Crawford Nickel Project Impact Statement

Chapter 14 Assessment of Potential Effects on Groundwater

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Acronyms and Abbreviations

amsl	above mean sea level
APV	Aquatic Protection Values
CCME	Canadian Council of Ministers of the Environment
CWQG-FAL	Canadian Water Quality Guidelines for the Protection of Aquatic Health
EPA	Environmental Protection Act
GCDWQ	Guidelines for Canadian Drinking Water Quality
kt/day	kilotonnes per day
LSA	Local Study Area
MDMER	Metal and Diamond Mining Effluent Regulations
MECP	Ministry of the Environment, Conservation and Parks
ODWQS	Ontario Drinking Water Quality Standards
O. Reg.	Ontario Regulation
OWRA	Ontario Water Resources Act
PA	Project Area
PTTW	Permit to Take Water
PWQO	Provincial Water Quality Objectives
RSA	Regional Study Area
TIS Guidelines	Tailored Impact Statement Guidelines
TMF	Tailings Management Facility
VC	Valued Component

Glossary of Technical Terms

Adsorption	The process by which a solid holds molecules of a gas or liquid or solute as a thin film on its surface.
Anthropogenic	Originating from human activity.
Aquifer	An underground layer of water-bearing rock, sand, or gravel that can store and transmit groundwater.
Artesian Pressure	Pressure in an aquifer from layers above that causes water to rise above the level of the aquifer.
Baseflow	The portion of stream or river flow that comes from groundwater seeping into the stream.
Baseflow Index	A measure of the proportion of streamflow that is contributed by groundwater.
Bedrock	The solid rock layer beneath the soil and overburden.
Brownfield properties	Previously developed land that may be contaminated and requires cleanup before it can be redeveloped.
Calibration	The process of adjusting a model to match observed data.
Chlorite Mineralization	The process of chlorite minerals forming and spreading through rock. Typically occurs under conditions of moderate heat and pressure.
Conductance	Conductance is a measure of how easily water can flow between a river and the underlying aquifer through a river or lakebed.
Contact water	Water that has come into contact with waste materials such as mine rock.
Cross Gradient	Perpendicular to the direction of groundwater flow.

Data Logger	An instrument that automatically and continuously records fluctuations in water level.
Dewatering	The removal of water (groundwater ad/or surface water) from a construction site, mine, or other area, typically to keep work areas dry.
Diffusion	The movement of particles from an area of higher concentration to an area of lower concentration, often resulting in an even distribution of the particles.
Dispersion	The process where dissolved chemicals spread out and mix within the groundwater due to tiny variations in the speed and direction of water flow through the small spaces between soil particles and rock fractures.
Dissolution	The process of dissolving a solid, liquid, or gas into a solvent, resulting in a solution.
Down Gradient	A location that is lower in groundwater elevation relative to another location.
Drawdown	The lowering of the water level in a well, reservoir, or aquifer due to extraction or pumping.
Drive-point piezometer	A small diameter monitoring well used to monitor shallow groundwater levels, often installed in river/lakebeds.
Esker	A long, winding ridge of stratified sand and gravel deposited by glacial meltwater streams.
Exploration borehole	A hole drilled to for mineral or oil exploration.
Fault	A fracture in the Earth’s crust along which movement has occurred.
Fault Gouge	A fine-grained, clay-like material found along fault lines, formed by the grinding of rocks during fault movement.

Felsic	Igneous rocks that are rich in lighter elements such as silicon, oxygen, aluminum, sodium, and potassium.
Fracture	A break or crack in a rock formation that can influence the movement of fluids.
Geochemical	Pertaining to geochemistry, which is the study of the chemical composition of the Earth and its rocks and minerals.
Geotechnical borehole	A hole drilled into the ground to investigate the soil and rock properties for engineering purposes.
Glaciolacustrine	Sediments deposited in lakes formed by glacial activity.
Grain Size Analysis	A test to determine the proportion of different-sized particles in a soil sample.
Groundwater Discharge	The flow of groundwater to the surface, such as into rivers, lakes, or oceans.
Groundwater Recharge	The process by which water from precipitation or other sources such as rivers and lakes infiltrates the ground and replenishes an aquifer.
Horizontal Hydraulic Gradient	A measure of how much groundwater levels change over a certain horizontal distance.
Hydraulic Conductivity	A measure of a material’s ability to transmit water.
Hydraulic response testing	Tests conducted to determine the hydraulic properties of an aquifer, such as hydraulic conductivity.
Hydrogeological	Pertaining to the study of the distribution and movement of groundwater.
Hydrostratigraphic	Refers to a body of rock or sediment characterized by its porosity and hydraulic conductivity, which influence the flow and storage of groundwater.

Infiltration	The process by which water on the ground surface enters the soil.
Lithostatic pressure	The pressure exerted on a body of rock by the weight of overlying rocks.
Mafic	Igneous rocks that are rich in heavier elements such as magnesium and iron.
Metal leaching and acid rock drainage	Naturally occurring processes where minerals containing metals and sulfur come into contact with air and water, leading to oxidation. This can produce acidic water that dissolves and transports metals.
Mineralization	The process by which minerals are deposited in a geological formation.
Monitoring well	A (typically) small diameter well used to monitor groundwater levels and quality.
Mounding	The rise of the water table around a point of increased recharge.
Numerical three-dimensional groundwater flow model	A computer model used to simulate groundwater flow in three dimensions
Outcrop	A visible exposure of bedrock on the surface of the Earth.
Overburden	The material that lies above bedrock. Overburden can include soil, sand, gravel, and other sediments that have not been compacted or lithified into solid rock
Porosity	A measure of how much void space is present in soil, overburden, or rock
Potable	Water that is safe to drink.
Precipitation (chemical)	The process by which a solid forms and separates from a liquid solution, often as a result of a chemical reaction.
Record of Site Condition	A document that summarizes the environmental condition of a property, typically required for redevelopment

Secondary porosity	Porosity that develops after the rock has formed, often due to processes like fracturing or dissolution.
Seepage	Contact water that has infiltrated to the groundwater flow system.
Sentry Well	A monitoring well used to detect contaminants in groundwater before they reach a critical area.
Steady state groundwater model	A computer model of a groundwater system in which groundwater levels do not change over time.
Stream bed and lakebed leakage	The movement of water between a stream or lake and the underlying groundwater system.
Ultramafic	Igneous rocks with very high magnesium and iron content, often found in the Earth's mantle.
Upgradient	A location that is higher groundwater elevation relative to another location.
Water table	The upper surface of the zone of saturation where the soil or rocks are permanently saturated with groundwater.
Watershed	An area of land that drains to a common water body.
Zone of Influence	The area affected by a particular activity, such as groundwater pumping.

14 Assessment of Potential Effects on Groundwater

Groundwater was selected as a Valued Component (VC) for assessment because it has potential to be a source of potable water, is important in maintaining ecological habitats by supporting stream flow, vegetation, and wetlands, and is of cultural importance. Groundwater includes domestic, commercial, and industrial groundwater-source water supplies and the groundwater component of freshwater ecosystems, including stream flow, vegetation, and wetlands. This VC is an integral component of the hydrologic cycle and is an important source of potable water for human consumption.

The Tailored Impact Statement Guidelines (TIS Guidelines) require an assessment of the effects of the Project on groundwater quality. The Crawford Nickel Project ('the Project') may affect groundwater because of potential changes to groundwater quality and quantity. These changes could affect groundwater levels, flow, and quality directly or indirectly through a lowering of the water table and seepage to groundwater from Project components such as Stockpiles, the Impoundment Facility, and the Tailings Management Facility (TMF).

Groundwater is linked to other VCs, including:

- Surface Water (Chapter 15), whereby groundwater can interact directly with surface water resources and surface water ecosystems at points of groundwater discharge (e.g., lakes and streams).
- Vegetation, Riparian and Wetland Environments (Chapter 16), whereby changes in groundwater levels can affect vegetation communities (wetlands) that are formed by or supported by groundwater.
- Fish and Fish Habitat (Chapter 17), whereby changes in the quantity or quality groundwater discharge to surface water have the potential to affect fish health and habitat.
- Health (Chapter 21), whereby groundwater is a transport pathway to humans through seepage to surface water followed by consumption of surface water.
- Social Conditions (Chapter 22), whereby changes in groundwater levels and quality (e.g., changes in groundwater wells) have the potential to directly affect residential, municipal, industrial, and commercial groundwater users.
- Indigenous Interests (Chapter 25 to 28), whereby changes in groundwater quality and/or quantity can affect the ability or desire of Indigenous nations to participate in traditional water-based activities (e.g., fishing, trapping, hunting) or features on the landscape considered to be of importance to Indigenous nations.

14.1 Scope of Assessment

There are several federal and provincial regulatory requirements that may apply to the Project, including environmental assessment and other environmental permitting obligations. The scope of the assessment of potential effects to groundwater was guided by the TIS Guidelines developed for the Project (Appendix A.1 of the Impact Statement) and various federal and provincial laws, regulations, policies, and guidelines protecting groundwater quantity and quality in Canada and Ontario.

In addition to regulations, policies, and guidelines, this section describes how engagement with the public and local Indigenous nations has influenced the scope of the assessment; the understanding of potential effects and pathways between the Project and groundwater quantity and quality during construction, operations, and decommissioning/closure of the Project; measurable parameters to be used to quantify potential effects of the Project on groundwater quantity and quality; spatial and temporal boundaries of the assessment; and the approach for characterizing and determining the significance of residual effects.

14.1.1 Regulatory and Policy Setting

14.1.1.1 Federal

The following provides a summary of federal regulations, policies, and/or guidelines that apply directly or indirectly to groundwater.

14.1.1.1.1 Fisheries Act

The *Fisheries Act*, 1985*,* administered primarily by Fisheries and Oceans Canada with some provisions administered by Environment and Climate Change Canada, restricts or controls the deposit of deleterious substances into waters or locations frequented by fish unless authorized by regulation. A number of regulations have been made to carry out the purposes and provisions of the *Fisheries Act*. The *Metal and Diamond Mining Effluent Regulations* (MDMER) define un-ionized ammonia, arsenic, copper, cyanide, lead, nickel, zinc, total suspended solids and radium 226 as deleterious substances and Schedule 4 of the MDMER imposes limits on their concentrations in effluent at the final discharge point to the receiving body of water. With respect to groundwater, the MDMER defines effluent as seepage containing any deleterious substance that flows over, through, or out of the site of a mine. The MDMER Schedule 4 criteria are used to screen the quality of seepage from mine rock and tailings associated with the Project.

14.1.1.1.2 Canadian Water Quality Guidelines for Protection of Freshwater Aquatic Life

The *Canadian Water Quality Guidelines for Protection of Freshwater Aquatic Life* (CWQG-FAL) are established by the Canadian Council of Ministers of the Environment (CCME 2024) and are intended to protect all forms of aquatic life, as well as all aspects of aquatic life cycles, including the most sensitive life stage of the most sensitive species over the long term from anthropogenic stressors such as chemical inputs or changes to physical components. These guidelines are developed collaboratively among provincial, territorial, and federal jurisdictions, and are regularly updated to reflect current toxicology information and guideline derivation approaches. They provide the science-based benchmark for a nationally consistent level of protection for aquatic life in Canada. The CWQG-FAL are used to characterize groundwater quality where groundwater is anticipated to discharge to surface water. For the parameters analyzed as part of the Project, the CWQG-FAL generally have the same values as the Ontario Provincial Water Quality Objectives (PWQO). Where the criteria for the CWQG-FAL and PWQO differed, the criteria based on the most recent update was considered applicable. For this Project, the CWQG-FALs are used with a ten times dilution factor, in a manor consistent with the development of GW-3 values under Ontario Regulation (O. Reg.) 153/04, as a comparison where groundwater is anticipated to discharge to surface water features (refer to Section 14.1.1.2.2).

14.1.1.1.3 Guidelines for Canadian Drinking Water Quality

The *Guidelines for Canadian Drinking Water Quality* (GCDWQ) are established by Health Canada in collaboration with the Federal-Provincial-Territorial Committee on Drinking Water and other federal government departments and are published by Health Canada (2024). These guidelines are based on current published scientific research related to health effects, aesthetic effects, and operational conditions of various parameters in drinking water.

The GCDWQ are used to characterize groundwater quality where groundwater is anticipated to be used as a source of drinking water and/or where groundwater is anticipated to flow beyond the spatial boundary of a study area prior to discharging to a surface water feature. The GCDWQ generally have the same values as the Ontario Drinking Water Quality Standards (ODWQS). Where the criteria for the GCDWQ and ODWQS differed, the criteria based on the most recent update was considered applicable.

14.1.1.2 Provincial

The following provides a summary of provincial regulations, policies, and/or guidelines that directly or indirectly apply to groundwater.

14.1.1.2.1 Mining Act and Building More Mines Act

The *Building More Mines Act*, 2023, amends the *Mining Act*, 1990, and sets out standards and criteria for mine closure through O. Reg. 35/24 Rehabilitation of Lands and the Mine Rehabilitation Code of Ontario. Specifically, with respect to groundwater, these statutes and regulations identify groundwater quality parameters to be monitored from mines, as well as monitoring and certification requirements for assessing the success of closure activities in protecting groundwater from potential mining effects. Additionally, these statutes and regulations provide guidance and direction regarding progressive rehabilitation to accelerate mine site rehabilitation in advance of close out activities. The monitoring requirements for the Project related to groundwater will be developed to meet the requirements under O. Reg. 35/24 and the Mine Rehabilitation Code of Ontario.

14.1.1.2.2 Environmental Protection Act

The *Environmental Protection Act* (EPA), 1990, is the principal pollution control statute in Ontario and is used in conjunction with the *Ontario Water Resources Act* (OWRA), 1990, to address sources of water pollution. The EPA contains general provisions that can be used to protect surface water and groundwater quality.

The EPA sets out requirements regarding discharges to the environment and environmental remediation. Part XV.1 of the EPA and O. Reg. 153/04 pertain to the remediation of contaminated properties. O. Reg. 153/04 applies to properties that are being redeveloped from a less sensitive property use (e.g., industrial) to a more sensitive property use (e.g., residential), and where a Record of Site Condition (RSC) is required. In practice, the regulation is applied to the assessment and management of soil, groundwater, and sediment contamination regardless of whether or not an RSC is required.

Surface water resources may be affected by brownfield properties as a result of the discharge of impacted groundwater to surface water receivers. Under O. Reg. 153/04, the Ministry of Environment, Conservation, and Parks (MECP) has developed Aquatic Protection Values (APVs) to protect aquatic biota from migration of impacted groundwater to surface water (MOE 2011). The APVs are designed to provide a scientifically defensible and reasonably conservative level of protection for aquatic organisms from the migration of contaminated groundwater to surface water resources. The APVs are the established water quality criteria in surface water and are used to determine the acceptable concentrations in groundwater (GW-3 values) by back-calculating through a defined modelling process that results in a ten times dilution in the receiving environment. For this Project, the defined modelling process that results in a ten times dilution in the receiving environment compared to groundwater is used when comparing the groundwater quality data to surface water criteria.

14.1.1.2.3 Safe Drinking Water Act

The *Safe Drinking Water Act*, 2002, is an Act to prevent drinking water health hazards through the control and regulation of drinking water systems and drinking water testing in Ontario. A number of drinking water regulations have been made under the *Safe Drinking Water Act*, including O. Reg. 169/03 (ODWQS), which set out prescribed drinking water quality standards in Schedule 1 (microbiological), Schedule 2 (chemical), and Schedule 3 (radiological). The ODWQS are used to characterize groundwater quality in areas where the use of groundwater as a source of drinking water is anticipated or where groundwater is anticipated to flow beyond the footprint of project activities. The ODWQS generally have the same values as the GCDWQ.

14.1.1.2.4 Ontario Water Resources Act

The OWRA is the principal statute governing water quality and quantity in Ontario. It is a general management statute that applies to groundwater and surface water. Administered by the MECP, the OWRA contains several important regulations that protect water resources, including:

- The Water Taking and Transfer Regulation (O. Reg. 387/04), which requires a permit for water takings of more than a total of 50 m^3/d (with some exceptions). Section 34 of the OWRA requires the proponent to obtain a Permit to Take Water (PTTW) and Section 9 of O. Reg. 387/04 requires all permit holders to collect, record and report data on daily volumes of water withdrawals.
- Section 53 of the OWRA requires an Environmental Compliance Approval (ECA), which is a permission that allows a business to operate their facility or site with environmental controls that protect human health and the natural environment. The ECA prescribes site-specific criteria for the quality and quantity of effluent discharged from a facility or site.

14.1.1.2.5 Provincial Water Quality Objectives

The PWQOs were developed by MECP (MOE 1999) through its responsibilities under the OWRA and EPA, along with management policies and guidelines, for the protection of aquatic life and recreational uses; they are numerical and narrative ambient surface water quality criteria that represent a desirable level of surface water quality. PWQOs for the protection of aquatic life are conservative values that, when met, are intended to be protective of aquatic life and the aquatic life cycle during an indefinite exposure to the water (MOEE 1999).

For this project, the PWQOs (or interim PWQO if applicable) are used with a ten times dilution factor, in a manor consistent with the development of GW-3 values under O. Reg. 153/04, as a comparison where groundwater is anticipated to discharge to surface water features.

14.1.2 The Influence of Consultation and Engagement on the Assessment

Canada Nickel Company (Canada Nickel) has engaged with potentially affected Indigenous nations, regulators, the public, and other stakeholders. Table 14.1 provides a summary of the topics, key information including Indigenous knowledge, and concerns that Canada Nickel identified as part of their engagement efforts that relate to Groundwater, as well as a summary of the influence that the outcomes of this engagement had on the assessment.

This information was considered when evaluating whether Canada Nickel's planned mitigation will effectively manage the identified potential interactions, or whether additional or refined mitigation is warranted. To date, concerns regarding dewatering and effects of seepage on quality of groundwater have been raised during engagement for the Project. Additional and specific mitigation measures were added to address one or more of the concerns, as described in Table 14.1.

Table 14.1 Summary of Key Information, Indigenous Knowledge, and Concerns for the Project Related to Groundwater

Topics	Key Information, Indigenous Knowledge, and Concerns	Influence on the Assessment	Where Information is Addressed in the Impact Statement
Groundwater and surface water interactions	• Apitipi Anicinapek Nation, Flying Post First Nation, Matachewan First Nation, Mattagami First Nation, and Taykwa Tagamou Nation expressed concern regarding changes to groundwater and surface water interactions. • Matachewan First Nation expressed concern regarding pesticides, chemicals, gasses, and other contaminants from the mining and forestry industries leaking into streams and groundwater supplies in the area, affecting local fish species, as seen through reported walleye health changes (abnormal colouring and growths on fish).	• Considered in the development of mitigation and management measures and supported scope of issues assessed. • Predicted changes to surface water quality because of groundwater discharge to surface water are presented in Chapter 15 of the Impact Statement (Assessment of Potential Effects on Surface Water). • Predicted changes to the aquatic environment because of changes in surface water quality are presented in Chapter 17 of the Impact Statement (Assessment of Potential Effects on Fish and Fish Habitat). • Informed the assessment on Indigenous Interests in Chapters 25 to 28 of the Impact Statement (Assessment of Potential Effects on Indigenous Interests).	• Chapter 14 (Assessment of Potential Effects on Groundwater), Sections 14.4.2.3 14.4.3.3, 14.9 • Chapter 15 (Assessment of Potential Effects on Surface Water) • Chapter 17 (Assessment of Potential Effects on Fish and Fish Habitat) • Chapters 25 to 28 (Assessment of Potential Effects on Indigenous Interests) • Groundwater Assessment (Appendix C.4 of the Impact Statement)

Topics	Key Information, Indigenous Knowledge, and Concerns	Influence on the Assessment	Where Information is Addressed in the Impact Statement
Tailings Management	• Matachewan First Nation expressed concern regarding the Water Management Plan and how water recycling will be used, and how tailings would be managed. • Taykwa Tagamou Nation recommends that Canada Nickel: - provide additional preliminary design information regarding how tailings storage facilities will be isolated from surface and groundwater sources, so that tailings do not encounter the uncontrolled environment - conduct ground and surface water modelling to demonstrate risks associated with post-closure tailing interaction with ground and surface water will not have the ability to migrate beyond the Open Pit	• Informed preliminary water management planning. • Design of the TMF included components to isolate tailings from surface and groundwater sources including placement of the TMF on surficial clay, use of a thickened tailings, perimeter dams designed with perimeter seepage collection ditches and ponds with water treatment as needed. • Effects on groundwater levels and the fate of groundwater in contact with the impounded tailings within the Open Pit was predicted using a three-dimensional numerical groundwater flow model. This included a refinement of the modelling granularity for river and lakebed conductance, and additional sensitivity analysis for the effect of conductance. • Informed the assessment on Indigenous Interests in Chapters 25 to 28 of the Impact Statement (Assessment of Potential Effects on Indigenous Interests). Canada Nickel's responses to mitigation recommendations made by the Indigenous nations are provided in Chapters 25 to 28 of the Impact Statement (Assessment of Potential Effects on Indigenous Interests).	• Chapter 3 (Project Description) • Chapter 14 (Assessment of Potential Effects on Groundwater), Sections 14.4.2.3 14.4.3.3, 14.9 • Groundwater Assessment (Appendix C.4 of the Impact Statement) • Conceptual Closure Plan (Appendix F of the Impact Statement)

Topics	Key Information, Indigenous Knowledge, and Concerns	Influence on the Assessment	Where Information is Addressed in the Impact Statement
Groundwater Quality	• Apitipi Anicinapek Nation expressed concern regarding the potential for sulphate leaching into groundwater. • Flying Post First Nation, Matachewan First Nation, Mattagami First Nation, recommend their participation in all ground and surface water studies as well as opportunities to provide input on the water management plans (e.g., water quality monitoring) and any site-specific closure plans (e.g., decommissioning of groundwater wells, water treatment ponds).	• Considered in the development of mitigation and management measures and supported scope of issues assessed. • Effects of seepage from mine infrastructure, including sulphate, on groundwater quality was assessed. • Anticipated Project emissions, discharges and wastes were inventoried and quantified. • Summary of Project emissions, discharges and wastes is presented in Chapter 3 (Project Description), Section 3.8. • Informed the assessment on Indigenous interests in Chapters 25 to 28 of the Impact Statement (Assessment of Potential Effects on Indigenous Interests). Canada Nickel's responses to mitigation recommendations made by the Indigenous nations are provided in Chapters 25 to 28 of the Impact Statement (Assessment of Potential Effects on Indigenous Interests). • Indigenous nations will be able to provide input on closure planning, including on aspects that involve groundwater.	• Chapter 3 (Project Description) • Chapter 14 (Assessment of Potential Effects on Groundwater), Sections 14.6.2 • Chapters 25 to 28 (Assessment of Potential Effects on Indigenous Interests) • Groundwater Assessment (Appendix C.4 of the Impact Statement) • Conceptual Closure Plan (Appendix F of the Impact Statement)
Groundwater Quantity	• Members of the public and/or other stakeholders expressed concern regarding groundwater drawdown related to Project activities. • Taykwa Tagamou Nation expressed concern regarding the use of groundwater and potential pressures on water systems in proximity to the PA. • Flying Post First Nation, Matachewan First Nation and Mattagami First Nation expressed concern regarding potential impacts to natural springs if present in the vicinity of the PA.	• Contributed to an understanding of existing conditions for groundwater quantity and supported scope of issues assessed. • Effects on groundwater levels (e.g., drawdown) were predicted using a three-dimensional numerical groundwater flow model. • No springs were identified within the groundwater regional study area during baseline field studies. • Informed the assessment on Indigenous Interests in Chapters 25 to 28 of the Impact Statement (Assessment of Potential Effects on Indigenous Interests).	• Chapter 14 (Assessment of Potential Effects on Groundwater), Section 14.4.2.3 • Chapters 25 to 28 (Assessment of Potential Effects on Indigenous Interests) • Groundwater Assessment (Appendix C.4 of the Impact Statement)

Where made available by Indigenous nations through engagement, information gathering, and voluntary information sharing, Indigenous knowledge has been considered and incorporated into the Impact Statement, as applicable. Refer to the Description of Engagement with Indigenous Peoples (Chapter 7 of the Impact Statement) for detailed methods regarding the incorporation of Indigenous knowledge to the Impact Statement.

14.1.3 Potential Effects, Pathways and Measurable Parameters

Table 14.2 summarizes the potential environmental effects of the Project on groundwater, effect pathways, and measurable parameters. These potential environmental effects and measurable parameters are selected based on professional judgement, understanding of the Project, recent environmental assessments for mining projects in Canada, and comments provided during engagement.

Table 14.2 Potential Effects, Effect Pathways and Measurable Parameters for Groundwater

Potential Effect	Effect Pathway	Measurable Parameter(s) and Units of Measurement
Change in groundwater quantity	Change in groundwater elevations resulting in: • Reduced groundwater availability for existing well users • Change in volume of groundwater discharge to surface water features.	• Shallow and deep groundwater levels measured in monitoring wells (m) • Well yield (L/min) for existing well users in the Project Area • Reduction in baseflow (%) in surface water features
Change in groundwater quality	• Degradation of groundwater quality in potable water supplies • Change in surface water quality from chemistry of groundwater discharging to surface water features	• Concentration of chemical parameters (various) in groundwater compared to applicable guidelines

14.1.4 Boundaries

14.1.4.1 Spatial Boundaries

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 includes the Open Pit, Stockpiles, Impoundment Facility, TMF, two 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. The extent of the PA for the Project is shown on Figure 14.1.

The **Local Study Area (LSA)** for groundwater encompasses the area in which Project-related effects (direct or indirect) were predicted or measured with a level of confidence appropriate for the assessment and in which there is a reasonable expectation that the potential effects in the LSA are of public interest. The LSA for groundwater was selected to extend beyond the likely extent of drawdown from dewatering the Open Pit and changes to flow or groundwater quality due to recharge from the Project components. The LSA, as shown on, is defined by major river watershed boundaries with the Central Mattagami River watershed boundary to the west, northwest, and southwest, and the Abitibi River watershed boundary to the east, northeast, and southeast.

The **Regional Study Area (RSA)** for groundwater includes the area within which cumulative effects on groundwater are likely to occur, depending on the location of other past, present, or reasonably foreseeable future projects or activities. Given the localized nature of potential Project-related effects to groundwater, the RSA for the groundwater assessment is equal to the LSA. The RSA is shown on Figure 14.1.

14.1.4.2 Temporal Boundaries

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+)

14.1.5 Residual Effects Characterization

The characterizations used to assess residual effects on groundwater are provided in Table 14.3.

Table 14.3 Characterization of Residual Effects on Groundwater

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Direction	The long-term trend of the residual effect	**Positive –** a residual effect that moves measurable parameters in a direction beneficial to groundwater relative to baseline. **Adverse –** a residual effect that moves measurable parameters in a direction detrimental to groundwater relative to baseline. **Neutral –** no net change in measurable parameters for the groundwater relative to baseline.

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Magnitude	The amount of change in measurable parameters or the VC relative to existing conditions	**Groundwater Quantity** **Negligible –** no measurable change relative to baseline **Low** — groundwater drawdown due to the Project predicted to be less than 1 m. **Moderate** — groundwater drawdown due to the Project predicted to be between 1 m and 5 m. **High** — groundwater drawdown due to the Project predicted to be greater than 5 m.
		Groundwater Quality **Negligible –** no measurable change relative to baseline **Low** — a measurable change in groundwater quality, but within normal variability of baseline groundwater quality. **Moderate** — a measurable change in groundwater quality, but quality remains within regulatory criteria and/or objectives. **High** — a measurable change in groundwater quality that results in an exceedance of health-based regulatory criteria and/or objectives for one or more parameters to the extent that a water supply well no longer meets the needs of current users or landowners beyond the PA.
Geographic Extent	The geographic area in which a residual effect occurs	**PA –** residual effects are restricted to the PA **LSA –** residual effects extend into the LSA **RSA –** residual effects extend into the RSA
Timing	Considers when the residual effect is expected to occur, where relevant to the VC.	**No sensitivity** – timing does not affect VC. **Moderate sensitivity**– timing may affect VC during lower sensitivity period, but the effects are manageable with proper planning and mitigation measures. **High sensitivity** – residual effects occur during high sensitivity period.
Duration	The time required until the measurable parameter or the VC returns to its existing condition, or the residual effect can no longer be measured or otherwise perceived	**Short term –** residual effect restricted to construction or decommissioning and active closure phases (<5 years) **Medium term –** residual effect extends through operations but is expected to subside when operations cease (5 years to 41 years) **Long term –** residual effect extends beyond the life of the Project (>41 years)
Frequency	Identifies how often the residual effect occurs and how often during the Project or in a specific phase	**Single event** **Multiple irregular event** – occurs at no set schedule **Multiple regular event –** occurs at regular intervals **Continuous –** occurs continuously
Reversibility	Pertains to whether a measurable parameter or the VC can return to its existing condition after the project activity ceases	**Reversible –** the residual effect is likely to be reversed after activity completion and reclamation **Irreversible –** the residual effect is unlikely to be reversed

14.2 Existing Conditions for Groundwater

Existing hydrogeological conditions for the Project are presented in detail in the Groundwater Baseline Report (Appendix B.5 of the Impact Statement). The following information provides a summary of groundwater conditions within the RSA.

14.2.1 Methods

The existing hydrogeological conditions within the RSA were developed based on a literature review and field surveys that included the drilling of 74 geotechnical boreholes and 384 exploration boreholes, installation of 31 monitoring wells and 7 drive-point piezometers, hydraulic response testing in 22 monitoring wells and 152 exploration boreholes, manual and automated water level monitoring at 31 locations, groundwater quality sampling in 33 overburden and bedrock monitoring wells over a period of 3 years, and grain size analyses on 63 river and lakebed sediment samples

14.2.2 Overview

Key findings of the Groundwater Baseline Report (Appendix B.5 of the Impact Statement) were as follows:

- Topography across the LSA/RSA is generally flat, with local topographic lows typically associated with surface water features, and topographic highs associated with watershed boundaries and an esker. The PA is undeveloped and naturally forested with no known anthropogenic sources that may affect groundwater quantity or quality. Within the PA, local ground surface elevations typically range between a high of 286 m above mean sea level (amsl) to the south, with a low of 266 m amsl to the northwest.
- The PA 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 drains into Kidd Creek and subsequently the Mattagami River. Several lakes located adjacent to the PA drain into the North Driftwood River, including David Lake, Mel Lake, Sutherland Lake, Jack Lake, Gerry Lake and Martin Lake. Surface water flow is typically in a northerly direction, towards James Bay.
- Based on a review of the online MECP Water Well Record (WWR) database, there are three wells located within the PA, one of which is abandoned. The other two wells are registered as supply wells, one being a commercial water supply well screened within a sand and gravel overburden aquifer, and the second being a domestic supply well screened in bedrock. An additional five properties with the potential to be supplied by water supply wells have been identified through field reconnaissance although they are not in the MECP WWR database and so details of potential well construction are unknown. One property is known to have a drilled well, and the remaining four are suspected to be on surface water supply.

- There are two active PTTWs within the LSA/RSA: one is for a water supply well and for dewatering from a mine sump that expires in 2024, (with a 10-year extension request currently under review with the MECP), and the second is for dewatering of groundwater and surface water at the Carnegie Township Quarry that expires in 2027.
- The LSA/RSA is located in the Northern Clay Belt, which is characterized as low lying, undulating plain of glaciolacustrine clay. This surficial clay is nearly continuous across the RSA except where eskers and bedrock outcrops are present. Underlying the clay is a discontinuous glaciofluvial sand deposit followed by glacial till (silt and/or clay) that overlies bedrock. A north-south trending esker composed of sand and gravel is located about 500 m west of the PA. There is only a small proportion of outcrop exposure, mostly confined to higher ground. Overburden thickness ranges from 10 m to 90 m, with an average thickness of about 40 m across the PA.
- The LSA/RSA is situated in the Abitibi Greenstone belt within the Superior Province. The bedrock in the LSA/RSA is composed of a felsic to mafic volcanic assemblage hosting the Crawford Ultramafic Complex, local metasediments (i.e., iron formation, minor metavolcanic rocks), and other local ultramafic sills. There is only one area in the northwest portion of the LSA/RSA where bedrock is outcropping.
- Several regional faults are found in the LSA/RSA, generally showing a north-northwest to south-southeast strike. The major regional faults following this trend are the Mattagami River Fault, the Buskegau River Fault, and the Main Regional Fault. Multiple discontinuous, unnamed faults have a similar strike.
- Testing indicates that the hydraulic conductivity of the Main Regional Fault is not significantly different than the average hydraulic conductivity of the surrounding rock suggesting the Main Regional Fault is not a preferential pathway for groundwater flow. Descriptions of the fault in four exploration drillholes suggest that fault contains gouge and some chlorite mineralization. The description on one exploration borehole indicates that the shearing of the fault is mostly annealed. Groundwater flow is generally in a south to north direction across the PA. Due to the surficial clay, artesian pressures are often observed at the monitoring wells. Given the confining nature of the surficial clay, direct water level responses to precipitation are not observed, and a muted seasonal water level response is noted (i.e., generally less than 1 m water level fluctuation throughout the year). Within the PA, the water table generally ranges from 267 to 281 m amsl.
- Where nested monitoring wells exist between the bedrock and overburden, a downward vertical hydraulic gradient was observed.
- A moderate regional baseflow index of 0.30 suggests that surface water features in the area may be groundwater discharge points and that upward vertical gradients are likely to be present in the shallow groundwater near surface water features.
- Mean concentrations of arsenic, cyanide (total and free), fluoride, iron, manganese, phosphorous, and hardness in overburden and/or bedrock wells in the PA exceeded at least one of the ODWQS, GCDWQ, PWQO, and/or CWQG-FAL. Concentrations of these parameters above these criteria are typical of groundwater in Ontario and are reflective of the natural mineralization and geochemical processes in the area.

- Within bedrock monitoring wells, the mean groundwater concentrations in collected samples exceeded at least one of the ODWQS, GCDWQ, PWQO, and/or CWQG-FAL for the following parameters considered atypical of groundwater in Ontario: pH, ammonia (un-ionized), boron and zinc.
- Within overburden monitoring wells, the mean groundwater concentrations in samples collected exceeded at least one of the ODWQS, GCDWQ, PWQO, and/or CWQG-FAL on a consistent basis for the following parameters considered atypical of groundwater in Ontario: pH, sodium and zinc.
- Within overburden monitoring wells, other parameters that were noted to be elevated above at least one of the ODWQS, GCDWQ, PWQO, and/or CWQG-FAL for mean concentrations in three or fewer wells included alkalinity, un-ionized ammonia, free cyanide, aluminum, cobalt, copper, silver, vanadium, and zirconium.
- Polycyclic aromatic hydrocarbons (PAHs) were generally non-detect in both overburden and bedrock wells. Select PAHs were detected in a single monitoring well screened within silty sand.

14.3 Project Interactions with Groundwater

Table 14.4 identifies, for each potential effect, the physical activities that might interact with the VC and result in the identified effect. These interactions are indicated by a check mark (✓) and are discussed in detail in Section 14.4, in the context of effects pathways, standard and project-specific mitigation/enhancement, and residual effects.

Table 14.4 Project Interactions with Groundwater

Physical Activities	Effects	
	Change to Groundwater Quantity	**Change to Groundwater Quality**
Construction		
Mobilization of construction equipment and materials on site.	–	–
Vegetation clearing, including the removal and disposal of trees, brush, shrubs, and other foliage.	✓	–
Stripping, including the removal of topsoil and other organic materials, as well as storing of some materials for use in reclamation.	✓	–
Grading of overburden to be used as fill.	✓	–
Handing and use of explosives, including blasting.	–	✓
Excavating and pre-stripping of mine rock from the Open Pit and surrounding area.	✓	✓
Development of the Impoundment Facility for storage of rock, clay, sand, and till.	✓	–

Physical Activities	Effects	
	Change to Groundwater Quantity	**Change to Groundwater Quality**
Preparation of construction surfaces, including hauling reclaimed graded material and crushed mine rock to construction locations.	✓	–
Construction of water management systems to collect, manage, treat and discharge contact water from mine components to the receiving waterbodies via collection ponds, ditches, and water treatment plants.	✓	✓
Construction of minor water diversions around perimeter of the mine site to collect and divert flows.	✓	–
Dewatering of natural water bodies within the PA.	✓	–
Waste management, including collection and temporary storage.	–	–
Construction of mine infrastructure, including crusher facilities, Process Plant and TMF, as well as the potable water well, and ancillary infrastructure (e.g., offices, workshop, fuel farm, magazine storage and explosives pad).	✓	✓
Construction of internal haul roads and internal access roads, including water crossings.	✓	–
Construction of power supply and distribution systems.	–	–
Construction of temporary Highway 655 by-pass and overpass.	✓	–
Construction of the rail spur.	–	–
Vehicle operation within the PA.	–	–
Employment and expenditures[1].	–	–
Operations (Mining and Processing)		
Construction of Project infrastructure, including the expansion of ore processing components.	✓	✓
Relocation and decommissioning of Highway 655 and associated infrastructure.	–	–
Relocation of 500 kV transmission line.	–	–
Construction of the North Driftwood Diversion Channel.	✓	✓
Handling and use of explosives including blasting.	–	✓
Ore extraction in the Main Zone and East Zone of the Open Pit, including drilling, loading and hauling of mine rock from the pit.	✓	✓
Maintenance and management of mine rock stockpiles, overburden, and TMF.	✓	✓
Ore processing, including conveyor, crushing and processing activities with and between the Stockpiles, crusher facilities and Process Plant.	–	–

Physical Activities	Effects	
	Change to Groundwater Quantity	**Change to Groundwater Quality**
Operation of water management systems, including the collection, management, treatment and discharge of contact water from mine components to the receiving waterbodies via collection ponds, ditches and water treatment plants.	✓	✓
Transportation of Ore via the rail spur line.	–	–
Waste management, including collection and temporary storage.	–	–
Vehicle operation within the PA.	–	–
Progressive reclamation of disturbed areas.	✓	✓
Employment and expenditures[1].	–	–
Decommissioning and Closure		
Pit flooding through the creation of channels from the collection ponds towards the Open Pit.	✓	✓
Water management, including groundwater and surface water.	✓	✓
Decommissioning, dismantling and/or disposal of buildings and mine infrastructure.	–	–
Removal of power lines and electrical equipment.	–	–
Decommissioning of potable water and sewage systems.	✓	–
Vehicle operation within the PA.	–	–
Reclamation, including the placement of overburden, seeding and re-grading.	✓	✓
Monitoring and maintenance.	–	–
Employment and expenditures[1].	–	–

Notes:
✓ = Potential interaction
– = No interaction
1. Project employment and expenditures are generated by most Project activities and are the main drivers of many potential socio-economic effects. Rather than acknowledging this by placing a checkmark against each of these activities, 'employment and expenditures' is listed as a separate item under each phase of the Project.

Project components and activities that will not directly change the groundwater quantity or quality are as follows:

- Employment and expenditure will not directly result in changes to the physical environment, including groundwater, during any Project phase.
- The diversion of noncontact water and dewatering of natural water bodies within the PA are not expected to result in a change in groundwater quality because there are no known sources of parameters of potential concern arising from such activities.

- Management of domestic waste from the Project site is not anticipated to affect groundwater quantity or quality, as it will be stored in waste containers and disposed of off site by a licensed third-party operator.
- The preparation of surfaces, construction of buildings and infrastructure, or vegetation clearing is not expected to interact with a change in groundwater quality because there are no sources of parameters of potential concern associated with such construction activities.
- Relocation and decommissioning of Highway 655 and the 500 kV transmission line is not expected to interact with a change in groundwater quality because there are no sources of parameters of potential concern associated with such construction activities
- Dewatering is not anticipated with the relocation of the 500 kV transmission line and therefore not anticipated to interact with a change in groundwater quantity.
- Ancillary facilities during construction, including fuel storage and dispensing, and vehicle operation are not predicted to interact with groundwater quality or quantity other than from an accidental fuel spill. Minor spills are possible during fuel delivery, storage, and/or dispensing which may impact groundwater if left unresolved.

14.4 Assessment of Residual Effects on Groundwater

The main residual effect of the Project on groundwater quantity is predicted to be the lowering of water levels through the dewatering of the Open Pit. Drawdown resulting from dewatering of the Open Pit may affect local groundwater users if located within the predicted zone of influence. The main residual effect of the Project on groundwater quality is predicted to be from groundwater seepage from the Stockpiles, Impoundment Facility, TMF, and groundwater flow in contact with the tailings impounded within the Open Pit. These changes to groundwater quantity and quality may also affect surface water quantity and quality in areas of groundwater discharge to surface water.

14.4.1 Analytical Assessment Techniques

The effects analysis for groundwater quantity and flow, and groundwater quality is carried out using a number of analytical methods and tools and includes laboratory analytical data and three-dimensional groundwater flow modelling. The techniques are described in detail in the Groundwater Assessment (Appendix C.4 of the Impact Statement).

A numerical three-dimensional finite difference groundwater flow model was developed to represent baseline conditions and to assess the potential effects of the Project on groundwater resources. The three-dimensional groundwater flow model was used to provide quantitative predictions about changes in groundwater levels and flow during the construction, operation, and closure phases of the Project and the resulting changes in groundwater discharge to surface water as follows:

- Construction:
  - Dewatering rates from the early development of the East Zone of the Open Pit for rock extraction to support construction activities.

- Operations:
  - Dewatering rates from development of the Open Pit, and associated changes to groundwater levels and baseflow to surrounding water bodies.
  - Groundwater seepage rates and flow pathways from the Stockpiles, Impoundment Facility, and the TMF.
  - Flow rates and pathways of groundwater in contact with the tailings used as backfill in the Main Zone of the Open Pit.
- Closure:
  - Groundwater inflow rates to the Open Pit at progressive stages during filling with water to form a pit lake.
  - Groundwater seepage rates and flow pathways from the closed and rehabilitated Impoundment Facility and TMF.
  - Flow rates and pathways of groundwater in contact with the tailings used as backfill in the Main and East Zone of the Open Pit.

The MODFLOW 6 numerical groundwater flow code was used to simulate steady-state groundwater flow under baseline, construction, operation, and closure scenarios. While each stage of Open Pit development is essentially a "snapshot" in time, the approach of completing separate steady-state model runs provides predictions of effects which represent the groundwater condition which could be created by each development stage if each stage were to exist in perpetuity. The three-dimensional groundwater flow model consists of 25 layers including: overburden (layers 1 to 5), upper bedrock (layers 6 to 8), and lower bedrock (layers 9 to 25). The model grid spacing is generally 800 x 800 m, with further refinement to 100 x 100 m in the vicinity of Project components. The model boundaries generally correspond to subwatershed boundaries and are assumed to be no flow boundaries. The upper boundary of the model is defined by the ground surface from the digital elevation model (DEM) (average 275 m amsl) and the bottom boundary is set at about -600 m amsl, which is beneath the base of the Open Pit.

Calibration of the model was achieved by adjusting hydraulic conductivity, recharge, and stream bed and lakebed leakage. The calibration process involved varying model parameters with the range of baseline data until an acceptable match to water levels and baseflow targets was obtained. The model is calibrated to be within acceptable industry standards. Details of the model development and calibration are presented in the Groundwater Assessment (Appendix C.4 of the Impact Statement).

Groundwater seepage quality from the Stockpiles, Impoundment Facility, and TMF is carried out using results of acid rock drainage and metal leaching testing that included testing of 299 rock samples, 109 ore samples, 4 tailings samples, and 50 overburden samples. The results of the individual testing are scaled based on the compositions of the lithologies predicted for the Stockpiles, Impoundment Facility, and TMF to predict the quality of seepage to groundwater from each of these facilities. Details on the seepage quality assessment of mine rock are presented in the geochemical analysis (Appendix H of the Impact Statement) while assessment of groundwater seepage rates and a summary of groundwater seepage quality are presented in the Groundwater Assessment (Appendix C.4 of the Impact Statement).

14.4.2 Change to Groundwater Quantity

14.4.2.1 Project Pathways

During construction, in the absence of mitigation, groundwater quantity and/or flow could be affected by temporary dewatering for the installation of foundations for buildings and utilities and changes to infiltration rates resulting from the construction of roads and initial development of various mine components (e.g. East Zone of the Open Pit, Stockpiles, Impoundment Facility, TMF). Of these Project components and activities, groundwater quantity and/or flow are anticipated to be primarily affected by the temporary lowering of groundwater levels through temporary dewatering for the installation of foundations and dewatering of the East Zone of the Open Pit to allow for the excavation of rock to support construction.

During operations, groundwater quantity and/or flow will primarily be affected by the lowering of water levels through the dewatering of the Open Pit. Drawdown resulting from dewatering of the Open Pit may affect local groundwater users if located within the predicted zone of influence. The resulting change in groundwater flow pattern and recharge rates may affect groundwater discharge to surface water features and wetlands. In the second half of operations, the rehabilitation of the TMF has the potential to change groundwater recharge rates, and the partial filling of the Open Pit with tailings and water have the potential to raise the water level which will affect groundwater flow patterns and discharge to surface water features and wetlands.

During passive closure, as the Open Pit continues to fill, groundwater levels will slowly rise and changes to groundwater flow direction and discharge locations are expected. These changes will extend past the passive-closure phase and reach a steady-state condition once the Open Pit is filled. The resulting change in groundwater flow pattern and recharge rates may affect groundwater discharge to surface water features and wetlands.

Potential effects to surface water features, wetlands, and fish and fish habitat from the lowering of groundwater levels and changes to baseflow in construction, operations, and decommissioning and closure are further assessed in Chapters 15 (Assessment of Potential Effects on Surface Water), 16 (Assessment of Potential Effects on Vegetation, Riparian and Wetland Environments), and 17 (Assessment of Potential Effects on Fish and Fish Habitat), respectively.

14.4.2.2 Mitigation Measures

The following mitigation measures have been incorporated into the design of the Project and/or are proposed to avoid or reduce Project-related effects on groundwater quantity and flow.

- Canada Nickel will limit the construction footprint (i.e., Project Area) to the extent possible to reduce the potential for reductions in groundwater recharge and limit the number of watersheds overprinted by the Project Area.

- Where trenches extend below the water table and there are risks to the surrounding environment (draining effect), Canada Nickel will limit the seepage by lining trenches with a low permeability soil layer (silt and clay) and apply best management practices to reduce water infiltration, if needed.
- If faults or fractures which act as conduits for increased flow of groundwater are encountered during advancement of the Open Pit, Canada Nickel will evaluate potential impacts from the increased flows and, if necessary, implement grouting or other practical measures to reduce groundwater inflow.

14.4.2.3 Project Residual Effects

14.4.2.3.1 Construction

Temporary Dewatering for Foundations and Installation of Infrastructure

Local changes in infiltration rates through compaction of ground surfaces or construction of infrastructure such as buildings and overburden or topsoil storage areas may result in reduced infiltration within the PA. Stripping of topsoil and removal of vegetation in the PA will result in changes in evapotranspiration rates and runoff and may result in decreased infiltration rates where impervious surfaces will remain or increased infiltration rates where vegetation is removed.

Due to shallow groundwater levels present within the PA, construction earthworks will likely encounter groundwater and require water management including contact water collection. The collection of contact water could result in minor local changes to groundwater flow direction, and/or lowering of groundwater levels and a potential decrease in discharge to surface water features. Short-term dewatering for installation of foundations and infrastructure may be required for construction of buildings such as the Process Plant, the Primary Crusher, and TMF dam, and preparation for the Stockpiles and Impoundment Facility.

Changes to groundwater quantity and/or flow due to temporary construction dewatering are characterized as adverse, short-term (e.g., limited to the construction phase and on an as-needed basis), reversible and will be confined to the PA. Changes will occur as multiple irregular events as different infrastructure is constructed. The magnitude is predicted to be moderate as dewatering for typical foundations is anticipated to be less than 5 m below ground surface. Timing (i.e., natural seasonal variations in precipitation) may affect dewatering rates, particularly during the spring when higher groundwater levels are expected; however, these variations would not be considered a Project-related effect.

Dewatering of the East Zone of the Open Pit

The primary activity that is anticipated to potentially influence groundwater quantity and/or flow during construction is the dewatering of the East Zone of the Open Pit as rock is extracted for use in construction. While this activity will extend into the operations phase, it has been simulated separately in the construction phase to document the potential changes to groundwater levels and/or flow in the early phases of Project development and to provide a conservative assessment of potential effects during construction.

The three-dimensional groundwater flow model was used to estimate a conservative groundwater inflow rate to the East Zone of the Open Pit at the end of Year -1 of 2,700 m^3/day. The predicted change in water table elevation (drawdown) due to dewatering of the East Zone of the Open Pit at the end of operations Year -1 in comparison to baseline conditions is shown on Figure 14.2. Dewatering of the East Zone of the Open Pit is predicted to lower the water table by a minimum of 1 m over an area extending 2 km to the east, 3 km to the west and south, and up to 7.5 km to the north of the Open Pit. There are no known water supply wells or active groundwater PTTWs that supply potable water within the 1.0 m water table drawdown contour for the Open Pit (Figure 14.2).

Table 14.5 presents the comparison of predicted groundwater discharge rates in baseline with predicted average groundwater discharge rates at the end of operations Year -1. The highest reduction in predicted groundwater discharge rate in the rivers/creek is predicted in the West Buskegau River as it is the closest to the Open Pit of the two rivers and one creek. Jack Lake and Martin Lake have higher reductions in predicted groundwater discharge rates relative to the other lakes in the area; however, Jack, Martin, and Gerry Lakes should be considered as one system as they are directly connected by an upper reach of the North Driftwood River. Assessments of how these changes in discharge rates will affect the receiving waterbodies and the associated fish and fish habitat are provided in Chapter 15 (Assessment of Potential Effects on Surface Water) and Chapter 17 (Assessment of Potential Effects on Fish and Fish Habitat), respectively.

Table 14.5 Predicted Groundwater Discharge to Surface Water Features – Operations Year -1

Surface Water Feature	Predicted Groundwater Discharge Rate (m^3/d)		
	Baseline[1]	Operations Year -1[1]	Percent Increase (Decrease)
Jocko Creek	6,104	5,846	(4)
North Driftwood River	6,334	9,085	43
West Buskegau River	1,234	-202	(116)
Unnamed Lake (South of Zed Lake)	1,054	1,011	(4)
Zed Lake	-1,620	-1,705	(5)
Mel Lake	1,211	1,147	(5)
Sutherland Lake	-2,858	-3,161	(11)
Jack Lake	350	-304	(187)
Gerry Lake	6,444	4,731	(27)
Martin Lake	1,577	25	(98)
Unnamed Lake (West Stockpile)	58	62	7

Note:
1. A negative number indicates that surface water is recharging groundwater at that reach/lake.

During construction, residual environmental effects related to dewatering of the East Zone of the Open Pit will occur through construction phase and extend into the operations phase of mine life. The changes to groundwater quantity and flow are characterized as adverse, medium-term, continuous, and irreversible.

The magnitude is high within the PA and low to moderate in the LSA/RSA. Timing (i.e., natural seasonal variations in precipitation) may affect dewatering rates, particularly during the spring period when higher groundwater levels are expected; however, these variations would not be considered a Project-related effect.

14.4.2.3.2 Operations Phase Year 17

The predicted average groundwater inflow into the Open Pit at the end of Year 17, when the Main Zone is developed to full depth and development of the East Zone is ongoing, is 10,500 m^3/day. The predicted change in water table elevation (drawdown) due to dewatering of the Open Pit at the end of Year 17 in comparison to baseline conditions is shown on Figure 14.3. The predicted 1 m drawdown contour due to Open Pit dewatering extends up to 3.2 km to the east, 3.9 km to the west, 2.5 km to the south, and 7.3 km to the north of the Open Pit. The predicted extent of drawdown to the south of the Open Pit is limited due to increased infiltration in the TMF footprint which results in mounding of the water table in and around the TMF. Mounding northwest of the Main Zone is also predicted and is due to the diversion of a portion of the North Driftwood River in Year 4. This portion of the North Driftwood River is estimated to receive 4,346 m^3/day of groundwater discharge in baseline conditions that is not removed in the Year 17 three-dimensional groundwater flow model due to diversion of the North Driftwood River, resulting in a groundwater mound of approximately 1 m above baseline. There are no known water supply wells or active groundwater PTTWs that supply potable water within the 1.0 m water table drawdown contour for the Open Pit (Figure 14.3).

Table 14.6 presents the comparison of predicted groundwater discharge rates to surface water features in baseline with predicted average groundwater discharge rates at the end of Year 17. The highest predicted reduction in groundwater discharge relative to baseline conditions were related to the diversion of a portion of the North Driftwood River in Year 4. The diversion results in changes to local groundwater levels which, in turn, results in a switch in Unnamed Lake (West Stockpile) from a lake which receives groundwater discharge to a lake which recharges groundwater. Assessments of how these changes in discharge rates will affect the receiving waterbodies and the associated fish and fish habitat are provided in Chapter 15 (Assessment of Potential Effects on Surface Water) and Chapter 17 (Assessment of Potential Effects on Fish and Fish Habitat), respectively.

Table 14.6 Predicted Groundwater Discharge to Surface Water Features – Operations Year 17

	Predicted Groundwater Discharge Rate (m^3/d)		
Surface Water Feature	**Baseline[1]**	**Operations Year 17[1]**	**Percent Increase (Decrease)**
Jocko Creek	6,104	7,797	28
North Driftwood River	6,334	848	(87)
West Buskegau River	1,234	2,243	82
Unnamed Lake (South of Zed Lake)	1,054	2,158	105
Zed Lake	-1,620	-842	48
Mel Lake	1,211	1,818	50

Surface Water Feature	Predicted Groundwater Discharge Rate (m^3/d)		
	Baseline[1]	Operations Year 17[1]	Percent Increase (Decrease)
Sutherland Lake	-2,858	-2,235	22
Jack Lake	350	543	55
Gerry Lake	6,444	7,180	11
Martin Lake	1,577	2,340	48
Unnamed Lake (West Stockpile)	58	-255	(540)

Note:
1. A negative number indicates that surface water is recharging groundwater at that reach/lake.

The lowering of water levels through continued dewatering of the Open Pit during operations will result in a change in groundwater quantity and flow. This change is characterized as adverse, long-term, continuous and irreversible. The magnitude is high within the PA and low to moderate within the LSA/RSA. Timing (i.e., natural seasonal variations in precipitation) may affect dewatering rates due to natural seasonal variations, particularly during the spring period when higher groundwater levels are expected; however, these variations would not be considered a Project-related effect.

Within the area of the TMF, residual environmental effects from mounding (increase) of the water table, due to increased recharge through the TMF, are characterized as positive, medium-term, continuous and reversible. The magnitude is high within the PA and extending into the LSA/RSA before decreasing to low.

14.4.2.3.3 Operations Phase Year 30

The predicted average groundwater inflow into the Open Pit at the end of Year 30, when the Main Zone and East Zone of the Open Pit are fully developed, is 9,400 m^3/day. While the footprint of the Open Pit is larger in Year 30 than Year 17, the groundwater inflow rate is higher at the end of Year 17 than Year 30 due to the presence of the TMF which provides enhanced recharge. In Year 30, the TMF is rehabilitated with cover and vegetation and therefore the recharge rate is reduced compared to Year 17 when the TMF is operational. The change in water table elevation (drawdown) due to dewatering of the Open Pit and rehabilitation of the TMF at the end of Year 30 in comparison to baseline conditions is shown on Figure 14.4 The predicted 1 m drawdown contour as a result of Open Pit dewatering extends up to 3.1 km east, 4 km west, 5.1 km south, and 9 km north of the Open Pit. The area of mounding northwest of the Main Zone is due to the diversion of a portion of the North Driftwood River in Year 4. This portion of the North Driftwood River is estimated to receive 4,346 m^3/day of groundwater discharge in baseline conditions that is not removed in the Year 30 three-dimensional groundwater flow model, resulting in a groundwater mound of approximately 1 m above baseline.

Table 14.7 presents the comparison of predicted groundwater discharge rates in baseline with predicted average groundwater discharge rates at the end of Year 30. The highest predicted reduction in net discharge from groundwater to a river was for the West Buskegau River due to its proximity to the Open Pit. With the exception of Unnamed Lake (West Stockpile), the three-dimensional groundwater flow model results indicate relatively small, predicted changes in net flow from groundwater to the lakes. The switch in Unnamed Lake (West Stockpile) from a lake which receives groundwater discharge to a lake which recharges groundwater is related to the changes in local groundwater levels after the North Driftwood River is diverted. Assessments of how these changes in discharge rates will affect the receiving waterbodies and the associated fish and fish habitat are provided in Chapter 15 (Assessment of Potential Effects on Surface Water) and Chapter 17 (Assessment of Potential Effects on Fish and Fish Habitat), respectively.

Table 14.7 Predicted Groundwater Discharge to Surface Water Features – Operations Year 30

Surface Water Feature	Predicted Groundwater Discharge Rate (m^3/d)		
	Baseline[1]	Operations Year 30[1]	Percent Increase (Decrease)
Jocko Creek	6,104	6,115	0.2
North Driftwood River	6,334	569	(91)
West Buskegau River	1,234	-2,000	(262)
Unnamed Lake (South of Zed Lake)	1,054	1,087	3
Zed Lake	-1,620	-1,653	(2)
Mel Lake	1,211	1,192	(2)
Sutherland Lake	-2,858	-2,717	5
Jack Lake	350	240	(31)
Gerry Lake	6,444	5,966	(7)
Martin Lake	1,577	2,029	29
Unnamed Lake (West Stockpile)	58	-254	(538)

Note:
1. A negative number indicates that surface water is recharging groundwater at that reach/lake.

The lowering of water levels through continued dewatering of the Open Pit during operations will result in a change in groundwater quantity and flow. This change is characterized as adverse, long-term, continuous and irreversible. The magnitude is high within the PA and low to moderate within the LSA/RSA. Timing (i.e., natural seasonal variations in precipitation) may affect dewatering rates due to natural seasonal variations, particularly during the spring period when higher groundwater levels are expected; however, these variations would not be considered a Project-related effect.

14.4.2.3.4 Passive Closure with Pit Lakes

Following completion of operation, dewatering of the Open Pit will cease and water levels will begin to rise within the Open Pit. The predicted rate of groundwater inflow to the Open Pit after the Main and East Zones have been fully developed and dewatering has ceased is presented in Table 14.8 Predicted Open Pit Filling Rates in Passive Closure. The predicted groundwater flow into the Open Pit once dewatering ceases is about 8,600 m^3/day and decreases to about 1,400 m^3/day once the stage of the pit lake reaches the design elevation of the spillways.

Table 14.8 Predicted Open Pit Filling Rates in Passive Closure with Pit Lakes

Water Level Elevation in Open Pit (m amsl)	Predicted Groundwater Inflow Rate into Open Pit (m^3/d)
-14 (top of tailings in East Zone)	8,600
86	8,000
136	7,900
186	7,400
236	5,900
272.5 (spillway elevation)	1,400 (to spillways)

The predicted steady-state flows from the flooded pit lakes to the east and west spillways in passive closure (pit lake full) are 900 and 500 m^3/day, respectively. The spillways control the stage of the pit in passive closure at 272.5 m amsl, which is approximately 7 m above to 3 m below the baseline groundwater elevation within the Open Pit. The predicted change in water table elevation (drawdown) in passive closure, when the pit lakes are flooded, in comparison to baseline conditions is shown on Figure 14.5. The area of mounding northwest of the Main Zone is due to the diversion of a portion of the North Driftwood River in Year 4. This portion of the North Driftwood River is estimated to receive 4,346 m^3/day of groundwater discharge in baseline conditions that is not removed in the passive closure three-dimensional groundwater flow model, resulting in a groundwater mound of up to 25 m above baseline below the TMF. This mounding is present in the operations phase three-dimensional groundwater flow model results for the Year 17 and Year 30 scenarios (Figure 14.3 and Figure 14.4, respectively), but is smaller in extent and magnitude due to the lowering of the water table resulting from the dewatering of the Open Pit during mine operations.

Table 14.9 presents the comparison of predicted groundwater discharge rates in baseline with predicted average groundwater discharge rates for the passive closure phase with the pit lakes formed to the design stage. The North Driftwood River Diversion Channel was maintained for the passive closure phase. In general, predicted groundwater discharge to surface water in passive closure with pit lakes is similar to baseline conditions before mine operations occurred. Martin Lake and the unnamed lake near the West Stockpile show an increase in groundwater discharge for passive closure. These lakes are located closest to the pit lake where a spillway maintains the surface water elevation at approximately 272.5 m amsl which is approximately 5 to 8 m above the baseline groundwater elevation in the vicinity of Martin Lake and the unnamed lake near the West Stockpile. This results in groundwater mounding in this area, which, in turn, results in a greater horizontal hydraulic gradient toward the lake and a higher than baseline predicted groundwater discharge rate to the lake. For the remaining lakes, predicted groundwater discharge to the local lakes generally return to baseline conditions in the passive closure phase with pit lakes. Assessments of how these changes in discharge rates will affect the receiving waterbodies and the associated fish and fish habitat are provided in Chapter 15 (Assessment of Potential Effects on Surface Water) and Chapter 17 (Assessment of Potential Effects on Fish and Fish Habitat), respectively.

Table 14.9 Predicted Groundwater Discharge to Surface Water Features – Passive Closure with Pit Lakes

Surface Water Feature	Predicted Groundwater Discharge Rate (m^3/d)		
	Baseline[1]	Passive Closure[1]	Percent Increase (Decrease)
Jocko Creek	6,104	6,230	2
North Driftwood River	6,334	2,160	(66)
West Buskegau River	1,234	1,788	45
Unnamed Lake (South of Zed Lake)	1,054	1,157	10
Zed Lake	-1,620	-1,584	2
Mel Lake	1,211	1,272	5
Sutherland Lake	-2,858	-2,627	8
Jack Lake	350	332	(5)
Gerry Lake	6,444	6,748	5
Martin Lake	1,577	2,809	78
Unnamed Lake (West Stockpile)	58	301	419

Note:
1. A negative number indicates that surface water is recharging groundwater at that reach/lake.

The changes in groundwater levels in passive closure in the area of the Open Pit are characterized as positive, long-term, continuous, irreversible, and will be confined to the LSA. The residual effect is characterized as positive due to mounding of the water table that would result in additional available drawdown within a water supply well, if present. The magnitude will be high within the PA and low within the LSA/RSA. Timing may affect water levels (i.e., natural seasonal variations), particularly during the spring period when higher groundwater levels are expected, but this is not considered a Project-related effect.

14.4.3 Change to Groundwater Quality

14.4.3.1 Project Pathways

During construction, rock extracted from the Open Pit will be crushed into aggregate and used for construction and therefore of a quality of rock suitable for construction and not predicted to effect groundwater quality. A small amount of ore will be stored in the East Stockpile for future processing.

Given that the construction period is 3 years, saturation of the East or West Stockpile to result in seepage to the groundwater table is not anticipated in construction and is instead evaluated further as part of the operations phase of the Project. The Impoundment Facility may be used to stockpile excess overburden that is stripped during site preparation, which will have appropriate water management collection and treatment, predominantly related to suspended solids that are not predicted to infiltrate through to groundwater. Site preparation of the TMF will commence but storage of tailings within the TMF will not occur and therefore effects of the TMF on groundwater quality are not predicted in construction. Minor spills are possible during fuel delivery, storage, and/or dispensing which may impact groundwater if left unresolved.

During operations, groundwater seepage from the Stockpiles, Impoundment Facility, TMF, and groundwater flow in contact with the tailings impounded within the Open Pit has the potential to affect groundwater and surface water quality where groundwater discharges to surface water receivers. During operations, the dewatering of the Open Pit will result in a change in groundwater flow and redirect groundwater recharge originating from the Stockpiles, Impoundment Facility, and TMF to the Open Pit, where it can be collected and treated prior to discharge. These changes will also affect groundwater flow pattern and discharge to surface water features and wetlands. The effects of these changes on surface water, wetlands, and fish and fish habitat are further assessed in Chapters 15 (Assessment of Potential Effects to Surface Water), 16 (Assessment of Potential Effects on Vegetation, Riparian and Wetland Environments), and 17 (Assessment of Potential Effects on Fish and Fish Habitat), respectively.

During passive closure, as the Open Pit fills, groundwater levels will slowly recover and the effect of the Open Pit on groundwater flow will be less than during operations. This will result in groundwater flow returning to baseline conditions in areas away from the Open Pit. This has the potential to affect surface water quality where groundwater recharge originating from the Stockpiles, Impoundment Facility, and TMF as well as groundwater flow in contact with the tailings impounded in the Open Pit discharges to surface water. The effects of these changes on surface water, wetlands, and fish and fish habitat are further assessed in Chapters 15 (Assessment of Potential Effects on Surface Water), 16 (Assessment of Potential Effects on Vegetation, Riparian and Wetland Environments), and 17 (Assessment of Potential Effects on Fish and Fish Habitat), respectively.

14.4.3.2 Mitigation Measures

The following mitigation measures have been incorporated into the design of the Project and/or are proposed to avoid or reduce Project-related effects on groundwater quality:

- Canada Nickel will prepare an Emergency Preparedness and Response Plan and a Spill Prevention and Contingency Plan which will describe spill prevention, contingency planning and reporting practices for the timely and effective response to fuel and other chemical spills.
- Canada Nickel will install contact water collection ditches around the Stockpiles, Impoundment Facility, and Tailings Management Facility to collect toe seepage and groundwater recharge from these Project components.

- Canada Nickel will implement progressive rehabilitation (placement of a vegetated soil cover) to reduce infiltration into the Impoundment Facility and Tailings Management Facility, thereby reducing the amount of water and loading to groundwater and improvements to groundwater quality.
- Canada Nickel will develop and implement a Metal Leaching and Acid Rock Drainage Management Plan to reduce and limit the known and potential risks of ML/ARD associated with the Project, thereby reducing potential effects to water quality
- In addition to the mitigation measures to reduce potential Project related effects on groundwater quality, Canada Nickel is also committed to follow-up and monitoring as outlined in Section 14.8.

14.4.3.3 Project Residual Effects

14.4.3.3.1 Construction

The construction of buildings and infrastructure is not expected to interact with a change in groundwater quality or surface water quality because there are no sources of parameters of potential concern associated with such construction activities, except for an accidental spill. As described in the Conceptual Metal Leaching and Acid Rock Drainage Management Plan (Appendix L of the Impact Statement), waste rock used for construction material will be sampled to confirm that it has a low potential to generate metal leaching and acid rock drainage.

As a result of potential minor spills, the residual effect on groundwater quality during construction is characterized as adverse, short-term, reversible, and will be confined to the PA. The magnitude is low because the volume of spills is expected to be low as a result of multiple irregular events that result in localized water quality effects within the PA relative to baseline conditions. No existing or foreseeable groundwater users are located in the areas where groundwater quality impacts may occur during construction.

14.4.3.3.2 Operations

The effect of the Project on groundwater quality is evaluated based on the quality of the seepage from Project infrastructure, relative to baseline conditions and regulatory criteria, and the fate (flow path) of seepage from the Project infrastructure. This allows an evaluation of whether a groundwater supply user may be affected by a change in groundwater quality (i.e. does the quality of water change relative to baseline and is a groundwater supply user located within the predicted flow path of the seepage).

Predicted Seepage Quality from Project Infrastructure

Seepage from the TMF, Impoundment Facility, and East and West Stockpiles has the potential to affect groundwater quality. The estimated seepage quality (Appendix K of the Impact Statement [Water Quality Assessment]) from the TMF, Impoundment Facility, and East and West Stockpiles, is presented in Table 14.10. Table 14.10 presents the 75th percentile, mean, and maximum concentrations for operations and passive closure for the Impoundment Facility and East and West Stockpiles. The TMF seepage quality is not predicted to vary over the life of mine and therefore a constant concentration is presented in Table 14.10. The quality of groundwater in contact with tailings impounded in the East and West Zones of the Open Pit was assumed to be equal to the quality of seepage from the TMF.

Table 14.10 Predicted Concentration of Groundwater Seepage from Project Components Compared to Baseline Concentrations

Parameter	Units	Criteria					Background Groundwater Quality (75th percentile)		West Stockpile			East Stockpile			Impoundment Facility			TMF
		MDMER	PWQO (x10)	CWCG-FAL (x10)	GCDWQ	ODWQS	Bedrock	Overburden	75th Percentile	Maximum	Mean	75th Percentile	Maximum	Mean	75th Percentile	Maximum	Mean	Constant
Ammonia (as N)	mg/L	n/v	n/v	27_{TBC2}^{L}	n/v	n/v	2.84	2.17	0.17	0.18	0.11	0.12	0.14	0.08	0.16	0.25	0.1	2.28
Bromide	mg/L	n/v	n/v	n/v	n/v	n/v	0.9	0.148	16.03	16.7	11.58	11.8	13.7	8.76	11.2	11.2	6.41	1.5
Chloride	mg/L	n/v	n/v	$1,200^{L}$	$\leq 250^{D}$	250^{I}	0.88	3.81	71.63	74.6	52.29	53.8	62.2	39.61	81.5	121	44.2	**282^{DI}**
Fluoride	mg/L	n/v	n/v	1.2^{L}	1.5^{E}	1.5^{F}	0.12	0.28	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Nitrate (as N)	mg/L	n/v	n/v	30^{L}	10^{E}	10.0_{d}^{F}	-	-	**23.55^{EF}**	**24.80^{EF}**	**16.12^{EF}**	**17.5^{EF}**	**20.3^{EF}**	**10.85^{EF}**	**23.1^{EF}**	**35.9^{EFL}**	**13.32^{EF}**	5.2
Nitrite (as N)	mg/L	n/v	n/v	0.6^{L}	1^{E}	1.0_{d}^{F}	0.046	-	0.17	0.18	0.11	0.07	0.08	0.04	0.16	0.25	0.11	0.22
Sulfate	mg/L	n/v	n/v	n/v	$\leq 500_{j}^{D}$	500_{h}^{I}	2.98	5.25	141	147	102.98	106	122	77.95	326	326	187.37	282
Aluminum	µg/L	n/v	n/v	$50/1,000_{VAR1}^{L}$	100_{a}^{D} $2,900^{E}$	100^{K}	5.7	7.3	24.5	24.5	24.32	24.4	24.4	24.2	24.8	24.9	24.5	25.3
Antimony	µg/L	n/v	200^{B}	n/v	6^{E}	6^{F}	0.418	0.41	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	3.93
Arsenic	µg/L	100	50^{B} $1,000^{C}$	50^{L}	10_{ALARA}^{E}	10^{F}	1.48	5.1	3.74	3.93	2.72	2.84	3.3	2.06	**37^{EF}**	**37^{EF}**	**21.19^{EF}**	1.12
Barium	µg/L	n/v	n/v	n/v	$2,000^{E}$	$1,000^{F}$	45.9	99.7	61.6	157	53.78	75.8	301	66.19	48.9	82.3	35.25	8.72
Beryllium	µg/L	n/v	$110/11,000_{s3}^{C}$	n/v	n/v	n/v	-	0.02	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035
Bismuth	µg/L	n/v	n/v	n/v	n/v	n/v	0.054	0.05	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Boron	µg/L	n/v	$2,000_{a}^{B}$	$15,000^{L}$	$5,000^{E}$	$5,000^{F}$	40.8	38.5	1.24	1.46	0.92	0.97	1.21	0.7	12	12	6.57	282
Cadmium	µg/L	n/v	$1/5_{s12}^{B}$ 2^{C}	0.9_{LTG}^{L}	7^{E}	5^{F}	0.0128	0.04	0.04	0.04	0.03	0.03	0.04	0.02	0.1	0.1	0.06	0.01
Calcium	µg/L	n/v	n/v	n/v	n/v	n/v	66,100	88,600	2,592.5	2,680	2,103.6	2,180	2,370	1,790.41	72,300	82,200	59,044.19	1,460
Chromium	µg/L	n/v	n/v	n/v	50^{E}	50^{F}	3.95	5.03	10.07	14.2	9.87	10.07	11.6	7.48	0.70	0.70	0.70	3.30
Chromium (Hexavalent)	µg/L	n/v	10^{C}	10^{L}	n/v	n/v	-	-	**13.63^{CL}**	**14.10^{CL}**	9.77	9.97	**11.5^{CL}**	7.38	0.6	0.6	0.6	3.2
Chromium (Trivalent)	µg/L	n/v	89^{C}	89^{L}	n/v	n/v	-	-	0.1	0.10	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Cobalt	µg/L	n/v	9^{B}	n/v	n/v	n/v	0.438	0.56	0.72	0.75	0.52	0.54	0.62	0.4	1.21	1.21	0.7	0.92
Copper	µg/L	100	$10/50_{s13}^{B}$ 50^{C}	20_{TBC1}^{L}	$\leq 1000^{D}$ $2,000^{E}$	$1,000^{I}$	0.825	2.12	8.01	8.32	5.84	5.99	6.93	4.42	**15.3^{B}**	**15.3^{B}**	8.77	1.00
Iron	µg/L	n/v	$3,000^{C}$	$3,000^{L}$	$\leq 300^{D}$	300^{I}	**$1,430^{DI}$**	**$4,450^{CDIL}$**	2.08	2.08	2.07	2.07	2.07	2.06	2.08	2.09	2.07	2.1
Lead	µg/L	80	$10/30/50_{s15}^{B}$ $50/100/200/250_{s14}^{C}$	10_{TBC1}^{L}	5_{ALARA}^{E}	10^{F}	0.17	0.12	1.27	1.32	0.93	0.96	1.1	0.7	2.89	2.89	1.66	0.09
Lithium	µg/L	n/v	n/v	n/v	n/v	n/v	1.9	7.35	1.48	1.55	1.08	1.12	1.29	0.82	9.16	9.16	5.29	38.5
Magnesium	µg/L	n/v	n/v	n/v	n/v	n/v	54,000	27,500	91,025	93,500	74,128.57	75,400	82,700	63,079.49	62,800	71,400	48,786.05	182,000
Manganese	µg/L	n/v	n/v	$4,300_{EQ4}^{L}$	$\leq 20^{D}$ 120^{E}	50^{I}	**124^{DEI}**	**165^{DEI}**	16.53	17.2	12.04	12.5	14.4	9.13	**189^{DEI}**	**189^{DEI}**	**108.9^{DI}**	**69.5^{DI}**
Mercury	µg/L	n/v	2^{C}	0.26^{L}	1^{E}	1^{F}	-	-	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Molybdenum	µg/L	n/v	400^{B}	730^{L}	n/v	n/v	3	11.2	5.38	5.59	3.92	4.03	4.66	2.97	23.3	23.3	13.44	28.4
Nickel	µg/L	250	250^{C}	250_{TBC1}^{L}	n/v	n/v	4.96	3	18.55	19.3	13.53	13.9	16	10.24	10.2	10.2	5.78	17.2
Phosphorus	µg/L	n/v	300_{s4}^{B}	n/v	n/v	n/v	210	142	42	42	42	42	42	42	0.72	1.9	0.67	19.5
Potassium	µg/L	n/v	n/v	n/v	n/v	n/v	2,650	3,680	287.75	299	233.49	243	263	198.75	13,100	14,900	10,739.77	2,930
Selenium	µg/L	n/v	$1,000^{C}$	10^{L}	50^{E}	50^{F}	0.73	0.36	1.33	1.38	0.96	0.99	1.14	0.73	2.16	2.16	1.24	2.94

Parameter	Units	Criteria					Background Groundwater Quality (75th percentile)		West Stockpile			East Stockpile			Impoundment Facility			TMF
		MDMER	PWQO (x10)	CWCG-FAL (x10)	GCDWQ	ODWQS	Bedrock	Overburden	75th Percentile	Maximum	Mean	75th Percentile	Maximum	Mean	75th Percentile	Maximum	Mean	Constant
Silver	µg/L	n/v	1^{C}	2.5^{L}	n/v	n/v	0.0162	0.205	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Sodium	µg/L	n/v	n/v	n/v	≤200000^{D}	$200,000_{g}^{I}$ $20,000_{g}^{J}$	11,800	**44,700^{J}**	233	241	188.16	196	212	160.26	18,900	**21,500^{J}**	15,494.88	**26,500^{J}**
Strontium	µg/L	n/v	n/v	n/v	$7,000^{E}$	n/v	392	452	115.5	121	84.32	86.4	99.9	63.8	431	431	248.52	9.6
Thallium	µg/L	n/v	3_{b}^{B}	8^{L}	n/v	n/v	-	-	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0575
Tin	µg/L	n/v	n/v	n/v	n/v	n/v	0.45	0.55	1.08	1.13	0.79	0.81	0.94	0.6	3.91	3.91	2.25	1.36
Titanium	µg/L	n/v	n/v	n/v	n/v	n/v	3.86	3.4	1.03	1.08	0.76	0.78	0.9	0.57	6.47	6.47	3.73	0.1
Tungsten	µg/L	n/v	300_{a}^{B}	n/v	n/v	n/v	0.175	0.88	1.60	1.66	1.16	1.19	1.38	0.88	3.54	3.54	2.04	7.54
Uranium	µg/L	n/v	50_{a}^{B}	150^{L}	20^{E}	20^{F}	0.16	1.17	10.63	11.1	7.78	8.03	9.26	5.89	**23.4^{EF}**	**23.4^{EF}**	13.47	0.01
Vanadium	µg/L	n/v	60^{B}	n/v	n/v	n/v	1.5	2.2	1.15	1.21	0.84	0.88	1.01	0.64	30.4	30.4	17.56	0.32
Yttrium	µg/L	n/v	n/v	n/v	n/v	n/v	-	-	0.28	0.29	0.21	0.21	0.25	0.16	0.64	0.64	0.37	0.07
Zinc	µg/L	400	200^{B} 300^{C}	70_{EQ2}^{L}	≤5000^{D}	$5,000^{I}$	**202^{BL}**	26.3	28.20	29.4	20.58	21.2	24.5	15.6	63.9	63.9	36.74	2.00

Notes:

MDMER	Metal and Diamond Mining Effluent Regulations, Schedule 4, Maximum Authorized Monthly Mean Concentration
PWQO (x10)	Provincial Water Quality Objectives of the Ministry of Environment and Energy (MOEE, 1999) (x10)
A	PWQO Table 2 - Calculated (x10)
B	PWQO Table 2 - Interim (x10)
C	PWQO Table 2 (x10)
GCDWQ	Health Canada (August 2024). Guidelines for Canadian Drinking Water Quality—Summary Table. Water and Air Quality Bureau, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario.
D	Guidelines for Canadian Drinking Water Quality - Aesthetic Objectives/ Operational Guidelines
E	Guidelines for Canadian Drinking Water Quality - Maximum Acceptable Concentration
O. Reg. 169/03	Ontario Drinking Water Quality Standards (January 1, 2018)
F	Schedule 2 - Chemical Standards (expressed as a maximum acceptable concentration)
G	Schedule 3 - Radiological Standards - Table 1 - Natural Radionuclides
H	Schedule 3 - Radiological Standards - Table 2 - Artificial Radionuclides
I	ODWS Table 4 - Chemical/Physical Objectives and Guidelines, Aesthetic Objectives
J	ODWS Table 4 - Medical Officer of Health Reporting Limit
K	ODWS Table 4 - Chemical/Physical Objectives and Guidelines, Operational Guidelines
CCME	Canadian Council of Ministers of the Environment
L	Canadian Environmental Quality Guidelines, Canadian Water Quality Guidelines for the Protection of Aquatic Life - Freshwater Aquatics Long Term x 10
6.5^{A}	Concentration exceeds the indicated standard.
15.2	Measured concentration did not exceed the indicated standard.
<0.50	Laboratory reporting limit was greater than the applicable standard.
<0.03	Analyte was not detected at a concentration greater than the laboratory reporting limit.
n/v	No standard/guideline value.
-	Parameter not analyzed / not available.
a^{B}	This Interim PWQO was set for emergency purposes based on the best information readily available. Employ due caution when applying this value.
a^{D}	This is an operational guidance value, designed to apply only to drinking water treatment plants using aluminum-based coagulants; it does not apply to naturally occurring aluminum found in groundwater. The operational guidance values of 0.1 mg/L applies to conventional treatment plants, and 0.2 mg/L applies to other types of treatment systems.
ALARA	as low as reasonably achievable
b	This Interim PWQO is currently under development. The value is subject to change upon publication by MOE.
d	Where both nitrate and nitrite are present, the total of the two should not exceed 10 mg/L (as nitrogen).
EQ2	The long-term CWQG is for dissolved zinc and is calculated using the following equation: CWQG = exp(0.947[ln(hardness mg·L-1)] - 0.815[pH] + 0.398[ln(DOC mg·L-1)] + 4.625) x 10. The value in the table is for surface water of 50 mg CaCO3·L−1 hardness, pH of 7.5 and 0.5 mg·L−1 DOC. The CWQG equation is valid between hardness 23.4 and 399 mg CaCO3·L−1, pH 6.5 and 8.13 and DOC 0.3 to 22.9 mg·L−1.
EQ4	The long-term CWQG is found using the look-up table (see Table 5) or the CWQG and benchmark calculator is Appendix B of CCME (2019). The value in the table is for surface water of 50 mg/L hardness and pH of 7.5. The CWQG table is valid between hardness 25 and 670 mg/L and pH 5.8 and 8.4.
g	The aesthetic objective for sodium in drinking water is 200 mg/L. The local Medical Officer of Health should be notified when the sodium concentration exceeds 20 mg/L so that this information may be communicated to local physicians for their use with patients on sodium restricted diets.
h	When sulfate levels exceed 500 mg/L, water may have a laxative effect on some people.
j	High levels (above 500 mg/L) can cause physiological effects such as diarrhea or dehydration.
LTG	The CWQG for cadmium (i.e. long-term guideline) of 0.09 µg·L-1 x 10 is for waters of 50 mg CaCO3·L-1 hardness. The CWQG for cadmium is related to water hardness (as CaCO3): When the water hardness is > 0 to < 17 mg/L, the CWQG is 0.04 µg/L x 10; at hardness ≥ 17 to ≤ 280 mg/L, the CWQG is calculated using this equation (CWQG (µg/L) = 10^{0.83(log[hardness]) – 2.46 }) x 10; At hardness > 280 mg/L, the CWQG is 0.37 µg/L x 10.

s3	The PWQO for beryllium is hardness dependent. If hardness <75 mg/L than PWQO is 0.011 mg/L. For hardness > 75 mg/L, PWQO is 1.1 mg/L.
s4	Applies to Phosphorus, total. PWQO is 0.03 mg/L for rivers and streams, 0.02 mg/L for lakes, and 0.01 mg/L for lakes naturally below this value.
s12	The interim PWQO for cadmium is hardness dependent. If hardness <100 mg/L than PWQO is 0.0001 mg/L. For hardness >100 mg/L, PWQO is 0.0005 mg/L.
s13	The interim PWQO for copper is hardness dependent. If hardness <20 mg/L than PWQO is 0.001 mg/L. For hardness >20 mg/L, PWQO is 0.005 mg/L.
s14	PWQO for lead is alkalinity dependent. For alkalinity <20 mg/L, PWQO is 0.005 mg/L. For alkalinity between 20-40 mg/L, PWQO is 0.01 mg/L. For alkalinity between 40-80 mg/L, PWQO is 0.02 mg/L. For alkalinity >80 mg/L, PWQO is 0.025 mg/L.
s15	Interim PWQO for lead is hardness dependent. For hardness <30 mg/L, interim PWQO is 0.001 mg/L. For hardness between 30-80 mg/L, interim PWQO is 0.003 mg/L. For hardness >80 mg/L, interim PWQO is 0.005 mg/L.
TBC1	Value is minimum value available. Sample-specific value to be calculated (equation).
TBC2	Calculated using pH=7.5 and temperature = 10 (geomean in overburden=7.0 and 7.3, respectively), then the present guideline values (mg/L NH3) can be converted to mg/L total ammonia-N by multiplying the corresponding guideline value by 0.8224.
VAR1	Variable, 5 µg/L if pH < 6.5 and 100 µg/L if pH > 6.5

Background groundwater quality was consistently elevated relative to the regulatory criteria for iron, manganese and sodium. Elevated concentrations of these parameters are typical of groundwater in Ontario and are reflective of the natural mineralization and geochemical processes in the area. Concentrations in bedrock were also found to be elevated relative to the regulatory criteria for zinc, which is considered atypical for a groundwater system. Instrumentation installed within monitoring wells may have resulted in elevated zinc; equipment adjustments will be made, and future sampling may confirm the cause of elevated zinc concentrations.

As presented in Table 7.1, the following trends were observed when comparing water quality in seepage from the TMF, Impoundment Facility, and East and West Stockpiles to relevant regulatory criteria:

East and West Stockpiles

- Seepage from the East and West Stockpiles is not predicted to exceed MDMER criteria
- Seepage from the East and West Stockpiles may exceed the ODWQS and/or the GCDWQ for nitrate.
- Seepage from the East and West Stockpiles may exceed 10 x PWQO and 10 x CWQG-FAL for Hexavalent Chromium. Hexavalent chromium was not measured in the baseline groundwater monitoring programs, however the 75th percentile total chromium concentrations in the baseline data for overburden and bedrock were approximately 50% below the predicted seepage concentrations. As hexavalent chromium comprises a portion of total chromium, the hexavalent chromium concentrations from the East and West Stockpile are not likely to exceed the 75th percentile baseline concentration and the baseline concentrations are not predicted to exceed 10 x PWQO or 10 x CWQG-FAL.

Tailings Management Facility

- Seepage from TMF is not predicted to exceed MDMER criteria
- Seepage from the TMF may exceed the ODWQS and/or the GCDWQ aesthetic guidelines for chloride. The predicted seepage concentration of chloride from the TMF is two to three orders of magnitude higher than the 75th percentile baseline concentrations in bedrock and overburden.
- Seepage from the TMF may exceed the ODWQS and GCDWQ aesthetic guidelines for manganese. The GCDWC health-based criteria, the Maximum Acceptable Concentration, is not predicted to be exceeded. The predicted seepage concentration of manganese from the TMF is approximately 50% of the 75th percentile baseline concentrations in overburden and bedrock which also exceed the aesthetic ODWQS and GCDWQ criteria.
- Seepage from the TMF may exceed the ODWQS Medical Officer of Health reporting limit for sodium. The predicted seepage concentration of sodium from the TMF is approximately 45% lower than the 75th percentile baseline concentration in overburden which also exceeds the ODWQS Medical Officer of Health reporting limit. The predicted seepage concentration of sodium from the TMF is approximately double the 75th percentile baseline concentration in bedrock which does not exceed the ODWQS Medical Officer of Health reporting limit.

Impoundment Facility

- Seepage from the Impoundment Facility is not predicted to exceed MDMER criteria.
- Seepage from Impoundment may exceed the ODWQS, GCDWQ, and/or the 10 x CWQG-FAL criteria for nitrate. The maximum predicted seepage concentration of nitrate form the Impoundment Facility is approximately 20% higher than the 10 x CWQG-FAL criteria. The predicted 75th percentile seepage concentration of nitrate from the Impoundment Facility is no predicted to exceed the 10 x CWQG-FAL criteria.
- Seepage from the Impoundment Facility may exceed the ODWQS and/or the GCDWQ for arsenic. The predicted 75th percentile seepage concentration of arsenic from the Impoundment Facility is approximately an order of magnitude higher than the 75th percentile baseline concentration in bedrock and overburden. Baseline concentrations do not exceed regulatory criteria.
- Seepage from the Impoundment Facility may exceed the 10 x PWQO (interim) criteria for copper but not the 10 x CWQG-FAL criteria. The CWQG-FAL criteria is based on newer science than the 10 x PWQO (interim) criteria. The predicted 75th percentile seepage concentration of copper from the Impoundment Facility is approximately one order of magnitude higher than the 75th percentile baseline concentrations in overburden and bedrock. Baseline concentrations do not exceed regulatory criteria.
- Seepage from the Impoundment Facility may exceed the ODWQS and the GCDWQ aesthetic and health-based criteria for manganese. The predicted seepage concentration of manganese from the Impoundment Facility is of the same order of magnitude as the 75th percentile baseline concentrations in bedrock and overburden, which also exceed the ODWQS and the GCDWQ aesthetic and health-based criteria.
- Seepage from the Impoundment Facility may exceed the ODWQS Medical Officer of Health reporting limit for sodium. The predicted seepage 75th percentile concentration for sodium in seepage from the Impoundment Facility is approximately 50% lower than the 75th percentile baseline concentration in overburden which also exceeds the ODWQS Medical Officer of Health reporting limit. The predicted seepage concentration of sodium from the Impoundment Facility is approximately double the 75th percentile baseline concentration in bedrock which does not exceed the ODWQS Medical Officer of Health reporting limit.
- Seepage from the Impoundment Facility may exceed the ODWQS and/or the GCDWQ for uranium. Baseline concentrations do not exceed regulatory criteria.

The quality of seepage from Project infrastructure is evaluated with the fate (flow path) of seepage from the Project infrastructure for Year 17 and 30 of operations to characterize the overall residual effect of the Project on groundwater quality.

Operations Year 17 – Fate of Seepage

The fate of seepage through the TMF, Impoundment Facility, and East and West Stockpiles under the groundwater flow condition representative of operations Year 17 was predicted using the three-dimensional groundwater flow model (Appendix C.4 of the Impact Statement). The fate of seepage at the Year 17 is presented on Figure 14.6 and assumes steady state conditions (i.e., in perpetuity for the given model set up). The model scenario does not include the effect of the contact water collection system for the Impoundment Facility or the TMF, and therefore overestimates the mass loading (flow rate multiplied by concentration) of parameters in seepage to groundwater from these features.

The predicted groundwater flow pathway of seepage from the Impoundment Facility is generally toward the west and east of the facility towards the North Driftwood and West Buskegau Rivers, respectively. The lower bound estimate of predicted travel times from the Impoundment Facility to a surface water feature is 150 years to the North Driftwood River.

The predicted groundwater flow pathway of seepage from the East and West Stockpiles is toward the Open Pit. The predicted groundwater flow pathway of seepage from the TMF west and extends into the LSA/RSA west to the esker lakes (Zed, Mel, Sutherland, Jack, and Gerry Lakes; and the unnamed lake south of Zed Lake); south towards Jocko Creek, and northeast to the West Buskegau River. The lower bound estimate of predicted travel times from the TMF to a surface water feature is 60 years to Gerry Lake.

As the lower bounds on predicted horizontal groundwater flow travel times of groundwater seepage from the TMF, Impoundment Facility, and Stockpiles to rivers or lakes are greater than 17 years, seepage is not predicted to reach a receiver during the period of mine life represented by the Year 17 model.

There are no known groundwater users located within the seepage pathways of the Impoundment Facility or East and West Stockpiles. There is one private residence with a drilled well for water supply located within the steady state seepage pathway of the TMF. The lower bound estimate of predicted travel time from the TMF to the drilled well is approximately 275 years. As described in Section 14.4.2.3.3, the TMF will be rehabilitated with a vegetative cover by Year 30 and the tailings within the TMF are anticipated to have drained resulting in less seepage from the facility than when the TMF was operating. This will reduce the mounding of the groundwater table caused by operation of the TMF and the groundwater flow path of seepage from the TMF will change and will begin to flow from the TMF north to the Open Pit, and away from the drilled well. Therefore, the drilled well is not predicted to be in the transient flow path of groundwater seepage from the TMF.

The three-dimensional groundwater flow model was also used to predict the inflow rates to the Open Pit and discharge to surface water features from the TMF, Impoundment Facility, and the Stockpiles. These predicted rates are presented in Table 14.11 and do not include reductions in groundwater discharge rates for the contact water collection systems. The main receivers of seepage to groundwater from the TMF are the Open Pit (34%), Jocko Creek (17%), and West Buskegau River (16%). The receivers of seepage to groundwater from the Impoundment Facility are the Open Pit (74%), North Driftwood River (17%), and West Buskegau River (9%). Seepage to groundwater from the East and West Stockpiles is predicted to report to the Open Pit. The effects of these changes in quality of baseflow on surface water and fish and fish habitat are further assessed in Chapters 15 (Assessment of Potential Effects on Surface Water) and 17 (Assessment of Potential Effects on Fish and Fish Habitat), respectively.

Table 14.11 Predicted Fate of Seepage From TMF, Impoundment Facility, and Stockpiles – Representing Steady State Conditions of Operations Year 17 Mine Plan

Surface Water Feature	Predicted Groundwater Discharge Rate of Seepage Originating from Project Infrastructure (m^3/d)		
	TMF	Impoundment Facility	Stockpiles
Jocko Creek	2,256	-	-
North Driftwood River	-	194	-
West Buskegau River	2,090	105	-
Unnamed Lake (South of Zed Lake)	1,503	-	-
Zed Lake	43	-	-
Mel Lake	1,099	-	-
Sutherland Lake	155	-	-
Jack Lake	58	-	-
Gerry Lake	1,453	-	-
Martin Lake	-	-	-
Unnamed Lake (West Stockpile)	-	-	-
Open Pit	4,427	843	324

Note:
\- = Groundwater flows greater than 1 m^3/d are not predicted from the project infrastructure to the surface water feature

The effects on groundwater quality during operation prior to revegetation of the TMF are characterized as adverse, long-term, continuous, irreversible, and extend into the LSA/RSA. The magnitude is moderate for the majority of parameters except for arsenic in seepage from the Impoundment Facility which is classified as high because the concentration of arsenic in the seepage to groundwater from the Impoundment Facility (i.e. prior to any reduction in concentration along the groundwater flow path) is predicted to increase above a regulatory criteria and/or objective for drinking water that is not exceeded in baseline conditions. No existing or foreseeable groundwater users are located within the areas with groundwater quality that exceeds the GCDWQ or ODWQS within the 30-year time of travel from the Project infrastructure. After 30 years, the operations phase is complete and the flow path of seepage from Project infrastructure changes and is evaluated in Section 14.4.3.3.3.

Operations Year 30 – Fate of Seepage

By year 30, the TMF will be rehabilitated with a vegetative cover and the tailings within the TMF are anticipated to have drained resulting in less seepage from the facility than in Year 17. The fate of seepage at the end of Year 30 is presented on Figure 14.7 and does not include the effect of the contact water collection system for the Impoundment Facility.

The predicted groundwater flow pathway of seepage from the Impoundment Facility is generally toward the west and east of the facility towards the North Driftwood and West Buskegau Rivers, respectively. The lower bound estimate of predicted groundwater flow travel times from the Impoundment Facility to a surface water feature is 220 years to the North Driftwood River.

The predicted groundwater flow pathway of seepage from the East and West Stockpiles is toward the Open Pit. The predicted groundwater flow pathway of seepage from the TMF extends into the LSA/RSA west to the esker lakes (Mel and Gerry Lakes and the unnamed lake south of Zed Lake). The lower bound estimate of predicted travel times from the TMF to a surface water feature is 60 years to Gerry Lake.

As the lower bounds on predicted horizontal groundwater flow travel times of groundwater seepage from the TMF, Impoundment Facility, and Stockpiles to rivers or lakes are greater than 30 years, seepage is not predicted to reach a receiver during the period of mine life represented by the Year 30 model.

There are no known groundwater users located within the seepage pathways of the TMF, Impoundment Facility, or East and West Stockpiles.

The predicted rates of inflow to the Open Pit and discharge to surface water features from the TMF, Impoundment Facility, and Stockpiles are presented in Table 14.12. The main receivers of seepage to groundwater from the TMF are the Open Pit (93%) and the Unnamed Lake south of Zed Lake (7%). The main receivers of groundwater seepage to groundwater from the Impoundment Facility are the Open Pit (89%), North Driftwood River (7%), and West Buskegau River (4%). Seepage to groundwater from the East and West Stockpiles is predicted to report to the Open Pit. Groundwater in contact with the tailings impounded in the Open Pit is predicted to be contained within the Open Pit. The effects of these changes in quality of baseflow on surface water and fish and fish habitat are further assessed in Chapters 15 (Assessment of Potential Effects on Surface Water) and 17 (Assessment of Potential Effects on Fish and Fish Habitat), respectively.

Table 14.12 Predicted Fate of Seepage From TMF, Impoundment Facility, Stockpiles, and Tailings Impounded in Open Pit – Representing Steady State Conditions of Operations Year 30 Mine Plan

Surface Water Feature	Predicted Groundwater Discharge Rate of Seepage Originating from Project Infrastructure (m^3/d)			
	TMF	Impoundment Facility	Stockpiles	Tailings Impounded in Open Pit
Jocko Creek	-	-	-	-
North Driftwood River	-	87	-	-
West Buskegau River	-	49	-	-
Unnamed Lake (South of Zed Lake)	64	-	-	-
Zed Lake	-	-	-	-
Mel Lake	2	-	-	-
Sutherland Lake	-	-	-	-
Jack Lake	-	-	-	-
Gerry Lake	-	-	-	-
Martin Lake	-	-	-	-
Unnamed Lake (West Stockpile)	-	-	-	-
Open Pit	840	1,051	323	1,981

Note:
- = Groundwater flows greater than 1 m^3/d are not predicted from the project infrastructure to the surface water feature

The effects on groundwater quality at the end of operation are characterized as adverse, long-term, continuous, irreversible, and are predicted to extend into the LSA/RSA. The magnitude is moderate for the majority of parameters except for arsenic in seepage from the Impoundment Facility which is classified as high because the concentration of arsenic in the seepage to groundwater from the Impoundment Facility (i.e., prior to any reduction in concentration along the groundwater flow path) is predicted to increase above a regulatory criteria and/or objective for drinking water that is not exceeded in baseline conditions. No existing or foreseeable groundwater users are located within the areas with groundwater quality that exceeds the GCDWQ or ODWQS.

In addition to the seepage from Project infrastructure, groundwater quality may also be affected by minor spills. This residual effect on groundwater quality during operations is characterized as adverse, short-term, reversible, and will be confined to the PA. The magnitude is low because the volume of spills is expected to be low as a result of multiple irregular events that result in localized water quality effects within the PA relative to baseline conditions.

14.4.3.3.3 Passive Closure with Pit Lakes

In passive closure, the East and West Stockpiles are depleted, graded, and revegetated. The fate of seepage in passive closure with tailings impounded in the pit lake once the pit lake has filled to design elevation (steady-state conditions have been realized) is presented on Figure 14.8. The predicted quality of seepage from the TMF, Impoundment Facility, and East and West Stockpiles is presented in Table 14.10 and summarized in Section 14.4.3.3.2.

The predicted groundwater flow pathway of seepage from the Impoundment Facility is generally toward the west and east of the facility towards the North Driftwood and West Buskegau Rivers, respectively. The lower bound estimate of predicted travel times from the Impoundment Facility to a surface water feature is 60 years to the West Buskegau River.

The predicted groundwater flow pathway of seepage from the TMF extends into the LSA/RSA west to the esker lakes (Mel, Sutherland, Jack, and Gerry Lakes; and the unnamed lake south of Zed Lake). The lower bound estimate of predicted travel times from the TMF to a surface water feature is 150 years to Gerry Lake.

Groundwater in contact with the tailings impounded in the Open Pit is predicted to travel west and southwest to the North Driftwood River diversion and Martin Lake, respectively. The lower bound estimate of predicted travel times from the tailings impounded in the Open Pit to a surface water feature is 920 years to Martin Lake.

There are no known groundwater users located within the seepage pathways of the TMF, Impoundment Facility, or the tailings impounded within the Open Pit.

The predicted rates of inflow to the Open Pit and discharge to surface water features from the TMF, Impoundment Facility, and Stockpiles are presented in Table 14.13. The main receivers of seepage to groundwater from the TMF are the Open Pit (59%), the Unnamed Lake south of Zed Lake (23%), and Mel Lake (7%). The main receivers of groundwater seepage to groundwater from the Impoundment Facility are, North Driftwood River (44%), West Buskegau River (35%), and the Open Pit (21%). Groundwater in contact with tailings impounded in the Open Pit are predicted to discharge mainly to the Open Pit spillways (90%), and the unnamed Lake near the West Stockpile (7%). The effects of these changes in quality of baseflow on surface water and fish and fish habitat are further assessed in Chapters 15 (Assessment of Potential Effects on Surface Water) and 17 (Assessment of Potential Effects on Fish and Fish Habitat), respectively.

Table 14.13 Predicted Fate of Seepage From TMF, Impoundment Facility, Tailings Impounded in Pit Lake – Passive Closure

Surface Water Feature	Predicted Groundwater Discharge Rate of Seepage Originating from Project Infrastructure (m^3/d)		
	TMF	Impoundment Facility	Tailings Impounded in Pit Lake
Jocko Creek	-	-	-
North Driftwood River	-	538	-
West Buskegau River	-	435	-
Unnamed Lake (South of Zed Lake)	208	-	-
Zed Lake	-	-	-
Mel Lake	58	-	-
Sutherland Lake	2	-	-
Jack Lake	-	-	-
Gerry Lake	528	-	2
Martin Lake	16	-	6
Unnamed Lake (West Stockpile)	12	5	22
Open Pit	69	256	277

Note:
- = Groundwater flows greater than 1 m^3/d are not predicted from the project infrastructure to the surface water feature

The effects on groundwater quality during passive closure are characterized as adverse, long-term, continuous, irreversible, and are predicted to extend into the LSA/RSA. The magnitude is moderate for the majority of parameters except for arsenic in seepage from the Impoundment Facility which is classified as high because the concentration of arsenic in the seepage to groundwater from the source (i.e. prior to any reduction in concentration along the groundwater flow path) is predicted to increase above a regulatory criteria and/or objective for drinking water that is not exceeded in baseline conditions. No existing or foreseeable groundwater users are located within the areas with groundwater quality that exceeds the GCDWQ or ODWQS.

14.4.4 Summary of Project Residual Effects

Table 14.14 summarizes Project residual effects on groundwater.

Table 14.14 Project Residual Effects on Groundwater

Residual Effect	Residual Effects Characterization							
	Project Phase	Direction	Magnitude	Geographic Extent	Timing	Duration	Frequency	Reversibility
Change in Groundwater Quantity Related to Construction	C	A	M	PA	NS	ST	IR	R
Change in Groundwater Quantity Related to Open Pit	C	A	H to L	LSA/RSA	NS	LT	C	I
	O	A	H	LSA/RSA	NS	LT	C	I
	D	P	H to L	LSA/RSA	NS	LT	C	I
Change in Groundwater Quantity Related to TMF	O	P	H	LSA/RSA	NS	MT	C	R
Change in Groundwater Quality	C	A	L	PA	NS	ST	IR	R
	O	A	M to H	LSA/RSA	NS	LT	C	I
	D	A	M to H	LSA/RSA	NS	LT	C	I

KEY
See Table 14.3 for detailed definitions.

Project Phase
C: Construction
O: Operations
D: Decommissioning and Closure

Direction:
P: Positive
A: Adverse
N: Neutral

Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Geographic Extent:
PA: Project Area
LSA: Local Study Area
RSA: Regional Study Area

Timing
NS: Not sensitive
MS: Moderate sensitivity
HS: High sensitivity

Duration:
ST: Short-term
MT: Medium-term
LT: Long-term

Frequency:
S: Single event
IR: Multiple irregular event
R: Multiple regular event
C: Continuous

Reversibility:
R: Reversible
I: Irreversible

N/A: Not applicable

14.4.4.1 Summary of Adverse Effects

The residual effects of the Project on groundwater quantity will results in measurable changes in groundwater levels as a result of Open Pit dewatering, diversion of the North Driftwood River, and operation of the TMF. The predicted maximum extent of drawdown (defined by the 1 m drawdown contour) at the end of dewatering activities in operations Year 30 extends up to 3.1 km east, 4 km west, 5.1 km south, and 9 km north of the Open Pit. The magnitude will be reduced during passive closure, as the Open Pit fills, groundwater will gradually rise to the final predicted levels during passive closure as the Open Pit fills with groundwater, with the final groundwater levels controlled by spillways which will maintain the surface water elevation at approximately 272.5 m amsl. Timing may affect dewatering rates due to natural seasonal variations, particularly during the spring period when higher groundwater levels are expected; however, these variations would not be considered a Project-related effect. No groundwater users are known to exist within the extents of groundwater drawdown or mounding for the Project. The residual effect of changes in groundwater discharge on surface water is evaluated in Chapter 15 (Assessment of Potential Effects on Surface Water), on wetlands in Chapter 16 (Assessment of Potential Effects on Vegetation, Riparian and Wetland Environments), and on fish and fish habitat in Chapter 17 (Assessment of Potential Effects on Fish and Fish Habitat).

The residual effects of the Project on groundwater quality may result in measurable changes in concentrations of parameters in groundwater and groundwater that discharges to surface water. Indicator parameters for residual effects of the Project on groundwater are those which do not exceed the ODWQS and/or the GCDWQ in baseline groundwater quality samples but are predicted to have concentrations which exceed the ODWQS and/or the GCDWQ in seepage to groundwater from Project infrastructure (i.e., prior to any reduction in concentration along the groundwater flow path). Arsenic and uranium are indicator parameters for seepage from the Impoundment Facility. One residential supply well is located approximately 3.8 km southwest of the TMF. The water supply well is located within the predicted steady state flow path of seepage from the TMF representing conditions in Year 17 of mine life, however the lower bound estimate of predicted travel time from the TMF to the supply well is 275 years. The flow path from the TMF is predicted to change after the TMF is rehabilitated and subsequently drains with groundwater seepage flowing from the TMF towards the Open Pit following rehabilitation. Therefore, water quality effects of the Project on this well are not predicted. This assessment of effects to groundwater quality does not include the effect of the contact water collection ditches located around the perimeter of the TMF which would reduce the mass loading of parameters (seepage rate multiplied by concentration) from the TMF to the environment.

In addition to the seepage from Project infrastructure, groundwater quality may also be affected by minor spills. The volume of spills is expected to be low as a result of multiple irregular events that result in localized water quality effects within the PA relative to baseline conditions.

A monitoring program as outlined in Section 14.8 will be implemented to confirm the predictions of the effects of the Project on groundwater quantity and quality.

14.4.4.2 Summary of Positive Effects

Mounding of the water table in the vicinity of the TMF during operations and in the PA during passive closure could result in additional available drawdown within a water supply well, if present.

14.5 Potential Effects on Federal Lands

There are no federal lands within the LSA or RSA. The closest Federal lands are the Taykwa Tagamou Nation Reserve lands located approximately 37 km away (straight line) from the PA (14 km southeast of Cochrane). No additional mitigation measures beyond those identified are specifically required for federal lands.

14.6 Prediction Confidence

14.6.1 Change in Groundwater Quantity

The assessment of baseline conditions and the inferred conceptualization of groundwater processes are based on applying industry standards and practices under quality assurance and quality control programs which are applied to both field and laboratory procedures.

The three-dimensional groundwater flow modelling was conducted using a model calibrated to within an acceptable range of error for groundwater levels and river baseflows to establish baseline conditions. Predictions made using the three-dimensional groundwater flow model are based on several conservatively protective assumptions to reduce the influence of uncertainty in the predictions. Therefore, the confidence in the predictions made using the three-dimensional groundwater flow model is considered high.

Conservatively protective parameters were applied in the three-dimensional groundwater model calibration and predictive analysis phases of the modelling investigations. Specifically, the three-dimensional groundwater flow model includes generally high hydraulic conductivity values applied uniformly throughout the entire depth of bedrock. The three-dimensional groundwater flow model did not represent reductions in hydraulic conductivity with depth that could occur due to lithostatic pressure, reduced fractures/connectivity, and reduced secondary porosity. Hydraulic conductivities for overburden hydrostratigraphic units were generally on the high end of the reasonable range of values for each unit or higher for some units (i.e., the surface glaciolacustrine deposits, and tills). Using higher hydraulic conductivity values in the calibrated three-dimensional groundwater flow model results in higher groundwater flow velocities and increased groundwater flow that may occur toward the pit. As such, this approach provided results that may be considered conservatively high for predicting mine operation-related changes in mine inflow rates.

The characterization of the Main Regional Fault in the groundwater flow model was based on review of logs from four exploration boreholes which intersected the fault and the results of one packer test which straddled the fault. A refined understanding of the Main Regional Fault would improve the confidence in predictions of effects of the Project on groundwater quantity. Another approach to increasing confidence regarding the Main Regional Fault is to conduct a sensitivity analysis to determine the sensitivity of the predictions of increased hydraulic conductivity of the fault. Typically, the conduit flow package (CFP) is used with MODFLOW6 to simulate the faults as zones of higher hydraulic conductivity over a defined dimension that is smaller than the groundwater flow model grid cell size. However, MODFLOW6 has undergone upgrades and the software code for the CFP package is not currently compatible with the MODFLOW6 code. Discussions with the developers of the code to rectify the issue have been ongoing. Therefore, simulation of the regional fault within the groundwater flow model was not feasible. As the project continues into permitting additional testing of the fault will be completed and the feasibility of simulating the fault within the model will continue to be discussed with the developers to refine the understanding of the influence of the regional fault on the predictions of effects of the Project on groundwater.

A steady-state modelling approach was selected for the Open Pit dewatering as this provides a conservatively high estimate of groundwater drawdown at the end of Year 30 (when the maximum drawdown extent is predicted) and, as a result, the potential effects on groundwater levels and reductions in groundwater discharge to surface water receivers. Furthermore, the use of separate steady-state three-dimensional groundwater flow model runs to simulate dewatering is expected to provide an over-estimation of the effects on shallow and deep groundwater levels and corresponding changes in groundwater discharge rates to surface water features. The steady-state modelling approach provides average annual groundwater inflow rates and may "under predict" Project inflows in the early phases of Open Pit development. However, while increased inflows due to storage in the aquifer materials and the slightly higher hydraulic gradients may be expected during the initial dewatering period, this is not expected to be an issue for the Project and the use of the multiple steady-state three-dimensional groundwater flow model runs reduces this potential effect. The three-dimensional groundwater flow model provides reliable long-term representation of groundwater inflows over the life of mine.

14.6.2 Change in Groundwater Quality

The effects to groundwater quality as a result of the Project are based on field data and geochemical characterization of overburden, ore, rock, and tailings. Prediction confidence in groundwater quality effects is high, as reductions in groundwater discharge to the natural environment did not consider collection within the contact water collection system for the ore stockpile and Impoundment Facility. Including the effect of the contact water collection system results in further reductions in loading to the natural environment. Furthermore, conservative estimates of groundwater recharge beneath the ore stockpile and Impoundment Facility are applied in the three-dimensional groundwater flow modelling, which overestimate the loadings to groundwater.

The prediction of concentrations in groundwater at the point of discharge to the receiving environment did not consider physical flow processes, such as dispersion and diffusion, and chemical processes, such as adsorption, precipitation, and dissolution along the groundwater flow path of the travel time to reach the ultimate receptor. These processes will result in reductions in groundwater concentrations along the groundwater flow path, and therefore not considering them in the predictions represents a conservative approach to estimating loading to the natural environment.

Furthermore, the groundwater quality assessment does not consider the effect of timing for infrastructure development (i.e., when the Impoundment Facility is in place) or the groundwater travel time in calculating the mass loading to the environment (seepage quality multiplied by groundwater discharge rate). Not accounting for timing of infrastructure development will result in a conservative prediction of the mass loading in early phases of the Project (i.e., operations) and provide a better representation of long-term water quality through passive closure, although still a very conservative prediction.

14.6.3 Refinement of Groundwater Flow Model

The following additional field studies are proposed with findings being incorporated into an updated groundwater flow model to refine the prediction of effects of the Project on groundwater quantity and quality to support permit applications.

- Additional hydraulic testing to refine the understanding of the hydrogeological properties of the Main Regional Fault.
- Drilling of boreholes and installation of monitoring wells within the footprint of the Impoundment Facility, TMF, and Stockpiles; along the proposed realignment channel of the North Driftwood River; and within the regionally mapped boundaries of the esker.
- Completion of geophysics to characterize hydrostratigraphy between discrete drilling locations in select areas.
- A pumping test in the footprint of the Open Pit to refine estimates of hydraulic conductivity.

14.7 Assumptions

The following are the main assumptions made during the construction and calibration of the three-dimensional groundwater flow model which was used to predict the effects of the Project on groundwater quantity and/or flow. Further details are presented in the Groundwater Assessment (Appendix C.4 of the Impact Statement).

Recharge Rate

Recharge rates were assigned based on the uppermost hydrostratigraphic units in the three-dimensional groundwater flow model. Two recharge units were defined: one unit to represent the relatively low infiltration capacity of the surficial clay associated with the Northern Clay Belt and till, and one recharge unit to reflect the higher infiltration capacity of the coarser deposits associated with the mapped eskers. The groundwater recharge rates for the calibrated model were 14.6 mm/year for surficial clay and till, and 40.2 mm/year for the eskers.

To test the performance of the three-dimensional groundwater flow model with varying recharge rates, two sensitivity scenarios representing a 100% increase and a 50% decrease from the calibrated baseline recharge value were run. The 100% increase in recharge rate is considered conservative as it is higher than climate change forecasts for Timmins which are in the range of 16% to 21% increase in precipitation for the next 20 to 50 years, respectively, under a high emissions scenario (ClimateData.ca 2024). Varying the recharge rate results in changes to the predicted groundwater elevations but not significant changes to the predictions of groundwater inflow rates to the Open Pit. For example, a 100% increase in recharge rates results in only a 1% increase in groundwater inflows to the Open Pit.

Overburden Hydraulic Conductivity

Hydraulic conductivities for overburden hydrostratigraphic units were generally set at the high end of the reasonable range of values for each unit or higher for some units (i.e., the surface glaciolacustrine deposits, and tills). Using higher hydraulic conductivity values in the calibrated three-dimensional groundwater flow model results in a conservative overestimate of groundwater inflow rates to the Open Pit and corresponding zone of influence (drawdown).

Two sensitivity scenarios were performed wherein the hydraulic conductivity of the overburden units was iteratively raised and lowered by two and by half, respectively. A third sensitivity scenario was run where the hydraulic conductivity of each overburden hydrostratigraphic unit was set at the high end of the expected range. Hydraulic conductivity for units that were already close to the high end of the range were modified less than those that were lower than the high end of the range. Increasing the overburden hydraulic conductivity to the high end of the expected values results in an increase in the mean residual of approximately 30% (a decrease in predicted heads on average) and a corresponding 81% increase in predicted groundwater inflow to the Open Pit. The lateral extent of predicted water table drawdown was not significantly impacted by this increase in overburden hydraulic conductivity, while predicted discharge to surface water was decreased by 9%, on average.

A sensitivity scenario was completed where the hydraulic conductivity of the esker was set equal to the hydraulic conductivity of the surrounding sediments. This 80% reduction in hydraulic conductivity of the esker resulted in a 10% increase in predicted inflow to the Open Pit. The increase in pit inflow was attributed to the removal of a preferential pathway from the esker. Consequently, drawdown is more uniform and generally radial from the Open Pit, given the removal of the local zone of higher hydraulic conductivity that connected to the surficial lakes A sensitivity scenario with increased esker hydraulic conductivity was not included as the calibrated value is already near the upper end of the expected range for esker materials.

Bedrock Hydraulic Conductivity

The three-dimensional groundwater flow model was constructed using hydraulic conductivity values near the high end of the range of values that have been estimated in the bedrock, applied uniformly throughout the entire depth of bedrock. The three-dimensional groundwater flow model did not represent reductions in hydraulic conductivity with depth that could occur due to lithostatic pressure, reduced fractures/connectivity, and reduced secondary porosity. Using higher hydraulic conductivity values in the calibrated three-dimensional groundwater flow model results in higher groundwater flow velocities and increased groundwater flow that may occur toward the Open Pit.

Four sensitivity scenarios were completed which indicated that the predicted rate of groundwater inflow to the Open Pit is moderately sensitive to changes in the hydraulic conductivity of the bedrock model layers. Reduction in hydraulic conductivity of 75% and 50% result in decreased predicted inflow into the Open Pit of 10% and 4%, respectively. An increase in hydraulic conductivity of 150% results in a 19% increase in predicted inflow to the Open Pit. A gradual reduction of hydraulic conductivity with depth in bedrock of four orders of magnitude from $1x10^{-7}$ m/s in the shallow rock to $1x10^{-11}$ m/s in the deepest rock at the base of the model resulted in a 13% reduction in the predicted inflow into the Open Pit. The gradual reduction in hydraulic conductivity with depth in the bedrock also results in a (30% smaller) predicted lateral extent of water table drawdown, while predicted discharge to surface water was increased by 12%, on average. The hydraulic conductivity for the regional fault was assumed to be equal to the hydraulic conductivity of the surrounding bedrock. Hydraulic conductivity testing on the regional fault resulted in a hydraulic conductivity value which was not significantly different than the average hydraulic conductivity estimated for the borehole suggesting that the fault does not act as a preferential pathway for groundwater flow at this location (Groundwater Assessment [Appendix C.4 of the Impact Statement]).

Further hydraulic conductivity testing will be completed across the fault so the groundwater inflow rates can be refined to support permitting.

River and Lakebed Conductance

The interaction between the surface water in rivers lakes and the groundwater in the underlying aquifers is defined in the three-dimensional groundwater flow model by the "conductance" term. This term represents the presence of a layer of sediment on the river or lakebed that can affect the rate of water transferred between surface water and underlying groundwater. The hydraulic conductivity used to define conductance in the lakes was consistent with the hydraulic conductivity of the till units present within the LSA/RSA. The hydraulic conductivity for river segments was assigned based on sediment analyses from sampling locations along the rivers within the PA.

River and lakebed conductance values were lowered by an order of magnitude and doubled in two iterative sensitivity scenarios to examine model effects at either end of a reasonable range of values. A doubling of the hydraulic conductivity river and lakebed sediments results in a 33% increase in the predicted rate of inflow of groundwater to the Open Pit. Decreasing the hydraulic conductivity of the river and lakebed sediments had a nearly negligible effect on predicted inflow to the Open Pit (less than 3% difference).

The following assumptions were made in prediction of effects of the Project on groundwater quality.

- The water quality infiltrating to groundwater from beneath the Stockpiles, Impoundment Facility, and TMF was assumed to be representative of the water quality at the predicted discharge location to the receiving environment. This approach provides a conservative estimate of groundwater quality discharging to surface water and does not consider physical or chemical attenuation processes along the groundwater flow path.
- Flow tracking was used in the three-dimensional groundwater flow model to provide a conservative estimate of groundwater discharge rates to surface water components based on advective and dispersive flow processes. The effects of other physical flow processes such as diffusion and chemical processes, such as adsorption and precipitation or dissolution, was not considered. These other processes will reduce parameter concentrations and arrival times.
- The timing for infrastructure development or the groundwater travel time of seepage from Project infrastructure to receiving environment is not considered in calculating the mass loading to the environment (seepage quality multiplied by groundwater discharge rate). This will result in a conservative prediction of the mass loading in early phases of the Project.

14.8 Follow-up and Monitoring

Canada Nickel will implement follow-up and monitoring programs to verify the accuracy of effects and to evaluate the effectiveness of mitigation measures, the results of which will be used to identify and implement adaptive management measures, as appropriate. As it relates to groundwater quantity and quality, follow-up and monitoring measures will be implemented to monitor groundwater levels and groundwater quality at key Project locations. Monitoring data will be used to verify and confirm the predicted effects identified in the three-dimensional groundwater flow model and to meet regulatory requirements related to specific permits or conditions of approval. Chapter 34 of the Impact Statement includes additional details on follow-up and monitoring programs proposed by Canada Nickel.

14.9 References

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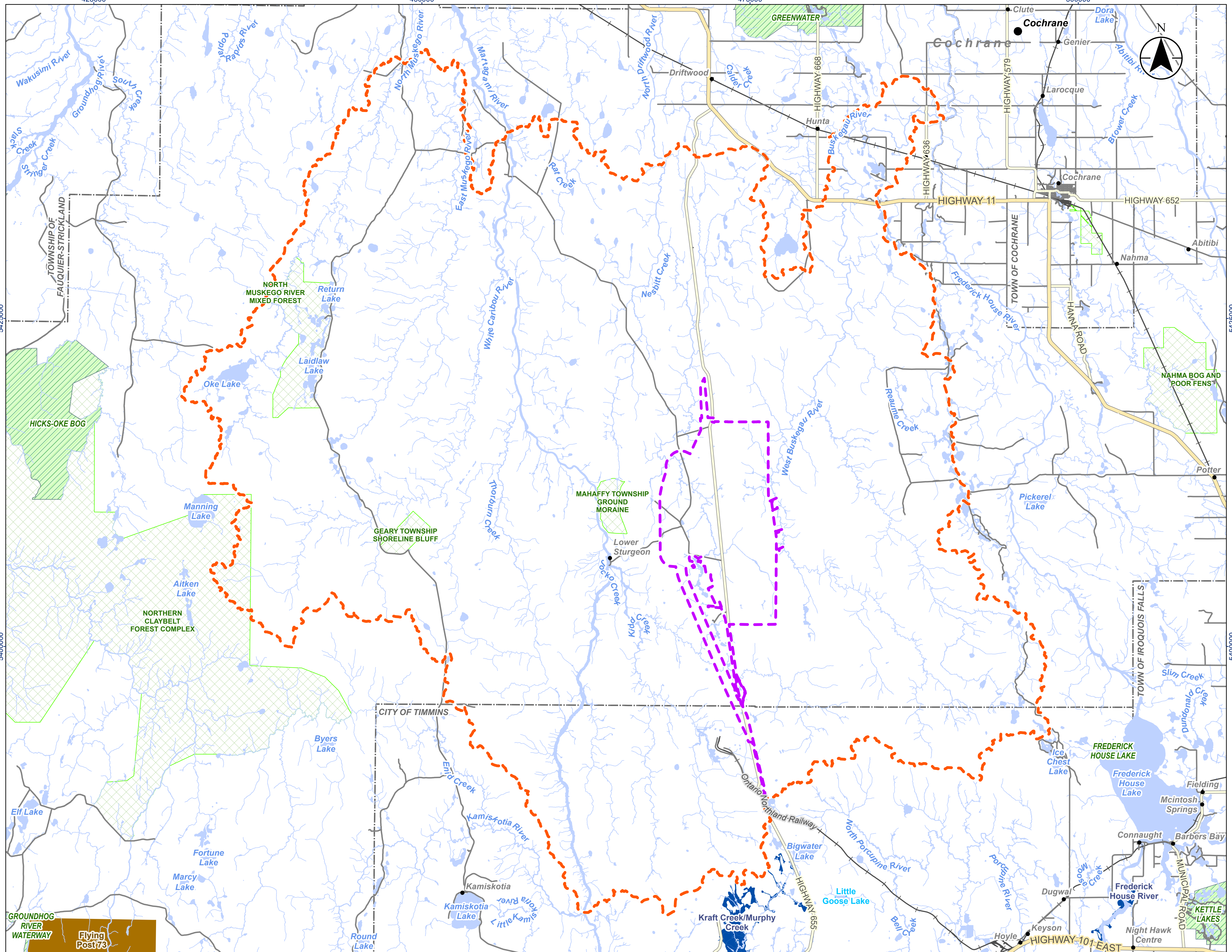
14.10 Figures



Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Local/Regional Study Area

Base Features

- Expressway / Highway
- Major Road
- Minor Road
- Railway
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier
- First Nation Reserve
- Conservation Reserve (Regulated)
- Provincial Park
- Wetland, Provincially Significant
- Wetland, Other Evaluated

0 10 20 km

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Notes

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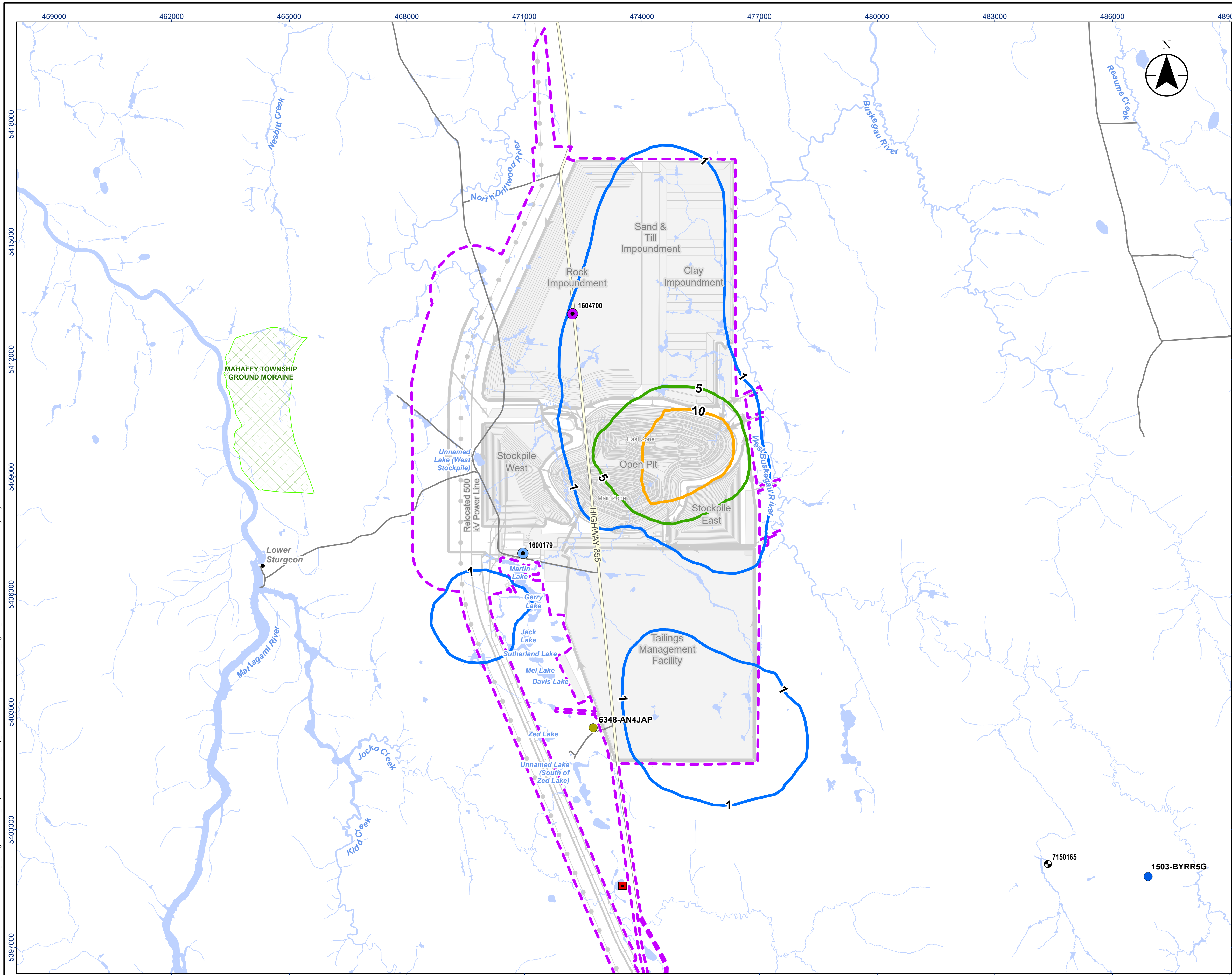
Project Location
Timmins, Ontario

160930456 REVA
Prepared by tcoghlan on 2024-09-20

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

Figure No.
14.1

Title
Local and Regional Study Areas



Stantec

CANADA NICKEL COMPANY

Legend

Project Area

Base Features

Major Road

Minor Road

Watercourse

Waterbody

Conservation Reserve (Regulated)

Drawdown Contours

1 m Drawdown

5 m Drawdown

10 m Drawdown

Private Residence with Drilled Well

MECP Water Well (Well ID)

Commerical

Domestic

Monitoring

Active Permit to Take Water within LSA/RSA (MECP)

Dewatering

Water Supply

Note: Wells 1604700 and 1600179 will be confirmed to be decommissioned prior to Project construction

0 1 2 km

1:100,000 (At original document size of 11x17)

Notes

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Project Location
Timmins, Ontario

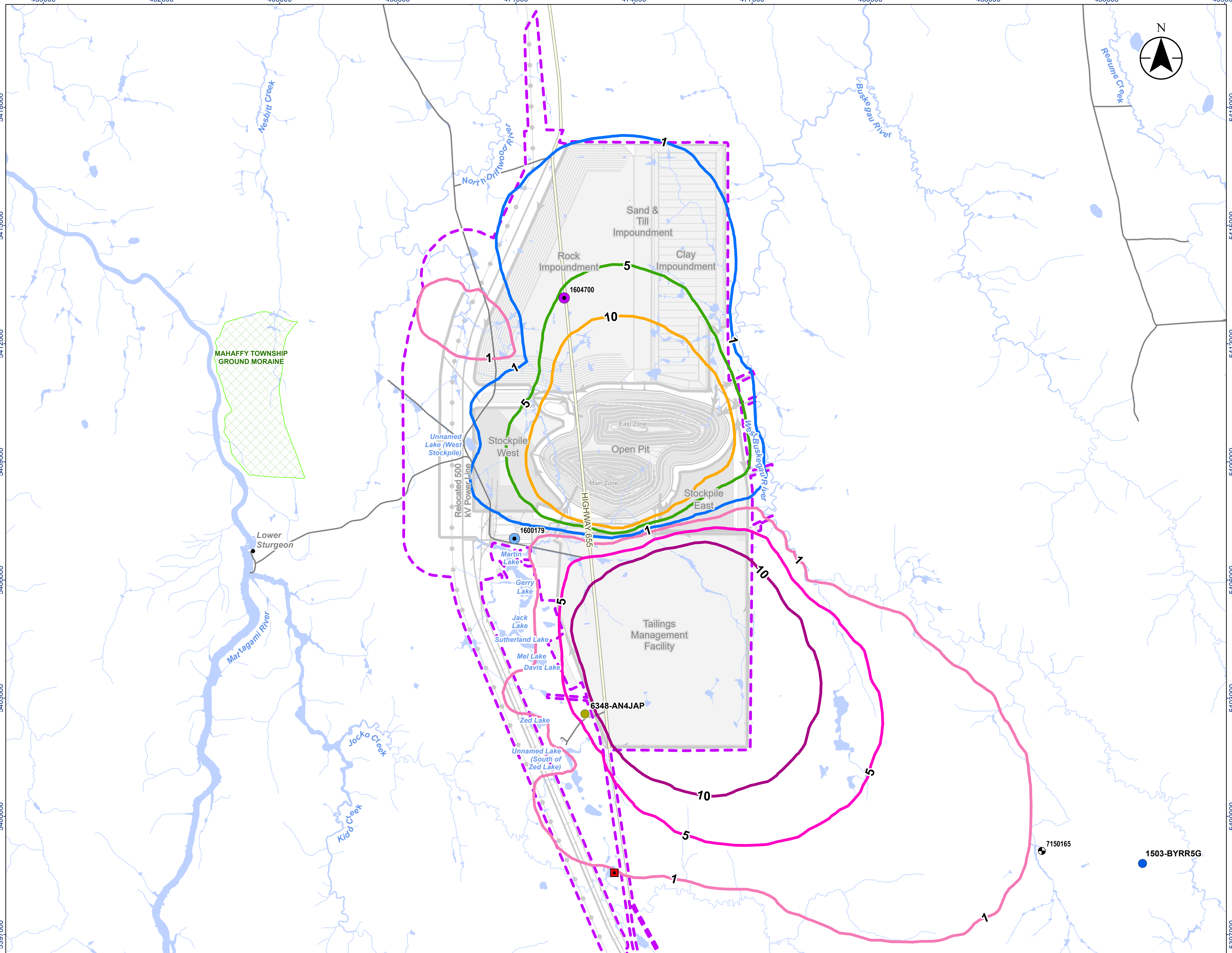
160930456 REVA
Prepared by tcoghlan on 2024-09-23

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

Figure No.
14.2

Title
Predicted Groundwater Table Drawdown - Operations Year -1

\\cd1004-f01\01609\active\160930456\gis_cad\gis\mxds\IS\IS_Chapter\160930456_IS_Chp_Grdw.aprx\160930456_IS-VC_Grdw_Fig14.2_DDownYear-1 Revised: 2024-09-23 By: tcoghlan



Stantec

CANADA NICKEL COMPANY

Legend

- Project Area
- Private Residence with Drilled Well

Base Features

- Major Road
- Minor Road
- Watercourse
- Waterbody
- Conservation Reserve (Regulated)

Active Permit to Take Water within LSA/RSA (MECP)

- Dewatering
- Water Supply

MECP Water Well (Well ID)

- Commerical
- Domestic
- Monitoring

Drawdown Contours

- 1 m Drawdown
- 5 m Drawdown
- 10 m Drawdown

Mounding Contours

- 1 m Mounding
- 5 m Mounding
- 10m Mounding

Note: Wells 1604700 and 1600179 will be confirmed to be decommissioned prior to Project construction

0 1 2 km

1:100,000 (At original document size of 11x17)

Notes

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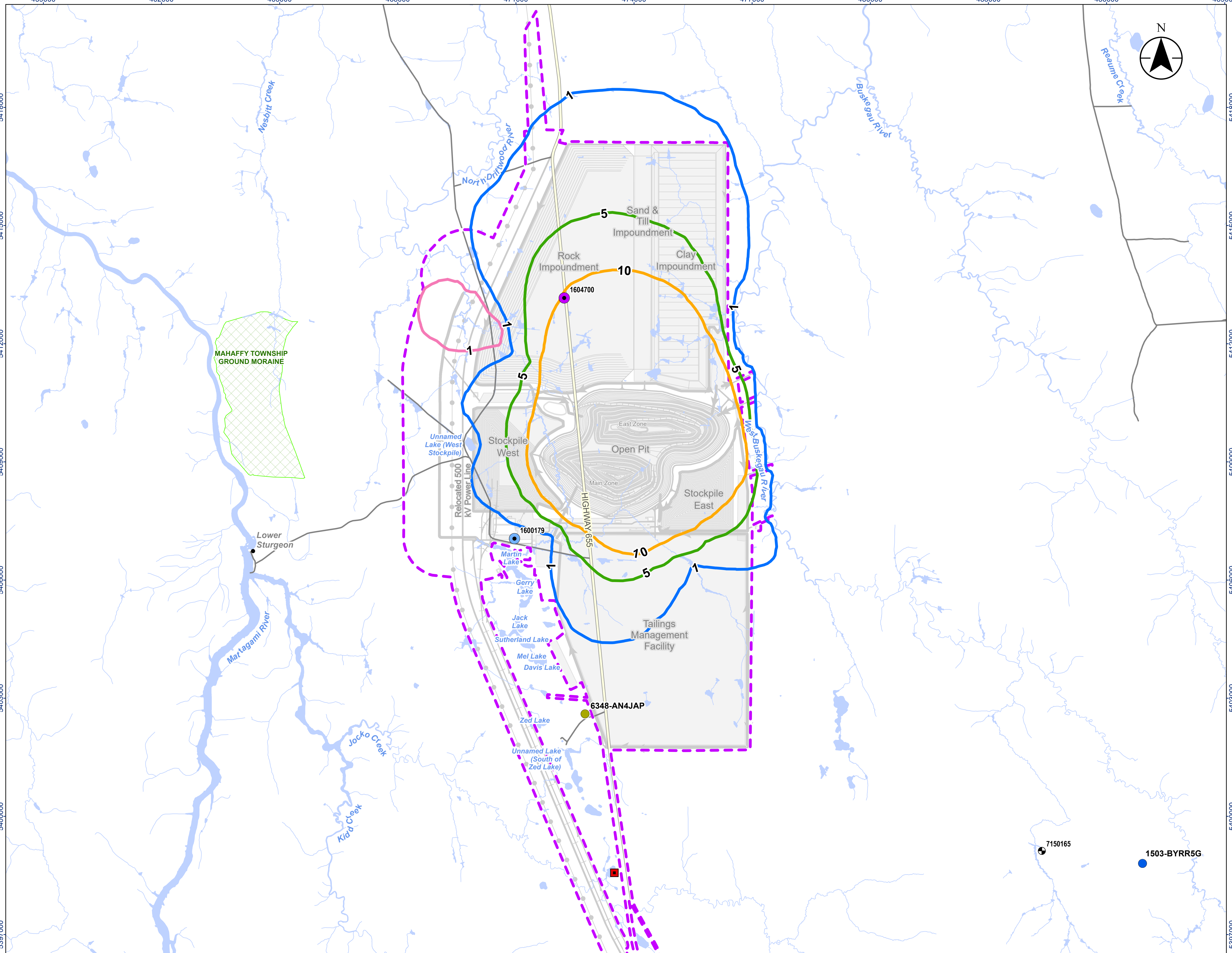
Project Location 160930456 REVA
Timmins, Ontario Prepared by tcoghlan on 2024-09-20

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

Figure No.
14.3

Title
Predicted Groundwater Table Drawdown - Operations Phase Year 17



Stantec

CANADA NICKEL COMPANY

Legend

- Project Area

Base Features

- Major Road
- Minor Road
- Watercourse
- Waterbody
- Conservation Reserve (Regulated)

Drawdown Contours

- 1 m Drawdown
- 5 m Drawdown
- 10 m Drawdown

Mounding Contours

- 1 m Mounding

- Private Residence with Drilled Well

Active Permit to Take Water within LSA/RSA (MECP)

- Dewatering
- Water Supply

MECP Water Well (Well ID)

- Commerical
- Domestic
- Monitoring

Note: Wells 1604700 and 1600179 will be confirmed to be decommissioned prior to Project construction

0 1 2 km

1:100,000 (At original document size of 11x17)

Notes

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Project Location
Timmins, Ontario

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Prepared by tcoghlan on 2024-09-20

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

Figure No.
14.4

Title
Predicted Groundwater Table Drawdown - Operations Phase Year 30

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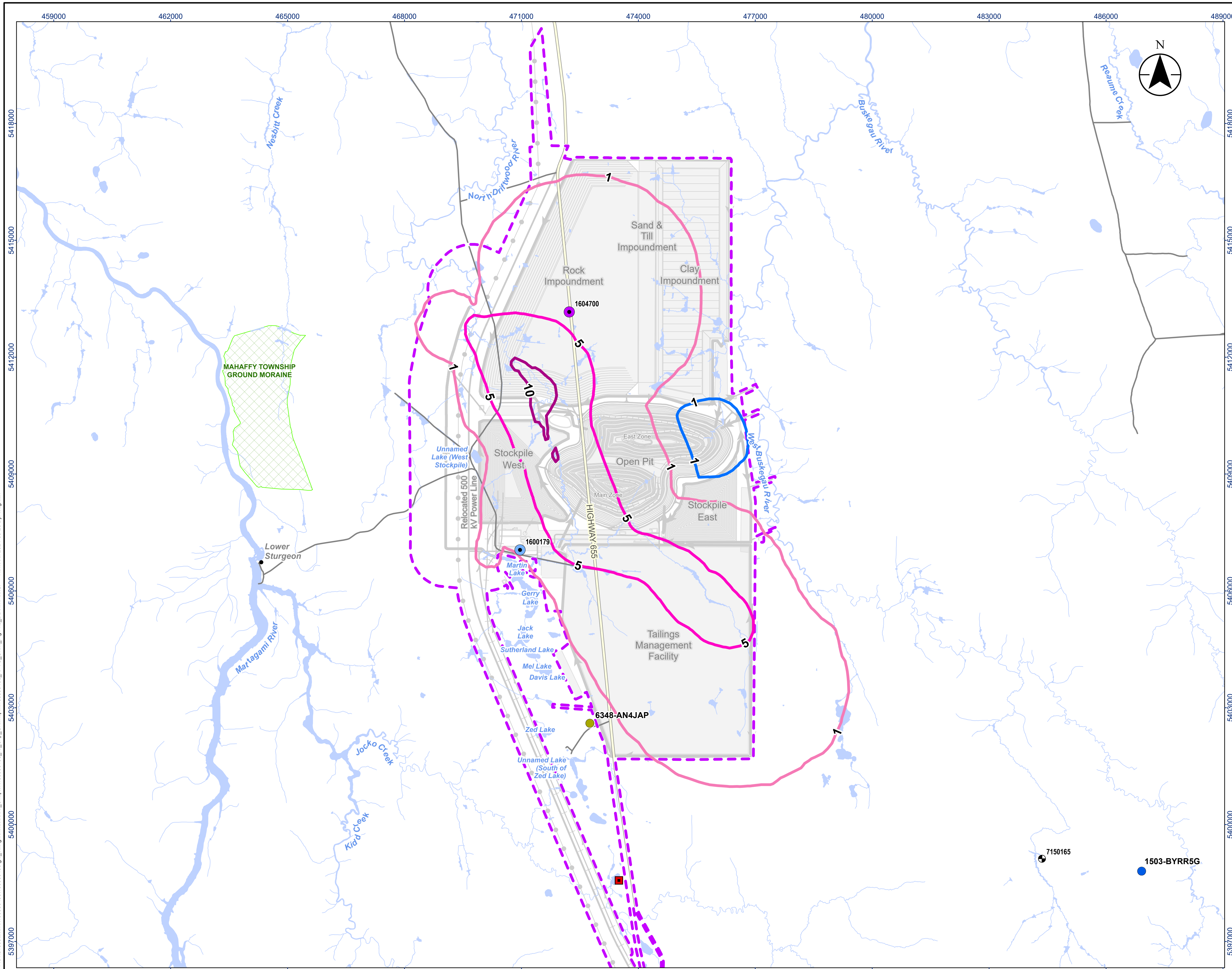

Stantec

CANADA NICKEL COMPANY

Legend

- Project Area

Base Features

- Major Road
- Minor Road
- Watercourse
- Waterbody
- Conservation Reserve (Regulated)

Drawdown Contours

- 1 m Drawdown

Mounding Contours

- 1 m Mounding
- 5 m Mounding
- 10m Mounding

- Private Residence with Drilled Well

MECP Water Well (Well ID)

- Commerical
- Domestic
- Monitoring

Active Permit to Take Water within LSA/RSA (MECP)

- Dewatering
- Water Supply

Note: Wells 1604700 and 1600179 will be confirmed to be decommissioned prior to Project construction

0 1 2 km

1:100,000 (At original document size of 11x17)

Notes

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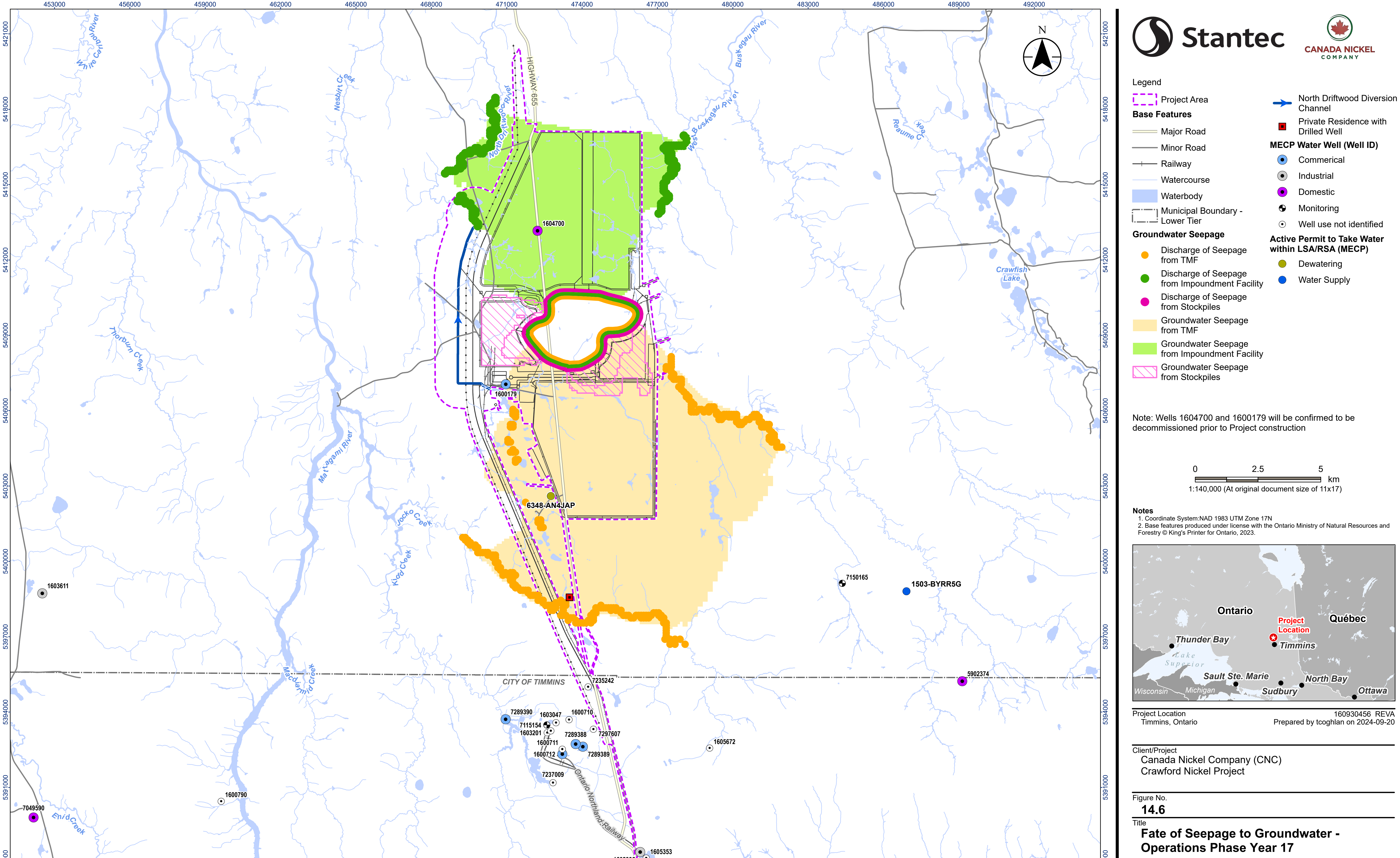
Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
14.5

Title
Predicted Groundwater Table Drawdown - Passive Closure with Pit Lake



Notes
1. Coordinate System:NAD 1983 UTM Zone 17N
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Project Location
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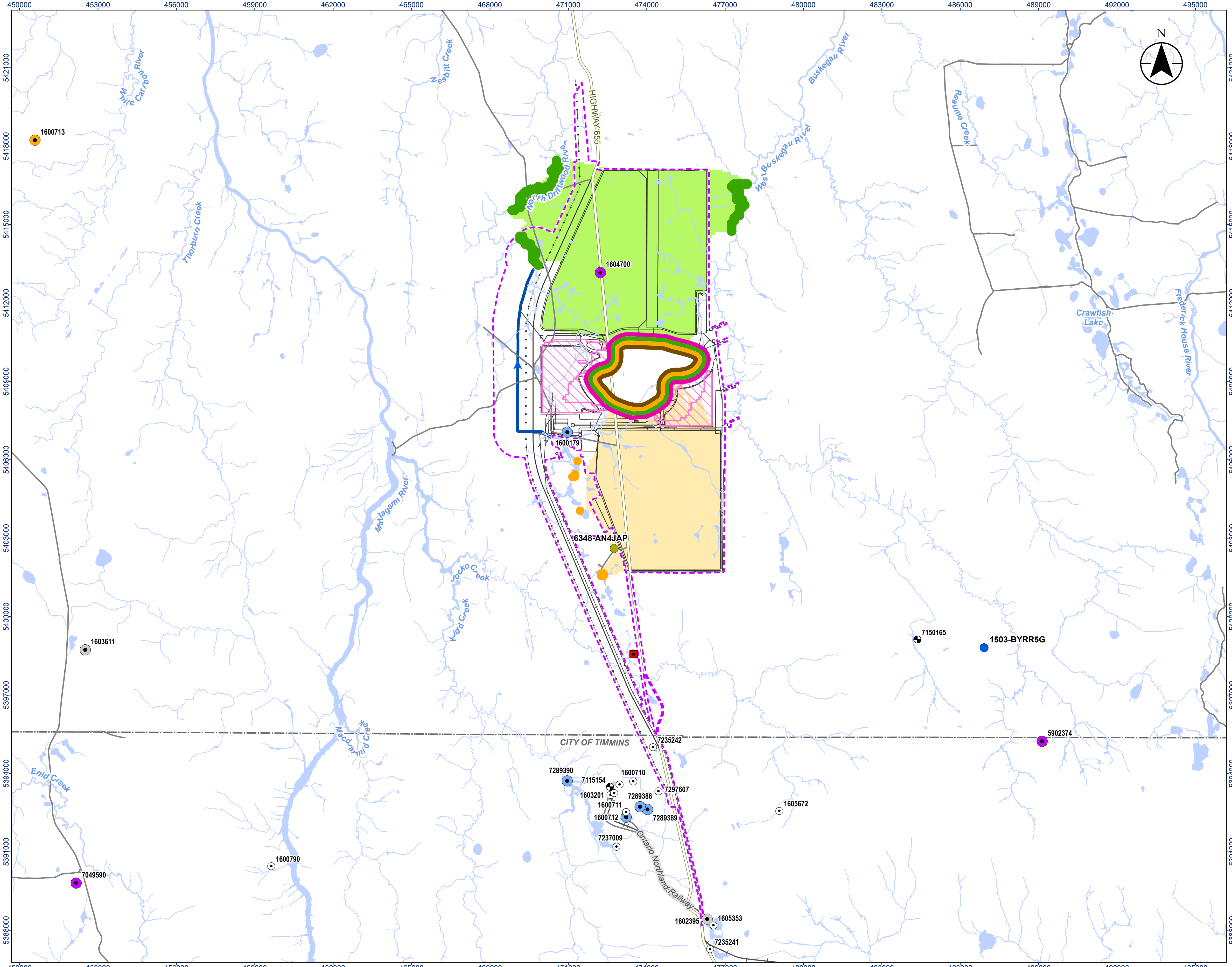
Prepared by tcoghlan on 2024-09-20

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

Figure No.
14.6

Title
Fate of Seepage to Groundwater - Operations Phase Year 17



Stantec

CANADA NICKEL COMPANY

Legend

- Project Area

Base Features

- Major Road
- Minor Road
- Railway
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier

Groundwater Seepage

- Discharge of Seepage from TMF
- Discharge of Seepage from Impoundment Facility
- Discharge of Seepage from Stockpiles
- Discharge of Seepage from Tailings
- Groundwater Seepage from TMF
- Groundwater Seepage from Impoundment Facility
- Groundwater Seepage from Stockpiles

- North Driftwood Diversion Channel
- Private Residence with Drilled Well

MECP Water Well (Well ID)

- Commerical
- Industrial
- Public
- Domestic
- Monitoring
- Well use not identified

Active Permit to Take Water within LSA/RSA (MECP)

- Dewatering
- Water Supply

Note: Wells 1604700 and 1600179 will be confirmed to be decommissioned prior to Project construction

0 2.5 5 km

1:150,000 (At original document size of 11x17)

Notes

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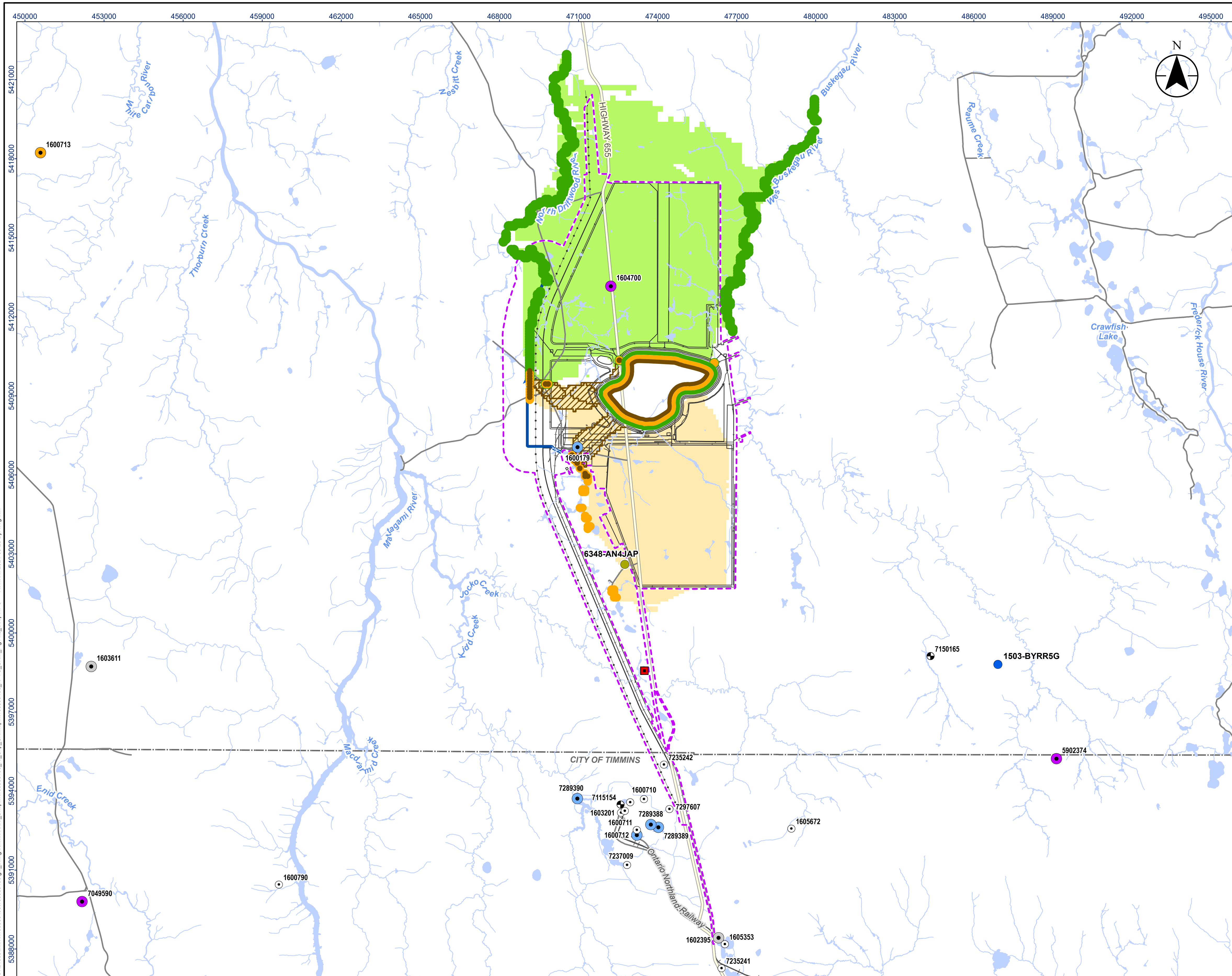
Client/Project
Canada Nickel Company (CNC)
Crawford Nickel Project

Figure No.
14.7

Title
Fate of Seepage to Groundwater - Operations Phase Year 30



Stantec

CANADA NICKEL COMPANY

Legend

- Project Area

Base Features

- Major Road
- Minor Road
- Railway
- Watercourse
- Waterbody
- Municipal Boundary - Lower Tier

Groundwater Seepage

- Discharge of Seepage from TMF
- Discharge of Seepage from Impoundment Facility
- Discharge of Seepage from Tailings
- Groundwater Seepage from TMF
- Groundwater Seepage from Impoundment Facility
- Groundwater Seepage from Tailings

- North Driftwood Diversion Channel
- Private Residence with Drilled Well

MECP Water Well (Well ID)

- Commerical
- Industrial
- Public
- Domestic
- Monitoring
- Well use not identified

Active Permit to Take Water within LSA/RSA (MECP)

- Dewatering
- Water Supply

Note: Wells 1604700 and 1600179 will be confirmed to be decommissioned prior to Project construction

0 2.5 5 km

1:150,000 (At original document size of 11x17)

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Project Location
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Prepared by tcoghlan on 2024-09-20

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

Figure No.
14.8

Title
Fate of Seepage to Groundwater - Passive Closure with Pit Lake

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