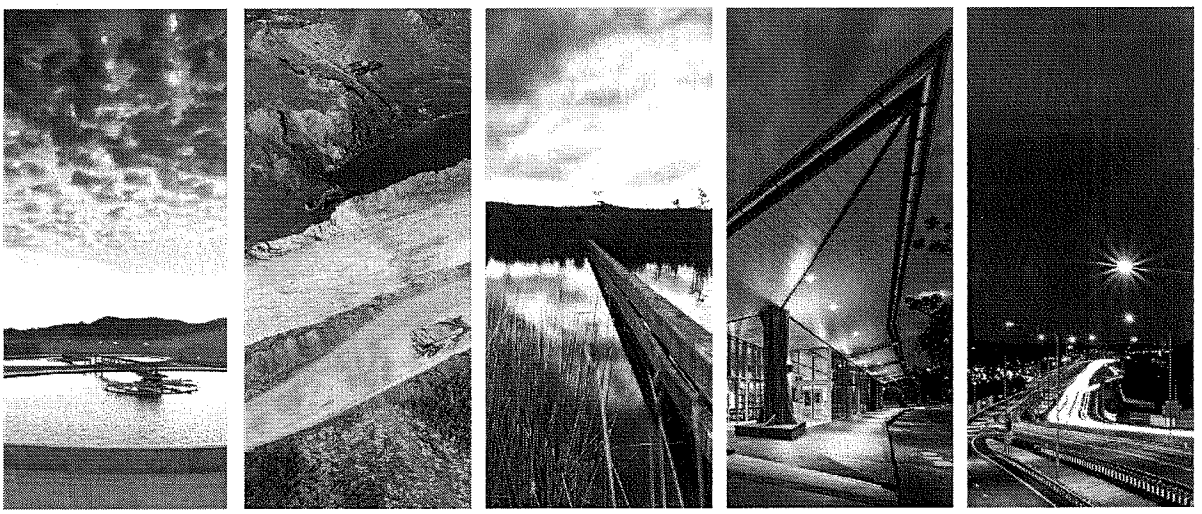

Risk Management Plan Assessment

Frobisher Depot
1800 Frobisher Street
Sudbury, Ontario

City of Greater Sudbury

GHD | 96 White Oak Drive Sault Ste. Marie Ontario P6B 4J8 Canada

039382| 42 | Report No 8 | January 18 2018

Executive Summary

GHD completed a Risk Management Plan Assessment (Assessment) for the Frobisher Depot located at 1800 Frobisher Street in Sudbury, Ontario (Site). The Site is an active winter maintenance depot operated by the City of Greater Sudbury (CGS). Winter maintenance activities conducted at the Site include salt and sand storage and handling; brine manufacturing; vehicle/equipment storage, maintenance, and repair; and administrative functions.

Road salt for the winter maintenance season is stored on Site in a covered salt storage dome with a relatively impermeable base. Pickled sand (i.e., sand mixed with salt at approximately five percent by weight) is stored on Site within and outside of the footprint of the former pickled sand dome located adjacent to the salt storage dome. Brine is prepared on demand in a separate building at the site. Application equipment used during the winter maintenance season is loaded at the site prior to deployment to respond to winter events.

Under the Clean Water Act (CWA), road salt handling and storage is a prescribed drinking water quality threat, which may contribute to the issue of rising sodium levels within Ramsey Lake. Based on the specific characteristics of road salt storage and handling at the Site (i.e. greater than 0.5 tonnes of road salt stored/handled) and the intersection of the Site with the Ramsey Lake Issues Contributing Area (ICA), the threat is deemed significant. As such, in accordance with the Greater Sudbury Source Protection Area Source Protection Plan Policy Sa-4E RMP, the Site requires a Source Water Risk Management Plan (RMP) for road salt handling and storage activities.

Surface water samples collected for sodium and chlorides, as part of the RMP Assessment, identified:

- Upgradient/background total sodium concentration of 152 milligrams per litre (mg/L) and chloride concentration of 117 mg/L.
- On-Site total sodium concentrations of 4,010 and 4,170 mg/L, and chloride concentrations of 6,220 and 6,430 mg/L.
- Downstream total sodium concentrations ranging from 181 to 313 mg/L, and chloride concentrations ranging from 322 to 558 mg/L. While total sodium concentrations generally remained the same downstream of Highway 55/Kingsway, chloride concentration generally slowly decreased with travel from 558 to 374/367 mg/L.

As expected, the highest sodium concentrations were observed immediately downstream of the salt depot where the pickled sand and mixing practices remain uncovered and exposed to the elements. Sodium concentrations were lower downstream. The on-Site (downgradient) low-lying swamp provides an excellent salt attenuation and buffer in minimizing the transport of salt from the Site towards the creek and eventually Ramsey Lake. No visual evidence of vegetative stress or deterioration was observed as a result of salt loadings from the Site.

As such, two measures available to CGS to manage the significant threat of road salt storage and handling within the Ramsey Lake ICA include:

- Maintain Site operations and implement Best Management Practices (BMPs) with monitoring to evaluate the effectiveness of BMPs.
- Relocate the winter maintenance material storage to a new site, located outside of any area where road salt storage and handling is deemed a significant threat, preferably within an area of low salt vulnerability as identified in the CGS Salt Optimization Plan.[1]

Considering the additional costs associated with relocating the depot, in association with the benefits provided by the low-lying downgradient swamp which provides salt attenuation and a buffer from salt travel, redeveloping the existing Site using BMPs (i.e., build a dome for the pickled sand, install a monitoring network) would be the most economical and practical option.

1 *"Salt Optimization Plan"*, Prepared by GHD on behalf of the City of Greater Sudbury, November 2017.

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1. Introduction

GHD was retained by the City of Greater Sudbury (CGS) to develop a Risk Management Plan Assessment (RMP Assessment) for its existing Frobisher Depot located at 1800 Frobisher Street in Sudbury, Ontario (Site/Property). GHD was also retained to collect downstream surface water samples to establish a baseline condition in support of the RMP Assessment. A Site location map and Site layout showing the Frobisher Depot are provided on Figures 1 and 2.

CGS owns the Frobisher Depot, which is operated as a winter maintenance depot including road salt handling and storage. The Site is located within the Ramsey Lake Issues Contributing Area (ICA), established due to elevated and rising sodium levels within the lake, which is a major drinking water source for CGS. In accordance with the Greater Sudbury Source Protection Area Source Protection Plan Policy Sa-4E RMP, the Site requires a Source Water Risk Management Plan (RMP) for road salt handling and storage activities.

The objective of this RMP Assessment is to characterize the geological and hydrogeological conditions of the Site and surrounding area with regard to development of the property and to develop Risk Management Measures (RMMs) to mitigate further impacts on the Ramsey Lake Drinking Water System (DWS).

This Report is organized into the following Sections:

Section 1.0 – Introduction: outlines the purpose, objectives and scope of work, and presents the report organization.

Section 2.0 – Methodology: outlines the methodology undertaken to complete the assessment.

Section 3.0 – Background: provides a description of the existing Site conditions, operations, background information and surrounding land uses, including the regional environmental setting, including the physiography, topography, main surface water features surrounding the Site, and the surficial and bedrock geology. GHD's surface water sampling investigation also is presented to provide a baseline assessment of the Site and downstream water quality as it relates to salts and chloride loadings flowing into Ramsey Lake.

Section 4.0 – Risk Management Measures (RMMs): includes information on prevention/mitigation/ management measures, monitoring, and emergency response. Prevention information includes industry standards, regulations, best management practices, policies, etc. that are in place to help prevent contamination from the existing land use, as well as information on how the Site will be maintained to ensure it operates as intended/designed, where applicable.

2. Methodology

Cognizant of the objectives of the Assessment, the following activities were undertaken:

- Review of available background information: topography, physiography, geology and hydrogeology mapping and report information, including the results of the geotechnical and investigations completed on the Site by others.
- Documentation of the Site/Property information including geological and hydrogeological conditions and vulnerable areas (Ramsey Lake ICA).
- Collection and analysis of surface water samples to assess current water quality.
- Compilation of RMMs to be considered for a Source Water RMP.

3. Background

3.1 Site Description

The Site is located within the southeast section of the City of Greater Sudbury, within the Township of Neelon, Lot 11, Concession 4, Parcel 26975 SES, at 1800 Frobisher Street (Figure 2). The Site is irregular in shape and approximately 40 hectares (100 acres) in size.

The Site is located within an area of the City of Greater Sudbury that is mainly comprised of light industrial (M2) and mixed industrial/service commercial (M1) land uses as well as lands zoned "flood plain overlay" (FD). The Site is zoned M2 and is bordered to the north and east by M1 lands as well as FD zoned areas, which are comprised of undeveloped wetland with bedrock outcrops. M1 zoned lands are located west of the Site and M2 lands and Kingsway Road (Highway 55) are located to the south, with mixed residential, commercial, parkland, and FD zoned lands located further south.

The western portion of the Site is developed and has two paved access roads that enter the Site from the west side: Frobisher Street, which comprises the main access road, and a driveway off Kingsway Road (Highway 55). The eastern portion of the Site is undeveloped wetland area with bedrock outcrops.

Buildings/structures located on Site, south of Frobisher Street, include an office/administrative building; operations building/garage; washing station building; the former Transit Services garage/administration building; a fuel UST and associated pumping facility; and a truck weigh scale. The municipal recycling processing building, household hazardous waste building, the salt storage dome, and pickled sand pile are located on Site north of Frobisher Street. In addition, various smaller buildings/sheds are located throughout the Site.

Fill materials (concrete/asphalt grindings/gravel/rock) from historical CGS operations are located within the north central portion of the Site, north and east of the salt storage dome.

Surfaces within the western portion of the Site are mainly asphalt paved, providing roadways and parking areas as well as outdoor equipment storage around the buildings located in that area. The

north central area of the Site is surfaced with sand/gravel fill and the remainder of the Site is vegetated.

The ground surface at the Site generally slopes from north to south. There are no storm drains located on Site other than roadside ditches along Frobisher Street. Storm water runoff flows through ditches and/or overland from the west towards the east into a low area located at the centre of the Site. This low, wetland area is constrained to the south by Kingsway Road (Highway 55) and drains southward via a small creek, which discharges into Ramsey Lake approximately 2.2 kilometres (km) south of the Site. Based on mapping provided in the Greater Sudbury Source Protection Area Source Protection Plan[2] and Junction Creek watershed mapping[3], a small portion of the Site, located within the northwest corner, drains to the west into the Junction Creek watershed.

The Site is serviced with municipal water supply and sanitary sewers.

3.2 Site Operations

CGS has owned and operated the Site as a municipal services depot for more than 40 years. The following activities are currently conducted on Site:

- Storage, maintenance, and repair of municipal road and winter maintenance equipment
- Fuel storage and handling
- Storage and handling of winter maintenance materials (i.e. road salt and pickled sand)
- Salt Brine manufacturing, storage, and handling
- Storage and handling of fill materials (concrete/asphalt grindings/gravel/rock)
- Municipal recycling processing facility
- Household hazardous waste depot

Road salt for the winter maintenance season is stored on Site within a salt storage dome, which has a relatively impermeable concrete base. Pickled sand (i.e., sand mixed with salt at approximately five percent by volume); however, is stored outdoors in uncovered piles located either within the footprint of a former dome on an impermeable pad and/or outside directly on the ground west and south of the salt storage dome. Brine is prepared on demand in a separate building with spill containment at the Site. Application equipment used during the winter maintenance season is loaded at the Site prior to deployment to respond to winter events. Vehicle washing is currently being conducted both indoors and outside.

Housekeeping practices employed at the Site include sweeping up tracked salt as needed and a periodic structural assessment to inspect the structural integrity of the salt storage dome. The Site does not have a runoff collection system or a formal plan for managing salt-impacted drainage.

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2 "*Greater Sudbury Source Protection Area Source Protection Plan*", Prepared on Behalf of the Greater Sudbury Source Protection Committee Under the Clean Water Act, 2016 (Ontario Regulation 287/07). Approved September 19, 2014.

3 *"Flood Response Planning 2012 Junction Creek Watershed"*, https://www.greatersudbury.ca/live/emergency-services/emergency-planning/emergency-management-program/emergency-plans/watershed-maps/junction-creek/

3.3 Source Water Protection Areas

The Ramsey Lake surface water intake is located approximately 4.5 kilometres (km) southwest of the Site. The surface water Intake Protection Zones (IPZs) and vulnerability scores associated with the Ramsey Lake surface water intake are presented on Figure 3.

The Site borders on significant groundwater recharge areas (SGRA) that intersects with a highly vulnerable aquifer (HVA), south and west of the Site.

A large portion of the Site falls within the Ramsey Lake Intake Protection Zone 3 (IPZ-3). IPZ-3 includes the area of Ramsey Lake that may contribute water to the intake and includes a 120-metre setback from the high water mark. Transport pathways (contributing tributaries, storm sewers, and roadside ditches) are also included, and a 120 m setback is applied to these as well.

The vulnerability scores associated with the areas within IPZ-3 were determined by considering the vulnerability of the Ramsey Lake intake as well as that of the contributing areas/watersheds. An area vulnerability factor, a measure of how easily a contaminant would travel from the area to the surface water intake, was assigned to each of Ramsey Lake's sub-watersheds based primarily on land surface cover type and permeability. The area of IPZ-3 Frobisher that intersects with the Site is assigned a Vulnerability Score of 9 based on high levels of urban development within the area and the presence of shallow and exposed bedrock.

Due to elevated and rising sodium levels identified within Ramsey Lake, the Assessment Report, produced in response to legislative requirements under the CWA[4], included the establishment of the Ramsey Lake Issues Contributing Area (ICA). The ICA encompasses the total area where activities may contribute to the identified issue(s), in this case the increasing sodium levels, and includes the entire Ramsey Lake IPZ-3.

Under the CWA, road salt handling and storage is a prescribed drinking water quality threat, which may contribute to the issue of rising sodium levels within Ramsey Lake. Based on the specific characteristics of road salt storage and handling at the Site (i.e. greater than 0.5 tonnes of road salt stored/handled), the threat is assessed as significant within the Ramsey Lake ICA. In accordance with the Greater Sudbury Source Protection Area Source Protection Plan Policy Sa-4E RMP, the Site requires a Source Water Risk Management Plan (RMP) for salt handling and storage activities.

Fuel storage and handling is also a prescribed drinking water quality threat under the CWA, however, it is assessed as a moderate threat within the Ramsey Lake IPZ-3. As such, and in accordance with the Greater Sudbury Source Protection Area Source Protection Plan Policies, an RMP is not required for this activity.

The Site is not located within the well head protection area (WHPA) of any of CGS' municipal supply wells. The nearest WHPA is the WHPA-D (travel time of a groundwater contaminant is less than or equal to 25 years but greater than 5 years) for the Garson wells 1 & 3, located approximately 6.1 km northeast of the Site boundary.

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4 *"Greater Sudbury Source Protection Area Assessment Report"*, Prepared on Behalf of the Greater Sudbury Source Protection Committee Under the Clean Water Act, 2016 (Ontario Regulation 287/07). Approved September 2, 2014.

The Greater Sudbury Source Protection Area Assessment Report identifies elevated sodium levels within the Garson wells, however, sodium was not identified as a drinking water quality issue for the Garson DWS due to insufficient available data to determine the presence of a significant increasing trend.

3.4 Site Setting

The CGS is situated within Ecoregion 5E (Georgian Bay) and is located within the southern portion of the Precambrian Shield[5], which is characterized predominantly by exposed and shallow bedrock covered with a discontinuous layer of glacial till. Other landforms include glaciofluvial and galciolacustrine deposits as well as wetland deposits[6].

The topography of the area is generally rolling/undulating with elevated bedrock outcrops and is generally sloped to the south towards Ramsey Lake. The Site ranges in elevation from approximately 273 metres above mean sea level (AMSL) within the northwest corner of the Site to 270 mAMSL within the low, wetland area located adjacent to Kingsway Road (Highway 55). Bedrock outcrops within the area have elevations of 285 to 330 mAMSL.

A discussion of the geology and hydrogeology within CGS is provided in the Greater Sudbury Source Protection Area Assessment Report. These topics are briefly discussed in the following sections.

3.4.1 Geology

Based on regional surficial geology mapping of the area[7], lands in the area of the Site are predominantly underlain by thin discontinuous soils (less than 1 m thick) overlying Precambrian bedrock with low lying areas of peat, muck, and marl wetland deposits. Surrounding lands to the northwest and south are underlain by deposits of the Wanapitei Esker and comprise sand and silt glaciolacustrine and modern fluvial deposits[8].

Based on a review of the MOECC well records[9], the overburden underlying the Site and immediately surrounding areas ranges from less than 2.0 m to greater than 10 m in thickness. Bedrock outcrops to the north and east of the Site. The overburden generally increases in thickness towards Ramsey Lake. Bedrock in the area is described as quartz-feldspar sandstone with minor siltstone, agillite and conglomerate of the Middle Precambrian, Mississaugi Formation with areas of horneblende, gabbro, metagabbro and amphibolite of the Nipissing Diabase[10],[11].

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5 *The Ecosystems of Ontario Part 1: Ecozones and Ecoregions*, Ministry of Natural Resources, 2009

6 Ontario Geological Survey (1999), Surficial Geology Regional Municipality of Sudbury – Map P.3399, Scale 1:100,000

7 Ontario Geological Survey (1999), Surficial Geology Regional Municipality of Sudbury – Map P.3399, Scale 1:100,000

8 Greater Sudbury Source Protection Area Assessment Report, Prepared on Behalf of the Greater Sudbury Source Protection Committee Under the Clean Water Act, 2016 (Ontario Regulation 287/07). Approved September 2, 2014.

9 https://www.ontario.ca/environment-and-energy/map-well-records

10 Ontario Geological Survey (1991), Bedrock Geology of Ontario, Southern Sheet – Map 2544, Scale 1:1,000,000.

11 Ontario Geological Survey (1975), Sudbury-Cobalt Geological Compilation Series, Algoma-Manitoulin, Nippising, Parry Sound, Sudbury and Timiskaming District – Map 2361, Scale 1:253,440

3.4.2 Hydrogeology

In general, the hydrostratigraphic framework of the area corresponds to overburden, predominantly comprised of glaciolacustrine deposits, constrained by bedrock outcrops and wetland deposits. Hydrostratigraphic units within the area of the Site include the following:

- Aquifer (unconfined) – glaciolacustrine sand and silt
- Aquitard – wetland deposits
- Aquitard – bedrock (groundwater flow restricted to relatively small, localized fractures)

In general, the hydrogeology of the Site can be described as a thin, discontinuous fine to medium textured glaciolacustrine unconfined aquifer confined by areas of bedrock outcrop and wetland deposits and overlying bedrock aquitard.

Based on a review of the MOECC well records for the area, groundwater depth within the area is variable ranging from 3 to 10 mBGS.

GHD is not aware of any Site-Specific hydrogeological investigations. In the absence of such information, and based on the area topography including elevated bedrock outcrops northwest and southeast of the Site and the general north to south slope of the lower lying glacial deposits and wetland areas on Site, GHD assumes that groundwater flow direction at the Site is generally to the southwards, toward Ramsey Lake.

3.4.3 Salt Vulnerability

CGS recently retained GHD to prepare a Salt Optimization Plan for the City of Greater Sudbury.[12] This effort included an assessment of salt vulnerability throughout the City of Greater Sudbury based on multi criteria analysis of mapped salt sensitive areas including source water protection areas (i.e. WHPA, IPZ, ICA, HVA, SGRA), wetlands, fish spawning areas, Lake Trout lakes and provincially tracked species. A salt vulnerability index map was generated showing area ranging from low to high risk. Based on this assessment, the majority of the Site was assessed as having a low salt vulnerability cumulative score (see Figure 4).

3.4.4 Anthropogenic Transport Pathways

The Site is serviced with below grade utilities (sanitary sewers and water mains) located within the western portion of the Site. CGS personnel were not aware of the existence of any potable water wells or septic systems at the Site. Stormwater generated on Site either infiltrates into the ground surface or moves as runoff towards roadside ditches along Frobisher Street and towards the wetland area located southeast of the Site.

A 150-mm sanitary sewer forcemain conveys sanitary sewage from the residential subdivision south of Highway 55/Kingsway onto the Site where it discharges into an 825-mm sanitary sewer, which traverses the western portion of the Site from close to the southern boundary up to Frobisher Street and then proceeds westward off-Site. A 150-mm water main servicing the on-Site buildings is located within the western portion of the Site. The locations of these utilities are shown on Figure 2.

12 *"Salt Optimization Plan"*, Prepared by GHD on behalf of the City of Greater Sudbury, November 2017.

The sanitary sewer main bedding may provide a preferential pathway for groundwater to move from the area of Frobisher Street to the southern portion of the Site. The main is located approximately 120 m downgradient of the winter maintenance materials storage area at its' closest point; however the rate of groundwater flow at the Site is unknown.

According to CGS personnel, no USTs have been or are presently owned or operated at the Site.

3.5 Previous Investigations

The following background report for the Site was provided by CGS and was reviewed during this assessment:

- *"Preliminary Geotechnical Investigation City of Greater Sudbury 1800 Frobisher Street Sudbury, Ontario"*, prepared by Terraprobe, 2008.

In 2008, Terraprobe conducted a borehole and test pit program at the Site to investigate subsurface conditions including soil type and groundwater presence/elevation. The investigation included advancement of ten (10) boreholes and excavation of seven (7) test pits up to a depth of approximately 6 mBGS all within the western portion of the Site. Most of the investigative locations were located south of Frobisher Street, however one (1) borehole and one (1) test pit were located north of the salt storage dome. Two (2) boreholes were located along the edge of the low-lying wetland area.

Based on the investigation findings, Site soils within the developed area of the Site are described as fill up to 6 m thick overlying native sand and silt to clayey silt. Soils within the low lying wetland area are described as sandy silt to a depth of 1.5 mBGS overlying clayey silt to a depth of 2.3 mBGS overlying silt and clay. The silt and clay was wet and soft to very soft and extended to the full depth of the boreholes advanced within wetland area.

As monitoring wells were not installed as part of the investigation, groundwater depth was assessed based on the soil conditions encountered at the Site and estimated to range from 1.5 to 3.0 mBGS.

3.6 Surface Water Quality Investigation

On October 4 and 5, 2017, GHD collected surface water samples for sodium and chlorides analyses to assess the existing salt runoff contribution towards Ramsey Lake based on the current Frobisher Depot configuration. As part of GHD's surface water assessment, surface water samples were collected from ten (10) sampling locations, which included one (1) upstream/background sample, two (2) on-Site samples, and seven (7) downstream surface water samples collected between Highway 55 (Kingsway) and Korpela Park, located approximately 300 metres prior to discharge into Ramsey Lake.

Surface water samples were collected in accordance with the standard operating procedure (SOP) for collecting surface water samples attached hereto as Appendix A. Surface water samples were collected directly into the laboratory-supplied containers by submersing the inverted bottle into the water and tilting the bottle opening upstream to fill. The sample was collected with the sample bottle completely submerged to minimize the collection of floating debris within the container.

Samples were placed directly into laboratory-supplied containers, packed in a cooler on ice, and submitted under chain-of-custody protocol to AGAT Laboratories (AGAT), an accredited analytical laboratory located in Sudbury, Ontario. The surface water samples were analyzed for total and dissolved sodium, chloride, and total suspended solids (TSS).

The surface water analytical results are presented on Table 1.

A review of the analytical data indicated the following:

- Upgradient/background total sodium concentration of 152 milligrams per litre (mg/L) and chloride concentration of 117 mg/L.
- On-Site total sodium concentrations of 4,010 and 4,170 mg/L, and chloride concentrations of 6,220 and 6,430 mg/L.
- Downstream total sodium concentrations ranging from 181 to 313 mg/L, and chloride concentrations ranging from 322 to 558 mg/L. While total sodium concentrations generally remained the same downstream of Highway 55/Kingsway, chloride concentration generally slowly decreased with travel from 558 to 374/367 mg/L.

As expected, the highest sodium concentrations were observed immediately downstream of the salt depot where the pickled sand and mixing practices remain uncovered and exposed to the elements. The downgradient low-lying swamp provides an excellent buffer in minimizing the transport of salt from the Site towards the creek and eventually Ramsey Lake.

During the Site investigation, GHD did not observe any significant or moderate evidence of vegetation stress or deterioration as a result of salt loadings from the Site.

A copy of the laboratory analytical report is attached as Appendix B.

4. Risk Management Measures

This section provides the risk management measures (RMMs) and best management practices (BMPs) relevant to the road salt storage and handling.

CGS has used the Site for the storage of winter maintenance materials for several decades. Road salt is currently placed within a covered salt storage dome on a relatively impermeable concrete base, whereas pickled sand is currently stored with no cover, as the dome was demolished in or around 2005. The Site was selected based on accessibility and the surrounding commercial / industrial land use. The road salt storage and handling area is situated within the Ramsey Lake ICA and as such additional mitigation measures are needed to address the potential drinking water threat.

Two measures available to CGS to manage the significant threat of road salt storage and handling within the Ramsey Lake ICA include:

- Maintain Site operations and implement BMPs with monitoring to evaluate the effectiveness of BMPs

- Relocate the winter maintenance material storage to a new location outside of any area where road salt storage and handling is not deemed a significant threat/low vulnerability

4.1 Maintain Existing Site Operations and Implement BMPs

The road salt storage and handling facility at the Frobisher Depot is owned by CGS and operated by CGS staff. In 2016, CGS retained GHD to updated the City of Sudbury Salt Management Plan (2016 SMP). As part of that work, GHD conducted a Site inspection and provided the following observations:

2016 Site Inspection Observations.[13]

Observation	Recommended Actions	Activity Level
Outdoor pickled sand piles, uncovered, located adjacent to the salt storage dome	Consider placing sand under cover and on an impermeable base to prevent salt from washing out	3
Salt stored within a wooden salt dome on a concrete paved base.	Conduct regular inspections of the salt storage dome and the paved base to ensure structural integrity.	2
Housekeeping required to sweep up salt outside of the salt dome	Maintain housekeeping. Conduct regular inspections of areas where salt tracking may occur to ensure housekeeping is maintained.	1
Brine tank located on Site. Staff report that the tank is inspected and maintained. Floor drains were not observed adjacent to brine tank.	Conduct periodic inspections of the brine tank to ensure its integrity	1
Winter maintenance material are stored adjacent to a wetland area	Monitor wetland for signs of vegetative stress	2
Site drainage is southwards towards wetland area within the Ramsey Lake ICA	Install and maintain sediment control and review Source Water Protection Plan Policy requirements. Implement stormwater management at the Site.	1, 2

Activity levels referenced above are defined as follows:

1. Requires minimal effort/cost to implement.
2. Requires minimal to moderate additional cost/effort to implement and will require short term planning and potential changes to department operations.
3. Requires significant cost/effort to implement and may require long term planning.

[13] GHD, May 2016. 2016 Salt Management Plan, City of Greater Sudbury.

Other BMPs for road salt storage and handling as provided in the Transportation Association of Canada's (TAC's), Synthesis of Best Management Practices, Road Salt Management[14] were included within the assessment of continuous improvement practices and strategies provided as Appendix C to the 2016 SMP. These strategies and BMP and their implementation status as of the 2016 SMP are included as Table 2.

The Ontario Ministry of the Environment and Climate Change (MOECC) provides guidance regarding storage of winter maintenance materials[15]. Specifically, MOECC recommends that winter maintenance materials (i.e. road salt and other de-icing materials) be stored within permanent structures underlain by an impermeable base and surrounded by a berm/dyke to prevent seepage and runoff resulting in salt losses to the environment.

4.1.1 Recommended Actions

Based on the recommendations made in the 2016 SMP, TAC's Synthesis of Road Salt BMPS and MOECC Guidance, CGS should ensure that the following BMPs are implemented within the Ramsey Lake ICA:

- Salt and pickled sand storage should be conducted under cover on impermeable surfaces
- Enforce and document housekeeping practices
- Ensure that wash water used to clean winter maintenance vehicles and equipment is collected and directed to the sanitary sewer, if possible
- Monitor surface water runoff and groundwater seepage quality to ensure that groundwater and surface water are not impacted by salt losses at the Site

4.1.2 Monitoring

The results of surface water monitoring conducted as part of this RMP assessment (further discussed in Section 3.6) indicated that surface water at the Site and downgradient of the Site is impacted with sodium and chloride, as compared to background surface water sample. Surface water samples collected within the Site and prior to the on-Site swamp/wetland were significantly elevated, which is a result of the lack of BMPs as described previously (i.e., exposed pickled sand operations, outdoor mixing operations). A visual observation did not observe any significant or moderate evidence of vegetation stress or deterioration as a result of salt loadings from the Site.

To ensure the salt management operations and BMPs remain effective, GHD recommends both surface water and groundwater monitoring on a scheduled frequency.

Surface water can be monitored on a bi-annual (spring and fall) frequency to monitor the effectiveness of BMPs in improving surface water quality. Sample locations could be reduced to four locations, which includes an upgradient/background sample, an on-Site sample located immediately downstream of the winter maintenance material storage, at the Site boundary adjacent

[14] Transportation Association of Canada, September 2003. Synthesis of Best Management Practices, Road Salt Management.

[15] Ministry of the Environment, February 2011. Guidelines on Snow Disposal and De-icing Operation in Ontario. PIBS8271e.

to Highway 55, and further downstream at Korpela Park, which is 300 metres prior to discharge to Ramsey Lake.

As there are no monitoring wells installed at the Site, GHD proposes the installation of three monitoring wells at the Site. One monitoring well would be installed upgradient of the salt operations with two downgradient monitoring wells (one immediately south and one further south). These wells would be used to establish sodium and chloride levels within the shallow overburden aquifers and determine the potential for impacted groundwater, if any, to migrate into the SGRA and HVA south of the Site. Given the tight soil formation within the wetlands, the frequency of sampling could commence on an annual basis with a reduction to bi-annual (every two years) should the levels not fluctuate considerably.

For budget purposes, the only capital cost associated with this monitoring would be the installation of four monitoring wells at an approximate cost of $15,000. Annual surface water and groundwater sampling would be approximately $5,000.

Figure 6 provides the proposed monitoring well and surface water sample locations for monitoring the Site conditions and BMPs.

4.2 Relocate Winter Maintenance Material Storage Outside of the Ramsey Lake ICA

The Ramsey Lake ICA covers the majority of the Site. There is no on-Site location where a new storage facility could be constructed outside of the ICA. As such, moving winter maintenance materials outside of the Ramsey Lake ICA will require relocating to a new property or to an existing CGS facility that is appropriately situated.

A new or significantly re-designed winter maintenance depot must consider the entire salt handling cycle including delivery, stockpiling, loading and off-loading, access routes, as well as equipment washing and wash water management. Variables to consider in selecting a new or existing Site for use as a winter maintenance operations facility include:

- Strategic location and existing site services
- Current and potential future surrounding property uses (minimize nuisance effects)
- Salt vulnerable areas on or near the Site (i.e., drinking water sources, groundwater recharge zones, salt sensitive species, and agricultural operations, etc.)
- Space requirements for material storage and handling as well as complimentary operations (i.e., vehicle washing, storage, fueling, maintenance, and repair; brine production and loading; wash water management)
- Availability or constructability of an indoor space for winter materials storage
- Site drainage and stormwater management requirement
- Potential contaminant transport pathways

A proposed new winter maintenance depot must be specifically designed and engineered for salt storage and management including:

- Site operation and management
  - Materials storage and handling practices
  - Stormwater management
  - Vehicle wash water management
  - Access routes
  - Housekeeping
- Security
- Equipment and vehicle management
- Fueling
- Training and record keeping
- Environmental monitoring

Design considerations include the establishment of an area where activities that may result in the creation of salt-laden runoff can be isolated (winter maintenance area) and all runoff from this area should be contained on Site through stormwater management features (e.g., vegetated filter strips, swales, retention pond). The winter maintenance area, swales, and wet pond must be lined with a low permeability layer, and sweeping undertaken surfaces where winter maintenance materials are handled to remove accumulated solids, debris and salt precipitate.

Compared to redeveloping the existing site, relocating the winter maintenance depot will involve significant additional cost and time, including:

- Identifying an appropriate location through the applicable planning process, which must consider the above-noted variables (i.e., potential for creating nuisance noise and traffic or impacting drinking water sources, groundwater recharge zones, species at risk, and agricultural operations, etc.)
- Property purchase and redevelopment (i.e., design and construction)
- Demolition of the existing winter maintenance depot

Should the decision between alternatives be based on cost, relocating the existing depot is considerably more expensive and not recommended.

4.3 Required Plans for Redevelopment or New Reconstruction

With either the reconstruction of the existing Site or a development of any new site, best management practices and plans anticipated include the following:

Operations, Maintenance and Monitoring (OMM) Plan

An Operations, Maintenance and Monitoring Plan should be prepared for any redeveloped or new Site, which would include routine inspection of material storage facilities (structures and asphalt

pads). Potential cracks or damaged areas of asphalt paving will be repaired on an ongoing basis, as required, to minimize the downward migration of surface water.

Storm Water Management (SWM) Plan

A Storm Water Management (SWM) plan should developed for any redeveloped or new Site, which would include sediment removal consisting of vegetated filter strips, vegetated swales, an oil/water separator, wet pond and an engineered outlet structure. These features should be constructed with a low permeability liner to optimize the containment and collection of salt precipitate. The vegetated filter strips and swales will promote particulate removal and plant uptake, the oil/water separator will remove sediments and hydrocarbons, and the wet pond will settle out fine particulates and provide a mixing volume to normalize chloride concentrations and dampen peak concentration discharge.

Operation and maintenance will include the following, as a minimum:

- Inspection of the asphalt deck for cracks, etc. and sealing as required to ensure minimal infiltration.
- Routine sweeping of the asphalt deck to remove deposited salt precipitate and sediments, and disposal off-Site at an approved location.
- Removal of debris and sediments from the level spreader, vegetated filter strip, and vegetated swales and management on Site or disposal at an approved off-site location.
- Regular inspection and cleaning of the oil/water separator at the beginning and end of the snow removal season to maintain optimal removal efficiency.
- Removal and disposal of sediments from the SWM Pond when sediment accumulation levels exceed the designed sediment capture volume/capacity. Plantings that are potentially disturbed during sediment removal activities will be restored where necessary.
- Monitoring of discharge water quality.

This installation will require an environmental compliance approval (ECA). An OMM Plan for all stormwater management controls will be required, which will become part of the stormwater ECA.

Spill Prevention and Contingency (SPC) Plan

If it is anticipated that fuels (petroleum hydrocarbons) and brine may be handled or stored on Site, and that vehicle servicing may also be conducted, a Spill Prevention and Contingency (SPC) Plan should be developed to prevent or reduce the risk of spills of pollutants; and prevent, eliminate, or ameliorate any adverse effects that result from spills of pollutants. The Plan will be developed after the completion of construction activities and prior to site being operational.

Site-Specific Health and Safety Plan (HASP)

A Site Specific Health and Safety Plan (HASP) should be also developed with instruction on maintaining security and site maintenance. This Plan will also be developed and implemented upon completion of the construction activities and prior to the site being operational.

5. Summary

GHD completed a Risk Management Plan Assessment (Assessment) for the Frobisher Depot located at 1800 Frobisher Street in Sudbury, Ontario (Site). The Site is an active winter maintenance depot operated by the City of Greater Sudbury (CGS). Winter maintenance activities conducted at the Site include: salt and sand storage and handling; brine manufacturing; vehicle/equipment storage, maintenance, and repair; and administrative functions.

Under the Clean Water Act (CWA), road salt handling and storage is a prescribed drinking water quality threat, which may contribute to the issue of rising sodium levels within Ramsey Lake. Based on the specific characteristics of road salt storage and handling at the Site (i.e., greater than 0.5 tonnes of road salt stored/handled) and the intersection of the Site with the Ramsey Lake Issues Contributing Area (ICA), the threat is deemed significant. As such, in accordance with the Greater Sudbury Source Protection Area Source Protection Plan Policy Sa-4E RMP, the Site requires a Source Water Risk Management Plan (RMP) for road salt handling and storage activities.

Surface water samples collected for sodium and chlorides, as part of the RMP Assessment, identified:

- Upgradient/background total sodium concentration of 152 milligrams per litre (mg/L) and chloride concentration of 117 mg/L.
- On-Site total sodium concentrations of 4,010 and 4,170 mg/L, and chloride concentrations of 6,220 and 6,430 mg/L.
- Downstream total sodium concentrations ranging from 181 to 313 mg/L, and chloride concentrations ranging from 322 to 558 mg/L. While total sodium concentrations generally remained the same downstream of Highway 55/Kingsway, chloride concentration generally slowly decreased with travel from 558 to 374/367 mg/L.

As expected, the highest sodium concentrations were observed immediately downstream of the salt depot where the pickled sand and mixing practices remain uncovered and exposed to the elements. Sodium concentrations were lower downstream. The on-Site (downgradient) low-lying swamp provides an excellent salt attenuation and buffer in minimizing the transport of salt from the Site towards the creek and eventually Ramsey Lake. No visual evidence of vegetative stress or deterioration was observed as a result of salt loadings from the Site.

As such, two measures available to CGS to manage the significant threat of road salt storage and handling within the Ramsey Lake ICA include:

- Maintain Site operations and implement BMPs with monitoring to evaluate the effectiveness of BMPs.
- Relocate the winter maintenance material storage to a new site, located outside of any area where road salt storage and handling is deemed a significant threat, preferably within an area of low salt vulnerability as identified in the CGS Salt Optimization Plan.

Considering the additional cost and time associated with relocating the depot, in association with the benefits provided by the low-lying downgradient swamp which provides salt attenuation and a

buffer from salt travel, redeveloping the existing Site using BMPs (i.e., build a dome for the pickled sand, install a monitoring network) would be the most economical and practical option.

All of Which is Respectfully Submitted,

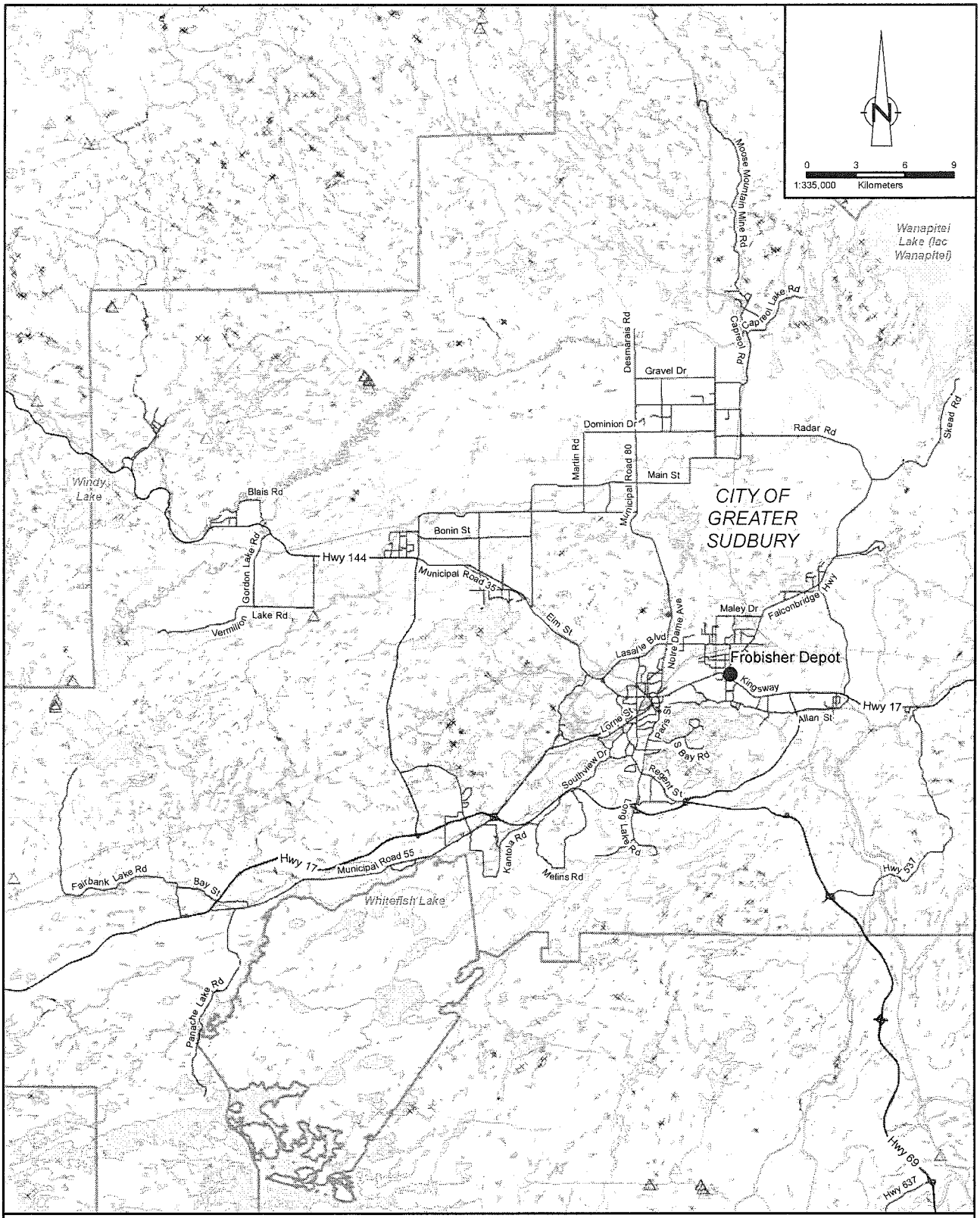
GHD

Robert Bressan, P.Eng., FEC

Sarah Ackert Ferguson, P.Eng.

Andrew Betts, M.A.Sc., P.Eng.

Figures



Source: MNRF NRVIS, 2014. Produced by GHD under licence from Ontario Ministry of Natural Resources and Forestry, © Queen's Printer 2017;
Coordinate System: NAD 1983 UTM Zone 17N

figure 1

SITE LOCATION MAP
RISK MANAGEMENT PLAN ASSESSMENT – FROBISHER DEPOT
CITY OF GREATER SUDBURY
Sudbury, Ontario

039382-42(008)GIS-OT001 Nov 09/2017

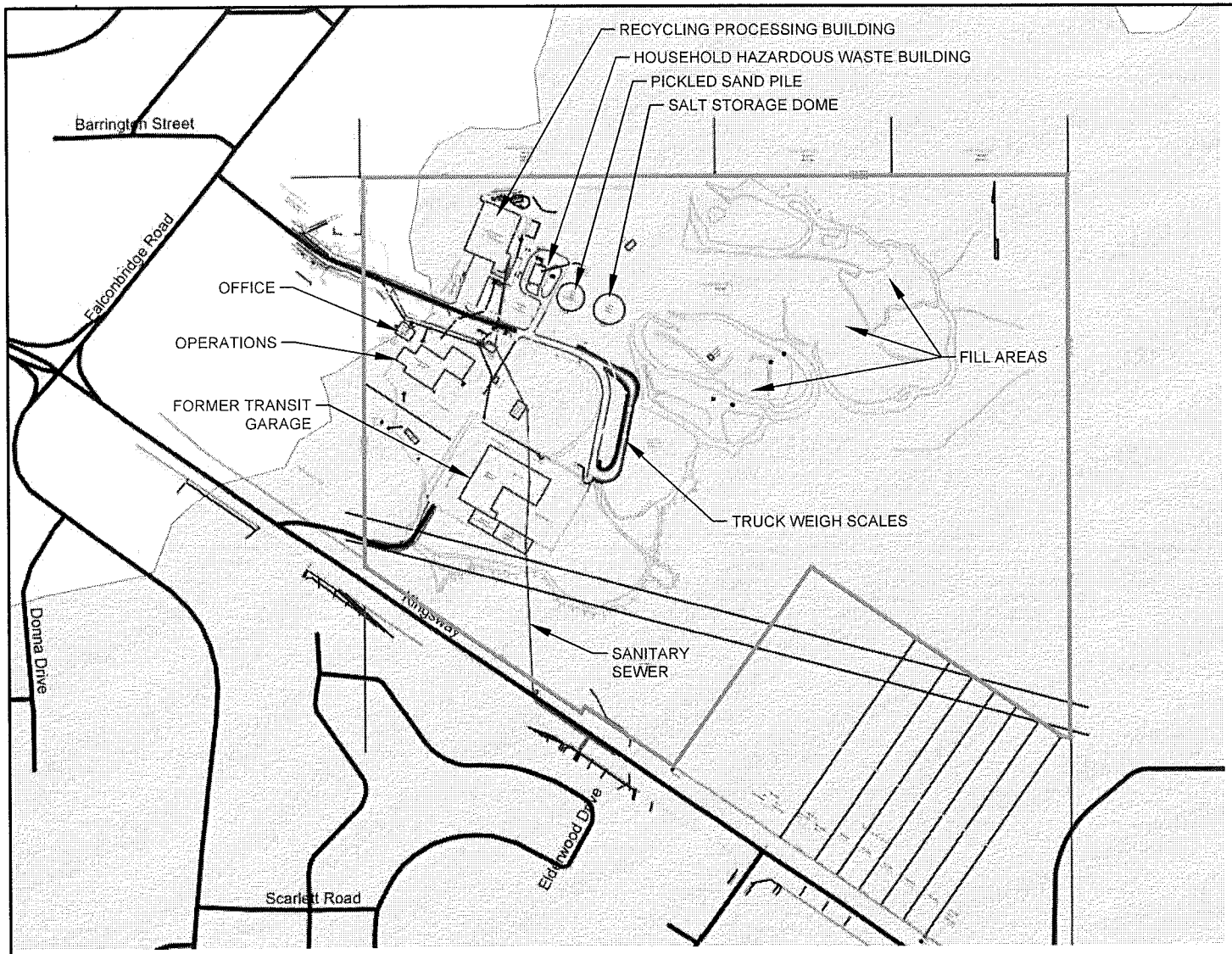


figure 2

SITE LAYOUT
RISK MANAGEMENT PLAN ASSESSMENT - FROBISHER DEPOT
CITY OF GREATER SUDBURY
Sudbury, Ontario

GHD

39382-42(008)GN-WA002 NOV 10, 2017

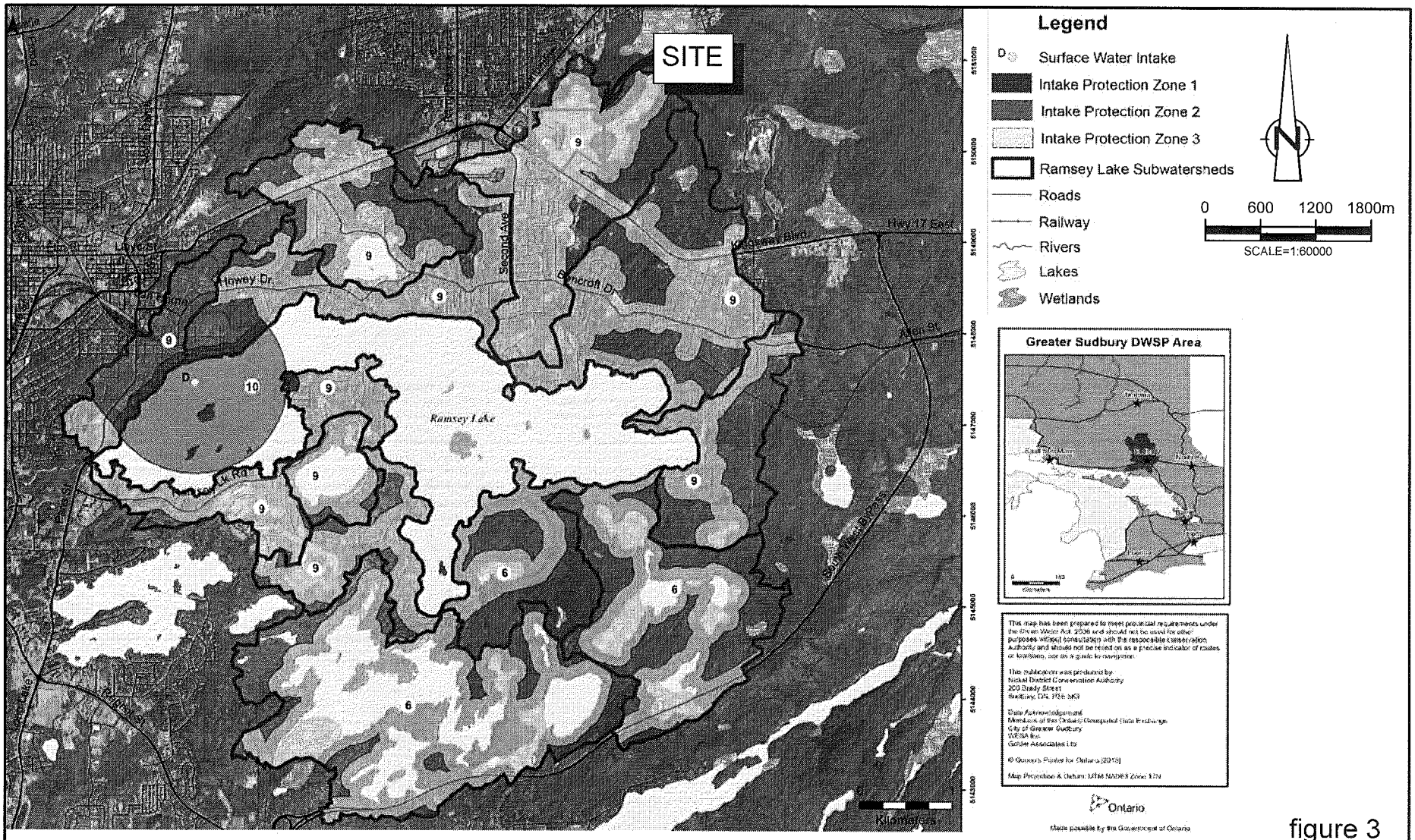
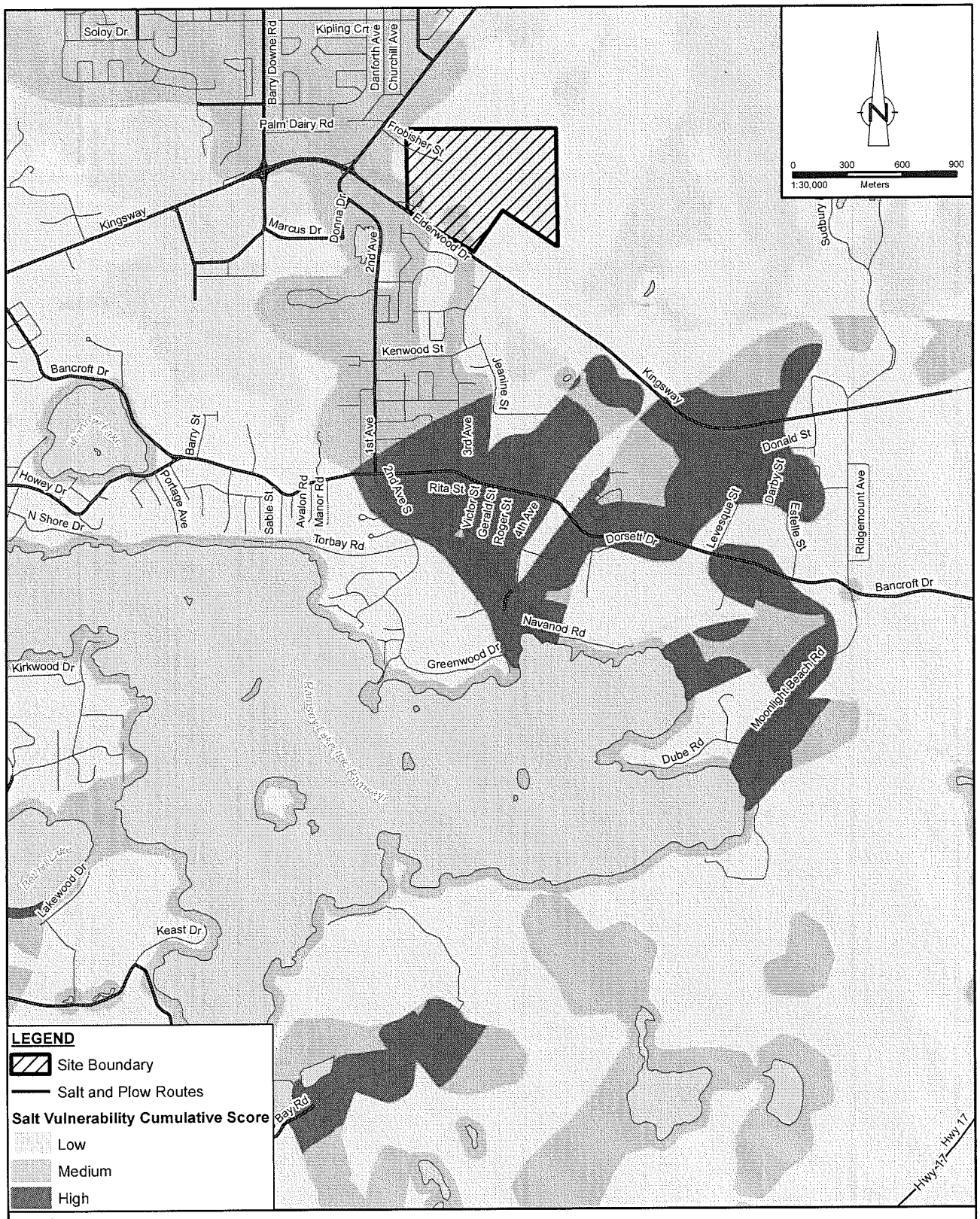


figure 3

RAMSEY LAKE INTAKE PROTECTION ZONES WITH VULNERABILITY SCORING
RISK MANAGEMENT PLAN ASSESSMENT - FROBISHER DEPOT
CITY OF GREATER SUDBURY
Sudbury, Ontario

39382-42(008)GN-WA003 NOV 9, 2017

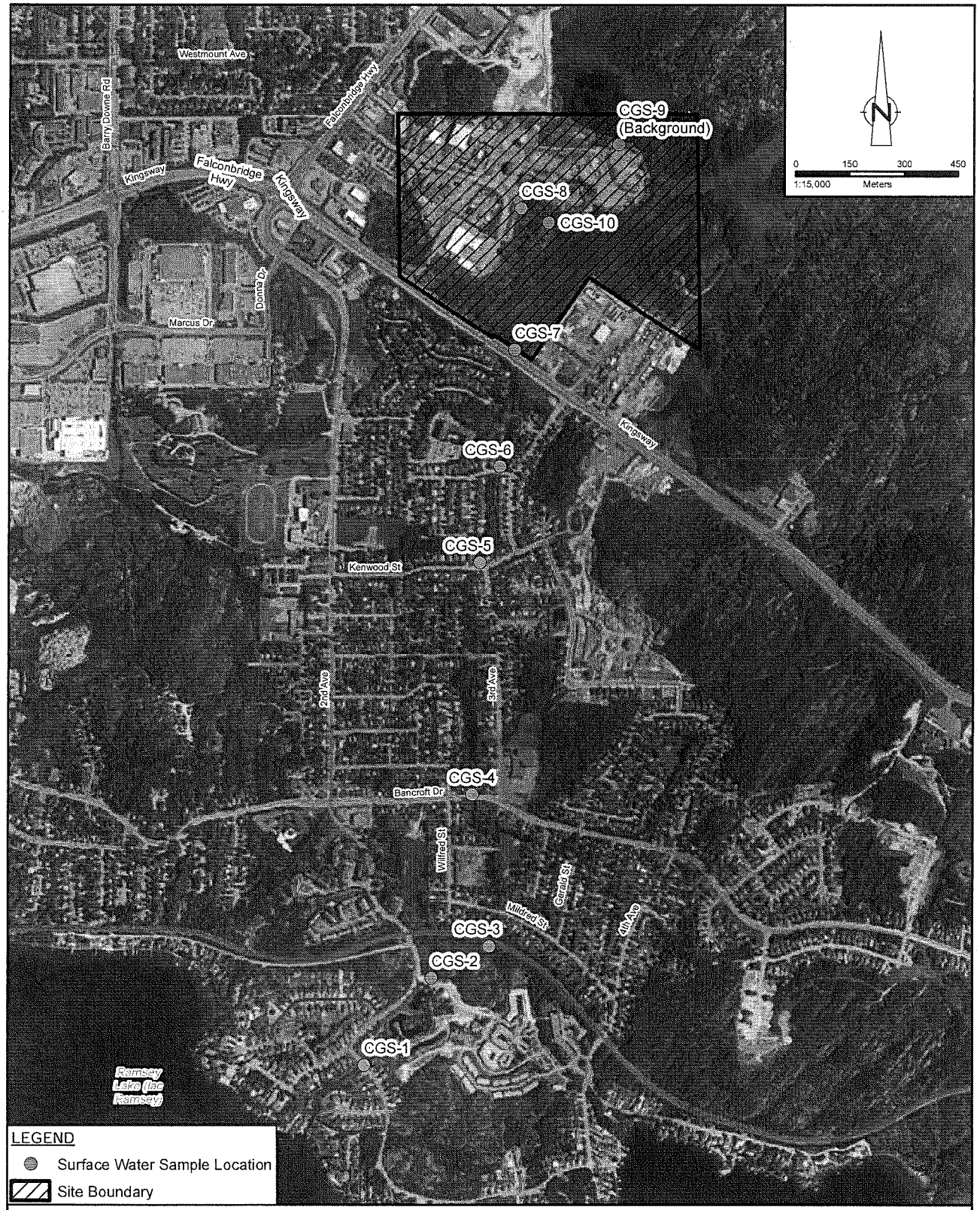


Source: Image ©2017 Google, Imagery date: 08/05/2016
Coordinate System: NAD 1983 UTM Zone 17N

figure 4

SALT VULNERABILITY INDEX
RISK MANAGEMENT PLAN ASSESSMENT – FROBISHER DEPOT
CITY OF GREATER SUDBURY
Sudbury, Ontario

039382-42(008)GIS-OT004 Nov 10/2017

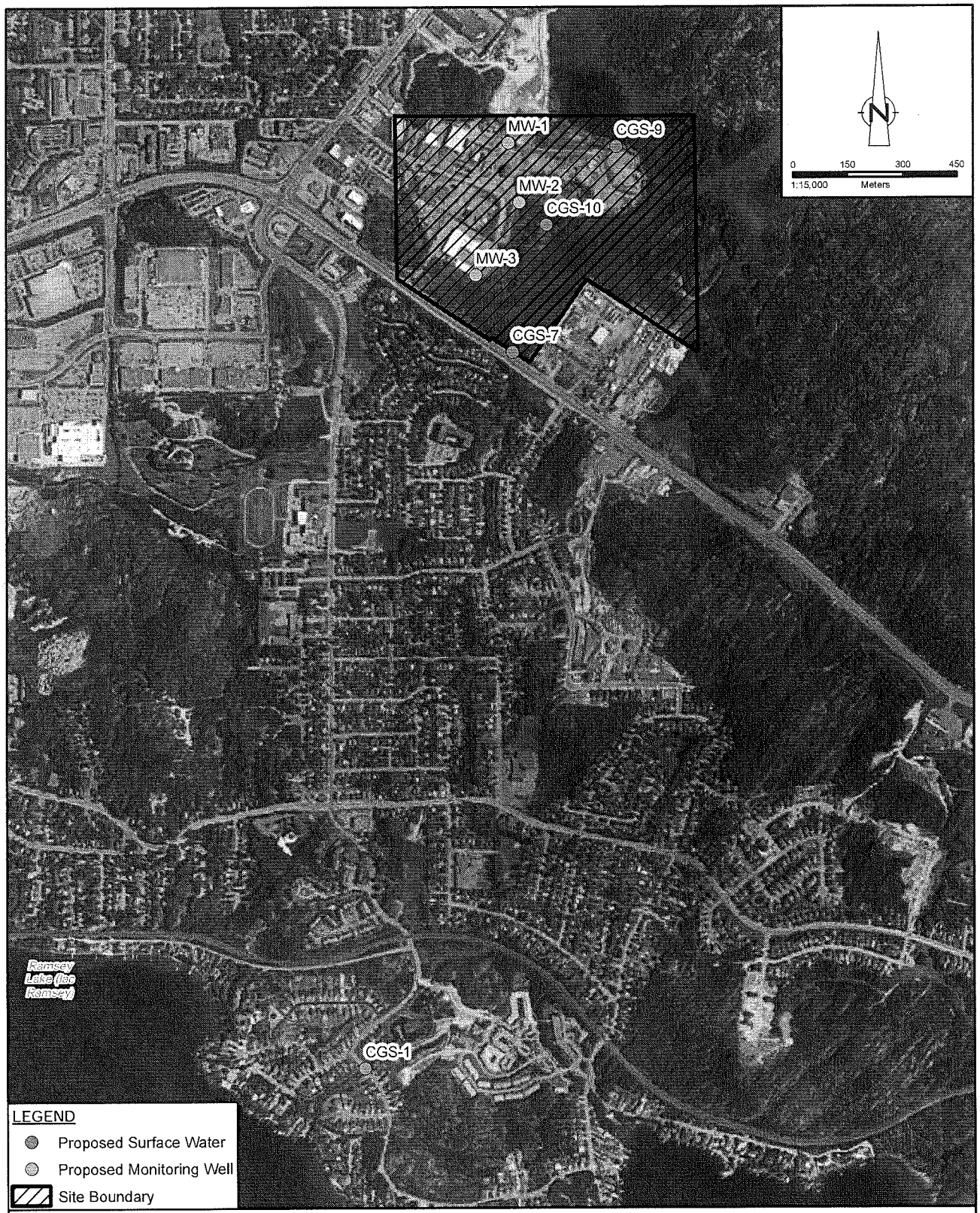


Source: Image ©2017 Google, Imagery date: 08/05/2016
Coordinate System: NAD 1983 UTM Zone 17N

figure 5

SURFACE WATER SAMPLES – OCTOBER 4 & 5, 2017
RISK MANAGEMENT PLAN ASSESSMENT – FROBISHER DEPOT
CITY OF GREATER SUDBURY
Sudbury, Ontario

039382-42(008)GIS-OT002 Nov 10/2017



Source: Image ©2017 Google, Imagery date: 08/05/2016
Coordinate System: NAD 1983 UTM Zone 17N

figure 6

PROPOSED MONITORING PROGRAM
RISK MANAGEMENT PLAN ASSESSMENT – FROBISHER DEPOT
CITY OF GREATER SUDBURY
Sudbury, Ontario

039382-42(008)GIS-OT003 Nov 10/2017

Tables

Table 1

Surface Water Sampling - Analytical Results
Frobisher Depot - Surface Water Sampling
City of Greater Sudbury, Ontario

					Chemical Analysis			
	Location ID	Location Description	Sample Date	Sample Identification	Chloride	Total Suspended Solids	Sodium-dissolved	Sodium - total
Surface Water Samples	CGS-1	Korpela Park (north of Kormak St.)	4-Oct-17	SW-39382-171004-RB-01	374	<10	200	218
	CGS-1	Korpela Park (duplicate)	4-Oct-17	SW-39382-171004-RB-02(1)	367	<10	202	203
	CGS-2	Finlandia Bridge (beneath)	4-Oct-17	SW-39382-171004-RB-03	322	<10	173	181
	CGS-3	CPR Concrete Culvert (south side)	4-Oct-17	SW-39382-171004-RB-04	414	<10	207	210
	CGS-4	Bancroft Drive (north side)	4-Oct-17	SW-39382-171004-RB-05	426	<10	224	225
	CGS-5	Kenwood Street (north side)	4-Oct-17	SW-39382-171004-RB-06	430	<10	238	248
	CGS-6	Highgate Road (north side)	4-Oct-17	SW-39382-171004-RB-07	451	<10	238	247
	CGS-7	Highway 17 Kingsway (north side)	4-Oct-17	SW-39382-171004-RB-08	558	10	282	313
	CGS-8	Depot (standing water)	4-Oct-17	SW-39382-171004-RB-09	6,220	27	3,790	4,010
	CGS-9	Background (north of fill material)	4-Oct-17	SW-39382-171004-RB-10	117	<10	81	152
	CGS-10	Downstream of Depot (stream into swamp)	5-Oct-17	SW-39382-171004-RB-11	6,430	<10	3,680	4,170

Notes:

All units are in milligrams per Litre (mg/L)

(1) Field duplicate sample

Na Sodium

TSS Total Suspended Solids

Table 2

Best Management Practices - Continuous Improvement
Risk Managment Plan Assessment - Frobisher Depot
City of Greater Sudbury, Ontario

Best Management Practices	Currently Reviewed and Updated As Needed	Need for Review and Updating	Requires periodic review to maintain continuous improvement	Currently Implemented or Completed	Not Currently Considered	NOTES
Material Delivery and Handling						
Defined winter maintenance material storage and handling area				✓		
Low permeability pad		✓				
Berm or curb to prevent runoff into surrounding area					✓	
Salt-laden runoff directed to catch basins					✓	There are no stormwater catchbasins on Site
Salt stored inside a permanent, roofed structure				✓		Salt is stored in a dome
Impermeable Floor		✓				Floor is relatively impermeable
Periodic Roof/wall Inspections			✓	✓		Regular inspection are conducted
Periodic Floor Inspections for cracks and leaks		✓				
Indoor Loading Salt into spreaders				✓		
Practices to minimize spillage during loading	✓		✓			
Practices for quick salt spill clean up/housekeeping	✓		✓			
Excess salt returned to storage			✓	✓		
Salt deliveries covered while in transport and delivered in good weather	✓			✓		
Clean loading pads following transfer of material indoors					✓	
Records kept: Weigh tickets with truck number for each delivery				✓		
Timing of transfer of material indoors		✓				
Cleaning of loading pad after material transfer					✓	
Pickled Sand stored inside a permanent, roofed structure					✓	Pickled sand is stored outside
Indoor Pickled sand mixing					✓	
Outdoor mixing in good weather	✓		✓			
Discontinue summer storage of pickled sand		✓			✓	
Equipment Washing						
Wash all vehicles indoors		✓				
Salt water retention/treatment area		✓			✓	
Oil/water separator installed		✓				
Liquid Brine Production, Storage, and Handling						
Are water wells located up-gradient						There are no drinking water wells on Site. The Site and surrounding area are servcies by municipal water supply
Sufficient water supply for brine production				✓		
Seondary Containment					✓	There are no floor drains in the area of the brine tank
Vehicle Impact Protection				✓		The brine tank is located inside a building
Brine transfer from tank to truck conducted on solid impermeable surface		✓			✓	
Periodic Inspections of tank and piping	✓		✓			
Consideration to use washwater or salt impacted drainage for brine production					✓	

Table 2

Best Management Practices - Continuous Improvement
Risk Managment Plan Assessment - Frobisher Depot
City of Greater Sudbury, Ontario

Best Management Practices	Currently Reviewed and Updated As Needed	Need for Review and Updating	Requires periodic review to maintain continuous improvement	Currently Implemented or Completed	Not Currently Considered	NOTES
Records of Material Usage						
Use material tracking system to rationalize amount of materials used with the amount ordered and the residual amount at the end of the season		✓	✓			CGS Fleet has previously experimented with various sensors on its' trucks without a reliable solution to date (comp spread, plow sensores, etc.)
Training						
Sufficient training for equipment operators on controls and operating procedures	✓		✓	✓		
Health and safety requirements for use of equipment and materials			✓	✓		
Environmentally Sensitive/Vulnerable Areas						
Identify vulnerable areas and areas of natural and scientific interest			✓	✓		
Liaise with local potable water supply agencies				✓		
Monitor ground water and recharge areas					✓	
Locate stockpiles and snow disposal sites outside of vulnerable areas		✓				
Communication Strategy						
Prepare an internal handbook for employees that communicates the Council approved winter maintenance policies and procedures and other important information such as, contact lists, shift assignments, etc.		✓	✓	✓		

Appendices

Appendix A
Surface Water Sampling Standard Operating Procedures (SOP)

Technical Memorandum

To:	Tony DeSilva, CGS Road Operations	Ref. No.:	39382-42
From:	Robert Bressan/lb/1	Tel:	705-254-2438
CC:			

Subject: **Surface Water Sampling Procedure - City of Greater Sudbury**

1. Field Procedure for Surface Water Sampling

The purpose of the surface water sampling program is to obtain samples of the creek that are representative of existing surface water conditions. The parameters to be sampled and analyzed include:

- Chloride
- Sodium
- Total Suspended Solids (TSS)

Physical water quality parameters to be recorded in the field at each sampling location as samples are being collected include:

- Conductivity in mS/cm or µS/cm (i.e., specific conductance, conductivity normalized to 25°C)
- Temperature in °C
- pH [unitless]
- Turbidity as NTU
- Dissolved Oxygen (DO) in mg/L
- Total Dissolved Solids (TDS) in mg/L
- Oxidation Reduction Potential (ORP) in mV

Prior Planning and Preparation

The following should be considered prior to conducting surface water sampling:

- Check the weather prior to the sampling date to ensure the appropriate conditions are being sampled. To capture base flow (i.e., dry) conditions, ensure the sample location has not received precipitation within the past three days (72 hours). To capture run-off (i.e., wet) conditions, ensure the sample location has received at least ten millimeters of precipitation within 24 hours of sampling.

- If sample locations are located on private lands, coordinate with the owner for property access prior to the sample event.
- Make proper arrangements with the laboratory with regard to sample containers and sample date.
- Make proper arrangements with field equipment supplier with regard to water quality meter and sample date for equipment pick-up and drop-off (i.e., Maxim Environmental and Safety Inc.). Ensure calibration certificates are provided to ensure equipment is functioning properly. Also, ask to ensure equipment is set to read-out specific conductance for conductivity. Conductivity is a temperature dependent parameter; therefore, the same body of water can have a different conductivity as the temperature increases or decreases. For data comparative purposes, specific conductance is preferred as it is the conductivity of the water body at 25°C. If using a Horiba U-50 series water quality meter, the unit uses an automatic temperature conversion function to calculate conductivity at 25°C at a temperature coefficient of 2 %/°C based on the measured value of the temperature (see section 6.5 of the manual for more information). Ask the supplier for a demonstration on how to use the unit if you are unsure.
- Assemble equipment and supplies prior to sample event (i.e., water quality meter, sample containers, sample coolers, ice, metre stick, waders/overboots, protective gloves, field book/worksheet, pencils/pens, camera/phone for photographs, sample location map/figure, sample work plan, additional equipment if required such as peristaltic pump or t-bars)
- Pre-plan the sampling sequence (i.e., downstream to upstream)
- Working in water presents hazards not encountered in on-land operations. Complete a hazard analysis prior to the first sample event to mitigate risks to the sampler and review with the sampler prior to each sampling event.

Sample Location Selection

Surface water samples should be collected in areas of the creek that have a uniform cross section and flow rate. Mixing is influenced by turbulence and water velocity, therefore surface water samples should be collected in locations immediately downstream of a riffle area (i.e., fast flow zone) to ensure good vertical mixing. To ensure continuity within the sampling program, all surface water samples should be collected at the same location during each sampling event (i.e., install a t-bar at each sampling location) and documented in field notes, including photographs. Wading into the creek increases the chances of disturbance of sediments from the creek bed and therefore should be performed with caution. Surface water samples must be collected with no suspended sediments and should be collected starting at the furthest downstream location to avoid sediment interference with upstream locations. The site should also be clear of immediate point sources (i.e., tributaries and industrial and municipal effects) unless the sampling is being performed to assess these sources.

Sampling Technique

Surface water samples will be collected using the "direct dipping" technique, which involves directly dipping the sample container into the creek, unless the sample container contains preservatives. If a sample container contains preservatives, a pre-cleaned unpreserved sample container should be used to collect the

surface water sample. The surface water sample can then be decanted into the appropriate preserved sample container.

To collect a surface water sample, wade into the water and stand downstream of the sample location, submerse the inverted bottle to the deserved sample depth (typically 15 centimetres below the water surface with the sample container being completely submerged to eliminate the collection of floating debris), and tilt the opening of the sample container upstream to fill. Avoid moving around which could increase the chances of sediment disturbance. If the sample is to be collected in an area where the flow depth is less than one inch, special equipment is required to eliminate sediment disturbance. Surface water samples may be collected using a pre-cleaned shallow container then decanted to the appropriate sample container, or sampling could be performed using a peristaltic pump. A small excavation in the creek bed to create a sump for sample collection can also be considered however, it should be prepared in advance to allow all the sediments to settle prior to surface water sampling.

Once the sample bottle has been filled, secure the lid and place into the appropriate sample bag (if provided) and then into a cooler. After all samples have been collected, the cooler should be filled with ice prior to delivery to the laboratory. If samples will be shipped by via courier to the laboratory, double bag the ice, and line the cooler with a garbage bag sealing ice and samples within the cooler to prevent the occurrence of leaking during shipping. If glass containers are shipped, special attention should be paid to protecting them during shipping. The cooler should be tapped closed with a custody seal in place to maintain chain-of-custody until delivered to the laboratory.

Sample Container Labeling

It is important to ensure all surface water samples are labeled correctly to reflect the sample identification number (i.e., sample ID) associated with the sample location on all sample containers. The laboratory supplying the sample containers will typically provide blank sample labels which can be filled out in the field however, if possible, sample containers/labels can be filled out the day before to save time. Typically, the following information is recorded on each sample container:

- Unique sample ID number
- Sample date and time
- Sampler name or initials
- Analysis requested (i.e., chloride/sodium/TSS)
- Any identifier that can reveal the location to the lab (e.g. WR1 [White River 1]) should be avoided to prevent lab bias in reviewing the sample analysis.

Labels should be written in permanent ink and affixed to the sample container. An example of a unique sample ID would be:

SW-MMDDYY-XXX-001

where:

SW = sample matrix is surface water

MMDDYY = month/day/year

XXX = sampler's first, middle, and last initials

001 = sequential number for the sample event

Chain-of-Custody (COC) is the sequence of possession of an item. A sample is considered to be in custody if it is in the actual possession of a person, in the view of the person after being in his/her actual possession, or was placed in a secure area by that person. The integrity of analytical data is dependent in part on the legally defensible chain of custody of the samples collected. Therefore, COC records must be completed in permanent ink for all samples collected as it documents the transfer of samples for the specified analysis. The COC record must be signed and dated by the sampler when transferring samples. Ask the laboratory how to properly fill out the COC if you are unsure. When shipping samples, the chain of custody is maintained by applying a seal across the cooler lid that must be broken to open the cooler. The receiving laboratory will break the seal and accept the chain of custody has been maintained in transit.

Field Notes for Surface Water Sampling

Use a field book or worksheet to document all surface water sampling activities and record the following at least once per day:

- Name/type of equipment in use for measuring field parameters, date of calibration certificate
- Results of on-site daily calibration test. Note post test-results, and any sensors that fail calibration
- Weather conditions (i.e., dry, raining, overcast) – indicate changes throughout the day

Record the following at each monitoring location:

- Description of surface water sampling location (i.e., location name and surrounding)
- Sampling technique (i.e., direct dipping, peristaltic pump)
- Description of photographs taken
- Physical field parameter values and associated parameter units (i.e., conductivity, pH, temperature, TDS, DO, turbidity, ORP)
- Air temperature and any changes to weather conditions (i.e. starts raining)
- Stream flow directions (i.e., north to south, east to west)
- Creek physical conditions (i.e., width, depth, etc.)
- Visual observations (i.e., presence of tributaries, impoundments, bridges, railway trestles, oil sheen, odours, buried debris, vegetation and canopy cover, algae, fish and other aquatic species, surrounding industrial area, creek and creek bank erosion)
- Unique sample ID including time sample was collected and location

Post Sampling Activities

The following should be performed once sampling has been completed:

- Equipment should be cleaned, allowed to dry completely, and stored
- Sample coolers dropped off at the laboratory with the COC record filled out and attached (check with laboratory for sample drop-off times and after hours procedure)
- File field notes and download photographs
- Compile laboratory results into location specific summaries

Appendix B
Analytical Data – Surface Water Sampling Event (October 4 & 5, 2017)

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: GHD LIMITED
651 COLBY DRIVE
WATERLOO, ON N2V1C2
(519) 884-0510

ATTENTION TO: Airesse MacPhee

PROJECT: 039382-42 - City of Greater Sudbury (PO# 73509263)

AGAT WORK ORDER: 17U268416

WATER ANALYSIS REVIEWED BY: Mike Muneswar, BSc (Chem), Senior Inorganic Analyst

DATE REPORTED: Oct 13, 2017

PAGES (INCLUDING COVER): 5

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 17U268416

PROJECT: 039382-42 - City of Greater Sudbury (PO# 73509263)

CLIENT NAME: GHD LIMITED

ATTENTION TO: Airesse MacPhee

SAMPLING SITE:

SAMPLED BY:

Inorganic Chemistry - Surface Water Samples

DATE RECEIVED: 2017-10-05

DATE REPORTED: 2017-10-12

Parameter	Unit	G / S	RDL	Date Prepared	Date Analyzed	SW-39382-171004-RB-01 Water 2017-10-04 8793582	SW-39382-171004-RB-02 Water 2017-10-04 8793584	SW-39382-171004-RB-03 Water 2017-10-04 8793589	RDL	SW-39382-171004-RB-04 Water 2017-10-04 8793594	SW-39382-171004-RB-05 Water 2017-10-04 8793603
Chloride	mg/L		0.50	2017-10-12	2017-10-12	374	367	322	1.0	414	426
Total Suspended Solids	mg/L		10	2017-10-11	2017-10-11	<10	<10	<10	10	<10	<10
Sodium-dissolved	mg/L		0.10	2017-10-12	2017-10-12	200	202	173	0.10	207	224
Total Sodium	mg/L		1.0	2017-10-12	2017-10-12	218	203	181	1.0	210	225

Parameter	Unit	G / S	RDL	Date Prepared	Date Analyzed	SW-39382-171004-RB-06 Water 2017-10-04 8793608	SW-39382-171004-RB-07 Water 2017-10-04 8793613	SW-39382-171004-RB-08 Water 2017-10-04 8793618	RDL	SW-39382-171004-RB-09 Water 2017-10-04 8793623
Chloride	mg/L		1.0	2017-10-12	2017-10-12	430	451	558	10	6220
Total Suspended Solids	mg/L		10	2017-10-11	2017-10-11	<10	<10	10	10	27
Sodium-dissolved	mg/L		0.10	2017-10-12	2017-10-12	238	238	282	2.5	3790
Total Sodium	mg/L		1.0	2017-10-12	2017-10-12	248	247	313	25	4010

Parameter	Unit	G / S	RDL	Date Prepared	Date Analyzed	SW-39382-171004-RB-10 Water 2017-10-04 8793628	RDL	SW-39382-171005-RB-11 Water 2017-10-05 8793634
Chloride	mg/L		0.20	2017-10-12	2017-10-12	117	10	6430
Total Suspended Solids	mg/L		10	2017-10-11	2017-10-11	<10	10	<10
Sodium-dissolved	mg/L		0.05	2017-10-12	2017-10-12	80.8	2.5	3680
Total Sodium	mg/L		1.0	2017-10-12	2017-10-12	152	25	4170

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to PWQO (mg/L)
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

8793582-8793634 Elevated RDLs indicate the degree of sample dilutions prior to analysis in order to keep the analytes within the calibration range of the instruments and to reduce matrix interferences.

Certified By:

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Quality Assurance

CLIENT NAME: GHD LIMITED

PROJECT: 039382-42 - City of Greater Sudbury (PO# 73509263)

SAMPLING SITE:

AGAT WORK ORDER: 17U268416

ATTENTION TO: Airesse MacPhee

SAMPLED BY:

Water Analysis

RPT Date:			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Inorganic Chemistry - Surface Water Samples															
Chloride	8793589	8793589	322	321	0.3%	< 0.10	101%	90%	110%	108%	90%	110%	85%	80%	120%
Total Suspended Solids	8793582	8793582	< 10	<10	NA	< 10	98%	80%	120%	NA			NA		
Sodium-dissolved	8793582	8793582	200	191	4.6%	< 0.05	99%	90%	110%	99%	90%	110%	98%	70%	130%
Total Sodium	8793582	8793582	218	209	4.2%	< 0.5	99%	90%	110%	88%	80%	120%	95%	70%	130%

Comments: NA signifies Not Applicable.
Duplicate Qualifier: As the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Certified By:

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Method Summary

CLIENT NAME: GHD LIMITED

AGAT WORK ORDER: 17U268416

PROJECT: 039382-42 - City of Greater Sudbury (PO# 73509263)

ATTENTION TO: Airesse MacPhee

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Water Analysis			
Chloride	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Total Suspended Solids	INOR-93-6028	SM 2540 D	BALANCE
Sodium-dissolved	MET-93-6105	EPA SW-846 6010C & 200.7	ICP/OES
Total Sodium	MET-93-6105	EPA SW 846 3010A & 6010C	ICP/OES

1742684916

AGAT Laboratories

5835 Coopers Avenue
Mississauga, Ontario L4Z 1Y2
Ph: 905 712 5100 Fax: 905 712 5122
webearth.agatlabs.com

Chain of Custody Record

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form (potable water consumed by humans)

Report Information:

Company: GHD
Contact: ROBERT BRESSAN
Address: 96 WHITE OAK DRIVE EAST
SAULT STE. MARIE ON
Phone: 705-254-2438 Fax: 705-254-2430
Reports to be sent to:
1. Email: robert.bressan@ghd.com
2. Email: alyssa.maybee@ghd.com

Project Information:

Project: CITY OF GREATER SUDBURY
Site Location: FRUSHER CREEK
Sampled By: ROBERT BRESSAN
AGAT Quote #: PO:
Please note: If quotation number is not provided, client will be billed full price for analysis.

Invoice Information:

Bill To Same: Yes [X] No [ ]
Company:
Contact:
Address:
Email:

Regulatory Requirements:

[ ] No Regulatory Requirement
(Please check all applicable boxes)

[ ] Regulation 153/04
Table (Indicate One) [ ] Ind/Com [ ] Res/Park [ ] Agriculture
Soil Texture (Check One) [ ] Coarse [ ] Fine

[ ] Sewer Use
[ ] Sanitary [ ] Storm
Region (Indicate One) [ ] MISA

[ ] Regulation 558
[X] CCME
[X] Prov. Water Quality Objectives (PWQO)
[ ] Other
(Indicate One)

Is this submission for a Record of Site Condition? [ ] Yes [X] No

Report Guideline on Certificate of Analysis [ ] Yes [X] No

Laboratory Use Only

Work Order #: 735092 63
Cooler Quantity: 1
Arrival Temperatures: 7.9 | 8 | 8.2
Custody Seal Intact: [ ] Yes [ ] No [ ] N/A
Notes:

Turnaround Time (TAT) Required:

Regular TAT [X] 5 to 7 Business Days
Rush TAT (Rush Surcharges Apply)
[ ] 3 Business Days [ ] 2 Business Days [ ] Next Business Day
OR Date Required (Rush Surcharges May Apply):
Please provide prior notification for rush TAT
*TAT is exclusive of weekends and statutory holidays
For 'Same Day' analysis, please contact your AGAT CPM

Sample Matrix Legend

B Biota
GW Ground Water
O Oil
P Paint
S Soil
SD Sediment
SW Surface Water

Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	Field Filtered - Metals, Hg, CrVI (Y/N)	O. Reg 153: Metals and Inorganics; All Metals; 153 Metals (excl. Hydrides); Hydride Metals; 153 Metals (incl. Hydrides)	ORPs: B-HWS; CN; Cr6+; EC; Hg; pH; SAR	Full Metals Scan	Regulation/Custom Metals	Nutrients: TP; NH3; TKN; NO2; NO3+NO2	Volatiles: VOC; BTEX; THM	PHCs F1 - F4	ABNs	PAHs	PCBs: Total; Aroclors	Organochlorine Pesticides	TCLP: M&I; VOCs; ABNs; B(a)P; PCBs	Sewer Use	TSS	Total Sodium	Dissolved Sodium
SW-39382-171004-RB-01	004/17	15:25	4	SW	* ALL &	N		X												X	X
RB-02		15:38			SAMPLES			X												X	X
RB-03		15:56			WERE			X												X	X
RB-04		16:19			NOT			X												X	X
RB-05		16:49			FIELD			X												X	X
RB-06		17:19			& FILTERED &			X												X	X
RB-07		17:58						X												X	X
RB-08		18:18			PLS LAB			X												X	X
RB-09		18:41			FILTER			X												X	X
RB-10		18:58						X												X	X
SW-39382-171005-RB-11		13:06	4	SW				X												X	X

Samples Relinquished By (Print Name and Sign)	Date	Time	Samples Received By (Print Name and Sign)	Date	Time
Robert Bressan	Oct 5/17	14:30	HOLLY SGOUROS	5 OCT 17	1430
Samples Relinquished By (Print Name and Sign)	Date	Time	Samples Received By (Print Name and Sign)	Date	Time
				17/10/6	1532
Samples Relinquished By (Print Name and Sign)	Date	Time	Samples Received By (Print Name and Sign)	Date	Time

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N°:

Pink Copy - Client | Yellow Copy - AGAT | White Copy- AGAT

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