TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

Abbreviation	Definition
CCME	Canadian Council of Ministers of the Environment
GNWT	Government of Northwest Territories
FAL	Canadian Sediment Quality Guidelines for the Protection of Freshwater Aquatic Life
INF	Department of Infrastructure
MTS	Marine Transportation Services
MVLWB	Mackenzie Valley Land and Water Board
PEHH	Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health
TSS	total suspended solids
WQ PAL	Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life

GLOSSARY

Term	Definition[1]
Background concentration	The level of a substance that is naturally occurring and not associated with dredging works
Composite sample	A mixture of several samples taken at different locations and combined to make a single sample
Dewatering	The act of removing water from sediment or waste material
Dredging	The act of cleaning out the bed of a harbour, river, or other body of water by scooping out material from the bottom
Grab sample	A single sample that provides a snapshot of water quality at the exact time and location the sample was taken
Receiving waters	The waters in Great Slave Lake and the Hay River surrounding the dredging areas that may be affected by dredging works
Sediment	Solid particles that are suspended or have settled at the bottom of a body of water
Soil	Sediment that has been dredged and dewatered

[1] These definitions are in the context of this monitoring plan.

1 INTRODUCTION

The Government of Northwest Territories (GNWT) – Department of Infrastructure (INF) retained Associated Environmental Consultants Inc. (Associated) to prepare a monitoring plan related to dredging works taking place in the marine navigation channel between Great Slave Lake and Hay River Harbour (Dredge Area A, Figure 1-1), and within the three fingers of the East Channel of the river (Dredge Area B, Figure 1-1). The dredging is proposed to begin July 16, 2023, and continue until September 14, 2023. This monitoring plan follows the Mackenzie Valley Land and Water Board's (MVLWB) Standard Outline for Management Plans (2021) and provides guidance on monitoring water, sediment, and soil quality associated with the proposed dredging activities.

1.1 Project Description

In 2022, the Hay River experienced unusually high-water levels, resulting in increased sediment being deposited in the Hay River Harbour and Great Slave Lake at the river outfall. The sediment, which has not been regularly maintained since 1997, has begun to fill the Dredge Areas. This has caused an emergency scenario, since the shallow water in the navigation channel poses a risk to boats (i.e., sea barge, Coast Guard, fishing, and recreational vessels) getting stuck in the sediment deposit and not being able to enter or exit the Hay River Harbour. Removing sediment so that boats can travel along the navigation channel. If boats cannot enter or exit the harbour, the supply for essential goods, and fuel for power and heat could be interrupted for up to 12 communities who rely on the sea barge system.

The GNWT-INF has proposed dredging the navigation channel to mechanically excavate a 30 m wide and 2.4 m deep navigation channel for emergency use, to be completed by local contractors in coordination with GNWT-MTS. The excavated sediment from the navigation channel would be loaded onto a barge, allowed to passively dewater, and when the barge is at capacity, the sediment would be offloaded to haul trucks located on shore. The haul trucks would transfer the sediment to GNWT-INF property on Vale Island, using a sealed truck bed to mitigate further dewatering on roads. The sediment would be temporarily stored on Vale Island, contained with 1 m berms, for ongoing passive dewatering. Once moved from the barge to land, the sediment[1] will be considered soil (CCME 1999) and may be made available for public use, if appropriate, or would be transferred to a final management area.

This emergency dredging program will include removal and temporary storage of the following estimated volumes of sediment:

- Dredge Area A: the shipping lanes approaching the outfall to Great Slave Lake to a width of 30 m, dredging 16,000 m^3; and
- Dredge Area B: the three fingers in the East Channel, dredging 68,000 m^3.

1.2 Monitoring Plan Objectives

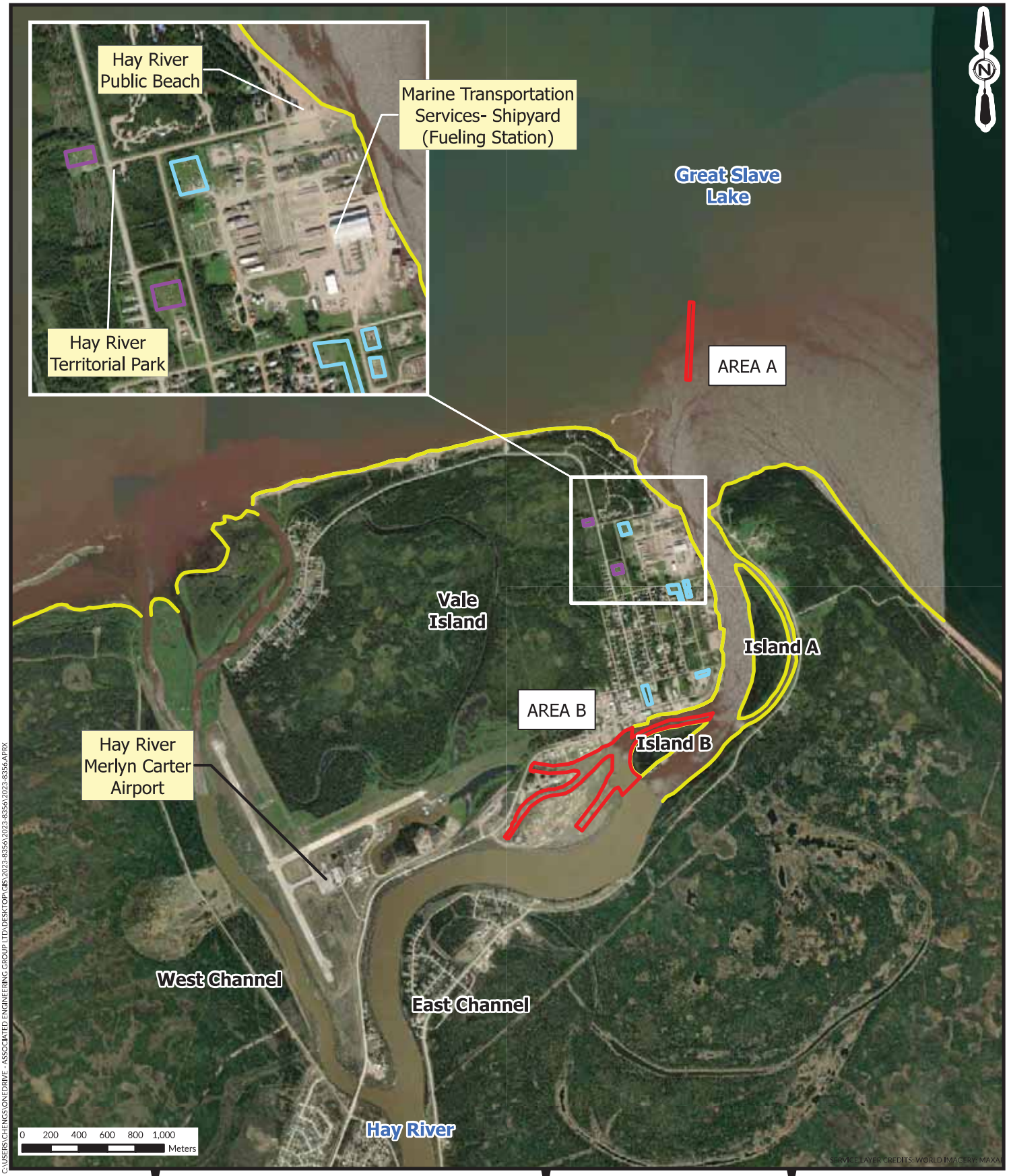
The objectives of the monitoring plan are to guide monitoring of:

- Water quality, particularly total suspended solids (TSS), of the Hay River and Great Slave Lake outside the work area (receiving waters) during the dredging activities;
- Water quality of runoff water collected from sumps during dewatering activities at the temporary storage location on Vale Island; and

[1] Sediment is unconsolidated material deposited on the bed of a waterbody or in a low spot or depression on land where the water velocity is insufficient to move the material (CCME 1999).

- Soil quality of the dewatered sediment proposed to be stockpiled on Vale Island (to inform final management for material potential for reuse).

The details of each monitoring objective are provided in Sections 3 and 4 of this document.



C:\USERS\CHENGS\ONEDRIVE - ASSOCIATED ENGINEERING GROUP LTD\DESKTOP\GIS\2023-8356\2023-8356\2023-8356\2023-8356.APRX

Associated Environmental

LEGEND
- Potential Spill Impacted Shoreline
- Dredging Areas
- Temporary Soil Storage (GNWT)
- Temporary Soil Storage (Town of Hay River)

AE PROJECT NO.	2023-8356
SCALE	1:36,000
COORD. SYSTEM	NAD 1983 UTM ZONE 11N
DATE	2023-03-28
REV	03
DRAWN BY	SC
CHECKED BY	JB

FIGURE 1-2
FUELING, POTENTIAL SPILL, POTENTIAL IMPACT LOCATIONS

GOVERNMENT OF NORTHWEST TERRITORIES-DEPARTMENT OF INFRASTRUCTURE

HAY RIVER HARBOUR RESTORATION

1.3 Regulatory Framework

GNWT-INF is committed to the environment and will be following the applicable required regulatory framework to mitigate potential environmental impacts from this project. As part of the regulatory processes, environmental planning and mitigation will form part of the necessary regulatory applications. Anticipated regulatory permits or authorizations include:

- Type B water licence from the MVLWB, regulated under the *Waters Act*, SNWT 2014, c.18;
- Minor works order from Transport Canada, regulated under the *Canadian Navigable Waters Act*, RSC, 1985, c. N-22; and
- Project review from Fisheries and Oceans Canada, regulated under the *Fisheries Act*, RSBC 1985, c. F-14, and the *Species at Risk Act*, SC 2002, c. 29.

Samples collected as part of monitoring efforts will be compared to the following guidelines (CCME 2023):

- Water chemistry will be compared to the Canadian Council of Ministers of the Environment (CCME) Canadian Water Quality Guidelines for the Protection of Aquatic Life (WQ PAL).
- Sediment chemistry will be compared to the CCME Canadian Sediment Quality Guidelines for the Protection of Freshwater Aquatic Life (FAL).
- Soil chemistry will be compared to the CCME Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health (PEHH) and the soil quality standards in the GNWT Environmental Guideline for Contaminated Site Remediation.

Given the duration of the project, the GNWT-INF may need to engage with qualified environmental professionals to adapt monitoring activities, while concurrently proceeding with updating the monitoring plan to meet the Type B water licence application requirements.

In addition to this monitoring plan, the following plans have been created to support the dredging works:

- Sediment and erosion control plan
- Spill contingency plan
- Waste management plan

1.4 Assumptions

Several assumptions were made in developing the monitoring plan. These include:

- Dredging will occur within the Fisheries and Oceans Canada allowable activity window (July 16 to September 14) (DFO 2023) to reduce the risk of harm to fish during spawning.
- Based on the short duration of the project and on the naturally high turbidity of the river, a sediment curtain is not considered essential for dredging in these areas. Due to the strong currents in the river and the large size of Dredge Area A, a sediment curtain would be ineffective and potentially unsafe. A sediment curtain also cannot be used in Dredge Area B due to the large size of the Hay River and the potential of disrupting ongoing boat traffic. Curtains in strong currents tend to drag along the bottom, which results in more sediment being released, rising the turbidity levels in the water. TSS is the only water quality parameter that will be monitored in real time. Metals and other parameters that require laboratory analysis cannot be managed in real time.

- Sediment will be stockpiled 30 m or more from any watercourse (refer to the sediment and erosion control plan for details, Associated 2023B).
- Surficial sediment chemistry in the Hay River, as evaluated in 2018 and 2023 (discussed in greater detail in Section 2.3), is representative of the sediment that will be dredged.
- The stockpile dewatering rate is expected to match the rate of water infiltrating onto underlaying soils. Excess water that does not infiltrate will be collected from sumps (i.e., water collected from dewatering stockpiles) has low levels of contamination and meets applicable water quality guidelines.
- Sediment will be stockpiled at multiple properties on Vale Island; the stockpiles will be contained using berms, and water will be managed through sumps and infiltration to the ground.
- Water runoff will meet the guidelines (since preliminary analyses met the guidelines for soils).

The monitoring plan is meant to be adaptive and allow for changes based on new information or changing conditions. The plan is a working document, with ongoing review from qualified professionals, using adaptive management practices (as discussed in Section 4).

2 SITE BACKGROUND

The Hay River is 1,114 km in length and has a watershed area that encompasses 48,200 km^2. It originates in northwest Alberta and travels through northern Alberta and British Columbia, before discharging into Great Slave Lake on the southwestern side (Atlas of Canada n.d.). The East Channel of the Hay River, at the outlet into Great Slave Lake, is used to access several communities to supply goods. The West Channel is too shallow for commercial shipping, and aerial photos showed no evidence of commercial shipping having occurred along this channel. Dredging is proposed at the outlet of the Hay River into Great Slave Lake (Dredge Area A, Figure 1-1) and in the East Channel of the river (Dredge Area B, Figure 1-1).

2.1 Dredge Area A

Dredge Area A is at the outlet of the Hay River, extending northward into Great Slave Lake, and is downstream of Dredge Area B. Dredge Area A is in open water in Great Slave Lake and is subject to high winds, lake currents, and is highly influenced by Hay River flow. The area is a depositional area for Hay River sediment, as evidenced by a turbid water gradient in the lake that can be seen in aerial imagery (Figure 1-1).

2.2 Dredge Area B

Dredge Area B is described as the area in the East Channel of the Hay River, specifically upstream of the river outlet into Great Slave Lake. The East Channel contains several side channels (fingers), which are planned for dredging (Figure 1-1). The upstream end of the three fingers in Dredge Area B is disconnected from the Hay River by the Hay River Highway and is thus not expected to be affected by the proposed dredging activities.

2.3 Historical Water and Sediment Quality

Water quality has actively been monitored at the following two locations near the Dredge Areas as part of the Northwest Territories Community-based Monitoring Program (DataStream Initiative 2023), which started in 2012 (locations shown in Figure 3-1):

1. Hay River, at the mouth of the river (Station ID: HAY-GSL); and
2. Hay River, upstream of the West Channel (Station ID: HAY-U/S).

These data were used to better understand the background concentrations of TSS around the Dredge Areas and determine the response framework, described in Section 4. Data are available online through Mackenzie DataStream (DataStream Initiative 2023).

Associated collected five surficial sediment samples from Dredge Area A in January 2023 (Appendix A) and characterized the sediment as sand or sandy loam in texture. The samples met the CCME FAL guidelines, except for arsenic. The average concentration of arsenic in the samples was 6.2 mg/kg (ranging from 5.0 to 7.0 mg/kg), which is slightly greater than the guideline of 5.9 mg/kg. In contrast, the samples met the CCME soil (residential/parkland, industrial/commercial land uses) and the PEHH guidelines. Results are available in Appendix A.

Nine surficial sediment samples were collected in March 2018. The samples exceeded CCME FAL guidelines for arsenic, cadmium, and copper but met criteria for CCME soil and PEHH guidelines. Detailed results shown in Appendix A.

3 MONITORING PLAN

Water quality in the receiving waters will be monitored during the dewatering process on the barge and when the sediment is transferred to Vale Island. Dewatered sediment will be monitored to determine whether the material may be reused off site. The monitoring plan has been split into the following three parts:

1. Water Quality Monitoring in Receiving Waters (Section 3.1);
2. Water Quality Monitoring for Dewatering Activities on Vale Island (Section 3.2); and
3. Soil Monitoring for Dewatered Material (Section 3.3).

Effects on the receiving environment during dredging are expected to be minimal based on the short duration of dredging activities and the contingencies in place, as documented in the monitoring plan response framework (Section 4).

3.1 Water Quality Monitoring in Receiving Waters

3.1.1 Monitoring Locations

Receiving waters are defined as the waters in Great Slave Lake (Dredge Area A) and the Hay River (Dredge Area B) surrounding the dredging areas. Five locations have been selected for monitoring around Dredge Area A and four locations have been selected for Dredge Area B (Figure 3-1). Monitoring locations have been determined based on the assumption that a sediment curtain will not be used during dredging.

The monitoring locations for Dredge Area A were chosen based on aerial imagery of the existing turbidity plume entering Great Slave Lake from the Hay River, and on available fisheries background information for the area (2023). Dredge Area A is not believed to have adequate spawning habitat for fish species considered important from a resource management perspective due to the high turbidity and sedimentation in this area (Associated 2023). Based on this knowledge, two monitoring locations are proposed on the east and west sides of the dredging works (four locations in total), to account for any changing currents that may occur during dredging activities (Table 3-1, Figure 3-1).

Table 3-1 Monitoring Locations in Dredge Area A

Site Name	Location and Rationale	UTM Coordinates (Zone 11V)
A-REF/B3[1]	At the mouth of the Hay River; this point will act as the reference point for the works in Great Slave Lake and will provide background data for TSS.	568882.98 m E 6747803.11 m N
A1	200 m west of Dredge Area A, in southwest corner; this site will act as one of four compliance points for the project.	568518 m E 6749038 m N
A2	200 m west of Dredge Area A, in the northwest corner; this site will act as one of four compliance points for the project.	568547 m E 6749383 m N
A3	200 m east of Dredge Area A, in the northeast corner; this site will act as one of four compliance points for the project.	569019 m E 6749388 m N

Site Name	Location and Rationale	UTM Coordinates (Zone 11V)
A4	200 m east of Dredge Area A, in the southeast corner; this site will act as one of four compliance points for the project.	568991 m E 6749024 m N

[1] This is the same location as the far-field site for Dredge Area B.

The monitoring locations along the Hay River in Dredge Area B were chosen based on knowledge of the flow dynamics in the area, which has very low velocity. The four sites along the Hay River (Table 3-2, Figure 3-1) were selected to represent background conditions (B-REF), conditions immediately downstream (B1 and B2) of the dredging works, and conditions at a far-field site further downstream (B3).

Table 3-2 Receiving Environment Monitoring Locations in Dredge Area B

Site Name	Location and Rationale	UTM Coordinates (Zone 11 V)
B-REF	Approximately 200 m upstream of Dredge Area B; this site will act as background for TSS for this area.	568307.08 m E 6745721.73 m N
B1	Directly downstream of Dredge Area B, on the northwest side of Island B; this site will act as a TSS monitoring site for the dredging occurring in the northern fingers of Dredge Area B.	568391.95 m E 6746421.90 m N
B2	Directly downstream of Dredge Area B, on the southwest side of Island A; this site will act as a TSS monitoring site for the dredging occurring near Island B.	569084.08 m E 6746800.36 m N
A-REF/B3[1]	Downstream of Dredge Area A, approximately 1 km east of Island B; this site will act as the monitoring point of the dredging occurring on the north side of Island B.	568882.98 m E 6747803.11 m N

[1] This is the same location as the reference site used for Dredge Area A.

Associated Environmental

- Historical Monitoring Locations
- Proposed Monitoring Locations
- Dredging Areas
- Temporary Soil Storage (GNWT)
- Temporary Soil Storage (Town of Hay River)

3.1.2 Frequency and Parameters

Before dredging, two 20 L grab samples will need to be collected at each location to create a TSS–turbidity correlation curve following the standard operating procedures outlined in Appendix B. Samples will be collected by an environmental monitor at least 2 weeks before the start of dredging to allow for adequate time for analysis at locations A1 and B1 (sites will be representative of Dredge Area A and Dredge Area B, respectively). This curve is required as standard industry sensors record only provide turbidity units, while historical data (historical locations are shown in Figure 3-1) and guidelines for TSS were reported in milligrams per litre.

During dredging, TSS is to be monitored continuously, using real-time sensors, at the monitoring locations proposed in Section 3.1.1. Sensors will be installed at a depth of 60% from the water surface and set to record TSS every 30 minutes. Data from the sensors may be downloaded remotely and will not require manual downloading.

Sensors in Dredge Area A will likely require attachment to a buoy platform that is anchored to the lake bottom. Sensors in Dredge Area B will likely be anchored to the shore. The sensors will also require ongoing maintenance to verify they are operating correctly, including potentially weekly cleaning of the sensors to rid them of algae and other debris. Instructions for installing and using these sensors will be provided by the entity supplying the sensors and will be followed to validate successful use. In addition to the monitoring completed using turbidity sensors, a qualified environmental professional will evaluate waters using similar technology (i.e., hand-held water quality meter), for quality control purposes. The environmental monitor will measure background TSS at each monitoring location before the start of dredging each day and will compare the results to those of the sensor stations to determine whether the sensors are operating correctly.

Data collection is expected to occur 1 week before the start of dredging to determine background TSS concentrations at the monitoring locations and to inform the response framework outlined in Section 4.1. Based on historical water quality data, background TSS concentrations are expected to fluctuate throughout the dredging period, ranging from 33 mg/L to 40 mg/L (DataStream Initiative 2023).

The monitoring plan will be continually evaluated and adjusted based on the data acquired; the response framework for the collected data is outlined in Section 4.1.

3.2 Water Quality Monitoring for Dewatering Activities on Vale Island

3.2.1 Monitoring Locations

An excavator situated on a barge will remove the sediment and stockpile it onto a barge deck. An engineered filter fabric will be installed on the deck, which will let water flow freely off the barge but sediment to remain on the deck, allowing for passive dewatering. When the barge is at capacity, the sediment will be transferred to Vale Island, where it will be stockpiled at multiple properties and allowed to passively dewater further. The stockpiles will be contained using berms, and water will be directed into sumps for infiltration to the ground.

Once the sediment is removed from water and placed on the land, it is classified as soil. Water quality samples will be collected from sumps on the stockpile properties to validate the quality of the water that will return to the Hay River through ground infiltration. The frequency of sampling is proposed to be weekly, but this should be re-evaluated before the start of dredging activities based on timing and frequency of offloading , dewatering activities, and relocation of soil (after dewatering).