

Appendix L

Conceptual Metal Leaching and Acid Rock Drainage Management Plan

**Crawford Nickel Project –
Conceptual Metal Leaching and
Acid Rock Drainage Management
Plan**

September 30, 2024

Prepared for:

Canada Nickel Company



Prepared by:

Stantec Consulting Ltd.



Limitations and Sign-off

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Acronyms and Abbreviations

ABA	Acid base accounting
ACA	Average crustal abundance
AP	Acid potential
BC MECCS	British Columbia Ministry of Environment and Climate Change Strategy
CCME	Canadian Council of Ministers of the Environment
CWQG-FAL	Canadian Water Quality Guidelines for Protection of Freshwater Aquatic Life
HCT	Humidity cell test
ICP-MS	Inductively coupled plasma mass spectrometry
kt/d	kilotonnes per day
MDL	Method detection limit
MDMER	Metal and Diamond Mining Effluent Regulations
ML/ARD	Metal leaching/acid rock drainage
MP	Management plan
NAG	Net acid generation
NPAG	Non-potentially acid generating
NP	Neutralization potential
NPR	Neutralization potential ratio
PA	Project Area
PAG	Potentially acid generating
PWQO	Provincial Water Quality Objectives
QA/QC	Quality assurance/quality control

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RPD	Relative percent difference
SFE	Shake flask extraction
TIS Guidelines	Tailored Impact Statement Guidelines
TMF	Tailings Management Facility
tpd	tonnes per day
VC	Valued Component
wt. %	Percent by weight

1 Introduction

Canada Nickel Company (Canada Nickel) proposes to develop, operate, and progressively reclaim the Crawford Nickel Project ('the Project'), a new open pit nickel mine and processing facility approximately 42 kilometres (km) north of Timmins, Ontario along Highway 655. The Project is being assessed in accordance with the *Impact Assessment Act, 2019* by the Impact Assessment Agency of Canada. Stantec Consulting Ltd. (Stantec) has been retained by Canada Nickel to develop a Conceptual Metal Leaching and Acid Rock Drainage (ML/ARD) Management Plan (MP) to support the preparation of the Impact Statement.

This Conceptual ML/ARD MP was developed in consideration of the Tailored Impact Statement Guidelines: Crawford Nickel Project (TIS Guidelines, Appendix A.1 of the Impact Statement). As per the TIS Guidelines, the objectives of this ML/ARD MP are to:

- outline the conceptual approach to operational testing to identify and manage potentially acid generating and/or metal(loid) leaching mine waste during mine construction and operations
- describe methods for the prevention, monitoring, management and control of acid rock drainage, neutral mine drainage, and/or and metal(loid) leaching during all project phases

1.1 Project Overview

Canada Nickel proposes to develop, construct, operate, and progressively reclaim a new Open Pit nickel mine and processing facility, collectively known as the Project. The Project includes the development of an Open Pit, stockpiles, ore processing plants, and other mine related infrastructure, as well as a new rail spur line and the relocation of Highway 655 and existing 500 kilovolt (kV) transmission line. Ore will be extracted from a single Open Pit that will be divided into an east zone and main zone. The Project has a mineral reserve estimate of 1,715 million tonnes (Mt) and an expected Project life of 41 years.

The Project is located approximately 42 km north of the City of Timmins, Ontario, in the geographic townships of Crawford, Carnegie, Kidd, Lucas, Beck, Nesbitt, Wark, and Prosser (Figure A.1). A small portion of the Project extent within the geographic townships of Kidd and Wark also lies within the municipal boundary of the City of Timmins.

Based on the current Project design, the maximum rate of ore extraction will be up to 240,000 tonnes per day (tpd), with an estimated average rate of 160,000 tpd over the life of mine. The two ore processing plants and associated service facilities will process run of mine ore delivered to primary crushers to produce nickel concentrate, iron concentrate, and tailings at a rate of approximately 60,000 tpd at the start of mine life, ramping up to a maximum of 120,000 tpd. In addition to nickel and iron, other metals such as cobalt, chromium, palladium and platinum are expected to be recovered from two concentrate streams.

Based on the proposed processing rate and current information regarding the ore body, the current life of the proposed Project is expected to be approximately 41 years. Mining would be completed at a faster pace than milling, thus mining of ore would occur for about 30 years, then milling alone for the last 11 years.

Concentrate from the processing plants will be loaded onto rail cars and shipped via the rail spur line for further processing offsite.

1.2 Management Plan Purpose

The purpose of the Conceptual ML/ARD MP is to document the protocols to be employed to reduce and limit the known and potential environment risks of ML/ARD associated with the Project. This Conceptual ML/ARD MP provides guidance to Canada Nickel for the testing and management of materials exposed during the Project. Procedures and test methods are included for the geochemical characterization of the mined, processed and exposed materials and the classification of ML/ARD potential. Criteria for the management of mined materials including overburden, waste rock, ore, and tailings and exposed materials including pit walls, and tailings beaches are defined, including the identification of materials that can be used for construction.

The objectives of the Conceptual ML/ARD MP are as follows:

- Identify the federal and provincial legislation, regulations and standards relevant to the management of exposed materials.
- Characterize the ML/ARD potential of the materials exposed by the Project.
- Outline the procedures to monitor and document geochemical characteristics of the materials, including testing schedules, parameters, and criteria.
- Describe the procedures to monitor contact water quality for early identification of conditions indicative of ML/ARD.
- Document the material management methods to be followed to reduce and limit the risk of ML/ARD generation from each Project component.
- Describe the adaptive management approach to mitigation measures for each Project component.
- Document triggers and procedures for revisions to the ML/ARD MP.

This Conceptual ML/ARD MP is a live document, which will be updated throughout the life of the Project. The Conceptual ML/ARD MP will also need to be updated in consideration of requirements identified through future permitting processes.

1.3 Relevant Documents

The geochemical characterization program conducted to support the Project's Impact Statement and this Conceptual ML/ARD MP considered the recommendations provided in "Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials" (MEND Manual) produced by MEND for ML/ARD prediction (MEND 2009). WSP used this Manual in developing the geochemical study design and establishing ML/ARD classification for the Project (appended as Appendix H of the Impact Statement [Crawford Geochemistry Characterization]). Conceptual ML/ARD MP also considered the federal "Environmental Code of Practice for Metal Mines" prepared by Environment and Climate Change Canada (Environment Canada 2009) and other industry best practices from other provinces.

Several other Project specific management plans and monitoring programs that relate to the management of ML/ARD include the Mine Plan, Mine Development Closure Plan, Construction Environmental Protection Plan, Erosion and Sediment Control Plan, Water Management Plan, Explosives Management Plan, Soil Management and Rehabilitation Plan, and the surface water and groundwater monitoring programs. The scope and relationship of these plans to the ML/ARD MP will be outlined in future iterations of the ML/ARD MP.

1.4 Regulatory Framework

Several provincial and federal Acts and their accompanying regulations apply to advanced mineral exploration and mine development activities in Ontario:

- *Ontario Environmental Assessment Act*
- *Mining Act*
- *Environmental Protection Act*
- *Fisheries Act*

Mine development and closure are regulated under Part VII of the *Mining Act* and O.Reg. 35/24. Under these statutes and regulations, monitoring and certification requirements for evaluating the protection of surface water and groundwater and the success of closure activities are identified, including surface water and groundwater quality parameters to be monitored and monitoring frequency. O.Reg. 35/24 includes requirements for geochemical characterization to assess the potential for ML/ARD and development of prevention, mitigation, and monitoring strategies, if necessary. According to the TIS Guidelines, the Conceptual ML/ARD MP is to be developed following the Mine Environment Neutral Drainage Prediction Manual (MEND 2009) and the Provincial Water Quality Objectives (PWQO) guidelines for the protection of water resources. It is noted that the PWQO are not legally enforceable but are used as a guide for the development of ML/ARD management and mitigation strategies. This Conceptual ML/ARD MP will be reviewed and updated as required during advanced engineering and following receipt of a permit for the development of the Project issued under the *Mining Act*.

1.5 Roles and Responsibilities

Interdisciplinary coordination from several departments is required during mine construction, operations, and decommissioning and closure, including mine engineering and environment teams. The roles and responsibilities require input and actions from various levels of the Project team and will be defined as the Project progresses through the authorization stages. General responsibilities may include:

- implementing the Conceptual ML/ARD MP
- providing training for site personnel in the requirements of the Conceptual ML/ARD MP
- directing sampling and testing activities
- providing the data to a qualified professional for review
- implementing materials tracking
- comparing data against ML/ARD criteria, water quality guidelines and ACA concentrations
- reviewing QA/QC results
- reviewing and updating this plan annually or as required
- reporting

2 Project Area and Mine Planning

The Project comprises approximately 11,785 hectares (ha) (118 square kilometres [km²]) along Highway 655, approximately 42 km north of the City of Timmins, Ontario in the geographic townships of Crawford, Carnegie, Kidd, Lucas, Beck, Nesbitt, Wark, and Prosser. A small portion of the Project extent within the geographic townships of Kidd and Wark also lies within the municipal boundary of the City of Timmins. The proposed Highway 655 realignment and rail spur line extend into the geographic Townships of Kidd and Wark (which are considered to be part of the City of Timmins). The Project Area (PA) encompasses the project footprint and is the anticipated area of physical disturbance associated with the construction, operations, and decommissioning and closure of the Project. The PA is shown on Figure A.1.

2.1 Geology

The Project site geology is described in Soils and Terrain Baseline Report (Appendix B.1 of the Impact Statement), Crawford Geochemistry Characterization (Appendix H of the Impact Statement), and the Conceptual Closure Plan (Appendix F of the Impact Statement). The geological formations in the area of the Project site are part of the Deloro Assemblage, consisting mainly of mafic to felsic calc-alkaline volcanic rocks with local tholeiitic mafic volcanic units and an iron formation cap which is typically iron poor chert-magnetite (Ayer et al., 2005; Thurston et al., 2008). The Deloro Assemblage is the host to the Crawford Ultramafic Complex at the PA (Crawford and Lucas townships) and several mafic to ultramafic sills in the northern part of the Crawford Township and in the neighbouring Lucas, Mahaffy, and Aubin townships.

The rocks at the Project site have undergone greenschist facies metamorphism with widespread carbonate, chlorite and sericite alteration in volcanic rocks and serpentinization in ultramafic rocks (i.e., dunite, peridotite). Serpentinization of the ultramafic rocks has resulted in the formation of chrysotile within the deposit, primarily in the dunite rock unit (Appendix B.1 of the Impact Statement).

2.2 Surface Water and Topography

Surface water bodies and the topography at the PA are presented in the Surface Water Resources Baseline Report (Appendix B.6 of the Impact Statement) and summarized in this section to provide additional context. The topography at the PA is typically flat to gently rolling, a typical topography of the glaciated Canadian Shield. The PA elevations range from about 265 to 290 metres (m) above sea level, with topographic relief averaging about 15 m. A thin layer of glacial till over bedrock is usually observed at high elevation areas whereas thicker overburden present in the low-lying areas. The overburden is predominantly glacial till consisting of sand, clay, loose gravel and boulders, and varies in thickness from less than 10 m to as much as 85 m, with an average thickness of about 50 m (Appendix B.6 of the Impact Statement).

As with most of northern Ontario, the Project site is crossed by a number of minor waterbodies and tributaries to larger rivers. The Project site is located primarily between the North Driftwood River and the West Buskegau River, both of which drain north into the Abitibi River. Jocko Creek crosses the southern portion of the PA and flows into Mattagami River which confluences with the Missinaibi River, then combines into the Moose River, one of the major rivers draining into James Bay (Appendix B.6 of the Impact Statement).

A Site-Wide Water Management Plan has been developed by Canada Nickel (Appendix J of the Impact Statement) to manage contact water around the Open Pit, Stockpiles, Impoundment Facility, and Tailings Management Facility (TMF) and non-contact water within the PA. The Site-Wide Water Management Plan (Appendix J of the Impact Statement) includes additional details regarding construction of diversion structures, sediment control, and water quality monitoring plan. Water quality assessment was conducted to evaluate regional water quality through reviewing existing monitoring data for seven Provincial Water Quality Monitoring Network stations and local water quality through collection and analysis of approximately 317 surface water samples within the PA. Additional details related to the surface water hydrology and water quality are presented in the Surface Water Resources Baseline Report (Appendix B.6 of the Impact Statement).

2.3 Mine Plan and Lithologies

The Project components include an Open Pit, Stockpiles, TMF, Impoundment Facility, two ore Processing Plants, and other mine related infrastructure (Figure A.2). Excavated and exposed materials at the PA include overburden, waste rock, ore, and tailings. Overburden is sub-classified and segregated into clay, organic, and mineral depending on the composition of the materials, and then stockpiled accordingly. Waste rock and ore are comprised of six major lithologies. The proportions of each lithology in waste rock and ore generated during the LOM are shown in Table 2.1 based on the mine plan presented in the Water Quality Assessment (Appendix K of the Impact Statement) and the description of these lithologies are as follows:

- Dunite: ultramafic rocks containing primarily olivine and serpentine and minor quantities of brucite, wustite, and hematite.
- Pyroxenite: ultramafic igneous rock essentially consisting of pyroxene mineral group including diopside and actinolite and minor amount of chlorite.
- Peridotite: serpentine dominated ultramafic rock with minor quantities of diopside and chlorite.
- Gabbro: intrusive mafic igneous rock with some andesite, primarily comprising of diopside, plagioclase, zoisite, actinolite, and minor amount of chloride.
- Metavolcanic/Basalt: extrusive igneous rocks mainly of basalts and andesite, primarily comprised of quartz and plagioclase and minor quantities of forsterite and diopside.
- Talc: talc rich unit.

Ore materials will be stored at two ore stockpiles: West Stockpile and East Stockpile. The annual balance of the lithology for each ore stockpile is presented in the Water Quality Assessment (Appendix K of the Impact Statement). Lithological composition of tailings will be approximately estimated based on the percentage of ore generated by lithology.

Table 2.1 Proportions of Waste Rock at the Impoundment Facility and Ore Milled by Lithology Over the Life of Mine

Lithology	Waste Rock		Ore	
	Tonnage (Mt)	Percentage of Total Waste Rock (%)	Tonnage (Mt)	Percentage of Total Ore (%)
Dunite	60.6	1.8	1,202	70
Peridotite	225	6.7	375.1	22
Pyroxenite	132	3.9	16.2	1.0
Gabbro	1,990	59	28.7	2.0
Metavolcanic/ Basalt	872	26	-	-
Talc	89.8	2.7	92.4	5.0
Total	3,370	100	1,715	100
Notes: Mt million tonnes % percent				

3 Project Development

The timing of activities and installation of Project components will occur in sequence to allow for the efficient extraction of materials. Various construction, operations, and decommissioning and closure activities are proposed throughout the life of the mine. The temporal boundary of the assessment includes all Project phases from the start of construction through to the end of closure. Based on the current Project schedule, the Project phases include:

- Construction (Year -3 to Year -1)
- Operations
 - Operations phase 1 (Year 1 to Year 5): 60 kilotonnes per day (kt/d) milling capacity with ore extraction
 - Operations phase 2 (Year 5 to Year 30): 120 kt/d milling capacity with ore extraction
 - Operations phase 3 (Year 30 to Year 41): 120 kt/d milling capacity with no ore extraction
- Decommissioning and closure
 - Active closure (Year 41 to Year 46)
 - Passive closure (Year 46+)

3.1.1 Construction Phase

The construction phase will include the preparation of the site up to the point at which the first process plant has been commissioned and is ready to commence operations. This phase will include site preparation, physical construction, pre-production, and commissioning activities. Construction is anticipated to begin in the Main Zone and East Zone, and rock extracted at this time may be crushed into aggregate using a mobile aggregate crusher for use during the construction of roads and other infrastructure, as necessary.

It is noted that additional construction will occur through the operations phase of the Project, and that this phase is defined by the start of ore processing.

3.1.2 Operations Phase

The operations phase is focused on the active processing of ore and generation of concentrate for delivery to market, specifically operation of the Process Plant(s). Due to the sequential nature of the mine operations, the operations phase of the Project has been divided into 3 sub-phases based on the Open Pit extraction schedule and sequential operation of the two Process Plants.

The three sub-phases of the operations phase are as follows:

- Operations phase 1 – this sub-phase includes the operation of the first of two Process Plants that will be operating at an ore processing capacity of approximately 60 kt/day (or 21.9 Mt/a). IPT carbonation within the process plant may also commence if a CO₂ source is available. Mining operations during this phase will produce more ore than the process plant can process, with surplus material to be stockpiled in the East Stockpile location for future processing. Construction will continue during the phase to expand and construct the second process plant and other supporting mine infrastructure, including the Highway 655 realignment. Material will begin to be stored within the West Stockpile at the end of this sub-phase.
- Operations phase 2 – this sub-phase includes the operation of both Process Plants that will be operating at an ore processing capacity of approximately 120kt/d (or 43.8 Mt/a), including IPT carbonation. Mining operations during this phase will produce approximately 240 kt/day, which is more ore than the process plants can process. Surplus ore will continue to be stockpiled in the East and/or the West ore Stockpiles.
- Operations phase 3 – this sub-phase includes continuation of the operation of both Process Plants at an ore processing capacity of approximately 120kt/d (or 43.8 Mt/a) following completion of mining operations (e.g., no further extraction of ore from the pit). The process plants, including IPT carbonation, will continue to operate by processing the ore stockpiled during operations phase 1 and 2. As mine operations cease, there will be an opportunity for progressive reclamation of the pit, haul routes, and other no longer used areas of the Project site.

3.1.3 Decommissioning and Closure Phase

Following the completion of ore processing, all Project operations will cease, and active closure will commence. Active closure includes the removal of buildings, structures, and other infrastructure, as well as reclamation and site stabilization activities. Once complete, the Project will then enter a passive closure phase as the pit lake fills. During this time, closure monitoring and adaptive mitigation will occur. Following pit lake filling, the Project site will be permanently closed.

Activities completed during the decommissioning and closure phase of the Project are focused on reclaiming the environments, establishing physical, chemical, and biological stability at the site, and to meet desired end land functions and uses. The Closure Plan will be updated throughout the life of the Project as necessary to reflect the environmental requirements in place at the time of closure. The Closure Plan will be prepared, refined, and implemented in accordance with the Ontario *Mining Act* and Ontario Regulation 35/24.

Progressive reclamation throughout the course of the mine life will occur, but the majority of the closure activities will commence at the cessation of mining activities and will be completed five years after ore processing ceases. Ongoing closure monitoring and maintenance activities will be carried out throughout active and passive closure phases until the closure objectives have been satisfied and the Project has been moved to a closed out and abandoned status.

4 Preliminary ML/ARD Assessment Summary

A three-phase geochemical testing program was completed by WSP to characterize the ML/ARD potential for materials that are excavated or brought to the Project area (Appendix H of the Impact Statement [Crawford Geochemistry Characterization]). The characterized materials included ore and mineral wastes from the Project including overburden, waste rock, ore, and tailings (Appendix H of the Impact Statement) in addition to lime that is used to stabilize clay being used for road construction. Results from the geochemical testing program to date are presented in the Crawford Geochemistry Characterization Report (Appendix H of the Impact Statement). The results are summarized in this section to support the preparation of the Conceptual ML/ARD MP.

4.1 Samples and Geochemical Test Methods

A total of 299 waste rock samples, 109 ore samples, four tailings samples, 50 overburden samples, five clay samples, and 15 lime amended clay samples prepared for structural stability testing have been characterized for geochemical characteristics to date (Appendix H of the Impact Statement [Crawford Geochemistry Characterization]). The selected samples were characterized for their ML/ARD potential through static and kinetic geochemical testing. A summary table showing the tests and number of samples completed for each lithology (Appendix H of the Impact Statement [Crawford Geochemistry Characterization]) is provided in Table 4.1 for reference.

Table 4.1 Static and Kinetic Tests Completed to Date

Material Type	Lithology	ABA	NAG	Elemental Analysis	Whole Rock Analysis	Mineralogy	Supernatant Liquid	SFE	HCT
Waste Rock	Dunite	15	-	15	1	1	-	8	-
	Gabbro	85	9	85	4	4	-	44	3
	Pyroxenite	37	1	37	2	2	-	18	1
	Metavolcanic/ Basalt	117	3	117	6	6	-	59	5
	Peridotite	45	6	45	2	2	-	23	2
Ore	Dunite	66	1	66	2	2	-	37	3
	Gabbro	4	-	4	-	-	-	3	-
	Pyroxenite	3	-	3	-	-	-	2	-
	Metavolcanic/ Basalt	4	-	4	-	-	-	3	-
	Peridotite	32	-	32	1	1	-	25	1
Tailings	Dunite	3	-	3	3	3	3	-	3
	Peridotite	1	-	1	1	1	1	1	1
Overburden	Organics	26	-	26	-	-	-	26	-
	Mineral	24	-	24	-	-	-	24	-
Clay and lime amended clay	Clay	5	-	-	-	-	-	5	-
	Lime amended clay	15	-	-	-	-	-	15	-
Total		482	20	462	22	22	4	293	19
Notes: '-' not analyzed ABA acid base accounting NAG net acid generation SFE shake flask extraction HCT humidity cell test Source: Appendix H of the Impact Statement									

4.2 Preliminary Results

The following preliminary results are summarized from the Crawford Geochemistry Characterization (Appendix H of the Impact Statement). Waste rock and ore samples at the PA consist of an abundance of serpentine, oxide minerals such as magnetite, brucite, and wustite, and minor quantities of chlorite. Carbonate was below 5 % by weight (wt. %) except for within the basalt lithology. Siderite was below 0.4 wt. % in analyzed lithologies of waste rock and below detection limit in ore samples. The sulphide content in waste rock and ore samples was below 0.2 wt. %.

Samples were considered to have ML/ARD potential if they meet one of the following criteria below:

- Potentially acid generating (PAG) where neutralization potential ratio (NPR) is less than two (MEND 2009).
- Potentially metal leaching if elemental concentrations are elevated relative to normal distribution. The concentrations were compared to a threshold of 10 times (10x) the average crustal abundance (ACA) following the Guidelines for Metal Leaching and Acid Rock Drainage at Mine Sites in British Columbia (Price 1997).
- Potentially metal leaching if SFE leachate concentrations are elevated relative to PWQO and Canadian Council of Ministers of the Environment (CCME) guidelines. It is noted that these guidelines are selected for screening metal leaching potential and constituents with SFE concentrations exceed PWQO or CCME guideline values do not necessarily indicate that water in contact with exposed waste rock and ore lithologies or tailings will exceed the guideline values for these constituents.

Acid generating potential assessment using carbonate neutralization potential (NP) provides a more conservative prediction as non-carbonate NP of mafic minerals such as serpentine, actinolite, and diopside minerals which were abundant within the waste rock, ore, and tailings lithologies. The lack of both carbonate and sulphur containing minerals in these materials resulted in low carbonate NP and also low acid potential (AP). Thus, carbonate NPR values might not be a reliable indicator for the assessment of acid generating potential. Thus, modified Sobek NPR values were used for the ARD assessment. The modified Sobek NP results indicated that the non-carbonate NP of these materials may provide sufficient NP to consume potential acid generation from sulphide minerals (Appendix H of the Impact Statement [Crawford Geochemistry Characterization]). Based on the modified Sobek NPR values, about 98% of analyzed waste rock samples were classified as NPAG which was consistent with NAG results on a subset of 20 samples. Similarly, 100% of analyzed ore, tailings, clay, and lime amended clay samples were classified as NPAG. About 85% of organic rich overburden samples were classified as NPAG whereas 100% of mineral rich overburden samples were NPAG. Overall, excavated materials at the PA do not likely generate acid drainage based on the ABA and NAG results completed to date.

Metal leaching potential was assessed based on both elemental concentrations and SFE leachate concentrations. Based on elemental concentrations, elements with elevated concentrations in comparison to 10x the average abundance of the crustal rocks (Price 1997) for ore samples included arsenic, bismuth, chromium, magnesium, nickel, and selenium. Elements with elevated concentrations for waste

rock included antimony and tin in addition to those identified for ore samples (Appendix H of the Impact Statement [Crawford Geochemistry Characterization]). The detection of bismuth (0.09 ppm) was greater than 10x the average crustal abundance for bismuth (0.0085 ppm). Thus, the reported bismuth elemental concentrations (below detection limit) for ore samples cannot be reliably used for screening for metal leaching potential for bismuth for ore materials. Based on SFE leachate concentrations, aluminum, boron, cadmium, copper, iron, lead, tungsten, thallium, uranium, vanadium, and zinc for waste rock, ore, and overburden materials exceeded PWQO guidelines (Appendix H of the Impact Statement [Crawford Geochemistry Characterization]). However, except for aluminum, the percentages of samples with SFE exceedances for any of these elements were low for waste rock (less than 20%) and ore (less than 20%; generally, less than 6%) which are the two major excavated and exposed materials at the PA. There was also no distinct difference in SFE leachate concentrations between waste rock lithologies. In combination with kinetic testing results, metal leaching potential of waste rock and ore was considered low. Elements with leaching potential were aluminum and arsenic for basalt lithology and chromium for dunite lithology in ore materials (Appendix H of the Impact Statement [Crawford Geochemistry Characterization]).

Additionally, elements with leaching potential for tailings were chromium and uranium based on four tailings samples analyzed to date. Analyses of additional tailings samples during the operations phase of the Project will be completed to provide a more refined assessment of metal leaching potential of mined materials.

5 ML/ARD Prevention and Management

Materials with the potential for ML/ARD are those excavated and exposed during the mine development include:

- waste rock generated during Open Pit development
- pit walls
- ore
- tailings, including beaches
- overburden
- roads, pads and infrastructure
- materials used in construction and closure activities

Solid waste generated during Open Pit development are anticipated to have similar characteristics with the materials characterized to date (Appendix H of the Impact Statement [Crawford Geochemistry Characterization]). The pit walls are expected to have similar composition to the waste rock and will not be sampled separately unless indicated by geological observations made during excavation of ore and waste rock from the open pit. Haul roads, pads, and infrastructure will be constructed using excess overburden, clay, sand and aggregates from the mine or from local quarries. Lime may be added to stabilize clay being used for the construction of roads. These materials will be characterized for ML/ARD during the waste rock sampling program prior to construction.

5.1 Sampling, Testing, and ML/ARD Classification

5.1.1 Operational Sampling

During construction and operations, sampling will be conducted to geochemically characterize disturbed and exposed materials at the Project site. Sampling is planned to be conducted at a rate indicated in Table 5.1 following MEND guideline (MEND 2009).

Table 5.1 Summary of Operational Sampling Program

Component	Estimated Total Tonnage Over Life of Mine (Mt)	Sampling Rate	Laboratory Analytical Schedule ³	
			Year 1 to Year 3	Year 4 to End of Mine Life
Overburden	0.65	1 per 10,000 t	Samples will be tested for ABA, SFE, and elemental concentrations of bulk samples. 10% of collected samples will be subjected to WRA and XRD test methods	TBD
Waste / Construction Rock	3,370	1 per 50,000 t (Year 1 to 3) ^{1,2} 1 per 10,000 t for rock used in construction within the PA		
Ore	1,715	1 per 100,000 t (Year 1 to 3) ¹		
Tailings (End of Pipe)	1,273	1 per 50,000 t (Year 1 to 3) ¹		
Tailings (Beaches)	TBD	1 per 10,000 m ² at closure		
Notes:				
1 sampling rate may be reduced during operations following results from the confirmatory sampling program				
2 per lithology				
3 laboratory analytical methods are described in detail in Section 5.1.2				
t tonnes				
ABA Acid-base accounting				
Mt million tonnes				
PA Project Area				
SFE Shake flask extraction				
TBD to be determined				
WRA Whole rock analysis				
XRD X-ray diffraction				

5.1.2 Laboratory Analysis

A procedure for collection of confirmatory samples will be developed prior to the start of the Project. The proposed analytical schedule for the samples collected during the operational monitoring program is shown in Table 5.1. Contingent on confirmation of the baseline data, the sampling rate may be reduced after the first three years of the operations phase (for example, reduced to 10% of the sampling rates proposed for the operational monitoring program). Analytical results from the operational sampling program will be reviewed by a qualified professional in Year 4 to develop a monitoring plan including sampling rate and analytical schedule for the remaining years of the LOM.

Confirmatory samples collected following the sampling rate outlined in Table 5.1 will be tested according to analytical schedule (Table 5.1). Methods are proposed to be consistent with MEND (2009) and the baseline geochemical characterization program (Appendix H of the Impact Statement) as follows:

- Acid-base accounting (ABA) package including modified Sobek neutralization potential (NP), carbonate NP calculated from total inorganic carbon by LECO furnace, fizz rating, paste pH, total sulphur by LECO, sulphate sulphur by HCl extraction and acid potential (AP) calculated from difference between total and sulphate sulphur. In addition, net acid generation (NAG) testing will be required for samples with carbonate NP below or near method detection limit.
- Shake flask extraction (SFE) testing method, involving continuous mixing of a crushed sample (85% passing 6.3 mm) with deionized water (1:3) for 24 hours, and analysis by inductively coupled plasma mass spectrometry (ICP-MS) for trace elements. In addition, SFE leachates will be analyzed for pH, alkalinity and acidity by titration, and sulphate by colourimetry.
- Elemental concentrations using a four-acid digestion method with ICP-MS detection.
- Whole rock analysis using lithium meta-borate fusion method followed by ICP-MS analysis to determine the concentrations of major elements, reported as oxides.
- Mineralogical analysis using X-ray diffraction (XRD) with Rietveld pattern interpretation to quantitatively determine the proportion of crystalline minerals to detection limits of approximately 0.5 to 2 wt. % depending on crystallinity.

Samples will be analyzed at an external laboratory for parameters outlined above unless an onsite laboratory is commissioned and demonstrated the accuracy and precision of results and establish quality assurance and quality control measures.

5.1.3 Quality Assurance and Quality Control

Replicate samples are used to evaluate sample reproducibility and laboratory data accuracy. One replicate sample will be collected for every 10 primary samples collected. Rock samples are inherently heterogeneous, and care must be taken to collect representative samples. Collection of replicate samples follows the same procedure used for the collection of primary samples. A standard operating procedure for rock sample collection will be developed in the future, prior to the start of the Project.

Reproducibility of data is evaluated using relative percent difference (RPD) calculations for samples with concentrations greater than five times the laboratory method detection limit (MDL).

$$RPD = \frac{\text{Abs}(C_1 - C_2)}{0.5 * (C_1 + C_2)} * 100$$

Where Abs is the absolute value, C_1 is the concentration in the primary sample, and C_2 is the concentration in the replicate sample.

Replicate results for rock samples are considered reproducible if RPD values are less than 50%. For concentrations greater than five times MDL, RPD values greater than 50% may indicate heterogeneity or sample collection or laboratory accuracy issues. Replicate data will be reviewed by a qualified professional to evaluate reproducibility.

5.1.4 ARD Screening Criteria

Samples will be considered to have ARD potential and defined as potentially acid generating (PAG) if they meet one of the following criteria:

- neutralization potential ratio (modified Sobek NPR) is less than two; or
- NAG pH is less than 4.5. NAG testing is required for samples with carbonate NP below or near method detection limit.

5.1.5 ML Assessment

Samples will be tested for metal leaching characteristics which will be compared to the preliminary results from the baseline studies (Appendix H of the Impact Statement) following the evaluation below.

- Potentially metal leaching if elemental concentrations are elevated relative to normal distribution. The elemental concentrations will be compared to a threshold of 10 times the average crustal abundance (ACA) following the Guidelines for Metal Leaching and Acid Rock Drainage at Mine Sites in British Columbia (Price 1997).
- Potentially metal leaching if SFE leachate concentrations are elevated relative to PWQO and Canadian Council of Ministers of the Environment (CCME) guidelines. It is noted that these guidelines are selected for screening metal leaching potential and constituents with SFE concentrations exceed PWQO or CCME guideline values do not necessarily indicate that water in contact with exposed waste rock and ore lithologies or tailings will exceed the guideline values for these constituents.

ML characteristics of samples collected during the operational monitoring program will be assessed in addition to the baseline data to refine the metal leaching characteristics of mined materials. The overall findings will be used to validate and implement the material and water management plans, and adjustments will be made, if needed.

5.2 Material Management

5.2.1 Waste Rock

Waste rock will be stored at the Impoundment Facility during excavation as shown in Figure A.2. Based on preliminary characterization data, waste rock is anticipated to be NPAG and acid rock drainage is not anticipated to occur during the LOM. No waste segregation will be conducted. Confirmatory samples will be collected during the construction phase and the first three years of the operations phase and results will be reviewed by a qualified professional to evaluate potential for ML/ARD.

If confirmatory testing indicates waste rock is PAG, the waste rock will be managed independently, and based on recommendations from a qualified professional, could be encapsulated by NPAG rock at the Impoundment Facility or backfilled in the open pit following completion of excavation. The median modified Sobek NPR value for the preliminary waste rock samples ranged from 5.8 for gabbro to 146 for dunite lithology, indicating that there is excess NP available if more PAG material is encountered compared to what is anticipated (Appendix H of the Impact Statement [Crawford Geochemistry Characterization]).

In addition to metal leaching from waste rock lithologies, nitrogen species originated from the residues of blasting reagents will be released into site contact water, particularly in source water from the waste rock dumps and the open pit. Monitoring nitrogen species in addition to water chemistry parameters in source water will help identify the sources and speciation of nitrogen species in mine waters and develop appropriate additional water management measures to mitigate the potential leaching of metal/metalloid and nitrogen species from the blasted rock at the waste rock dumps and tailings facility into mine contact water.

5.2.1.1 Waste Rock for Construction Materials

During the construction phase, waste rock generated from the East Zone of the Open Pit will be initially available for use as construction materials for haul roads, tailings dam, and other infrastructure. Construction rock will be crushed using a mobile aggregate crusher to produce aggregate. Additional rock required for construction is assumed to be purchased from local quarries. Excess waste rock will be stored temporarily at laydown areas or stockpiled in the Impoundment Facility.

Confirmatory waste rock samples from the PA or aggregate from local quarries will be used to assess the suitability of waste rock for use as construction material, and the assessment will be conducted by a qualified professional. Confirmatory samples will be screened against the criteria identified in Section 5.1.4 to evaluate the potential of the material to develop ARD. Waste rock may be used for construction material if screening criteria indicate it is NPAG as follows:

- If a minimum of three confirmatory samples from a given lithology are below the screening criteria, the material may be used for construction.
- If a sample from a given lithology exceeds the screening criteria, a minimum of 10 samples will be used to determine the median value. If the median values of either modified Sobek NPR or NAG pH meet the screening criteria, the material may be used for construction. The results will be evaluated before the rock can be used for construction.

5.2.1.2 Waste Rock Piles

Excess waste rock will be stockpiled at the Rock Impoundment within the Impoundment Facility to be constructed north of the Open Pit (Figure A.2). Waste rock storage areas shall be rehabilitated to meet physical and chemical stability criteria as required by O. Reg. 35/24. Based on preliminary characterization data, waste rock is anticipated to be NPAG. Thus, waste rock segregation is not necessary and will not be conducted. Where possible, progressive development and reclamation

strategies should be adapted. The waste rock pile at the Impoundment Facility should be built out to minimize the footprint as well as contact water runoff from the pile during construction and operations. This measure will help improve overall site water quality and reduce the water quantity that might require treatment. Waste rock used for the outer surface areas of the waste rock pile will be analyzed to confirm that the waste rock has low potential for ARD and suitable for revegetation when covered by topsoil. Additional mitigation measures can be implemented during mine rehabilitation to reduce the potential for ML/ARD during closure, if necessary.

5.2.2 Ore

During operations phase 1 and 2, ore will be stockpiled for processing at a later stage or when ore extraction is temporarily halted during equipment maintenance. Two ore stockpiles will be developed on the east and west sides of the pit (Figure A.2). Based on preliminary characterization data, ore is anticipated to be NPAG and ARD is not likely to occur during the operations phase when the ore is stockpiled for processing.

5.2.3 Pit Walls

Exposed pit wall lithologies are expected to have similar characteristics with waste rock and ore lithologies. Preliminary characterization data showed that these lithologies are anticipated to be NPAG and acid generation is not expected to occur (Appendix H of the Impact Statement [Crawford Geochemistry Characterization]). Additional mitigation measure will be implemented by flooding the pit during the closure phase. Under saturated conditions (submerged in water), sulphide oxidation is significantly reduced as the oxygen diffusion rate in water is several orders of magnitude lower than the diffusion rate in the atmosphere (MEND 2009).

5.2.4 Tailings

Tailings will be deposited in the TMF starting from Year 1 to the end of Year 17 of operations (Figure A.2). The TMF will be located to the south of the Open Pit and has been designed to hold 495 million cubic metres (Mm³) of tailings covering an area of 2,300 ha. Preliminary characterization data based on four tailings samples showed that tailings is anticipated to be NPAG and acid generation is not expected to occur (Appendix H of the Impact Statement). Tailings of both dunite and peridotite ore lithologies exhibited metal leaching potential. Confirmatory tailings samples will be collected during the first three years of the operations phase and the results will be reviewed by a qualified professional to evaluate potential for ML/ARD of tailings from dunite and peridotite ore lithologies. Tailings classified as NPAG should be placed at the surface towards the end of deposition in Year 17 of operations. A “thickened tailings cone” deposition method will be applied at the TMF to increase the TMF storage capacity while limiting the perimeter dam height and to allow a steeper beach slope, minimizing exposed tailings at beach areas (Appendix F of the Impact Statement). The TMF will be rehabilitated within five years after the deposition ceases by placing a 0.15 m layer of overburden and/or organic soil, subsequently vegetated to reduce ML potential from the interactions of tailings and runoff (Appendix F of the Impact Statement). Tailings produced during Year 18 of operations until the end of the operations phase will be deposited in the Open Pit. Over the LOM, about 61% of tailings will be deposited in the Open Pit and

ultimately covered by water in closure to reduce the potential for ML/ARD (Appendix J of the Impact Statement).

5.2.5 Overburden and Clay

Overburden and clay will be stockpiled at the Sand and Till Impoundment and Clay Impoundment, respectively. Overburden and clay will be used for future reclamation. In addition, clay will be amended with lime to improve stability for use in construction of roads, laydowns, and the Impoundment Facility. Preliminary ML/ARD results showed that clay and most overburden (92%) are NPAG based on modified Sobek NPR values. ARD is not expected to occur in water in contact with overburden and clay materials. Where possible, mineral soil can be layered with organic rich soil to reduce ML potential and improve overall quality of the soil for vegetation growth.

6 Contact Water Monitoring, Testing, and Screening

A contact water monitoring program will be developed and established to verify the prediction that ML/ARD should not occur at the Project site and identify any potential early-stage ML/ARD. The water quality model results showed that constituents of potential concerns include nitrate, nitrite, sulphate, arsenic, chromium (VI), copper, selenium, uranium, vanadium, and zinc for water at the water management ponds and the TMF Northwest Collection Pond. Of those, chromium (VI), arsenic, and nitrate concentrations exceeded more than ten times of the CCME CWQG-FAL and PWQO guidelines (Appendix K of the Impact Statement [Water Quality Assessment]). Temporal changes in the concentrations of these constituents should be assessed annually during operations to identify trends and apply mitigation measures, if needed, to reduce the leaching potential of these constituents. Details of contact water monitoring will be developed prior to the start of the Project and included in the surface water and ground water management and monitoring plans.

The proposed monitoring programs will likely include surface water monitoring at effluent discharges, downstream receivers, water treatment plant inlets and outlets, and reference sites. Sample frequency will be determined during the development of the management and monitoring plans.

Seepage monitoring locations from overburden, waste rock, ore Stockpiles, and the Open Pit will be identified to trace any potential ML/ARD sources before it appears at a discharge location. The current plan is to complete monthly seepage surveys, however a detailed sampling schedule will be developed and incorporated into future updates of this plan when seepage monitoring locations are established during detailed engineering. Testing and screening criteria from early detection of ML/ARD are provided below.

6.1 Laboratory Analysis

In situ measurements of pH, oxidation reduction potential (ORP), temperature, oxidation-reduction potential, dissolved oxygen, turbidity and conductivity will be collected in the field and samples will be collected for the laboratory analysis of the parameters listed in Table 6.1.

Table 6.1 Laboratory Analyses

Parameters	Sample Container	Preservation	Filtration
Physical parameters (pH, conductivity), total hardness, total dissolved solids, total suspended solids, turbidity, alkalinity, acidity and select anions (chloride, fluoride, bromide, and sulphate)	500 mL HDPE plastic	None	None
Nitrate/nitrite/total ammonia/un-ionized ammonia/total nitrogen	100 mL amber glass bottle	Sulfuric acid	Field (0.45 µm filter)
Dissolved organic carbon	120 mL amber glass	Sulphuric acid	Field (0.45 µm filter)

Parameters	Sample Container	Preservation	Filtration
Total metals	60 mL HDPE plastic	Nitric acid	None
Dissolved metals	60 mL HDPE plastic	Nitric acid	Field (0.45 µm filter)
Notes: HDPE = high-density polyethylene			

This parameter list will cover the Metal and Diamond Mining Effluent Regulations (MDMER; ECCC 2024) requirements for effluent testing (Appendix B; Table B.1) and a set of relevant parameters with Canadian Water Quality guidelines for Protection of Freshwater Aquatic Life (CWQG-FAL; CCME 2024), PWQO (MOEE 1994), and British Columbia Ministry of Environment and Climate Change Strategy (BC MECCS 2023) for the protection of aquatic life guideline for sulphate (Appendix B; Table B.2) including input values for calculations of site-specific guidelines (pH, temperature, hardness and dissolved organic carbon [DOC]) for linkage with the future surface water and groundwater monitoring plans.

6.2 Quality Assurance and Quality Control

Quality assurance and quality control (QA/QC) samples are used to evaluate the effects of sample contamination and/or heterogeneity. One field blank and one replicate sample will be collected for every 10 water quality samples collected. A standard operating procedure for the collection of contact water samples will be developed in the future prior to the start of the Project.

Replicate results for water samples are considered reproducible if RPD values are less than 20%. For concentrations greater than five times MDL, RPD values greater than 20% indicate potential data collection issues and values greater than 50% indicate definite issues. Sample contamination and heterogeneity are the most likely causes of poor reproducibility (Environment Canada 2005).

Field blanks are used to evaluate potential sample contamination. Concentrations in field blanks should be less than MDL. Common sources of sample contamination include sample collection equipment (e.g., filtration equipment), blowing dust, and PPE (e.g., nitrile gloves).

6.3 Water Quality Screening Criteria

Screening Criteria proposed for contact water samples is presented in Appendix B (Table B.1). Contact water sample results from the laboratory analyses described above will be screened against a value that is 75% of the maximum authorized monthly mean concentration for parameters included in Schedule 4 of the MDMER. In addition to the screening criteria presented in Appendix B (Table B.1), effluent samples from each final discharge point will be tested for acute lethality in accordance with the MDMER.

7 Records and Reporting

7.1 Inventory and Materials Tracking

A materials inventory and tracking system is required for the control of ML/ARD. Excavated material will be tracked using truck counts and an annual summary will be maintained. An example of data to be included in the annual summary is presented in Table 7.1. Detailed inventory and tracking procedures will be developed during detailed engineering and included in future iterations of the plan.

Table 7.1 Materials Inventory Tracking

Pit Phase ID	Bench ID	Blast ID	Blasted to Elevation (m)	Blasted Depth (m)	Blasted Volume (m ³)	Lithology	Sample ID	Sample Collection Date	Material Type (m ³)			Destination (m ³) Notes				
									WRCS	WRST	Haul Roads	TMF	Impoundment	Other	Notes	

Notes:
 WRCS = Waste rock that is suitable for construction
 WRST = Waste rock that does not meet criteria for use as construction materials as indicated in Section 5.2.1 and will be stored at Impoundment Facility

7.2 Reporting

Reporting procedures and documents associated with the ML/ARD MP will be developed to comply with the conditions of release from the provincial and federal environmental assessment processes and permitting requirements (e.g., annual reports requirements).

7.3 Plan Revisions

This Conceptual ML/ARD MP is a living document and will be reviewed and updated by a qualified professional as follows:

- following detailed engineering
- at a minimum, annually during construction and operations
- following changes in the mine plan that may influence ML/ARD prediction
- as required, based on additional laboratory and/or field data that could potentially change the ML/ARD predictions or management protocols provided in this MP.
- results of monitoring programs that require a change or adaptation of the management approach(es) that are described in this document.

Updates or proposed changes to this plan will be submitted to the applicable regulatory authorities for approval, as necessary. Initiation of revisions and revision tracking (e.g., revision history log) will be developed in future iterations of the document.

All ML/ARD MP holders may initiate revisions by forwarding proposed revisions to the Environmental Department. The following information will be provided on the Revision Request Form for all revision requests:

- section to be revised
- nature of the revision
- rationale for the revision (e.g., environment/worker safety)
- name of the revision requestor

Approval for revisions will be required from Canada Nickel. When the Environmental Department approves a revision request, details of the revision will be distributed to all ML/ARD MP holders and will be documented in a revision history log. Each revision will be accompanied by:

- revision instructions
- list of sections being superseded
- an updated Table of Contents indicating the status of each section in the ML/ARD MP
- when ML/ARD MP holders receive a revision, they will, in a timely manner:
 - read the text of the revision

- check the control sheet to confirm that all the listed pages have been received
- remove and destroy the superseded pages from their copy of the ML/ARD MP
- insert the revised pages in the proper place in their copy of the ML/ARD MP
- page check the ML/ARD MP, using the updated table of contents to confirm the ML/ARD MP is complete and current
- enter the revision number and date entered on the revision history log
- incorporate the revision into the area of responsibility, as applicable
- confirm that personnel in their purview are informed of and familiar with the revisions

8 References

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- Thurston, P.C., Ayer, J.A., Goutier, J., and Hamilton, M.A. 2008: Depositional Gaps in Abitibi Greenstone Belt Stratigraphy: A Key to Exploration for Syngenetic Mineralization. Economic Geology v103, pp. 1097-1134.

Appendices

Appendix A Figures



- Legend**
- Project Area
 - Local/Regional Study Area
 - Railway
 - Expressway / Highway
 - Major Road
 - Minor Road
 - Watercourse
 - Provincial Park
 - First Nation Reserve
 - Waterbody



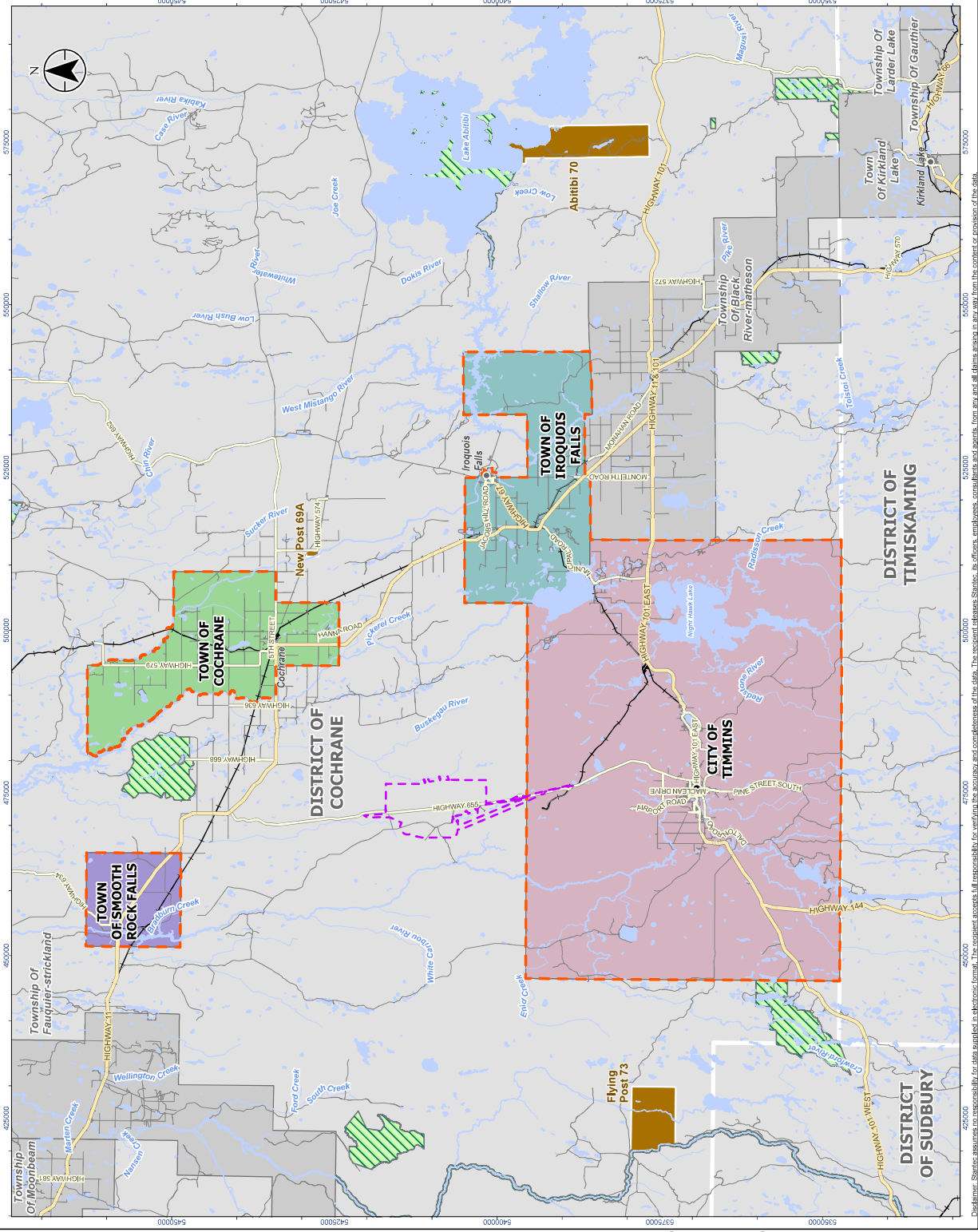
Notes

1. Coordinate System NAD 1983 UTM Zone 17N
2. Base feature provided under license with the Ontario Ministry of Natural Resources and Forestry by the Province of Ontario, 2022.



Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
A.1
Title
Project Area



Crawford Nickel Project - Project Area - Figure A.1 - 18030456 REV1 - Prepared by toghlan on 2024-08-11



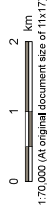
Stantec



Legend

- Project Area**
- Base Features**
- Proposed Project Components**

- Relocated Hwy 655
- Rail Spur Line
- Major Road
- Minor Road
- Existing Transmission Line
- Watercourse
- Waterbody
- Discharge Route
- Non-Contact Water Channel
- Contact Water Channel
- Site Road
- Discharge Location
- Ore Stockpile
- Open Pit
- Clay Impoundment
- Pond
- Tailings Management Facility
- Rock Impoundment
- Reclaim Stockpile
- Sand & Till Impoundment
- Process Plant Area



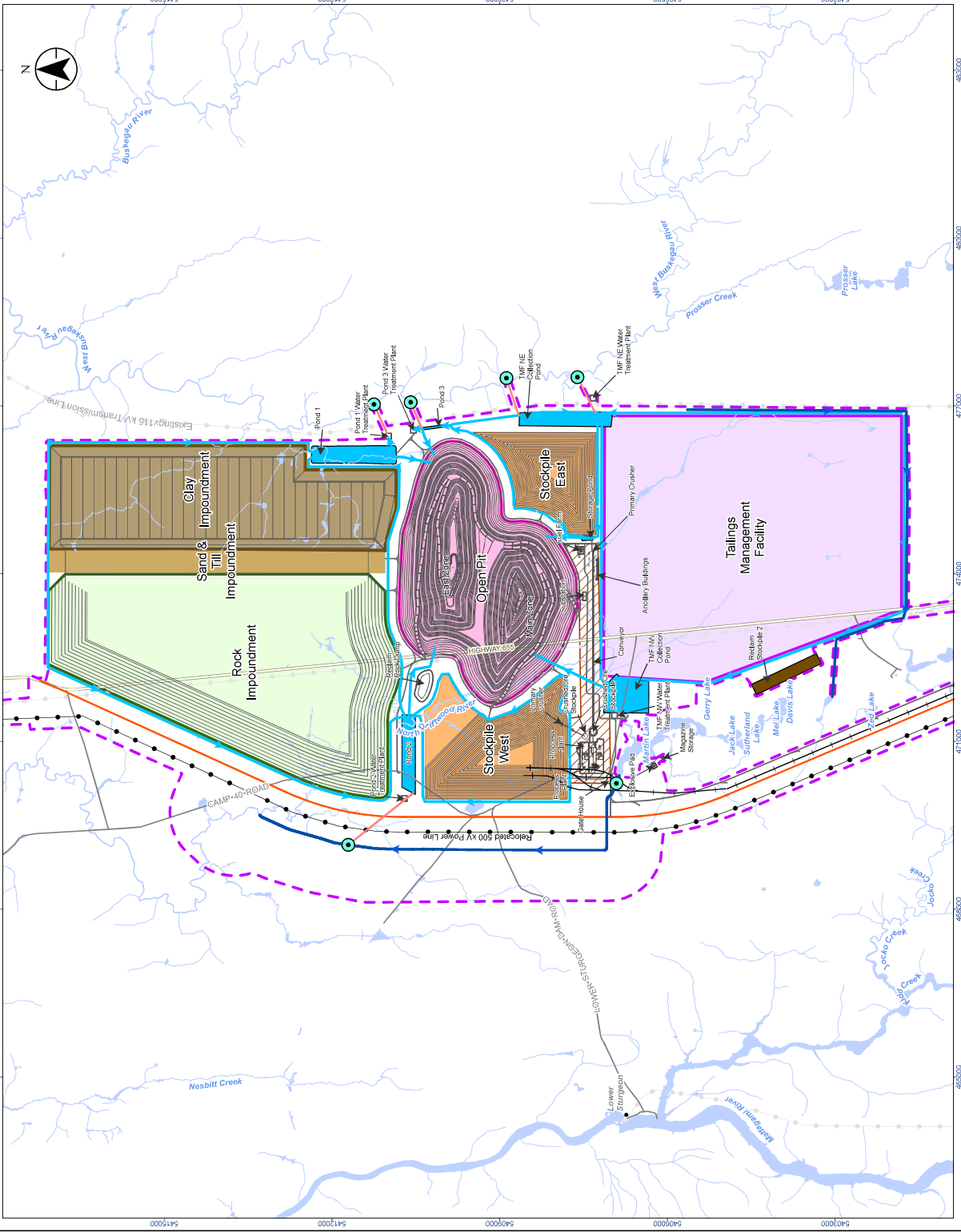
Notes

- Coordinate System NAD 1983 UTM Zone 17N
- Base feature extracted under license with the Ontario Ministry of Natural Resources and Forestry by a Printer for Ontario, 2023.



Client: **Canada Nickel Company (CNC)**
 Crawford Nickel Project

Figure No. **A.2**
 Title **Project Site Plan - Mine Site**



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Appendix B Surface Water and Contact Water Screening Guidelines

Table B.1 MDMER Discharge Limits and Screening Criteria (75% of MDMER) for Contact Water

Parameters	Unit	Maximum Authorized Concentration in a Grab Sample	Screening Criteria (75% of MDMER)
Un-ionized Ammonia (as N)	mg/L	1	0.75
Arsenic (Total)	mg/L	0.2	0.15
Copper (Total)	mg/L	0.2	0.15
Nickel (Total)	mg/L	0.5	0.375
Lead (Total)	mg/L	0.16	0.12
Zinc (Total)	mg/L	0.8	0.6
Radium 226	Bq/L	1.11	0.83
Suspended Solids	mg/L	30	22.5
Notes: Cyanide is not included as one of the screening criteria because cyanide is not used at the Project site.			

Table B.2 Surface Water Quality Screening Criteria

Parameter	Units	Reportable Detection Limit (RDL)	CCME CWQG-FAL Guidelines		Provincial Water Quality Objectives
			Short-term	Long-term	
Field pH	-	0	-	6.5 – 9	6.5 – 8.5
Field Temperature	°C	-5	-	-	-
Field Dissolved Oxygen (DO)	mg/L	0	-	Narrative ^l	Table ^u
Field conductivity	µS/cm	0	-	-	-
Alkalinity	mg/L as CaCO ₃	2	-	-	-
Colour	TCU	5	-	-	-
Dissolved organic carbon	mg/L	1	-	-	-
Total Hardness (as CaCO ₃)	mg/L	0.1	-	-	-
Ammonia (as N)	mg/L	0.005	-	Table ^d	
Calculated un-ionized ammonia (as N)	mg/L	NA		0.016	0.0165
Nitrate (as N)	mg/L	0.02	124	3	-
Nitrite (as N)	mg/L	0.01	-	0.06	-
Total Nitrogen (as N)	mg/L	1	-	-	-
Total Phosphorus (as P)	mg/L	0.002	-	Guidance Framework ^k	Guidance ^w
Sulphate	mg/L	0.3	-	Table ^m (BC MECCS guideline)	
Chloride	mg/L	0.2	640	120	-

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Parameter	Units	Reportable Detection Limit (RDL)	CCME CWQG-FAL Guidelines		Provincial Water Quality Objectives
			Short-term	Long-term	
Oil and Grease, Total	mg/L	1	-	-	-
Total Suspended Solids	mg/L	0.67	-	Narrative ^c	
Total Dissolved Solids	mg/L	10	-	-	-
Radium 226	Bq/L	0.005	-	-	1
Chrysotile Asbestos	MFL	0.20	-	-	-
Fluoride	mg/L	0.06	-	0.12	-
Dissolved Phosphorus	mg/L	0.05	-	-	-
Cyanide	Free	mg/L	0.001	0.005	0.005
	Total	mg/L	0.002	-	-
	Weak Acid Dissociable Cyanide	mg/L	0.001	-	-
Methyl Mercury	D	ng/L	0.02	-	-
	T	ng/L	0.02	4	
Mercury	D	ng/L	0.01	-	200
	T	ng/L	0.01	26	-
Aluminum	D	µg/L	1	Narrative ^e	Narrative ^p
	T	µg/L	1	-	-
Antimony	D	µg/L	0.1	-	-
	T	µg/L	0.1	-	20
Arsenic	D	µg/L	0.1	-	-
	T	µg/L	0.1	-	5
Barium	D	µg/L	0.1	-	-
	T	µg/L	0.1	-	-
Beryllium	D	µg/L	0.02	-	-
	T	µg/L	0.02	-	Table ^r
Bismuth	D	µg/L	0.05	-	-
	T	µg/L	0.05	-	-
Boron	D	µg/L	2	-	-
	T	µg/L	2	29000	1500
Cadmium	D	µg/L	0.005	-	-
	T	µg/L	0.005	Equation ^f	Equation ^g
Calcium	D	µg/L	50	-	-
	T	µg/L	50	-	-
Cerium	D	µg/L	1	-	-
	T	µg/L	1	-	-

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Parameter		Units	Reportable Detection Limit (RDL)	CCME CWQG-FAL Guidelines		Provincial Water Quality Objectives
				Short-term	Long-term	
Cesium	D	µg/L	0.01	-	-	-
	T	µg/L	0.01	-	-	-
Chromium	D	µg/L	0.1	-	-	-
	T	µg/L	0.1	-	-	-
	Chromium III	µg/L	0.1		(III) – 8.9;	8.9
	Chromium VI	µg/L	0.1		(VI) – 1 ^h	1
Cobalt	D	µg/L	0.1	-	-	-
	T	µg/L	0.1	-	-	0.9
Copper	D	µg/L	0.2	-	-	-
	T	µg/L	0.2		Equation ⁿ	Table ^t
Europium	D	µg/L	1	-	-	-
	T	µg/L	1	-	-	-
Gallium	D	µg/L	1	-	-	-
	T	µg/L	1	-	-	-
Iron	D	µg/L	10	-	-	-
	T	µg/L	10	-	300	300
Lanthanum	D	µg/L	1	-	-	-
	T	µg/L	1	-	-	-
Lead	D	µg/L	0.05	-	-	-
	T	µg/L	0.05		Equation ^o	Narrative ^v
Lithium	D	µg/L	1	-	-	-
	T	µg/L	1	-	-	-
Magnesium	D	µg/L	4	-	-	-
	T	µg/L	4	-	-	-
Manganese	D	µg/L	0.1	Equation ⁱ	Variable ^j	-
	T	µg/L	0.1	-	-	-
Molybdenum	D	µg/L	0.05	-	-	-
	T	µg/L	0.05	-	-	-
Nickel	D	µg/L	0.5	-	-	-
	T	µg/L	0.5	-	Equation ^a	25
Niobium	D	µg/L	1	-	-	-
	T	µg/L	1	-	-	-
Potassium	D	µg/L	50	-	-	-
	T	µg/L	50	-	-	-
Rhodium	D	µg/L	1	-	-	-
	T	µg/L	1	-	-	-

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Parameter		Units	Reportable Detection Limit (RDL)	CCME CWQG-FAL Guidelines		Provincial Water Quality Objectives
				Short-term	Long-term	
Rubidium	D	µg/L	0.2	-	-	-
	T	µg/L	0.2	-	-	-
Scandium	D	µg/L	1	-	-	-
	T	µg/L	1	-	-	-
Selenium	D	µg/L	0.05	-	-	-
	T	µg/L	0.05	-	1	100
Silicon	D	µg/L	50	-	-	-
	T	µg/L	50	-	-	-
Silver	D	µg/L	0.01	-	-	-
	T	µg/L	0.01	-	0.25	0.1
Sodium	D	µg/L	50	-	-	-
	T	µg/L	50	-	-	-
Strontium	D	µg/L	0.2	-	-	-
	T	µg/L	0.2	-	-	-
Sulphur	D	µg/L	500	-	-	-
	T	µg/L	500	-	-	-
Tellurium	D	µg/L	0.2	-	-	-
	T	µg/L	0.2	-	-	-
Thallium	D	µg/L	0.01	-	-	-
	T	µg/L	0.01	-	0.8	0.3
Thorium	D	µg/L	0.1	-	-	-
	T	µg/L	0.1	-	-	-
Tin	D	µg/L	0.1	-	-	-
	T	µg/L	0.1	-	-	-
Titanium	D	µg/L	0.3	-	-	-
	T	µg/L	0.3	-	-	-
Tungsten	D	µg/L	0.1	-	-	-
	T	µg/L	0.1	-	-	30
Uranium	D	µg/L	0.01	-	-	-
	T	µg/L	0.01	33	15	5
Vanadium	D	µg/L	0.5	-	-	-
	T	µg/L	0.5	-	-	6
Yttrium	T	µg/L	1	-	-	-
	D	µg/L	1	-	-	-
Zinc	D	µg/L	1	Narrative ^b	Narrative ^b	-
	T	µg/L	1	-	-	20

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				Short-term	Long-term	
Zirconium	D	µg/L	0.2	-	-	-
	T	µg/L	0.2	-	-	4

Notes:

NA - not applicable, T – total, D - dissolved

- a) Ni equation: Hardness ≤ 60 mg calcium carbonate (CaCO_3) $\cdot\text{L}^{-1}$, CWQG-FAL is 0.025 mg/L, Hardness >60 to ≤ 180 mg $\text{CaCO}_3\cdot\text{L}^{-1}$ use equation $e^{(0.76[\ln(\text{hardness})]+1.06)}$, Hardness >180 mg $\text{CaCO}_3\cdot\text{L}^{-1}$, CWQG-FAL is 0.15 mg/L
- b) Zn (dissolved) equation: short-term = $\exp(0.833[\ln(\text{hardness mg}\cdot\text{L}^{-1})] + 0.240[\ln(\text{DOC mg}\cdot\text{L}^{-1})] + 0.526$ for hardness 13.8 and 250.5 mg $\text{CaCO}_3\cdot\text{L}^{-1}$ & DOC 0.3 and 17.3 mg $\cdot\text{L}^{-1}$, long-term = $\exp(0.947[\ln(\text{hardness mg}\cdot\text{L}^{-1})] - 0.815[\text{pH}] + 0.398[\ln(\text{DOC mg}\cdot\text{L}^{-1})] + 4.625)$ for hardness 23.4 and 399 mg $\text{CaCO}_3\cdot\text{L}^{-1}$, pH 6.5 and 8.13 and DOC 0.3 to 22.9 mg $\cdot\text{L}^{-1}$
- c) TSS narrative “clear flow: Maximum increase of 25 mg/L from background levels for any short-term exposure (e.g., 24-h period). Maximum average increase of 5 mg/L from background levels for longer term exposures (e.g., inputs lasting between 24 h and 30 d).”
- d) Total Ammonia as N table is temperature and pH dependent. Measurements of total ammonia in the aquatic environment are often expressed as mg/L total ammonia-N. The present guideline values (mg/L NH_3) can be converted to mg/L total ammonia-N by multiplying the corresponding guideline value by 0.8224. Consult the CWQG-FAL factsheet for specific table.
- e) Al CWQG = 5 µg/L if pH <6.5 , 100 µg/L if pH ≥ 6.5
- f) Cd short-term: 0.11 µg/L if hardness 0 to <5.3 mg $\text{CaCO}_3\cdot\text{L}^{-1}$, $10\{1.016(\log[\text{hardness}]) - 1.71\}$ if hardness ≥ 5.3 mg $\text{CaCO}_3\cdot\text{L}^{-1}$ to ≤ 360 mg $\text{CaCO}_3\cdot\text{L}^{-1}$, 7.7 µg/L if hardness >360 mg $\text{CaCO}_3\cdot\text{L}^{-1}$
- g) Cd long-term: 0.04 µg/L if hardness 0 to <17 mg $\text{CaCO}_3\cdot\text{L}^{-1}$, $10\{0.83(\log[\text{hardness}]) - 2.46\}$ if hardness ≥ 17 to ≤ 280 mg $\text{CaCO}_3\cdot\text{L}^{-1}$, 0.37 µg/L if hardness >280 mg $\text{CaCO}_3\cdot\text{L}^{-1}$
- h) Chromium, trivalent (Cr(III)) = 8.9 µg/L; Chromium, hexavalent (Cr(VI)) = 1 ug/L; Chromium, total = no guideline
- i) Mn (dissolved) short-term: benchmark calculator in Appendix B of Scientific Criteria Document for the Development of the Canadian Water Quality Guidelines for the Protection of Aquatic Life: Manganese
- j) Mn (dissolved) long-term: CWQG calculator in Appendix B of the Scientific Criteria Document for the Development of the Canadian Water Quality Guidelines for the Protection of Aquatic Life: Manganese.
- k) TP narrative = Trigger Ranges for Total Phosphorus (mg/L) (see Guidance Framework for Phosphorus factsheet): ultra-oligotrophic <0.004 , oligotrophic 0.004-0.01, mesotrophic 0.01-0.02, meso-eutrophic 0.02-0.035, eutrophic 0.035-0.1, hyper-eutrophic >0.1 .
- l) DO Narrative = Lowest acceptable DO concentrations for the protection of freshwater organisms; 6 mg/L or greater for early life stages of warmwater species, 5.5 mg/L or greater for other life stages of warmwater species, 9.5 mg/L or greater for early life stages of cold-water species, and 6.5 mg/L or greater for other life stages of cold-water species
- m) Sulphate guideline value is from British Columbia Ministry of Environment and Climate Change Strategy for the protection of aquatic life (Guideline: 128 mg/L for hardness 0 to 30 mg $\text{CaCO}_3\cdot\text{L}^{-1}$; 218 mg/L for hardness 31 to 75 mg $\text{CaCO}_3\cdot\text{L}^{-1}$, 309 mg/L for hardness 76 to 180 mg $\text{CaCO}_3\cdot\text{L}^{-1}$, 429 mg/L for hardness 181 to 250 mg $\text{CaCO}_3\cdot\text{L}^{-1}$) (Meays and Nordin 2013)
- n) Cu long-term: 2 µg/L if hardness 0 to <82 mg $\text{CaCO}_3\cdot\text{L}^{-1}$, $0.2\cdot e^{\{0.8545[\ln(\text{hardness})]-1.465\}}$ if hardness ≥ 82 to ≤ 180 mg $\text{CaCO}_3\cdot\text{L}^{-1}$, 4 µg/L if hardness >180 mg $\text{CaCO}_3\cdot\text{L}^{-1}$

Notes cont.

- o) Pb long-term: 1 µg/L if hardness 0 to <60 mg CaCO₃·L⁻¹, $e^{\{1.273[\ln(\text{hardness})]-4.705\}}$ if hardness ≥60 to ≤180 mg CaCO₃·L⁻¹, 7 µg/L if hardness >180 mg CaCO₃·L⁻¹
- p) At pH 4.5 to 5.5 the Interim PWQO is 15 µg/L based on inorganic monomeric aluminum measured in clay-free samples, at pH >5.5 to 6.5, no condition should be permitted which would increase the acid soluble inorganic aluminum concentration in clay-free samples to more than 10% above natural background concentrations for waters representative of that geological area of the Province that are unaffected by man-made inputs and at pH >6.5 to 9.0, the Interim PWQO is 75 µg/L based on total aluminum measured in clay-free samples
- q) Beryllium: 0.011 mg/L if hardness is <75 mg CaCO₃ L⁻¹, 1.1 mg/L if hardness >75 mg CaCO₃ L⁻¹
- r) Cadmium: 0.0001 mg/L if hardness is 0 to 100 mg CaCO₃ L⁻¹, 0.0005 if hardness is >100 mg CaCO₃ L⁻¹
- s) Copper: 0.001 mg/L if hardness is 0 to 20 mg CaCO₃ L⁻¹, 0.005 mg/L if hardness is >20 mg CaCO₃ L⁻¹
- t) Dissolved oxygen: Consult PWQO table depending on cold water or warm water fish species present <https://www.ontario.ca/page/water-management-policies-guidelines-provincial-water-quality-objectives>
- u) Lead: 0.001 mg/L if hardness is <30 mg CaCO₃ L⁻¹, 0.003 mg/L if hardness is 30 to 80 mg CaCO₃ L⁻¹, 0.005 mg/L if hardness is > 80 mg CaCO₃ L⁻¹
- v) Phosphorus, total (TP): To avoid nuisance concentrations of algae in lakes, average TP concentrations for the ice-free period should not exceed 0.02 mg/L, A high level of protection against aesthetic deterioration will be provided by a TP concentration for the ice-free period of 0.01 mg/L or less. This should apply to all lakes naturally below this value, and excessive plant growth in rivers and streams should be eliminated at a TP concentration below 0.03 mg/L