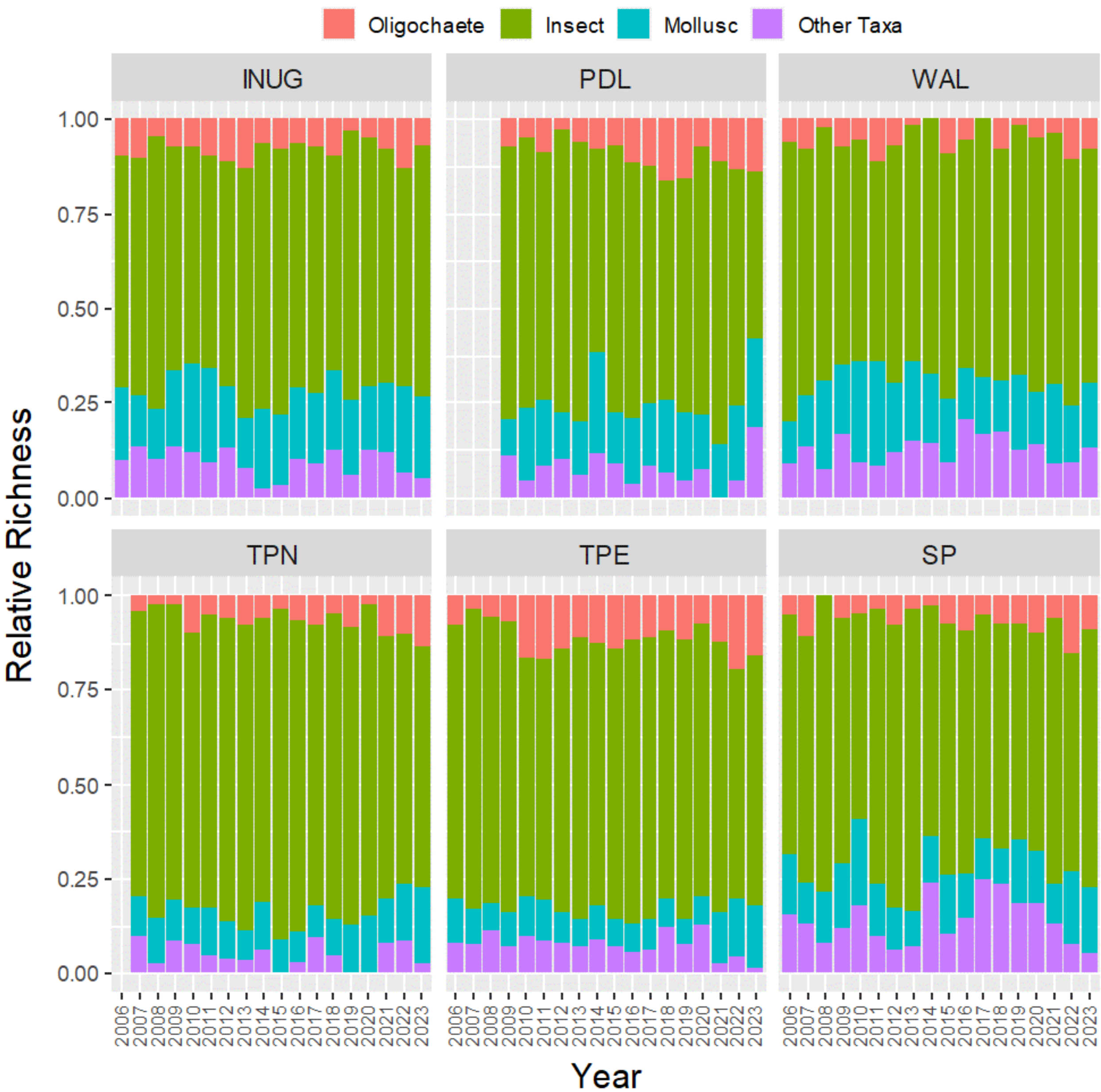


Figure 4-33. Benthic invertebrate relative richness by major taxa from Meadowbank study area lakes since 2006.

Notes: Meadowbank areas TPS, TE, and TEFF have not been sampled since 2015. For results from these areas from 2006 to 2015 see Azimuth 2021.



5 WHALE TAIL

5.1 Overview of the Whale Tail CREMP

This section presents findings from the 2023 CREMP for the Whale Tail study area lakes. The scope of the 2023 program included water quality, sediment chemistry, phytoplankton community, and benthic invertebrate community monitoring. Relevant figures and tables are organized at the end of the section, by study component.

Six lakes are currently included in the study design for monitoring mining-related changes downstream of the Whale Tail mine:

- **Near-field**: Whale Tail Lake – South Basin (WTS), Kangislulik Lake[30] (KAN/MAM), and Nemo Lake (NEM)
- **Mid-field**: Lake A20 and Lake A76
- **Far-field**: Lake DS1.

INUG and PDL are the primary reference areas for the Whale Tail CREMP. Locations where water sampling was done in 2023 are shown in **Figure 5-1**. Sediment and benthic invertebrate sampling areas are shown in **Figure 5-2**.

The landscape around the Whale Tail mine consists of rolling hills and relief with low-growing vegetative cover and poor soil development. Numerous lakes are interspersed among boulder fields, eskers and bedrock outcrops. Except for Nemo Lake, all Whale Tail study area lakes are part of the *A* Watershed that flows from SE to NW and drains into Amur Lake (aka DS1). Nemo Lake is located north of Whale Tail mine in Watershed *C*, separated from WTS and KAN/MAM by a drainage divide to the north of Whale Tail Lake.

Construction of the Whale Tail Dike in 2018 to develop the Whale Tail Pit deposit altered the flow path and hydrology in the area to the south of Whale Tail Lake. Prior to construction of the Whale Tail Dike, water flowed from Lake A20 through WTS, KAN/MAM, Lake A76, and into Lake DS1. Construction of the dike and ensuing changes in the local hydrology raised the level of the south basin of Whale Tail Lake. Higher water levels flooded tributary lakes A20, A65, and A63, among others, and created an impoundment. Lake A20 is no longer *upstream*, as the channel between WTS and A20 flooded; however, the connection between WTS and A20 is shallow, and hydrostatic pressure from input sources to Lake

[30] Kangislulik Lake (KAN) was previously referred to as Mammoth Lake (MAM). The acronym MAM will still be used in some tables and figures in the document for consistency with previous reports.

A20 likely limits water exchange. To regulate water level in the impoundment, a diversion channel was constructed in 2019/2020 for water to flow from the north end Lake A20 to the south end of KAN/MAM. The changes to Whale Tail Lake and Lake A20 are shown in **Figure 5-1**.

Area designations changed from *control* to *impact* for WTS and KAN/MAM in 2018 as a result of the onset of construction activities. The other four lakes were unaffected by construction activities in 2018 and remained in the baseline (*control*) designation. Lakes A20, A76, and DS1 changed from *control* to *impact* at the start of 2019 as mine construction and mine activities continued to expand. Nemo Lake switched to *impact* after the July 2019 sampling event when heavy precipitation necessitated dewatering AP5 (sump) onto the tundra within the Nemo Lake watershed.

A chronology of construction activities relevant for interpreting results from the Whale Tail CREMP are provided in **Table 1-1**. Construction activities and onsite water management in 2023 are summarized below:

- **Whale Tail Impoundment** – Currently, seepage water is directed to the Whale Tail Attenuation Pond and managed as part of this infrastructure. In 2023, construction of a thermal berm at the western abutment of Whale Tail Dike (Upstream) occurred in April.
- **Effluent Discharge to Kangislulik Lake** – Treated effluent meeting MDMER and Water License limits was discharged to Kangislulik Lake between June 4 and September 14.
- **Effluent Discharge to Whale Tail South Basin** – Treated water was discharged intermittently to WTS between January 8 and October 11. During this time, water met the MDMER and Water License limits.

5.2 Limnology

Limnology data provide an initial assessment of whether conditions are changing within a sampling area to a degree that may require additional investigation. The timing of the limnology and water sampling program for Whale Tail coincided with the Meadowbank CREMP sampling program. Limnology profiles were conducted at locations shown in **Figure 5-1**. Each point shown on the map is labelled with a number corresponding to the month the profiles were collected (e.g., 1 = January). Results for each lake focus on the deepest location sampled per event; matching water chemistry sample IDs (where available) for 2023 are listed in **Table 5-1** for cross-reference.

Table 5-1. Samples included in the limnology profiles for the Whale Tail study area lakes in 2023.

Area	Jan	Feb	Mar	Apr	May¹	Jun	Jul	Aug	Sep	Oct	Nov	Dec
WTS	☑	☑	WTS-78	☑	Ice not safe for travel	Ice not safe for travel	WTS-80	WTS-82	WTS-84	Ice not safe for travel	WTS-86	☑
MAM	☑	☑	MAM-78	☑			MAM-80	MAM-82	MAM-83		MAM-86	☑
NEM	☑	☑	NEM-77	☑			NEM-80	NEM-81	NEM-84		☑	☑
A20	☑	☑	A20-72	☑			A20-74	A20-75	A20-78		☑	☑
A76			A76-69				A76-72	A76-73	A76-75			
DS1			DS1-67				DS1-69	DS1-71	DS1-73			

Notes:
☑ = One profile is collected from the near-field areas (and occasionally one mid-field area) in months where water sampling is not completed.
The sample IDs shown represent the deeper of the two locations sampled each month.
[1] The May sampling event was cancelled due to unsafe ice conditions. An abbreviated sampling event took place in November at WTS and KAN/MAM.

5.2.1 General Observations

Except for Lake DS1, the lakes in the Whale Tail study area are shallow. DS1 is the deepest lake in the study area, with a maximum recorded depth of approximately 33 m. A20, A76, and NEM have areas of steep relief, but most of the surface area is less than 15 m deep.

Like the Meadowbank study area lakes, the ice-free season is short for lakes within the Whale Tail study area. Ice break-up usually occurs during mid to late June in the region and begins to form again in October. Sampling in June and October is avoided due to safety concerns surrounding ice conditions. Surface water temperatures measured at 3 m depth typically reach a yearly high between 10°C and 15°C sometime in August before cooling in the fall (**Figure 5-4**). As with Meadowbank, water temperatures in 2023 were higher than in previous years. The maximum surface water temperature measured across the Whale Tail study lakes was 17.3°C at A76 during the August 13 sampling event, about 2°C higher than temperatures measured in August 2022.

Temperature, dissolved oxygen, and specific conductivity profiles for each of the 2023 sample events are shown in **Figure 5-5** to **Figure 5-7**. Profiles for reference areas INUG and PDL are included where available.

5.2.2 Temporal and Spatial Trends

Temperature and Dissolved Oxygen

Lakes in the Whale Tail study area are typically unstratified for temperature and oxygen during the open-water season due to strong winds and shallow depths. Thermal stratification, if any, is brief and water temperatures typically only differ 4°C to 5°C between surface and bottom during these times. In

2023, the strongest evidence of thermal stratification occurred at NEM (August), DS1 (July), and A20 (June) where water temperatures differed by 5°C to 9°C between surface and bottom; this pattern was no longer evident by September (**Figure 5-5**). The maximum reported temperatures in 2023 were elevated at all of the study lakes, including reference. The shallower headwater lakes surrounding Whale Tail (e.g., WTS and KAN/MAM) generally demonstrated the highest increases compared to previous year, while the larger, deeper reference lakes showed muted increases (**Figure 5-4**).

The lakes are well oxygenated throughout the year, with DO generally above 10 mg/L (**Figure 5-6**). In 2023, the lakes were mostly unstratified, with slight stratification observed during the spring ice-covered months: March and April. Conditions were well mixed in the summer months (July, August, and September). DO concentrations in 2023 were consistent with previous years, and the seasonal patterns were typical of this Arctic area. Further, patterns were similar between the control lakes (INUG and PDL) and the NF and MF monitoring areas.

Conductivity

The conductivity results from the limnology profiles collected throughout the year at Whale Tail study area lakes are shown in **Figure 5-7** and discussed below by lake.

Whale Tail Lake – South Basin – In 2023, conductivity in WTS ranged from approximately 115 to 180 µS/cm with no evidence of vertical stratification across each month of sampling. The ice-covered months demonstrated the highest conductivities which increased from January to April. The ice-free months (July to September) showed very similar profiles and were characterized by the lowest conductivities. Overall conductivities were comparable to 2022 except that peak conductivities in April were somewhat higher in 2023 (180 µS/cm versus 150 µS/cm in May 2022). Higher conductivities corresponded to discharging periods at WTS (January to June).

Kangislulik Lake – Prior to November 2018, conductivity in KAN/MAM was characteristically unstratified, measuring below 60 µS/cm (Azimuth, 2019a). In November and December 2018, the conductivity in KAN/MAM increased to 150 µS/cm, following the discharge of treated contact water into KAN/MAM. Through 2021, there was an overall increase in conductivity with concentrations often exceeding 175 µS/cm and as high as 360 µS/cm.

Conductivities in 2023 generally ranged between 125 and 200 µS/cm. Since 2020, the highest conductivities have occurred during the winter months followed by declines during open-water periods (**Figure 5-7**). From July to December, monthly conductivity profiles were higher than in 2022 (125-210 versus 110-175 µS/cm), which roughly corresponded to discharging periods (June to end of August). The remainder of the year was comparable to 2022. In May 2023 (the month in which maximum conductivities typically occur), conductivity profiles were not collected due to unsafe ice conditions. A comparison of maximum conductivity readings from each sampling event in 2022 and 2023 is provided in **Table 5-2**.

Kangislulik Lake is fairly shallow and somewhat hourglass shaped, with distinct east and west basins. Water chemistry sampling and limnology profiling targets water depths of more than 5 m. To meet these requirements, samples are collected in the deeper east and west basins of the lake. This practice provides good spatial coverage while meeting minimum depth requirements. For paired water samples, the conductivity observed in the east basin was consistently higher than the conductivity in the west basin (**Table 5-2**). The narrow portion in the middle of the lake is relatively shallow and creates a natural sill that slows water exchange between the basins, particularly during winter when ice cover further limits water exchange between the basins. Thus, mine influences on water quality are temporarily concentrated in the east basin closest to the effluent discharge point, a pattern which has been confirmed by plume delineation surveys (Portt and Associates and Kilgour & Associates, 2021).

Conductivity readings in both the east and west basins of Kangislulik Lake increased in 2023 compared to 2022. During discharging periods (June to mid-September) in 2023, conductivities in the east basin increased by 14 to 37% compared to 2022 (**Table 5-2**). These findings are corroborated by the major ion water chemistry results (**Section 5.3.2**).

Table 5-2. Maximum conductivity readings from each sampling event in Kangislulik Lake and relative percent difference (RPD) between readings from 2022 and 2023.

Month	West Basin			East Basin		
	2022	2023	RPD	2022	2023	RPD
January	-	-	na	189	195	3%
February	-	200	na	187	-	na
March	198	196	1%	253	231	9%
April	-	206	na	220	-	na
May[1]	183	-	na	295	-	na
July	121	124	2%	113	155	31%
August	116	137	17%	135	167	21%
September	129	144	11%	170	194	13%
November	166	177	7%	-	193	na
December	-	-	na	181	207	14%
ANNUAL MEAN[2]	**146**	**156**	**6%**	**174**	**191**	**10%**

Notes:
[1] In May 2023 sampling was not conducted due to unsafe ice conditions.
[2] Mean calculated only where data was available for a given month across both years.
"-" no sample collected; na = RPD not calculated.

Nemo Lake, Lake A20, Lake A76, and Lake DS1 – In 2019, field conductivity measurements at NEM after August showed evidence of an upward trend in response to temporary discharge of contact water to

NEM. Since then, conductivities have demonstrated somewhat amplified seasonal fluctuations ranging from 100 µS/cm up to 140 µS/cm near the end of the ice-covered period (April/May). More pronounced seasonal fluctuations in conductivities appear to be a characteristic of the mine-affected lakes and can be seen to the greatest extent at WTS and KAN/MAM (**Figure 5-7**).

Lakes A20, A76, and DS1 demonstrated a much smaller seasonal range in conductivities compared to WTS and KAN/MAM. Conductivities at Lake A20, A76, and DS1 ranged close to 60, 100, and <50 µS/cm, respectively.

5.3 Water Chemistry

This was the fifth year of formal BACI analyses to assess spatial and temporal changes in water quality at the Whale Tail study area lakes. Water chemistry results for the study area lakes were also compared to predictions in the FEIS for the Approved Expansion Project (Golder, 2019) and triggers for arsenic and phosphorus in the *Adaptive Management Plan* (Agnico Eagle, 2021).

5.3.1 Key Findings from the 2023 Water Chemistry Monitoring Program

- There were no trigger exceedances for parameters with effect-based thresholds (e.g., aquatic life guidelines).
- In 2023, there were a number of parameters for which concentrations at NF and MF Whale Tail area lakes increased relative to baseline/reference conditions: major ions (TDS, Ca, Mg, K, Na, HCO_3 [alkalinity]), hardness, conductivity, nutrients (TKN, total phosphorus, TOC, and DOC), and lithium (only at WTS and KAN/MAM).
- Some parameters have increased in WTS, A20, KAN/MAM, and A76 coinciding with construction of the impoundment and discharge of treated contact water.
- Total phosphorus and arsenic concentrations at WTS and KAN/MAM were within the normal operating ranges in 2023 and Level 0 water management strategy is in effect in 2024 as per the *Adaptive Management Plan* (Agnico Eagle, 2021).

5.3.2 Temporal and Spatial Trends

Parameters included in the temporal and spatial trends assessment are listed in **Table 5-6**. A total of 56 parameters out of 79 (approximately 71%) were retained for further examination in 2023. Of these, 55 were retained because the frequency of detected concentrations exceeded 10%. Dissolved selenium detection frequencies were less than 10%, but were retained for discussion because they were detected more frequently at impact areas compared to control (reference) areas.

Parameters retained in the analysis are plotted in **Figure 5-9** through **Figure 5-13**. Trigger values[31] are shown on the time series plots as a red dashed line. Water quality predictions were developed as part of the FEIS process for some parameters in Kangislulik Lake and Whale Tail Lake – South Basin (see **Section 2.3.1** and Golder, 2019); these are depicted as a blue dashed line in the plots. Water chemistry figures and raw data for all parameters, including those that were not retained for discussion based on the trend assessment are presented in **Appendix B2**.

BACI analyses were conducted for parameter/area combinations if the mean concentration in 2023 exceeded the trigger value. The BACI model tests for statistically significant increases (i.e., one-tailed test looking for uni-directional changes [i.e., increases]). In this analysis, the model interaction term (or BACI effect term) represents the change at the test area in 2023 (*after* period) relative to baseline (*before* period) after accounting for natural temporal changes (i.e., temporal changes at the reference area). For simplicity, changes are noted *relative to baseline/reference* conditions.

Parameter/area combinations for which the yearly mean exceeded the trigger are listed in **Table 5-7** and were carried forward for BACI analysis (**Table 5-8**). The results are discussed in terms of ecological significance and spatial context below, by parameter type.

Major Ions and Conventional Parameters

Major ions (dissolved salts) are the seven ionic compounds found in greatest abundance in freshwater systems. They include the cations: calcium, magnesium, potassium, and sodium; as well as the anions: chloride, bicarbonate, and sulphate. These seven ions are measured directly or are important in a number of composite conventional measures (e.g., total alkalinity, conductivity, TDS, and hardness) **Figure 5-9**. Collectively, these parameters have shown the greatest proportional changes in water chemistry since mining operations began (**Table 5-8**). However, it is worth noting that while major ion concentrations (along with associated parameters) increased at the NF lakes (WTS and KAN/MAM) between 2022 to 2023, year-over-year changes were marginal or absent at the MF lakes (A20 and A76).

Most of the parameters in this group do not have effects-based thresholds (e.g., CCME water quality guidelines). As discussed in detail in **Section 4.3.2**, major ions are essential elements, and all species of aquatic life, from algae to fish, have evolved to actively regulate their osmotic, ionic, and acid-base balance by uptake of ions from their environment (Martemyanov and Mavrin, 2012). Furthermore, in oligotrophic freshwater lake environments adverse effects on primary producers and secondary consumers (e.g., zooplankton) are more commonly associated with major cation deficiency than enrichment (Alstad et al., 1999; Arnott et al., 2017).

[31] Refer to Appendix I in the 2019 CREMP report (Azimuth, 2020a) for a description of the methods used to establish triggers for each parameter.

The only parameters in this group to have an effects-based threshold are chloride, fluoride, and sulphate. While these parameters have shown increased concentrations since mining activities started, none have had mean annual concentrations exceeding their respective triggers at any sampling area.

These results indicate that mine-related changes have occurred, but that these changes would not be expected to result in adverse effects to aquatic life (see similar discussion in **Section 4.3.2**).

Nutrients

Four nutrient-related parameters had mean annual concentrations exceeding their respective triggers (**Table 5-7**): Total Kjeldahl Nitrogen (TKN), total phosphorus, and total and dissolved carbon (TOC and DOC). All of these parameters were significantly ($p < 0.05$) higher at WTS and A20 in 2023 compared to baseline/reference conditions. At KAN/MAM, only TKN and TOC were found at concentrations significantly higher than baseline/reference conditions (**Table 5-8**).

Nitrogen-containing compounds – TKN is one of four nitrogen-containing compounds in the CREMP. It is a composite parameter that includes both organic and inorganic forms including ammonia, nitrate, nitrite, and organic nitrogen compounds. While TKN does not have an effects-based threshold, all three of the other nitrogen-containing compounds in the CREMP do. Although each of these compounds have increased due to mining activity, they are generally stable with all annual mean concentrations below their respective triggers. March samples from WTS and a few samples from KAN/MAM exceeded ammonia (NH_3) triggers in 2023, however these did not represent an increasing trend (**Figure 5-11**). Nitrogen-containing compounds are not a concern at the Whale Tail study lakes.

Total phosphorus – Total phosphorus is one of the main constituents of concern for the Whale Tail mine. It is important as a key macronutrient for plants and is often limiting in freshwater ecosystems, making it one of the most important nutrients for primary productivity. The CCME provides guidance for site-specific application rather than a particular effects-based guideline for total phosphorus. While the CCME framework specifies <0.004 mg/L of total phosphorus for ultra-oligotrophic lakes, up to a 50% increase in concentrations over baseline is considered acceptable (Azimuth, 2020; see Appendix I). Since the 95th percentile baseline concentrations of total phosphorus for Meadowbank, Wally, Baker, and Whale Tail exceeded 0.004 mg/L, the lake-specific triggers were set to those 95th percentile concentrations and the 0.01 mg/L threshold was used (higher end of the range for oligotrophic lakes; CCME 2004).

The trigger was exceeded in all *impact* Whale Tail study area lakes at least once in 2023, except for A76 and NEM (**Figure 5-11**). The annual mean total phosphorus concentrations at WTS and A20 exceeded the trigger (**Table 5-7**) and the BACI analysis indicated that observed changes were statistically significant at these lakes (**Table 5-8**). Since 2021, total phosphorus concentrations have been stable at WTS and A20. At KAN/MAM in 2023, total phosphorus concentrations were below the trigger.

The increase in nutrients at WTS, KAN/MAM, and A20 since 2019/2020 combined with occasional exceedances in other lakes downstream is likely contributing towards an increase in primary productivity, as predicted in the FEIS (**Table 5-3**; Golder, 2018). Phosphorus is discussed further as it relates to the Adaptive Management Plan (AMP) in **Section 5.3.4**.

Table 5-3. FEIS predictions and trigger values compared to mean concentrations of total phosphorus in Kangislulik Lake and Whale Tail Lake (South Basin), 2023.

Area	2023 FEIS predictions		Trigger	2023 Mean [1]
	Minimum	Maximum		
KAN/MAM	0.0074	0.0077	0.0045	0.004
WTS	0.008	0.01	0.0045	0.0067

Notes:

Reported values are all in units of mg/L.
[1] WTS and KAN/MAM 2023 means include data from Mar, Jul, Aug, Sep sampling events for trigger comparisons. Results from abbreviated sampling in Nov are included in plots and compared to FEIS predictions.

TOC and DOC – In 2023, TOC and DOC concentrations exceeded the triggers for all samples collected in WTS, KAN/MAM, and A20. Triggers were also exceeded at least once in all of the other *impact* lakes (**Figure 5-9**). Mean annual concentrations exceeded the triggers (TOC trigger = 2.42 mg/L; DOC trigger = 2.43 mg/L) in WTS, KAN/MAM, A20, and DS1 (**Table 5-7**). The increases in mean TOC and DOC were statistically significant for WTS, KAN/MAM, and A20, but not significant for DS1.

Increasing TOC and DOC in WTS at the end of 2019 was likely related to the flooding of terrestrial habitat with the impoundment of the south basin and dewatering inputs from WTN; this also explains the increases in Lake A20, which experienced flooding and has been joined to WTS since 2019. KAN/MAM and A76 occur downstream of WTS and increases in TOC/DOC at these locations may be the results of inputs from WTS.

Since 2018, a muted increase in TOC and DOC also appears to be occurring in reference lake INUG. This pattern suggests organic carbon inputs to lakes in the region may be increasing which would also contribute to the changes observed at the mine influenced lakes. In a pan-Arctic assessment of lake DOC, Stolpmann and colleagues (2021) linked higher DOC levels to rates of evaporation, lake connectivity, and permafrost extent. It is possible that regional multi-year climactic changes or global climate change could contribute to broad changes in organic carbon across the study lakes over time. Parallel increases in TOC/DOC in the Meadowbank lakes may also be occurring, with increasing patterns at WAL and SP most evident (**Figure 4-9**). Regional changes in organic carbon are further discussed for Baker Lake in **Section 6.3.3**.

There are no effects-based thresholds for TOC or DOC, but increases in these parameters can be related to increased productivity or allochthonous carbon inputs. While changes in TOC and DOC at WTS were likely due to inputs from flooded terrestrial areas, changes observed at far-field Lake DS1 were likely due to natural inputs (e.g., terrestrial organic matter; BC MOE, 1998).

Metals

A number of metals show trends of increasing concentrations associated with mining activities. These include: antimony (Sb), arsenic (As), barium (Ba), copper (Cu), iron (Fe), lithium (Li), manganese (Mn), molybdenum (Mo), nickel (Ni), selenium (Se), silicon (Si), strontium (Sr), titanium (Ti), and uranium (U) (**Figure 5-12** and **Figure 5-13**). Of these, lithium, silicon, titanium, and uranium exceeded triggers at least once in 2023. Only lithium and silicon, which do not have effects-based thresholds, had annual mean concentration exceeding triggers (**Table 5-7**).

Lithium – Total and dissolved lithium, were the only metal parameters where annual mean concentrations exceeded trigger values at WTS and KAN/MAM in 2023 (total and dissolved lithium trigger = 0.0020 mg/L). Peak concentrations occurred in 2019 and since 2022 concentrations appear to have stabilized at both lakes. The BACI analysis indicated that the change in total and dissolved lithium relative to INUG was statistically significant at both WTS and KAN/MAM (p-value < 0.05).

Note that lithium does not have an effects-based threshold. The US EPA does have a factsheet on lithium toxicity in freshwater (MDEQ, 2008), but does not have a formal water quality guideline. The factsheet includes chronic toxicity results for zooplankton (water flea *Ceriodaphnia dubia*) and fish (fathead minnow *Pimephales promelas*). The no observable effect concentration (NOEC) for a 6-day test targeting *C. dubia* reproduction was 1.97 mg/L, while 3.6 mg/L was the lowest observable effect concentration (LOEC). The NOEC for the 7-day *P. promelas* test targeting growth was 3.6 mg/L, while the LOEC was 6.9 mg/L. These toxicity test results are two to three orders of magnitude higher than the lithium concentrations observed in the Whale Tail study lakes.

Silicon – Silicon concentrations have historically been close to the trigger value for most Whale Tail study area lakes, even prior to the start of mining development (**Figure 5-12**). Dissolved silicon concentrations exceeded the trigger (0.57 mg/L) at WTS, KAN/MAM, and DS1. Concentrations in all impact lakes were higher during the first half of the year, however, the yearly mean concentrations exceeded the trigger solely at DS1 (0.59 mg/L; **Table 5-7**) but the change was not statistically significant (**Table 5-8**). However, while there is evidence of a mining-related trend at WTS and KAN/MAM (an increase coinciding with mine development followed by a downward trend since 2020), that is not the case at DS1, where results have been fairly consistent since the baseline period.

5.3.3 Comparison to FEIS Model Predictions

A number of water quality changes have been identified in the Whale Tail mine area as a result of development-related activities and/or effluent discharge to the downstream environment. The FEIS water quality predictions are estimates of water quality changes in Kangislulik Lake and Whale Tail Lake (South Basin). The monthly mean results for water quality parameters were screened against the FEIS monthly predictions for KAN/MAM and WTS and a summary of exceedances is provided in **Table 5-10**. Water quality data for 2023 were screened against the FEIS predictions and are tabulated in **Appendix B2**.

Often, parameters that exceed their trigger also exceed the FEIS predictions in one or more sampling events. In 2023, the yearly mean concentrations for total phosphorus, total alkalinity, TDS, lithium, and the ionic compounds calcium, magnesium, potassium, and sodium exceeded both their respective triggers and the monthly FEIS predictions in WTS. At KAN/MAM, the same parameters, except for total phosphorus, exceeded both the triggers and FEIS predictions. Of the parameters that exceeded their respective trigger values and FEIS model predictions in 2023, the absolute concentrations of these parameters remain *low*. Phosphorus, along with several other COPCs (e.g., nitrate, arsenic) were predicted by the FEIS to exceed baseline conditions following the discharge of treated effluent into WTS and KAN/MAM. Phosphorus was the only COPC that was also predicted to exceed water quality guidelines (Golder, 2018).

The FEIS predicted the magnitude of potential effects on water quality in each of the lakes as *low* (i.e., <1x CCME WQG) for all parameters; see **Section 2.3.1** for more details on the decision criteria for effects magnitude). Thus, the Whale Tail study area water quality results are generally consistent with FEIS predictions.

5.3.4 Comparison to Adaptive Management Thresholds

For parameters identified as the main COPCs for the Whale Tail mine (i.e., total phosphorus and arsenic), there are associated AMP water quality thresholds that correspond to adaptive management 'Levels' as described in **Section 2.3.1**. The adaptive management thresholds and corresponding adaptive management levels and strategies that are applied at mine discharge areas WTS and KAN/MAM are summarized in **Table 2-4**. The water quality data collected as part of the annual CREMP were used to assess adaptive management levels going into 2024. The mean concentrations of paired monthly sampling results were compared to AMP thresholds. Findings are summarized in **Table 5-4** and described below.

Whale Tail South

- Mean total phosphorus concentrations remained at Level 0 for each month of sampling at WTS in 2023.

- Mean total arsenic concentrations remained at Level 0 for each sampling event at WTS in 2023.
- Conclusion – Level 0 is in effect for both total phosphorus and total arsenic based on the results of the November 2023 sampling event.

Kangislulik Lake

- Mean total phosphorus concentrations remained at Level 0 for each month of sampling at KAN/MAM in 2023.
- Mean total arsenic remained at Level 0 for each sampling event at KAN/MAM in 2023.
- Conclusion – Kangislulik Lake is within the normal operating range and Level 0 water management strategy is in effect based on the results of the November 2023 sampling event.

Table 5-4. Water chemistry data compared to AMP thresholds for total phosphorus and arsenic for Whale Tail Lake (South Basin) and Kangislulik Lake, 2022 and 2023.

Lake & Area	AMP Benchmark[1]	WTS FEIS Predictions											Whale Tail Lake South Basin (Impoundment) – Mean Monthly Concentrations (mg/L)											Current Mgmt Level
Year		2022					2023						2022					2023						
Month		Mar	May	Jul	Aug	Sep	Mar	May	Jul	Aug	Sep	Nov	Mar	May	Jul	Aug	Sep	Mar	May[2]	Jul	Aug	Sep	Nov	
Phosphorus (mg/L)	0.01	0.0065	0.0067	0.0070	0.0074	0.0079	0.0081	0.0081	0.0096	0.010	0.010	0.010	0.0076	0.0051	0.0053	0.0063	0.0054	0.0067	-	0.0085	0.0057	0.0058	0.0034	Level 0
Arsenic (mg/L)	0.025	0.0047	0.0047	0.0067	0.0076	0.0087	0.0094	0.0093	0.011	0.012	0.013	0.013	0.00087	0.0022	0.0016	0.0011	0.00087	0.00089	-	0.00096	0.00094	0.00079	0.00092	Level 0

Lake & Area	AMP Benchmark[1]	MAM FEIS Predictions											Kangislulik Lake – Mean Monthly Concentrations (mg/L)											Current Mgmt Level
Month		2022					2023						2022					2023						
Area-Replicate ID		Mar	May	Jul	Aug	Sep	Mar	May	Jul	Aug	Sep	Nov	Mar	May	Jul	Aug	Sep	Mar	May[2]	Jul	Aug	Sep	Nov	
Phosphorus (mg/L)	0.01	0.0090	0.0090	0.0077	0.0077	0.0076	0.0075	0.0075	0.0075	0.0076	0.0076	0.0077	0.0083	0.0051	0.0037	0.0037	0.0029	0.0048	-	0.0044	0.0026	0.0041	0.0053	Level 0
Arsenic (mg/L)	0.025	0.0077	0.0077	0.0063	0.0063	0.0063	0.0063	0.0063	0.0069	0.0069	0.0071	0.0074	0.0013	0.0013	0.0011	0.0014	0.0013	0.0011	-	0.0011	0.0015	0.0014	0.00058	Level 0

Notes:

[1] The AMP Benchmark for phosphorus guideline is the upper limit of oligotrophic status from CCME (2004); The AMP Benchmark for arsenic is the site-specific water quality objective (Golder, 2019).

[2] Samples were not collected in May 2023 due to unsafe ice conditions.

Formatting aligns with the AMP thresholds in the *Whale Tail Expansion Project – Adaptive Management Plan* (Agnico Eagle, 2021):

Level 0	Normal conditions	<= 20% FEIS predictions.
Level 1	Area of concern	>= 20% FEIS predictions AND < 80% water quality guideline.
Level 2	Area of concern	>= 20% FEIS predictions AND between 80% and 100% water quality guideline.
Level 3	High risk	>= 20% FEIS predictions AND between 100% and 120% water quality guideline.
Level 4	Emergency situation	>= 20% FEIS predictions AND > 120% water quality guideline.

5.3.5 Summary and Recommendations

Following the assessment strategy for MF and FF areas outlined in the *CREMP Plan Update* (Azimuth, 2022b), the 2023 trigger exceedances were evaluated and applied to the decision criteria outlined in **Section 2.2.3** to determine the effort level and sampling frequency required at the MF and FF areas in 2024. The assessment strategy interprets the water quality assessment results from the NF areas in the current year (in this case 2023) to inform sampling at MF and FF areas the following year (i.e., 2024) (**Figure 5-8**).

A summary of the trigger screening results for the Whale Tail study areas are presented in **Table 5-9** according to their corresponding degree of change based on mean annual concentrations:

- no trigger exceedance,
- minor changes = trigger exceeded for parameters without effects-based thresholds,
- moderate changes = trigger exceeded for parameters with effects-based thresholds, or
- major changes = exceedance of the effects-based threshold.

In 2023, observed water quality differences and trigger exceedances classified as *minor changes* (**Table 5-9**). The 2023 water quality results from Whale Tail area lakes do not require additional management actions as per the *CREMP Plan Update* and *Adaptive Management Plan* (Azimuth, 2022b, Agnico Eagle, 2021). **Routine water quality monitoring will continue in 2024 to track emerging spatial and temporal trends.**

5.4 Phytoplankton Community

2023 was the fourth full year in which all Whale Tail study area lakes were designated as *impact*. Areas WTS and KAN/MAM have been classified as *impact* areas since mid-2018. Areas A20, A76, and DS1 were classified as *impact* areas from the beginning of 2019, and NEM switched to *impact* in August 2019[32]. In 2023, winter phytoplankton samples collected in March were archived as per the *CREMP Plan Update* (Azimuth, 2022b). Phytoplankton collected at the reference and NF areas during open-water sampling in July, August, and September were analyzed.

5.4.1 Key Findings from the 2023 Phytoplankton Monitoring Program

- Mean annual Chlorophyll-a concentrations at the NF and MF lakes were higher relative to reference. Concentrations appear to have increased at WTS and A20, but were variable at KAN/MAM and A76. These observations are based on time series plots since no statistical

[32] Baseline phytoplankton taxonomy data for the Whale Tail study area lakes was summarized in (Azimuth, 2018b). The baseline report focused on describing the dominant species and seasonal variability in taxonomy metrics (e.g., biomass and richness) within and between areas.

analysis is completed for chlorophyll-a. It is important to note that chlorophyll-a is only an indicator of phytoplankton productivity; phytoplankton biomass (see next bullet) is a more direct measure of primary productivity.

- WTS, KAN/MAM, A20, and NEM results showed an increase in biomass compared to baseline conditions. The BACI analysis showed significant increases at WTS and A20 with effect sizes of 102% to 243% respectively. Phytoplankton biomass appears to be trending upwards at WTS and A20 since 2021. The increases in phytoplankton biomass identified at NF areas since the onset of mining activities are consistent with predictions made in the FEIS regarding increasing nutrient concentrations in these lakes (Golder, 2018).
- Slight decreases in taxa richness were observed at the study lakes, though the changes were not statistically significant.
- There is correspondence between increases in phytoplankton parameters and nutrient increases demonstrated in the water chemistry data. Nutrient increases and phytoplankton responses appear to roughly align over both temporal and spatial scales. However, phytoplankton communities respond to a host of seasonal factors such as sunlight and water temperature and therefore it is difficult to distinguish between seasonal fluctuations and influence of nutrients from to mining activities.

5.4.2 General Observations

The general description of phytoplankton taxa in Meadowbank project lakes (**Section 4.3.3**) applies equally to the lakes within the Whale Tail study area. Six major taxonomic groups of phytoplankton are present in the Whale Tail study lakes. These are blue-green algae (Cyanophyta), green algae (Chlorophyta), golden-brown algae (Chrysophyta), diatoms (Bacillariophyta), cryptophytes (Cryptophyta), and dinoflagellates (Dinoflagellata). Species composition varies throughout the year depending on water temperature, nutrient concentration, time of year, water clarity and amount of sunlight, and predation by zooplankton. In general, the biomass of the phytoplankton community during the baseline period or at the reference areas was comprised predominately of chrysophytes (golden-brown algae; **Figure 5-16**).

5.4.3 Temporal and Spatial Trends

The approach for identifying potential mine-related impacts involved visually searching for temporal-spatial patterns that might be associated with mine-related activities (outlined in **Section 5.1** and summarized in **Table 1-1**), augmented by statistical analyses of the 2023 data to test for changes relative to baseline/reference conditions using the BACI model (see **Section 2.3.3** for details). Both methods look for evidence of temporal-spatial patterns that might be associated with the mine-related activities.

Tabulated phytoplankton community data from the 2023 CREMP are presented in **Appendix D2**. The metrics used to assess changes in the community were chlorophyll-a (**Figure 5-14**), total phytoplankton biomass (**Figure 5-15** to **Figure 5-17**), and species richness (**Figure 5-18**). Supplemental plots showing major taxa biomass (mg/m^3) and density (mg/L) are included in **Appendix D2**. The BACI statistical test results of changes in the phytoplankton community (total biomass and total species richness) in 2023 relative to baseline/reference conditions are provided in **Table 5-11**; key results are discussed below.

Chlorophyll-a

Chlorophyll-a is an indicator of primary productivity and is often used as a surrogate for phytoplankton biomass. Given the direct measure of total phytoplankton biomass (see below), statistical analysis is not completed for chlorophyll-a. However, the time series plots provided in **Figure 5-14** show that chlorophyll-a concentrations in the latter half of 2023 were generally higher at WTS and A20 than in baseline samples. The 2023 mean annual concentration of chlorophyll-a at WTS and A20 exceeded 1 µg/L which is considered characteristic of oligotrophic systems (Kasprzak et al., 2008). At A76 and NEM chlorophyll-a concentrations were less than 1 µg/L throughout the year. At KAN/MAM and FF area DS1, chlorophyll-a concentrations fluctuated around 1 µg/L. Except for WTS and A20, chlorophyll-a concentrations in the Whale Tail area lakes were generally representative of baseline trophic status in the lakes. Possible factors influencing the patterns of chlorophyll-a and phytoplankton biomass are discussed in more detail below.

Total Biomass

Time series plots for total phytoplankton biomass (mg/m^3) are provided in **Figure 5-15**[33]. Overall, seasonal patterns are evident, with peak biomass occurring during the open water period. Total biomass remained comparable to 2022 findings, except for higher concentrations at A20 and lower concentrations at A76. The largest contributor to community biomass at each of the study lakes were chrysophytes, except at KAN/MAM where diatoms dominated in 2023 (**Figure 5-16** and **Figure 5-17**).

In the BACI analysis, the model interaction term (or BACI effect term) represents the change at the test area in 2023 (*after* period) relative to baseline (*before* period) after accounting for natural regional temporal changes observed at reference area INUG. For simplicity, changes are noted *relative to baseline/reference* conditions. Relative to baseline/reference conditions (**Table 5-11**), 2023 total phytoplankton biomass was higher in WTS (102%), KAN/MAM (17%), A20 (243%), and NEM (19%), but lower in A76 (-13%) and DS1 (-29%). None of these changes were statistically significant ($p > 0.1$), except

[33] The time series plot uses a log-scale for total biomass as mg/m^3. This is a common approach for data that ranges broadly within or across years. While the approach reduces emphasis on extreme values, it could also lessen the appearance of certain mine-related trends.

at WTS and A20. These results are discussed further in the summary at the end of the phytoplankton section.

The increases in phytoplankton biomass identified at NF and MF areas since the onset of mining activities are consistent with predictions made in the FEIS regarding increasing nutrient concentrations in these lakes (Golder, 2018).

Major Taxa Composition

The number of taxa varies by season, with a more diverse community typically present during the open-water season than when ice covers the lakes (**Figure 5-16**). Typically, more than 30 different species of phytoplankton are present during the open-water season. Chrysophytes dominated the community at most lakes with the exception of NEM (July), WTS (September), and KAN/MAM (July, August) when diatoms were the dominant taxa (**Figure 5-17**). During the baseline period, diatoms made up a small proportion of the community at KAN/MAM and WTS. The greater contributions to community biomass in 2023 could indicate mining influence, though a clear increasing trend is not evident. Furthermore, chlorophytes, which typically respond first to nutrient enrichment (Holmgren, 1984) have not demonstrated a clear response since the NF lakes transitioned to *impact*.

Taxa Richness

Taxa richness was similar to previous years with the exception of A20 in September which had the highest richness observed since monitoring began. The BACI results for 2023 showed that effect size estimates for taxa richness were below the trigger (20%) at all areas except A76 (-25%), although none of the changes were statistically significant (**Table 5-11**). Similarly, low September richness was documented during the baseline period at A76 (**Figure 5-18**). Further discussion related to the ecological significance of these results is presented in the summary below.

5.4.4 Summary and Recommendations

Statistically-significant changes in phytoplankton biomass in 2023 exceeding the 20% effect size trigger occurred only at A20 and WTS. For phytoplankton taxa richness, Lake A76 was 25% lower than baseline/reference conditions, but the result was not statistically significant.

The response patterns observed in phytoplankton biomass suggest a combination of mining influence and natural variability. As described in **Section 5.3**, mining-related changes in water quality have been identified at Whale Tail at all NF and MF areas. Nutrients are generally a limiting factor for phytoplankton growth in oligotrophic systems and any inputs can lead to changes in productivity. Since mining activity began, there has been a general correspondence between increases in nutrient levels at WTS, KAN/MAM, and A20 and increased phytoplankton biomass. According to the FEIS, phosphorus and nitrate levels are predicted to increase at both WTS and KAN/MAM until 2026, after which concentrations are predicted to decline. With these predicted increases in nutrients, phytoplankton biomass is expected to increase over the next three years of CREMP sampling. Although FEIS predictions are limited to WTS and KAN/MAM, it is expected that effects will extend into the MF lakes. Despite these predictions, phytoplankton communities respond to a host of environmental seasonal factors such as sunlight and water temperature. The influence of nutrient inputs on the phytoplankton community is challenging to interpret given these natural seasonal fluctuations which contributes to lower statistical power (BACI results were not significant). Phytoplankton productivity, biomass, and richness, as well as associated patterns in key nutrients, will continue to be tracked in 2024.

The Whale Tail phytoplankton program will follow the same schedule as the routine water quality monitoring component of the program in 2024.

5.5 Sediment Chemistry

Sediment core and grab samples were collected from all of the study area lakes in August 2023. Grab samples were analyzed for moisture content, particle size, TOC, and select organic compounds. Core samples were analyzed for metals. Changes in sediment chemistry were formally tested using the statistical before-after (BA) analysis for metals that exceeded their respective trigger values. In addition, visual assessment of temporal-spatial patterns that might be associated with mine-related activities was conducted.

Tabulated sediment quality data for 2023 data are provided in **Appendix C**.

5.5.1 Key Findings from the 2023 Sediment Chemistry Monitoring Program

- The following parameters exceeded the trigger in 2023; arsenic (WTS, KAN/MAM, and A20), chromium (WTS, KAN/MAM and A20), and copper (A20). Except for chromium, the changes over time are most likely due to the variable metals concentrations in sediment that exist without the influence of mining.
- Chromium may be increasing at WTS. A similar change was observed at TPE after construction of Bay-Goose Dike. Similar increases were observed at Meadowbank's TPE related to dike construction, but it was concluded that the changes did not pose unacceptable risks to benthic invertebrates.
- TOC concentrations show variations across Lakes related to productivity levels, but within lakes concentrations have remained stable since monitoring began. The stability of TOC at the NF lakes shows that TOC is not being enriched by mining activity.

5.5.2 Temporal and Spatial Trends

For the purpose of interpreting the 2023 sediment data, Whale Tail study area lakes (KAN/MAM, NEM, A20, A76, DS1) were considered *impact* starting in 2019 except for WTS, which was designated as *impact* in 2018. Note that there are missing results for 2021 (INUG, PDL, KAN/MAM, A20, and DS1) across figures; these samples were inadvertently discarded prior to analysis due to a laboratory error (See Azimuth, 2022a for details).

Metals

Lakes within the Project area are naturally enriched in some metals compared to CCME sediment quality guidelines (SQGs). Arsenic, cadmium, chromium, copper, mercury, and zinc exceeded the interim sediment quality guideline (ISQG) in at least one sample collected during the baseline period. Lake-specific triggers were developed (due to strong natural spatial trends among the lakes) in 2019 based on the 2017 sediment core results.

Metals concentrations are shown by area/basin for the different sampling methods (grab [data points] vs core samples [box and whisker plots]) since 2015; **Figure 5-21** to **Figure 5-28**). The red dashed line represents the lake-specific trigger value, where available. The box and whisker plots illustrate the statistical distribution of core samples within each area.

While there were a number of trigger exceedances across the study lakes in 2023, the results are often driven by unrepresentative trigger values rather than by actual changes in sediment chemistry. Trigger values may be unrepresentative if the 2017 sediment coring data do not fully represent the prevailing conditions in a particular lake.

Arsenic, chromium, and copper were the only metals where the annual mean concentrations in sediment cores exceeded their respective trigger values in at least one study area (**Table 5-12**). Results of the statistical before-after (BA) analysis indicated that the majority of these exceedances were statistically significant (**Table 5-13**). The statistically significant sediment quality exceedances for arsenic, chromium, and copper are discussed below.

Arsenic

- Arsenic concentrations in sediment core samples exceeded lake-specific trigger values in 2023 at WTS and A20 (**Figure 5-22**).
- The apparent increase at WTS in 2023 (mean = 211 mg/kg dw) relative to baseline conditions (trigger value = 83.1 mg/kg dw), while statistically significant (**Table 5-13**), is most likely due to the variable arsenic concentrations in sediment that exist without the influence of mining. The majority of core sample results remain roughly within the grab sample ranges observed in 2017 baseline sampling. It should also be noted that baseline arsenic concentrations in the northern

part of Whale Tail Lake (WTN) ranged from about 500 to 1,800 mg/kg dw, indicating the presence of mineralization in the area (Azimuth, 2018a). Further, similar results were seen in reference lake PDL, where 2023 concentrations were substantially higher than those observed in either the 2017 or 2020 coring events, suggesting a ‘change’ in arsenic concentrations that was likely driven by spatial heterogeneity rather than any regional factors. Consequently, it is likely that the observed ‘change’ at WTS in 2023 is an artefact of natural spatial variability rather than a mine-related increase. Arsenic will be assessed with grab sampling in 2024 for clear divergence from baseline concentrations.

- The mean sediment core arsenic concentration at A20 exceeded the trigger and was approximately 1.7-fold above the mean baseline concentration in cores collected in 2017. However, similar to WTS, observed concentrations in 2023 were all within the range of baseline core and grab results (**Figure 5-22**), indicating that the change may be an artefact of natural spatial heterogeneity.

Chromium

- Mean sediment concentrations at WTS, KAN/MAM, and A20 exceeded their respective triggers in 2023. Chromium concentrations at each of these lakes in 2023 showed statistically significant increases of 1.2 to 1.5-fold above the 2017 baseline coring results (**Figure 5-24**).
- At WTS, there is conflicting information regarding the nature of these apparent changes. The range of concentrations observed in 2023 is roughly within the range of concentrations observed during the baseline period (Azimuth, 2018a), suggesting that natural spatial heterogeneity may be responsible for the apparent increase seen in 2023. However, excluding a single elevated grab sample result in 2016, chromium concentrations appear to have been on an increasing trend since the onset of mining activity. Similar results were observed at Meadowbank study area TPE after dike construction and are believed to be related to the use of chromium-rich ultramafic rock in the Bay Goose Dike. As discussed in **Section 4.5.3**, targeted studies over several years concluded that the observed changes were not posing unacceptable risks to the benthic community (see Azimuth, 2020a for more details).
- At KAN/MAM and A20, the 2023 results are most likely due to natural spatial variability. Chromium concentrations for most of the samples were within the range observed during the baseline period. KAN/MAM had slightly higher concentrations in 2023 than the baseline range, but has not shown much of a trend during operations.

Copper

- Lake A20 mean copper concentration in 2023 marginally exceeded the trigger (**Figure 5-25**) but were within the range of baseline concentrations, likely reflecting natural spatial heterogeneity rather than a mining-related increase.

In addition to the mean trigger exceedances for the above metals, there were trigger exceedances for individual samples (**Appendix C2**): three trigger exceedances for cadmium (two at KAN/MAM and one at A76), eight for zinc (two at A20, one at KAN/MAM and five at A76), and one for lead at KAN/MAM (57.5 mg/kg dw, considered an outlier as it is 1.5 times the interquartile range, see **Figure 5-26**). These exceedances in individual samples were generally reflective of natural spatial variability rather than mining-related changes. This is supported by the overall lack of temporal changes relative to baseline conditions for cadmium (**Figure 5-23**) and zinc (**Figure 5-28**) at the locations listed above.

Organic Compounds

Total Organic Carbon (TOC)

Since 2015, there is no evidence of an increasing trend in TOC at any of the study lakes (**Figure 5-19**). TOC varies slightly between years, but has remained remarkably stable within each of the Whale Tail study lakes. What is apparent, is the difference in TOC across the study lakes. KAN/MAM consistently has the highest proportions of TOC, while the reference lakes (INUG, PDL) have the lowest. These results reflect differences in productivity levels across the lakes, with shallow, lower-volume lakes tending to be more productive relative to deeper, high-volume lakes.

Hydrocarbons

All parameters with CCME screening values were below both detection limits and Probable Effects Levels (PEL) (**Appendix C2**). Hydrocarbons are not considered a significant COPC based on the mining activities occurring at either the Whale Tail or the Meadowbank sites.

5.5.3 Summary and Recommendations

Sediment chemistry in the Whale Tail study area is naturally elevated in several metals and their concentrations can be quite variable due to spatial heterogeneity. In 2023, several metals (arsenic [WTS, KAN/MAM, A20], chromium [WTS, KAN/MAM, A20] and copper [A20]) showed apparent increases in sediment concentrations relative to baseline conditions. However, the most likely explanation is natural spatial heterogeneity. The potential exception is chromium at WTS, where the increase could be related to mining activity; similar increases were observed at Meadowbank's TPE related to dike construction, but it was concluded that the changes did not pose unacceptable risks to benthic invertebrates.

The 2023 sediment chemistry results from Whale Tail area lakes do not require additional management actions as per the *CREMP Plan Update* (Azimuth, 2022b). **Routine sediment grabs will be collected and analyzed for chemistry in 2024 to track emerging spatial and temporal trends.**

5.6 Benthos Community

Summary results for abundance and richness of major taxa in 2023 are presented in **Appendix E2,** along with supplemental plots showing abundance and richness at the major taxonomic group level since the start of baseline sampling.

5.6.1 Key Findings from the 2023 Benthos Community Monitoring Program

- For the benthic invertebrate community abundance and taxa richness, four time periods were assessed using statistical analysis (2023, 2022-23, 2021-23, and 2020-23) to identify changes from baseline/reference.
- In 2023 there appeared to be large (45–166 %) increases in benthic invertebrate abundance at all NF and some MF areas. There were small decreases (8–22 %) observed at MF area A76 and FF area DS1. For taxa richness, there appeared to be large (34–59%) increases at all areas except DS1 which showed a comparatively small increase (10%) in 2023.
- For all time periods, there were significant increases in benthic invertebrate abundance at KAN/MAM and NEM compared to baseline/reference. In 2022-23, there was a significant increase at WTS. While nutrient inputs from mining activities may lead to an increase in benthic abundance, it is challenging to distinguish between mining-related changes and environmental variability.
- For all time periods, there were significant increases in benthic invertebrate taxa richness at KAN/MAM and NEM compared to baseline/reference. For 2022-23, 2021-23, and 2020-23 time periods, there were significant increases in benthic invertebrate taxa richness at MF area A20.

5.6.2 General Observations

Benthic invertebrate (benthos) abundance in the Whale Tail study area can vary widely for a given lake on an annual basis, though multiple years of baseline data helps to characterize variability in abundance among the areas. Richness tends to be relatively stable year-over-year. While the relative proportions of different taxa may vary, the number of total taxa was consistent throughout the baseline period and at the start of construction in the Whale Tail study area. Abundance (organisms/m^2) and richness (# unique taxa) is characteristic of depositional areas in northern lakes with low productivity and nutrient cycling with insects, primarily chironomids in the subfamilies Chironominae and Tanypodinae, and fingernail clams (Sphaeriidae) being the dominant benthic invertebrates.

Temporal and Spatial Trends

The methods and approaches used to assess benthos community metrics described for the Meadowbank CREMP also apply to the Whale Tail study area. Changes in benthos total abundance and richness were evaluated in 2023 using the BACI study design outlined in **Section 2.3.3**. Dike construction in 2018 was the major mining event responsible for the transition of the Whale Tail lakes from *control* to *impact* due to the proximity of construction activities to the lakes (**Table 2-3**).

Time-series plots showing total abundance and richness endpoints were used to assess spatial and temporal trends for the Whale Tail lakes (**Figure 5-29** to **Figure 5-34**). Identifying potential mine-related impacts generally involved visually examining the data for spatial/temporal patterns that matched mine-related events. This was augmented with formal statistical analyses of the data to test for changes in total abundance and total taxa richness relative to baseline/reference conditions using the BACI model (see **Section 2.3.3** for details). Key results are described below.

Abundance (Density)

Total benthos abundance is highly variable within the lakes and among years (**Table 5-14**). However, in 2023 and 2022 high benthos abundance was reported in the NF lakes, where totals reached the highest abundances observed since monitoring started in 2015. In the reference lakes, these increasing patterns were not observed, rather levels have been more stable since 2015. The apparent changes in NF abundance compared to reference lakes could indicate the influence of mining activity, however, there are number of non-mining environmental factors (e.g., temperature) that could also result in the divergent patterns.

From a BACI context, where change is measured relative to baseline/reference conditions, higher abundance in a given year at the reference area could translate into a relative decrease at NF and MF lakes if annual abundance in those lakes remained stable. For clarity, we refer to those cases as *apparent* changes (increases or decreases). Abundances at WTS, KAN/MAM, A20, A76, and NEM in 2023 were all higher than reference in 2023 (**Figure 5-29**), but were only statistically significant (p-value < 0.1) at KAN/MAM and NEM (**Table 5-15**). These two areas also had significantly higher abundance in the 2022-23, 2021-23, and 2020-23 time periods. In the 2022-23 time period, WTS also had significantly higher abundance relative to baseline/reference conditions (**Table 5-15**). Note that the BACI analysis was run as a two-tailed test, to better define the significance of enriching effects (**Section 2.3.3**).

For the NF lakes, only KAN/MAM and NEM showed abundances ranging above what was observed during the baseline period (**Figure 5-29**). From 2022 to 2023 densities dropped from 13,066 to 9,285 organisms/m^2 at KAN/MAM and rose from 4,619 to 5,087 organisms/m^2 at NEM. During the baseline period, mean densities ranged from 3,050 to 4,236 organisms/m^2 at KAN/MAM and 1,712 to 2,897 organisms/m^2 at NEM. Densities similar to those reported at KAN/MAM in 2022 and 2023 have been observed at the Meadowbank study area lakes; Wally Lake (WAL), the shallowest of those lakes, has historically had the highest benthic densities, with measures up to 14,253 organisms/m^2.

Based on 17 years of monitoring benthic communities at the Meadowbank study lakes, the most likely explanation for the observed spike in density in 2022 and 2023 is a regional climate trend rather than a mine-related change. For example, maximum water temperatures recorded in 2023 and to a lesser extent in 2022 were higher than in previous years (**Section 5.2.2**). Alternatively, while increases in nutrients (**Section 5.3.2**) and primary productivity (**Section 5.4.3**) have been observed in water, these have not resulted in notable changes to sediment TOC (**Section 5.5.2**), which is an important pathway for nutrient enrichment in the benthic community and would help explain the sharp increased seen in 2022 and 2023 (Hyland et al., 2005; Pearson and Rosenburg, 1978). The potential influence of TOC on benthic communities is provided in **Table 5-5**, which shows the proportion of TOC may influence benthic abundance in an area. However, the changes in abundance observed in 2022 and 2023 are not corroborated by the sediment results which show that the proportions of TOC in Whale Tail lakes have been consistent since sampling began (**Figure 5-19**). Further, the densities observed in 2021, under a similar nutrient and primary production regime, were among the lowest observed across the Whale Tail impact lakes since 2015. As was the case for the elevated densities at WAL, additional monitoring data should help understand the cause of the increased densities observed in 2023.

Table 5-5. Comparison of TOC to benthic invertebrate abundance at the near- and mid-field Whale Tail study area lakes.

Area	Exposure	Mean 2015-2023	
		Abundance[1]	TOC[2]
INUG	Reference	1326 (6)	3.80 (6)
PDL	Reference	982 (7)	2.68 (7)
WTS	Near-field	3157 (4)	5.60 (5)
MAM	Near-field	6032 (1)	9.79 (1)
NEM	Near-field	3485 (3)	7.96 (2)
A20	Mid-field	3073 (5)	6.11 (4)
A76	Mid-field	4385 (2)	7.01 (3)

Notes:
Rank order of abundance and TOC shown in parentheses.
1. Mean value of abundance across years shown in **Table 5-14**.
2. Mean TOC across all lake samples within time period.

Taxa Richness

The same taxa observed at the Meadowbank lakes were documented during the baseline period for the Whale Tail lakes. Taxa richness is typically between 10 and 15 taxa in the Whale Tail lakes (**Figure 5-32**), with insects dominating in both number of taxa (**Figure 5-33**) and proportion of the total sample richness (**Figure 5-34**). Molluscs were the next most dominant taxonomic group in terms of the number species and relative richness.

The overall patterns observed at the NF and MF lakes are generally aligned with baseline conditions, but within-area temporal trends are quite variable across the lakes. In 2023, richness at all study lakes was within historical baseline ranges except for KAN/MAM where richness ranged from 16 to 20 (in 2023) compared to baseline levels ranging from 10 to 17 (2015 through 2018). Mean richness at both KAN/MAM and NEM appears to have consistently increased since mining activities began in 2019. Similar to total abundance, the BACI analysis found statistically significant (p-value < 0.1) increases in taxa richness at KAN/MAM and NEM in all time periods, at A20 in 2022-23, 2021-3, and 2020-23, and at DS1 in the 2022-23 time period (**Table 5-16**). While the results are likely due to natural variability, additional data should help verify the cause of the increased richness observed in 2023.

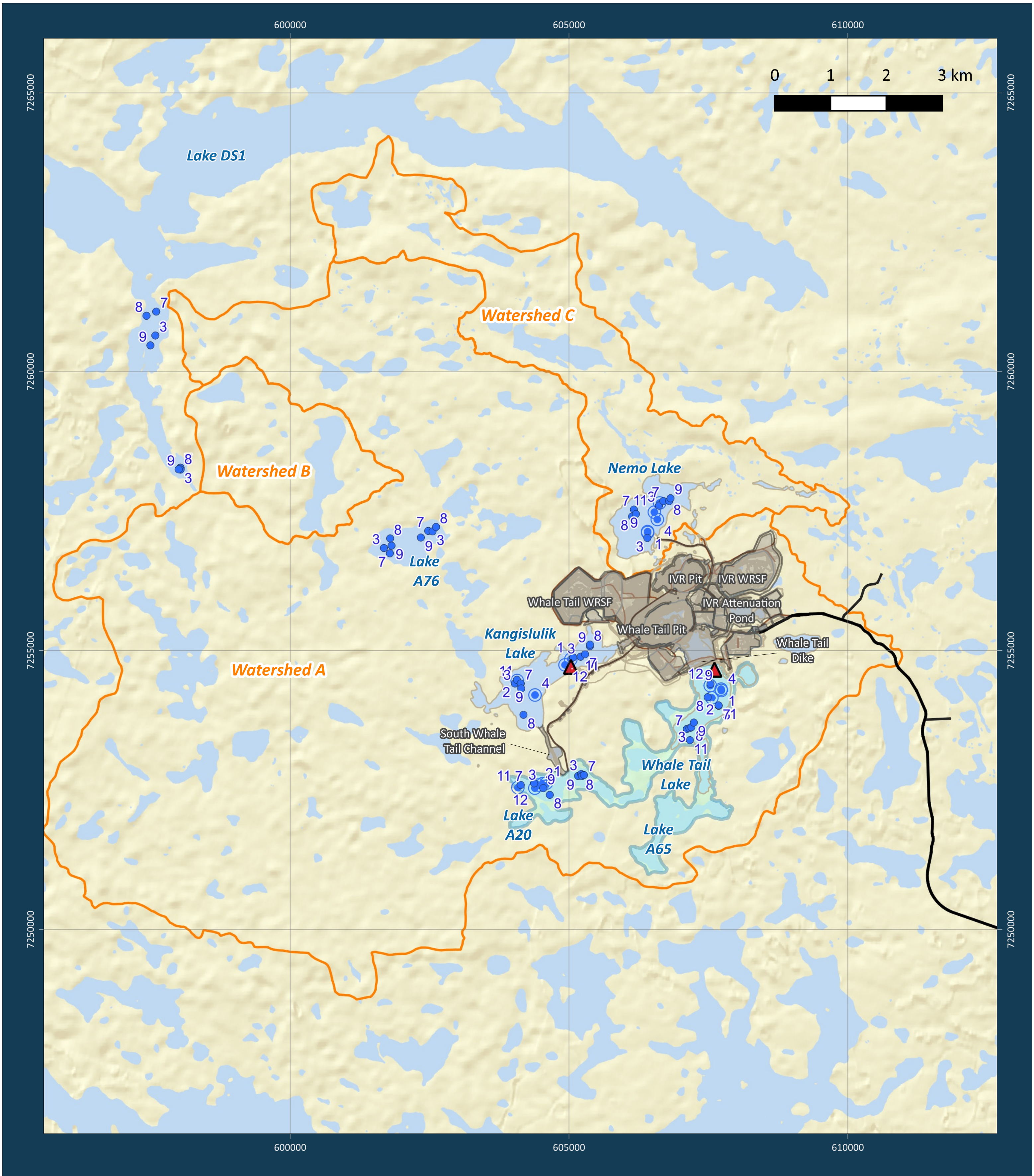
5.6.3 Summary and Recommendations

Increases in benthos abundance and taxa richness were observed at Whale Tail area lakes. For all time periods, there were significant increases in benthic invertebrate abundance at MAM and NEM compared to baseline/reference. In 2022-23, there was a significant increase at WTS. While nutrient inputs from mining activities may lead to an increase in benthic abundance, it is challenging to distinguish between mining related changes and environmental variability. For all time periods, there were significant increases in benthic invertebrate taxa richness at MAM and NEM compared to baseline/reference. For 2022-23, 2021-23, and 2020-23 time period, there were significant increases in benthic invertebrate taxa richness at MF area A20. While there has been some indication of episodic nutrient enrichment and increased phytoplankton production in the water column (**Section 5.4.3**), no notable increases in sediment TOC have occurred to suggest that any increases in benthic parameters indicate an enrichment effect (**Figure 5-19**). The apparent changes in the benthic community observed in 2023 are likely due to natural variability rather than to mining activities, and will continue to be monitored in 2024.

5.7 Whale Tail Tables and Figures

The tables and figures for the Whale Tail study areas provided in this section follow, except for the large tabulated datasets and figures for parameters that are not included in the detailed analysis (see in-text references to appropriate Appendices). Subsections are provided for each of the CREMP components (e.g., limnology, water chemistry, phytoplankton, sediment chemistry, and benthos).

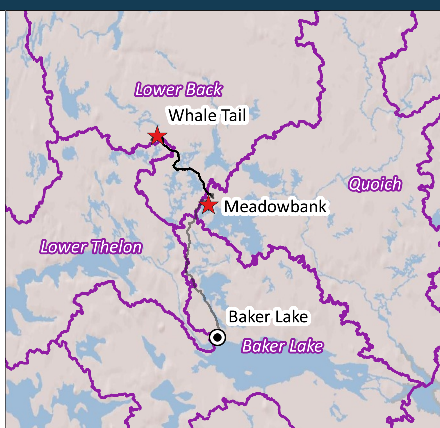
Note: For Kangislulik lake, the acronyms MAM and/or KAN are used interchangeably in the Whale Tail figures and tables.



Legend

- Water *
- Limno
- Kangislulik & Whale Tail Lake Diffusers
- Whale Tail Lake (South Basin)
- Amaruq Watersheds
- Regional Watersheds
- Haul Road

Note:
* Water samples are collected from fixed monitoring locations in the project lakes where the water depth is at least 5 m.



AZIMUTH

Client	Agnico Eagle Mines Limited Meadowbank Division
Figure 5-1	Whale Tail Study Area - 2023 Water Quality Sampling Stations
Project	CREMP 2023 Meadowbank Complex

Date: March 19, 2024
Datum: NAD 83 UTM Zone 14N
Scale: 1:90,000
Software: QGIS Version 3.22.11-Białowieża
By: M. DiMauro, E. Franz, I. McIvor

REFERENCES:
1. Basemap imagery from ESRI.
2. Mine plan and sub-watershed boundary layers from Agnico Eagle.
3. Watershed boundaries and watercourse from NRCan.