Stantec

Thompson Mine Extension Phase 1 Project – Notice of Alteration Detailed Report

FINAL REPORT

September 30, 2019

Prepared for:

Vale Canada Limited

Prepared by:

Stantec Consulting Ltd.
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169518673

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Notice of Alteration Form

Manitoba
Sustainable Development

Client File No. : 557.10	Environment Act Licence No. : CEC Order 960VC
Legal name of the Licencee: Vale Canada Limited	
Name of the development: Thompson Mine Extension Phase 1	
Category and Type of development per Classes of Development Regulation: Mining — Mines, other than pits and quarries	
Licencee Contact Person: Madonna Campeau Mailing address of the Licencee: 487 Power Street City: Copper Cliff Province: Ontario Postal Code: P0M 1N0 Phone Number: (705) 682-5846 Fax: n/a Email: madonna.campeau@vale.com	
Name of proponent contact person for purposes of the environmental assessment (e.g. consultant): Carmen Anseeuw, Stantec Consulting Ltd.	
Phone: (204) 928-8809 Fax: (204) 453-9012	Mailing address: 500-311 Portage Avenue Winnipeg, Manitoba R3B 2B9
Email address: carmen.anseeuw@stantec.com	
Short Description of Alteration *(max 90 characters)*: Underground extension at T3 mine, ventilation upgrades and surface works.	
Alteration fee attached: Yes: ☑ No: ☐ If No, please explain:	
Date: September 20, 2019	Signature: [signature] Printed name: Madonna Campeau

A complete Notice of Alteration **(NoA)** consists of the following components:

- ☑ **Cover letter**
- ☑ **Notice of Alteration Form**
- ☑ **2 hard copies and 1 electronic copy of the NoA detailed report** (see "Information Bulletin - Alteration to Developments with Environment Act Licences")
- ☑ **$500 Application fee, if applicable** (Cheque, payable to the Minister of Finance)

Submit the complete NoA to:

Director
Environmental Approvals Branch
Manitoba Sustainable Development
1007 Century Street
Winnipeg, Manitoba R3H 0W4

For more information:

Phone: (204) 945-8321
Fax: (204) 945-5229
http://www.gov.mb.ca/sd/eal

Note: Per Section 14(3) of the Environment Act, Major Notices of Alteration must be filed through submission of an Environment Act Proposal Form (see "Information Bulletin – Environment Act Proposal Report Guidelines")

Executive Summary

Vale Canada Limited (Vale) operates two underground metal mines (Thompson T1 Mine and Thompson T3 Mine, collectively "the Thompson Mine") adjacent to the City of Thompson and is proposing to undertake the Thompson Mine Extension Phase 1 (TMEP1) Project (herein "the Project"), which consists of an extension to the Thompson T3 Mine. As required under Manitoba's *The Environment Act*, an application for Notice of Alteration (NOA) to the existing mine operations is submitted with supporting information to Manitoba Sustainable Development (MSD) for consideration. The Thompson T3 Mine is located in the southern part of SW35-14-15W on property that is owned by Vale (formerly Inco Limited). The Clean Environment Commission Order 960VC, dated December 21, 1983, provides the regulatory licence terms for the current mine operations.

Vale is proposing to extend its Thompson T3 Mine to mine deeper below existing operations at a production rate of 3,050 tonnes per day (tpd). No net change in production is anticipated. The new production would ramp up to the current approved capacity, providing replacement ore sources as existing mining areas at Thompson Mine deplete, facilitating ongoing economic and employment opportunities at the Thompson Mine Site. The Project also includes:

- Early works to prepare the Site
- A new paste fill plant and associated transfer pipelines
- A new return air raise and associated access road and ventilation system upgrades
- A new surface switchyard and associated power line
- A new T3 control room
- Surface water management with ditching and culverts

Early works as part of the Project include all site clearing and grubbing required for surface Project components, construction of a new 800 m access road (and railway crossing) from the existing 378 RAR location to the new 389 RAR fan station, and preliminary collar work (piling) at the 389 RAR location. Clearing will be completed before April 1, 2020, to avoid the start of the migratory breeding bird season.

This NOA has been prepared by Stantec Consulting Ltd. (Stantec) on behalf of Vale. Potential environmental effects of the Project are limited to the construction phase and are related to fairly routine activities. The proposed alteration will facilitate continued production within approved capacity so that the economic and employment opportunities at the Thompson Mine Site continue to be realized, while maintaining environmentally responsible development. Residual operational effects are considered to be negligible. On the basis of the desktop and field studies undertaken, and information available to date as presented in this report, effects associated with the proposed alteration are determined to be not significant.

1.0 INTRODUCTION

1.1 PROJECT OVERVIEW

Vale Canada Limited (the Proponent) operates two underground metal mines (Thompson T1 Mine and Thompson T3 Mine) and a mill adjacent to the City of Thompson, Manitoba. The Proponent is proposing to undertake the Thompson Mine Extension Phase 1 (TMEP1) Project (the Project) and, subject to approval, proposes to extend its existing T3 Mine to mine deeper below existing operations (from 4,250 feet to 5,600 feet below surface) at a production rate of 3,050 tonnes per day (tpd). The Project will consist of ventilation upgrades, an associated access road, a new paste fill plant and two aboveground pipelines (for conveying tailings slurry to the new paste fill plant and excess process water back to the existing T1 mill), a 138 kilovolt (kV) transmission line and associated 138 kV substation, a new control room at the T3 Mine, and surface water management (**Figure 1-1**). The proposed alterations involve making changes to the existing development to maintain the currently approved Thompson Mine production as existing mining areas at Thompson Mine deplete. No net change to the current production capacity is proposed. The Thompson Mine is governed under Clean Environment Act Order No. 960VC (**Appendix C**).

Section 14(1) of *The Environment Act* requires a Proponent to notify the Director (for Class 1 and 2 developments) if the Proponent intends to alter a licensed development so that it no longer conforms to licence conditions or has the potential to change the environmental effects (MSD 2017).

This NOA request has been prepared by Stantec Consulting Ltd. (Stantec) on behalf of the Proponent. The existing mine operation is considered a Class 2 Development under the Classes of Development Regulation (MR 164/88). This report documents the relevant portions of the mine, the proposed alterations, and the potential environmental effects and planned mitigation measures associated with construction and operation of the altered mine site.

1.2 THE PROPONENT

For the purposes of development licensing, the Proponent is Vale Canada Limited (hereafter “Vale”).

For further information regarding the Project please contact the following:

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Senior Air Quality Engineer
Vale – Base Metals – North Atlantic
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1.3 LAND OWNERSHIP AND PROPERTY RIGHTS

The Thompson Mine occupies parts of Sections 2 and 11, Township 78, Range 3W1 on property under sole ownership by The International Nickel Company of Canada (Inco Ltd., now Vale) since 1958 (**Appendix C**). The legal description for the subject property is described under Plan 4745 (NLTO). Current Mining Rights for the patented owned lands (the Site) are registered to Vale Canada Limited (**Figure 1-2**). The Site is already heavily developed as part of the Thompson mining operation.

1.4 PREVIOUS ALTERATIONS/STUDIES

In 2016, Vale submitted an NOA application to MSD for the Thompson Concentrate Load Out Project. The alteration involved the construction and operation of a dewatering plant, including a dry soda ash system, located in the mill facility's existing copper concentrate area and a new copper concentrate load out facility located adjacent to the mill building at Vale's site. MSD approved this NOA as a minor alteration in November 2016.

Vale's Thompson Smelter and Refinery shut down in 2018. A closure NOA was submitted to MSD in March 2017 and approved as a minor alteration in March 2018.

In 2019, Vale has submitted two NOAs to MSD. The first, submitted in May 2019, requested the deposit of Birchtree Eluate to the Tailings Management Area (TMA). A second NOA, the Truck to Rail Project, which involves the transfer of concentrate from the Thompson Concentrate Load Out facility to a shear shed, and subsequently to rail cars, was submitted in August 2019. Approval of these NOAs remains pending.

For the subject Project, Vale undertook a series of supporting studies, including hydrological, hydrogeological, terrestrial and aquatic studies, as well as air dispersion modeling. The results are summarized in this report.

1.5 PUBLIC ENGAGEMENT

Pending regulatory approval, a site-specific public engagement plan will be developed and implemented for the Project. The plan will be developed in concert with Vale's annual Indigenous and community outreach and will include forums for public input. The communication process will include public notification of Project milestones and will include the monitoring of local media and engaging the City to help communicate with residents. External engagement opportunities exercised by Vale include Community Liaison Committee meetings – held three times a year with stakeholders from within Thompson and surrounding areas, ranging from educators and health care providers to Indigenous organizations and municipal officials. Formal public engagement is also planned as part of Vale's placement of the NOA on the Public Registry for public review and comment if required by MSD.

1.6 FUNDING

Vale will provide funding for all undertakings related to the Project.

2.0 PROJECT DESCRIPTION

2.1 EXISTING LICENSED DEVELOPMENT

Existing mine infrastructure that will support the Project consists of parts of the T3 Mine, the 345 Return Air Raise (RAR), 354 Fresh Air Raise (FAR), and 378 RAR, and is connected by a network of access roads, trails, and rail lines (see **Figure 1-1**). Alterations to the mine surface will consist of the installation of new infrastructure (**Figures 1-3a to 1-3g**). On-site temporary and permanent laydown yard areas are also required for construction purposes (see **Figure 1-3b**).

2.2 PROPOSED ALTERATIONS

The Project comprises the following alterations at the Thompson T3 Mine:

- Early works to prepare the Site
- Extension of underground mine workings (**see Figure 1-3a**), including an underground ore pass
- New paste fill plant (**see Figure 1-3b**) and two aboveground pipelines to T1 Mine (**see Figure 1-3c**)
- New 389 return air raise (RAR) and fan station and associated access road (**see Figure 1-3b**)
- New 138 kV transmission line and 371 switchyard (**see Figures 1-3d-f**)
- New T3 control room (**see Figures 1-2 and 1-3g**)
- Surface water management (see **Figure 1-3b**; **Figures 1-3h-j**)
- Changes to existing works, consisting of the conversion of the 378 RAR to a FAR (including the addition of a heater and propane delivery system), and variable frequency drive upgrades to the 345 RAR.

Access to the underground ore body will be through the existing infrastructure via the T3 Mine Shaft. The Project does not include changes to ore transportation (or rock hauling) to the existing mill or increases in tailings placement in the TMA. The new paste fill plant offers a reduction in surface deposition requirements because it uses a greater portion of the tailings stream as feed for backfill than the current system. The Project also does not involve changes to handling of process water management.

2.2.1.1 Early Works

Early works as part of the Project include all site clearing and grubbing required for surface Project components, construction of a new 800 m access road (and railway crossing) from the existing 378 RAR location to the new 389 RAR fan station, and preliminary collar work (piling) at the 389 RAR location. Clearing will be completed before April 1, 2020, to avoid the start of the migratory breeding bird season.

2.2.1.2 Underground Mine Workings

The extension of the existing mine involves ramping up activity in certain areas as activities in other areas are ramped down. Underground mine development at T3 will consist of various underground infrastructure works at and above the 4250 level, including at the 3600 level, and an ore pass system operating between the 4600-4900 level and the 5050 level. The major underground infrastructure consists of vent and airlock doors, and an additional garage bay and a garage extension at the 3600 level. The garage extension will have fire sprinklers, two overhead bridge cranes, a welding bay, compressed air and water service; and ventilation for the garage extension. An ore pass system will also be installed using a raise and ore pass fingers to transfer ore to an automated chute at the 5050 level (approx.) for subsequent truck loading and hauling.

2.2.1.3 Paste Fill Plant and Transfer Pipelines

The proposed location for the paste fill plant is at the 378 RAR site. The plant system will be composed of a high compression thickener, an agitated storage tank, two vacuum disc filters, a cement silo, a conditioning mixer, a paste backfill mixer and paste backfill discharge hopper, and associated conveyors, dust collectors and hoppers. The new paste fill plant will be designed to accommodate a backfill rate of 140 dry tonnes per hour, with a possible expansion in production to 280 dry tonnes per hour should additional mineral resources be identified.

A system will collect the full tailings stream from the existing mill. At present, tailings require hydraulic backfill, with rejected fines and excess full tailings going to the tailings pump box for subsequent transfer to the tailings ponds. An existing sump line to the final tailings pump box will be modified to allow for controlled flow of tailings slurry into the tailings feed pump box with a second line for mill process water or dilution water. The paste fill plant process flow is illustrated in **Figures 1-4a and b**.

Four 250 horsepower staged centrifugal pumps (two operating, two standby) will be used to supply the tailings feed to the paste fill plant through a 14-inch insulated overland pipeline. The overland pipeline will extend approximately 5.5 km along an existing road from the existing mill to the paste fill plant with an 18-inch return overland insulated pipeline routed to transfer back excess process water from the paste fill plant to the mill. During non-operation periods of the paste fill plant, water will be recirculated between the mill and the paste fill plant using both overland pipelines, addressing the need for heat tracing but requiring continuous pumping energy.

Tailings feed slurry (approximately 20 weight [wt]% solids) will be discharged from the mill feed line into a thickener feed box that feeds the high compression thickener. Flocculent will be added to aid in the settling of solids. Thickener underflow (approximately 70 wt% solids) will then be pumped to an agitated storage tank with approximately 8 hours of capacity. From the filter feed tank, the slurry stream will be pumped to the disc filters (3.2 m in diameter with 12 discs per filter bank). The resultant tailings filter cake (approximately 80 wt% solids) will be discharged onto a conveyor and fed into the conditioning mixer.

The paste fill plant has been designed with a standard batch system (continuous filter cake conditioning mixer followed by a batch mixer). Water and binder will be added to the batch mixer for final slump adjustment. The thickener overflow and filtrate from the disc filters are transferred to the process water tank and subsequently pumped back to the mill via an overland pipeline. This water will also be used for flushing the underground backfill line, with the balance being returned to the mill. The batch mixer will discharge paste backfill to a hopper, which will feed two boreholes drilled to the underground to allow discharge at a constant controlled rate of 140 dry tonnes per hour.

An additional series of distribution boreholes will be drilled underground at various levels. These internal holes will deliver the paste fill throughout the orebody (between the 4,250 ft and 5,600 ft levels).

2.2.1.4 389 RAR and Fan Station

The new 389 RAR and fan station will consist of a/an:

- Fan station with two centrifugal fans
- New two-lane access road (approx. 800 m) to the 389 RAR
- New fan site substation with a 13.8 kV to 4.16 kV power transformer
- Electrical house (E-house) complete with MV switchgears, 4,100v/600v transformer, various systems, IT cabinet, and auxiliary low voltage electrical equipment for monorails, building heating, lighting and associated equipment.

The 389 RAR will be 22 ft in diameter consisting of a smooth concrete wall or shotcrete (rough wall). It is constructed by drilling a 6 ft hole down with an underground reaming bit that is pulled back up to make a 22 ft hole (raised opening). The new 389 access road will travel northeast from the existing 378 RAR, crossing a rail line before turning southeast to the proposed 389 RAR extension area. The site for the 389 RAR is not cleared of vegetation.

The Project will also involve the refurbishment of two fan stations, the conversion of the existing 378 RAR to a FAR and an upgrade of the 345 RAR with the addition of a variable frequency drive, and various works to the underground ventilation system.

2.2.1.5 138 kV Transmission Line and 371 Switchyard

A proposed 138 kV transmission line, approximately 5 km in length, will be routed between the T1 Mine to the new 371 switchyard (138 kV to 13.8 kV) along an existing access road (**see Figure 1-3d-f**).

The proposed 371 switchyard will be located to the south of the existing 378 RAR in a partially cleared area. The switchyard will include two 15 mega volt amp (MVA) transformers, two power factor correction capacitor banks, and an E-house. Three power feeders will be installed – one 13.8 kV power feeder to the paste fill plant; one 13.8 kV power feeder to the new 389 RAR fans; and one 600-volt alternating current (VAC) power feeder to the existing 377 FAR in the existing hoist house. Two 13.8 kV underground power feeders, two grounding conductors, two 15 kV switchgears, and two 13.8 kV supply power feeders to two booster fan stations are also part of the underground infrastructure tie-in between the new substation and electrical and switch rooms at the 4,250 level.

2.2.1.6 T3 Control Room

The Project will require a new central control room (the T3 control room) to be constructed on the surface at the T3 Mine headframe. The T3 control room will consist of a prefabricated building (approximately 116 m^2) connect to the current T3 main building. The existing Process Control Network will be extended to connect to the new control room being built for the new paste fill plant, surface and underground ventilation controls and monitoring stations, and the new substation E-house. Modifications will also be made to the existing main Human-Machine Interface (HMI) station programming at the T3 Mine to allow monitoring of the paste fill plant remotely and to permit monitoring and control of the new underground ventilation systems. A fire alarm system will be added for the new buildings along with a main ramp traffic signaling system underground.

2.2.1.7 Surface Water Management

Surface water management on the Site will be addressed as follows (see **Figure 1-3b**; **Figures 1-3h-j**):

- A ditch will be constructed along the north side of the 378 fan station area, including the northeast and northwest corners, which will direct surface contact waters to the watershed reporting to the Thompson open pit for subsequent drainage to and treatment at Vale’s TMA.
- The terrain on the east side of the proposed paste fill plant (on the east side of the 378 area) will be graded so that surface contact water drains into the Thompson open pit.
- Ditches will be constructed around the south and east sides of the new 389 RAR, which will direct surface contact water towards a surface catchment basin that will be constructed along the north side of the 389 RAR. A pump in the basin will pump surface contact water to the new surface drainage system in the 378 area.
- The new 389 RAR will be fitted with a mist eliminator drain system, oil separator and pump. Up to 80 gpm of clarified water will be pumped to the surface drainage system in the 378 area during the summer and diverted underground through a slurry line during the winter.
- The 389 access road will be constructed with clean fill to avoid contaminating surface contact water.
- Five culverts beneath the 389 access road will be constructed to address surface water flow.
- The proposed aboveground tailings feed pipeline to the paste fill plant will be constructed with periodic break points, each located within containment areas, to manage potential spills and avoid surface water contamination.

2.2.2 Construction Inputs and Outputs

During the construction phase of the Project, materials required may include concrete, steel, rebar, field-survey tape, paint spray cans, drywall, flooring, fuel and other materials. Raw materials such as gravel, water, and fill will also be required for site works. Most of these materials will be brought to the Site from other areas. There may be temporary storage of construction materials in lay-down areas on the Site. Heavy equipment used on-site will be typical for construction, including cranes, drill rigs, front-end loaders, excavators, brush clearing machines, rock/dump trucks, etc. used for paste fill plant, RAR, transmission line and substation, and pipeline installation. Construction activities at the Site will consist of early works consisting of clearing and grubbing, surveying, and moving vehicles and equipment, drilling, blasting, trenching, and dewatering.

A small amount of handling, transfer and storage of waste rock and/or overburden is anticipated during construction. Mineralized mine wastes exposed to the elements have the potential to generate acidic runoff with elevated levels of metals that can result in environmental degradation over time. While not characterized, the waste rock and overburden will be assumed to be potentially acid generating. Mineralized rock or ore will be stored in an area within the TMA dedicated to accepting such wastes if/when they are generated during construction.

The number of contract workers for construction at the Site will total approximately 600, with a maximum peak workforce of 232 occurring in the year 2020. Accommodations for the construction workforce are expected to be in Thompson's hotels, motels and rental properties (i.e., apartment blocks, townhouse rental units).

Outputs during construction could include surface runoff and fugitive dust and vehicle emissions from construction equipment. Other outputs generated from construction work (e.g., related to spent packaging materials, solvents, used oils, surplus building materials, etc.) will be regularly transported off the Site and disposed of or recycled according to applicable regulations. Ground clearing and site preparation will produce construction noise through the operation of heavy equipment.

During construction, portable toilets will be available near construction areas until completion of the construction works. Permanent facilities are also available at the T3 Mine. Large volumes of construction waste are not anticipated during construction. Containers for solid waste disposal (i.e., demolition waste, domestic waste, paper, cardboard, wood) will be located at appropriate locations on the construction site.

2.2.3 Operation Inputs and Outputs

2.2.3.1 Water Use and Wastewater Production

Potable and Process Water

Until recently, the Thompson Water Treatment Plant (WTP) provided approximately 750 gpm of potable water to Vale's Thompson Operations. Due to Vale's Thompson Smelter and Refinery shutting down in 2018, the potable water demand on the WTP has been reduced to, at most, 500 gpm (200 gpm on average). Historically, Vale's Thompson Operations have used up to 28,000 gpm of process water. Process water consumption rates in 2019 have since been closer to 8,000-12,000 gpm on a monthly basis. Moreover, as part of continuous improvement projects, Vale intends to progressively tie in process water to areas that currently use potable water but do not require water to be potable.

The paste fill plant is the only Project element that will use water during operation. It will receive a tailings stream containing water from the existing mill. This water is firstly used at the mill and would otherwise discharge directly to the TMA. The tailings stream will be decanted, and clarified water will be sent back to the mill. A portion will be intermittently used for flushing the paste fill lines and supplementing the paste mixture, if required.

A potable water line will be available to provide water for flushing the paste fill lines, supplementing the paste mixture if required, and for personnel use. This amount is expected to be less than the difference in potable water demand due to the 2018 smelter and refinery shut down. As such, the rate of consumption will not put an undue stress on the existing Thompson WTP system.

The water system currently supplying the T3 mining operations will be extended into the new mine workings. Water use is not expected to increase or decrease as the proposed mine extension will ramp up as older operations ramp down.

Sewage

An increase in sewage is not expected as a result of the Project because the workforce is not expected to increase relative to historic numbers.

Tailings Water Management

The existing Thompson Mine operations (T1 and T3 Mines) contribute approximately 11,000 cubic metres (m^3) per month of wastewater to the TMA where it is treated prior to discharge to the natural environment via a licensed Metal and Diamond Mine Effluent Regulation (MDMER) discharge point and the licensed 960VC discharge point. The future dewatering rate at the Site with the proposed Project is estimated to be three times the current dewatering rate (24 Litres per second [L/s] to 72 L/s). The contribution of mine dewatering, even when tripled (11,000 m^3/month to 33,000 m^3/month), is much less than the 1,000,000 m^3/month of water contribution from the Smelter and Refinery that was recently removed. As such, it is expected that the TMA has the physical capacity to handle the Project's increase in mine water contribution. Because of the relatively small contribution of mine water to the TMA, even with the Project tripling the dewatering rate, it is not likely that the change will impose a load onto the treatment system that it cannot handle.

The proposed paste fill plant will divert tailings from the TMA. The tailings will be decanted, and the majority of the water will be returned to the mill. Approximately 2,116 gpm of water (346,000 m^3/month) will be delivered to the paste fill plant as part of the tailings. Approximately 2,060 gpm water (336,900 m^3/month) will be decanted and sent back to the mill (i.e., no tailings). This represents slightly less than half of the water that Vale historically contributed to the TMA as tailings; therefore, there will be no net increase in tailings water over historical operations.

2.2.3.2 Waste Management

The Thompson Operations follow the “SLAM Dunk” program, which is a nine-stream colour-coded waste bin system to segregate waste into categories such as paper, general recyclables, scrap metals and plastics. Vale’s Waste Management Facility is located on-site and accepts waste in accordance with its Waste Disposal Ground operating permit. Wastes such as asbestos, concrete and waste oil are handled by Vale’s Waste Material Facility.

As the Project proposes to ramp up as others are ramp down, it is not expected to create new types of waste or waste in quantities above typical operations. The new 389 RAR will be fitted with a mist eliminator drain system, oil separator and pump. The oil will be periodically pumped into barrels and brought to the Waste Management Facility, per existing protocols (temporary storage until delivery for final off-site disposal by third party).

2.2.3.3 Fuel and Electrical Utilities

The power requirements for the Project necessitate the construction of a 138 kV-13.8 kV substation and associated 138 kV transmission line. Fuel demand is expected to change at the facility as more fresh air will be provided that will require heating (i.e., burning propane). The electrical demands for the FAR and RAR as well as the operation of the paste fill plant will be accommodated within the existing electrical load at the Site.

2.2.3.4 Waste Rock

Waste rock generated as part of the Project is intended to remain underground and be used as backfill. Occasionally, waste rock is brought to the surface and is used for construction in the TMA.

2.2.3.5 Emissions

Atmospheric emissions associated with the Project will be metal-bearing particulate matter and products of fuel combustion, which is typical of mining industrial activity. Noise will be generated through various activities during construction and operation of the access road, RAR, switchyard and transmission line, pipelines, and paste fill plant.

2.2.3.6 Workforce

Operation of the new paste fill plant will require five new workers at the Site. No other projected additions to the operational workforce requirements are expected.

2.3 PROJECT SCHEDULE

Dependent on company and regulatory approvals, the start of the construction phase is expected to be February 2020, with completion and commissioning of the entire Project by August 2022. Early works consisting of clearing, access road building, and preliminary collar work are planned for early 2020. Clearing will be completed prior to April 1, 2020, as per the applicable start date of the breeding bird season in the area for migratory birds.

3.0 SCOPE OF THE ASSESSMENT

3.1 SPATIAL AND TEMPORAL BOUNDARIES

For the purposes of this NOA, the spatial boundaries are defined as:

- **Project Development Area (PDA)** – the physical footprint of the existing T3 Mine and surface workings for the Project components within the subject property (**Figure 1-5**).
- **Local Assessment Area (LAA)** – encompasses the area in which the construction and operation of the Project could have potential direct and/or indirect effects on the environment. For this project, the biophysical LAA includes the PDA and a one-km buffer of the PDA boundary (**Figure 1-6**).
- **Regional Assessment Area (RAA)** – encompasses the area that establishes context for determining the significance of project-specific effects, including the LAA and PDA. For this Project, the RAA is a ten-km buffer from the PDA boundary (**Figure 1-7**).

The temporal boundaries for the assessment are defined as Construction phase, Operation phase, and Decommissioning phase as follows:

- **Construction phase** – a period of 42 months from February 2020 to August 2022 over which time construction is planned to occur.
- **Operation phase** – the period over which the mine extension will be in operation, until the resource is exhausted.
- **Decommissioning phase** – decommissioning would consist of the removal of mine equipment from the site. Decommissioning would be conducted according to Licence conditions, closure plan, and regulatory requirements current at the time.

4.0 ASSESSMENT APPROACH

This NOA has been prepared in general accordance with MSD's 2017 Information Bulletin, "*Alterations to Development with Environment Act Licences*" and in accordance with Section 14(1) of *The Environment Act*. The approach focuses on potential environmental and human health effects that could result from the proposed alteration. Potential project-related environmental effects are discussed, considering design and mitigation measures that help to reduce or avoid the effect. Residual project-related environmental effects are characterized using specific criteria (e.g., direction, magnitude, geographic extent, duration, frequency). Definitions of the effects description criteria included in the assessment are provided in **Table 4-1**.

Table 4-1 Description of Residual Environmental Effects Criteria

Characterization	Quantitative Measure or Qualitative Categories
Direction	**Positive**— an improvement in the component compared with existing conditions and trends **Adverse**— a decline in the component compared with existing conditions and trends **Neutral**— no change in the component from existing conditions and trends
Magnitude	**Negligible**—no measurable change **Low**— a change that falls within the level of natural variability **Moderate**— a measurable change which is unlikely to affect the component **High**— a measurable change which is likely to affect the component
Geographic Extent	**PDA**—residual effects are restricted to the Project Development Area **LAA**—residual effects extend into the LAA (up to a 1 km buffer of the PDA) **RAA**—residual effects extend to adjacent areas of the property (up to a 10 km buffer)
Frequency	**Single event**— residual effect occurs once throughout the life of the Project **Multiple irregular event**— residual effect occurs sporadically throughout **Multiple regular event**— residual effect occurs repeatedly and regularly throughout **Continuous**—residual effect occurs continuously throughout the life of the Project
Duration	**Short-term**— residual effect restricted to the duration of construction **Medium-term**— residual effect extends to ten years **Long-term**— residual effect extends for longer than ten years
Reversibility	**Reversible**— the effect is likely to be reversed after activity completion and decommissioning **Irreversible**— the effect is unlikely to be reversed even after decommissioning
Ecological and Socio-economic Context	**Undisturbed**— area is relatively undisturbed or not adversely affected by human activity **Disturbed**— area has been substantially previously disturbed by human development or human development is still present

The NOA focuses on environmental components that could be affected through interactions of the environment and the Project. The rationale for including or excluding each environmental component is explained and potential general interactions between the Project and components are identified in **Table 4-2**.

Table 4-2 Environmental Components and Rationale for Inclusion

Environmental Component	Potential Project Interaction	Rationale for Exclusion or Inclusion in the NOA
Air quality	✓	Included because ventilation changes to air raises have the potential to change ground level concentrations of air emissions.
Noise	✓	Included because heavy equipment use during site preparation will produce construction noise. In addition, changes to the air raises have the potential to increase noise effects.
Greenhouse gas (GHG) emissions	×	Excluded because GHG emissions associated with Vale's Thompson Operations are not changing as a result of the Project. There is potential for an increase in fuel consumption (propane) with the new fresh air requirements. The change of approximately 35% is expected to be within the year-to-year variation expected due to operational variations.
Soils / terrain	✓	Included because the Project will result in some disturbance of soils in the PDA that have been previously undisturbed.
Surface water / groundwater	✓	Included because the T3 extension will require the management of site surface water via water control features such as ditches, sumps and berms. In addition, extension of the T3 Mine underground workings to access deeper portions of the ore body and the construction of a new RAR have the potential to interact with groundwater through dewatering.
Vegetation	✓	Included because the Project will result in the loss or alteration of native vegetation communities within a previously disturbed LAA.
Wildlife and wildlife habitat	✓	Included because the Project will result in the loss and alteration of wildlife habitat, despite limitations on the quantity and quality of habitat due to existing disturbance in the LAA.
Fish and fish habitat	✓	Included because fish habitat is present in the PDA
Heritage resources	×	Excluded because the PDA is located within an existing industrial area that is already disturbed; there are no heritage concerns.
Human Health	×	Excluded because contractors engaged in Project construction will be subject to site specific health and safety plans and worker protection standards under *The Workplace Safety and Health Act*. The Site is located within an existing mining industrial area. The site is not in immediate vicinity of residential receptors. The Project is not anticipated to change the risks for worker/public Health and Safety

Based on **Table 4-2**, environmental components included in this assessment are:

- Air quality
- Noise
- Soils and terrain
- Surface water/groundwater
- Vegetation
- Wildlife and wildlife habitat
- Fish/fish habitat

5.0 EXISTING ENVIRONMENT

5.1 BIOPHYSICAL ENVIRONMENT

The Project is located in the Sipiwesk Lake Ecodistrict in the Hayes River Upland Ecoregion of the Boreal Shield Ecozone. The Sipiwesk Lake Ecodistrict is part of the glacial Lake Agassiz basin (Smith et al. 1998).

5.1.1 Air Quality

Ambient air quality data is available for the City of Thompson. Background ambient air quality data for $PM_{2.5}$, PM_{10}, SO_2, and O_3 collected at 1-hour intervals for 2018 is noted in **Table 5-1** and indicated:

- $PM_{2.5}$ – average of 6.1 µg/m^3, 95th percentile of 20.9 µg/m^3
- PM_{10} – average of 13.1 µg/m^3, 95th percentile of 31.9 µg/m^3
- SO_2 – average of 0.008 ppm (22.5 µg/m^3), 95th percentile of 0.012 ppm (33.1 µg/m^3)
- O_3 – average of 28.6 ppb (Vale 2019a; MSD 2019)

Data on concentration levels for two parameters, particulate matter ($PM_{2.5}$) and ozone (O_3), collected in 2015 as part of Manitoba's Ambient Air Quality Monitoring Program is also shown in **Table 5-1**. The 24 hour and annual average $PM_{2.5}$ recorded at the Thompson monitoring station was 21 µg/m^3 and 3.7 µg/m^3 respectively (MSD 2016). The trend in particulate matter concentrations ($PM_{2.5}$) over the period 2005 to 2014 increased, largely as a result of a highly active wildfire season in 2013 (MSD 2016). In terms of ozone, data collection in Thompson only started in 2012, so no long-term trend could be identified; however, the levels did show a decrease over the three-year period (Manitoba Sustainable Development 2016). In terms of air zone management level, Thompson has been designated as "Yellow" which indicates actions are required for avoiding air quality deterioration (Manitoba Sustainable Development 2016).

Maximum short-term and annual mean concentrations of four air pollutants for the Thompson station recorded in 2013 are also summarized in **Table 5-1**. There was one exceedance of ground level ozone (O_3) guidelines and one exceedance of the 24-hour average for particulate matter ($PM_{2.5}$ and PM_{10}) (MCWS 2013). Vale's smelting and mining operations and transportation were the main sources of emissions in Thompson (Manitoba Sustainable Development 2016). However, Vale's smelter and nickel refinery closed in 2018.

Table 5-1 Air Pollution Concentration Summary, Thompson Monitoring Site (2013-2018)

Pollutant	Period	Thompson (Westwood School)	Canadian Ambient Air Quality Standards - CAAQ (2015)	Manitoba Air Quality Objective – MTL (2005)	Manitoba Air Quality Objective – MAL (2005)	Manitoba Air Quality Objective – MDL (2005)
Ozone (O_3) ppb	1 hour	**54.1* /** 28.6[1]	n/a	200	82	50
	8 hour	n/a	63	n/a	n/a	n/a
	24 hour	52.23*	n/a	n/a	n/a	n/a
	Annual	**28.0***	n/a	n/a	15	n/a
Sulphur Dioxide (SO_2) ppb	1 hour	0.44*+ / 0.008[1]	n/a	n/a	2.0+	n/a
	24 hour	54*	n/a	n/a	n/a	n/a
	Annual	3*	n/a	n/a	n/a	n/a
Particulate Matter 10 (PM_{10}) µg/m^3	1 hour	783.7* / 13.1[1]	n/a	n/a	n/a	n/a
	24 hour	**70.4***	n/a	n/a	50	n/a
	Annual	11.8*	n/a	n/a	n/a	n/a
Particulate Matter 2.5 ($PM_{2.5}$) µg/m^3	1 hour	186.2* / 6.1[1]	n/a	n/a	n/a	n/a
	24 hour	21^ **/ 63.0***	28	n/a	30	n/a
	Annual	3.7^ / 4.3*	10	n/a	n/a	n/a

Notes: Numbers in **bold** indicate exceedance; n/a – no guideline or objective; + indicates objective level in parts per million; __ indicates objective level that is exceeded

CAAQ – values for selected air pollutants consisting of fine particulate matter ($PM_{2.5}$) and ozone (O_3)

MTL – the maximum tolerable level denotes a time-based concentration of an air contaminant beyond which, given a diminishing margin of safety, appropriate action is required to protect the health of the general population

MAL – the maximum acceptable level deemed essential to provide adequate protection for soil, water, vegetation, materials, animals, visibility, personal comfort and well-being

MDL – the maximum desirable level defined as the long-term goal for air quality providing a basis for an anti-degradation policy for unpolluted areas of Manitoba and for the continuing development of control technology

Source**:** Vale 2019a[1]; MSD 2019[1]; MSD 2016^**;** MCWS 2013*; Manitoba Conservation 2005

5.1.1.1 Greenhouse Gas Emissions

The Provincof Manitoba's greenhouse gas (GHG) emissions from various sectors for the years 1990 to 2016 were reviewed. According to Canada's National Inventory Report 1990-2016, Manitoba emitted a total of 20,900,000 tonnes of carbon dioxide equivalent (CO_2 e) in 2016, a 100,000 tonne increase from 2015 (Environment and Climate Change Canada 2018a). Based on the latest Manitoba data (2017), GHG emissions were composed of the following sources: fossil fuel burning (61%) involving the transportation of goods and people, stationary combustion (e.g., commercial heating) and fugitive sources (e.g., flaring); agriculture (31%); waste disposal (4%); and industrial processes (4%). Manitoba's fossil fuel burning category was much lower proportionally than that of Canada largely due to Manitoba's use of hydro power to produce electricity. The overall trend in Manitoba's GHG emissions was higher in 2017, 18.0%

above the 1990 level (Manitoba Eco-Network 2019). Manitoba's GHG emissions also increased between 2005 and 2017 (7.7%) but to a lesser extent than in other provinces (Environment and Climate Change Canada 2019a).

5.1.2 Noise

An environmental noise study was undertaken at the Site in 2019. During the study, noise baseline data was collected from two points located at the nearest City of Thompson boundary. Spot measurement locations were chosen to reflect the area most impacted by the addition of future noise sources. Spot measurement sound levels at these two points were found to be at 52 dBA and 45 dBA respectively, during lulls in local noise (RWDI 2019). Noise source locations at the Site were modelled and generated sound levels range from 50 to 60 dBA at the nearest City of Thompson boundary and points of interest under winter and summer conditions for future operations (RWDI 2019).

5.1.3 Soils and Terrain

Regional topography in the area of the Site is relatively flat, with the Burntwood River being approximately 15-20 m lower than the surrounding lands. The Site is at an elevation of approximately 210 m above mean seal level (amsl); the bog area north of the Site is at an equal or slightly higher elevation (210-220 amsl) (Stantec 2019b).

Physiography in the region is characteristic of a level to undulating clayey, glaciolacustrine plain with prominent, hummocky granitoid outcrops generally capped by glaciolacustrine blankets and veneers (Smith et al. 1998). The region has a cold, sub-humid to humid Cryoboreal soil climate with permafrost observed in areas as deep as 30 m (Stantec 2019; Dillon 1996; HBT Agra 1992).

The surficial geology conditions in the Thompson, MB area generally consist of a combination of glaciolacustrine and glaciofluvial sediments, with a 1- to 20-m-thick layer of clay, silt, and minor sand low-relief deposits to a 1- to 20-m-thick layer consisting of a sand and gravel complex as well as thin, low-relief deposits (Matile et al. 2006). The underlying bedrock consists of rocks of the Precambrian Shield and is overlain by a discontinuous veneer of Holocene Offshore glaciolacustrine sediments and organic deposits with numerous outcrops daylighting (Stantec 2019a; Manitoba Energy and Mines 1995).

Little information exists on the extent of overburden sand and gravel deposits in the RAA. Based on recent investigation, soils in the area were observed to consist of peat (0 - 1 m thick) overlying clay with a thin layer of silt sand in bedrock depressions at lower elevations, overlying granitic gneiss bedrock (Stantec 2019a). The predominant soil series in the region include imperfectly drained Gray Luvisols and some Eutric Brunisols developed on clayey deposits (Smith et al. 1998).

5.1.4 Surface Water and Groundwater Resources

The Site is located in the Burntwood River watershed. Drainage in the area is generally to the northeast (Smith et al. 1998). A total of five sub-watersheds (1,429 ha) have been delineated in and around the Site (Golder 2019), draining northward towards a tributary of the Burntwood River, westward to a culvert that discharges to the Burntwood River, and southward towards the existing open pit (Stantec 2019a). The Site and surrounding area have two watercourses (**Figure 1-8**). The nearest surface waterway to the PDA is Watercourse 1, which will be crossed by the new 138 kV transmission line lying within the PDA.

The RAA consists of Precambrian bedrock of the Churchill/Superior geological provinces. The general bedrock geology is made up of mainly Granites and Granitoid Gneiss rock types. Within the bedrock, groundwater flow is expected to be restricted to fractures and joints. Additionally, permafrost conditions up to 20 m below ground surface (BGS) including ice crystals and ice seams were observed on the Site (Stantec 2019a; Dillon 1996). Few active water wells have been drilled in the Thompson area although there have been numerous test wells. The groundwater wells that have been advanced in the RAA were for domestic and industrial water use, primarily for production purposes (Groundwater Information Network 2014). There have been very little to no intensive groundwater investigations in the Precambrian bedrock regime. Three groundwater monitoring wells were installed on the Site in March 2019 and static groundwater levels were observed at 0.70-2.23 m BGS, representing the shallow, thawed groundwater (Stantec 2019a). Groundwater was sampled in July 2019 for general chemistry, dissolved metals, and total metals. Overall the groundwater quality was within Manitoba and Canadian guideline limits (i.e., Manitoba Water Quality Standards, Objectives and Guidelines, Guidelines for Canadian Drinking Water Quality, and Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life) for dissolved metals, with the exception of chromium and manganese; however, several exceedances were observed for total metals suggesting sediment-bound metals in groundwater are prominent (Stantec 2019a). Hydraulic conductivity in the overburden/bedrock interface was observed to range from 3.3×10^{-6} m/s to 1.1×10^{-7} m/s (Stantec 2019a).

5.1.5 Vegetation

The Site supports mostly existing mine infrastructure and adjacent brownfield sites, and associated access roads, trails, and rail lines. Lands have been heavily modified by human development, which accounts for the largest proportion (29%) of the LAA. The remaining landcover consists of coniferous forest (27%), followed by broadleaf/deciduous forest (12%), shrubland (13%), wetland (9%), water (7%) and mixedwood forest (4%) (**Figure 1-9**).

The predominant tree species in the area include black spruce, along with tamarack larch in low-lying areas and white spruce in upland areas. Upland stands on well drained soils support mixedwood species including trembling aspen, black poplar, and black spruce. Large, shallow water wetlands exist between the T1 Mine and the T3 Mine, while smaller wetlands and peat bogs are prevalent around the 378 RAR, the proposed 389 area, and in the northern part of the LAA. Mixedwood forests in the LAA tend to occur along the edges of infrastructure and previously disturbed sites, while larger patches of coniferous forest are more prevalent north of the proposed 389 area. Broadleaf forest and shrubland is limited to small patches near the northern edge of the LAA (Stantec 2019b). The RAA has the potential to support nine plant SAR based on range maps and land cover data (**Table B1**, **Appendix B**), however, the highly modified nature of the LAA means it is unlikely to provide habitat for plant SAR. As a result, no rare plants are anticipated in the LAA and none were observed during the 2019 field program.

5.1.6 Fish and Fish Habitat

Most of the waterbodies and watercourses located in the vicinity of the proposed transmission line right of way (ROW) function as part of the Thompson Mine wastewater management area and are not considered natural fish habitat; however, Watercourses 1 and 2, located outside of the wastewater management area, are considered natural habitat (see **Figure 1-8**). Watercourse 1 is blocked by a beaver dam located 300-m upstream, with a nearly dry channel on the downstream side of this dam (Stantec 2019b). Intensive beaver activity along other parts of Watercourse 1 has created areas of deeper water separated by beaver dams, potentially obstructing fish movement in the watercourse. Watercourse 1 flows downstream of Station B final discharge point and through a large culvert, passing under surface water features, a rail line, and a road before connecting to Watercourse 2 and ultimately discharging into a tributary of the Burntwood River (see **Figure 1-8**; Stantec 2019b).

Watercourse 1 and 2 are characterized by flat channels intersected with beaver dams. The stream bed is composed of fine substrates covered with in-water aquatic vegetation. For Watercourse 1, spawning is moderate, overwintering and rearing is good, and migration is poor for forage fish. Minnows were observed upstream at the culvert under the mine access road (Stantec 2019b). For Watercourse 2, spawning, overwintering, rearing and migration habitat potential is poor for forage fish. Both watercourses provide Type D habitat, i.e. direct simple habitat with non-indicator (forage) fish species and perennial or intermittent flows with low sensitivity ranking (Milani 2013). Habitat in the watercourses is not suitable for coarse or sport fish; however, the fish species present are expected to be moderately resilient to change.

Desktop results returned no previously recorded observations of fish species of conservation concern within a 4-km radius of the Site (pers. com. with Murray 2019).

5.1.7 Wildlife and Wildlife Habitat

In general, wildlife habitat in the LAA is highly altered and composed predominately of fragmented stands of coniferous forest interspersed with wetland habitats. The LAA contains 71% natural wildlife habitat (i.e., wetland, water, forest, shrubland) and 29% developed lands.

5.1.7.1 Birds

The RAA has the potential to provide breeding habitat for approximately 195 bird species (Carey et al. 2003, MB BBA 2019) and 35 breeding bird species were observed during the 2019 breeding bird survey and included 24 species of passerines (Stantec 2019b). The most commonly observed species were Tennessee warbler (*Leiothlypis peregrina*), rubycrowned kinglet (*Regulus calendula*), dark-eyed junco (*Junco hyemalis*), and alder flycatcher (*Empidonax alnorum*). Other species observed incidentally during breeding bird surveys included great blue heron (*Ardea herodias*), lesser yellowlegs (*Tringa flavipes*), mallard (*Anas platyrhynchos*), sandhill crane (*Antigone canadensis*), and spotted sandpiper (*Actitis macularius*). No SAR were observed during breeding bird surveys.

5.1.7.2 Mammals

The RAA has the potential to provide habitat for species such as moose (*Alces alces*), black bear (*Ursus americanus*), woodland caribou (*Rangifer tarandus caribou*), Canada lynx (*Lynx canadensis*), muskrat (*Ondatra zibethicus*), snowshoe hare (*Lepus americanus*), and bats (Smith et al. 1998). Given the previously disturbed and developed nature of the site, mammal investigations were limited to bat surveys since both little brown myotis (*Myotis lucifugus*) and northern myotis (*Myotis septentrionalis*) are SARA-listed as endangered (Government of Canada 2019) and most likely to be affected by the Project. Four bat species in total were detected with the most common being hoary bat (*Lasiurus cinereus*), followed by silver-haired bat (*Lasionycteris noctivagans*), little brown myotis, and eastern red bat (*Lasiurus borealis*) (Stantec 2019b).

5.1.7.3 Amphibians

The LAA has the potential to provide habitat for boreal chorus frog (*Pseudacris maculate*), wood frog (*Lithobates sylvaticus*), and northern leopard frog (*Lithobates pipiens*; SARA-listed as special concern [Government of Canada 2019]). All but northern leopard frog have been recorded in the LAA (MHA 2019).

5.1.7.4 Species at Risk

The RAA has the potential to provide habitat for 17 animal SAR, as defined in Sections 5.1.7.1 to 5.1.7.3 based on range maps and land cover data (**Table B1**, **Appendix B**): 12 bird species, 4 mammal species, and 1 amphibian species. Historical records exist within the LAA for nine SAR with three being observed during the 2019 field surveys: common nighthawk, barn swallow (*Hirundo rustica*), and little brown myotis (Stantec 2019b). These three species typically tolerate an elevated level of anthropogenic disturbance.

The relatively high degree of anthropogenic development and disturbance in the LAA and RAA likely limits the suitability of the available habitat for some SAR that are more sensitive to such influences, such as woodland caribou and wolverine. It is unlikely that these species would inhabit the LAA now and in the future.

5.2 SOCIO-ECONOMIC ENVIRONMENT

5.2.1 Land Use and Infrastructure

Most potential land use in the region revolves around natural resources. There are currently no hydroelectric, eco-tourism, winter weather testing, or forestry operations adjacent to or near the Site.

Vale’s holdings east of the city (in which TMEP1 is located) fall within Registered Trapline 44 of the Pikwitonei Section. The total area of Trapline 44 is 254 square km. The Registered Trapline system covers the entire north, and as such, there is no land that is not within a Registered trapline. There are four registered trappers with whom Vale communicates. Vale will explain the project and provide trappers with results of studies and reports. The Project will have no impact on their traplines, as there will be no change to water drainage beyond the immediate area of the TMA.

The City of Thompson has a municipal water service system that uses surface water (i.e., the Burntwood River) as the primary source (MSD 2015). The Thompson Water Treatment Plant was constructed by Vale and was transferred over to the City of Thompson in advance of the June 2019 revocation date of Vale's license to operate the plant. The water supply system consists of a river pump house/intake structure, the water treatment plant, raw water and potable water pipes to Vale (which Vale still maintains), and a city potable water distribution system (City of Thompson 2019, 2018; Vale 2014).

5.2.2 Population and Economy

The City of Thompson population (2016) is approximately 13,678 people. The population growth rate between 2011 and 2016 was 4.2%. Of the total 5,482 private dwellings recorded in 2016, 4,910 dwellings were occupied. The total land area of the City of Thompson is 20.8 sq. km. with a population density of 657.6 persons per sq. km. (Statistics Canada 2016).

There are 658 hotel rooms in Thompson able to accommodate 860 persons, not counting the use of extra cots, hide-a-beds, etc. Most hotels provide long-term stay rates. In addition, there are four apartment blocks / townhouse rental units that offer short-term or month-to-month rates suitable for contractors. There is currently a 14% apartment vacancy in the city, which is high for Thompson (Vale 2019b).

Mining has been, and still is, an important driver of the city's economy. The city also has a diversified service hub economy based on industrial and business, health and education, and government services. Tourism remains an important part of economic development for the city. The city is also home to aerospace winter weather testing as well as winter testing for the automotive sector (City of Thompson 2019).

The closest community to Thompson is Nisichawayasihk Cree Nation (NCN), 88 km by all-weather road and with a population exceeding 2,500. Vale and the City of Thompson are in the traditional lands of NCN (Treaty 5) and Vale has worked to consult with and partner with NCN on a number of employment and training initiatives.

5.2.3 Heritage Resources

A review of the provincial Archaeological Sites Inventory Database revealed 16 recorded sites within the RAA. The closest sites are two campsites located approximately 1.9 and 2.0 km north of the PDA on the Burntwood River (Historic Resources Branch pers. comm. 2019). No heritage resources were identified in the PDA.

6.0 ENVIRONMENTAL EFFECTS AND MITIGATION

6.1 ASSESSMENT OF ENVIRONMENTAL EFFECTS

6.1.1 Air Quality

Potential air quality emission sources associated with the Project related to the new ventilation system include:

- Exhaust from the new 389 RAR
- Emissions from the propane burners for the new 378 fresh air return system/heater house
- Emissions and fugitive dust generation from construction equipment used for the 389 RAR and associated infrastructure including the new road, five fan stations, and associated e-houses, fresh air heater house, and underground ventilation.

Potential air quality effects associated with the Project related to the new paste fill plant and new power supply include emissions and fugitive dust generation from construction equipment used for the construction of the new paste fill plant building, pipeline installation/drilling, borehole drilling, installation of the associated piping, 138 kV transmission line, switchyard/substation, and power feeders.

Other emissions associated with the Project include fugitive dust generation and gasoline/diesel emissions due to vehicular traffic on the Site, and odors from activities and materials used during construction.

6.1.1.1 Ventilation Upgrades

The Thompson Mine currently operates eight RARs. The new ventilation upgrades associated with the proposed Project include converting two of the existing RARs into FARs and adding the new 389 RAR, consisting of three centrifugal fans. The additional emissions associated with the new ventilation system consist of exhaust from the new 389 RAR including particulate matter, metals, and products of combustion from existing underground operations such as material handling, welding, blasting, diesel equipment operation, and comfort and shaft heating. Products of propane combustion will also be generated through the operation of the new fresh air heater house. The primary potential emissions include dust, metals, NO_x, NH_3, CS_2, COS, SO_2, and CO (Vale 2019a). Annual propane usage will increase from approximately 12.3 million litres to 16.6 million litres. Air flow from the Mine will increase by 35% from the current status (Pitz pers. comm. 2019).

An air dispersion model was carried out by Vale (2019a) to predict the change in ground level concentrations that would result from the ventilation system changes to the RARs associated with the Project (**Appendix D**). Overall, the model indicated that the exhaust from the RARs will increase from 1.73 million cubic feet per minute (Mcfm) to 2.73 Mcfm, representing a 58% increase in emissions. Annual emissions are presented in **Table 6-1** along with historical emissions from Vale Thompson operations (including the smelter and refinery which was shut down in 2018), as reported to the NPRI.

Table 6-1 Current and Future RAR Emissions Compared to Historical Emissions

Contaminant	Current RAR Emissions	Future RAR Emissions	2015 NPRI Report	2017 NPRI Report
	Tonnes/year			
TSP	11.60	18.30	1715	747
PM_{10}	11.60	18.30	894	594
$PM_{2.5}$	11.60	18.30	618	273
Ammonia	5.93	9.35	not reported	not reported
Carbon Disulfide	0.05	0.08	not reported	not reported
Carbonyl Sulfide	0.08	0.13	not reported	not reported
SO_2	5.52	8.72	151,154	117,192
CO	74.68	117.84	not reported	not reported
NO_x	90.96	143.54	not reported	not reported
Nickel	0.24	0.38	65	47
Copper	0.02	0.03	5.6	3.5
Cobalt	0.0034	0.0053	1.6	1.5
Arsenic	0.0059	0.0093	6.3	3.2
Lead	0.0015	0.0024	4.8	2.97
Silver	7.30E-06	1.15E-05	not reported	not reported
Iron	1.40	2.20	not reported	not reported
Note: TSP – total suspended particulate; PM_{10} and $PM_{2.5}$ – particulate matter Source: Vale 2019a				

The effect of ventilation upgrades on air quality is expected to be adverse in direction, continuous in frequency, and medium-term in duration in the LAA, since the new RAR system is expected to be in operation in perpetuity or until resources are exhausted. The magnitude of the Project air emissions is anticipated to be negligible within the LAA, given that the air quality emission for the Thompson Mine as reported to the NPRI in 2015 and 2017 are historically several orders of magnitude higher than the RAR emissions for all reported parameters due to the historical operation of the smelter.

6.1.1.2 Fugitive Emissions and Dust

During construction, changes to air quality can occur due to vehicle movements and construction equipment exhaust, blasting, general use of equipment, as well as the generation of dust from on-site traffic. Odors typical of some construction processes and materials may also be generated during the construction phase of the project, including those associated with asphalt roofing, adhesives, and painting.

Construction equipment will be maintained in good working order to reduce emissions. In comparison to the existing truck traffic on the Site as well as traffic on PTH 6 immediately adjacent to the Site, the change in local air quality due to these emissions are expected to be adverse in direction, low magnitude within the PDA, and are considered negligible in the LAA. The effect will be short term (limited to the construction phase) and reversible upon completion of the construction phase of the Project.

Odors typical of some construction processes and materials may also be generated during the construction phase of the Project. The activities generating these odors are expected to be short term, occurring multiple times irregularly over the construction phase. The prevailing wind direction for Thompson in the spring is from the northeast and for the remainder of the year from the west, based on the Thompson Airport meteorological station (Environment and Climate Change Canada 2019b). The closest residence to the Site is approximately 150 m northwest of the PDA. The lands surrounding the PDA are largely industrial with vacant, undisturbed lands to the east and residential development to the northwest. The nature and short-term duration of odor generating activities reduces the effect of odors at the Site on air quality in the LAA. The adverse effects of odor on air quality for receptors in the area are expected to be negligible in the LAA.

Similar to odors, fugitive dust emissions from construction equipment movements may result in irritation to nearby residents. However, the potential for Project-related air quality effects from dust emissions is expected to be negligible given the nature of the construction activities and location of the planned construction activities. As a continued mitigation measure, if required, additional dust suppression activities such as limiting traffic speeds in specific areas of the site or applying dust palliatives to select areas, may be considered if deemed necessary at the Site.

Summary

With the implementation of the mitigation measures described above and application of an environmental monitoring program, including dust monitoring, the potential effects on air quality from the construction of the Project are expected to be negligible, limited to the LAA, short-term in duration, and multiple irregular in frequency. The potential effects from operation are expected to be negligible, limited to the LAA, short-term (fugitive emissions) to medium-term (RAR emissions) in duration, and continuous in frequency. All air quality effects are expected to be reversible upon Project decommissioning.

6.1.2 Noise

An increase in noise levels at the Site could potentially affect sensitive receptors (residences) and wildlife resources (in terms of distribution and abundance) from construction and operation activities.

Outdoor noise emissions during construction are limited to construction equipment, including pumps and generators used for surface works at the Site. There will be some noise associated with ground clearing and site preparation, and the operation of heavy equipment. Trenching and surface blasting are anticipated to be required during construction. Noise level monitoring, impact assessment and mitigation methods will be incorporated into the overall construction monitoring process. The potential construction-related noise effects are expected to be short-term in duration and negligible.

As discussed in Section 5.1.2, a noise study was carried out to assess the noise impact of the fresh and return air raises at the Vale Thompson site. The study characterized current noise impacts from the Vale Thompson Mine Site through on-site measurements to provide maximum allowable sound power levels for future air raise equipment to be installed at the Thompson Mine Site and evaluate that sound levels at nearby points of reception do not increase.

The result of the noise model assessment did not indicate a major change to the predicted overall sound level from current levels at calibration points located at the nearest City of Thompson boundary next to a designated industrial heavy zone. It was determined that the existing 378 FAR remained the loudest predicted sound source at the receptor points. As such, it was determined that the soundscape at the distant receiver is not anticipated to substantially change from the current perceptions (RWDI 2019). The installation of the new equipment with sound power levels at or below the maximum levels noted in the noise study (ranging from 117 to 136 dBA) as part of the Project is not expected to substantially change the overall sound levels at the studied points of interest, with a less than 1 dB increase (RWDI 2019).

Operation of the 389 RAR will generate noise; however, the location and orientation of the RAR will not increase noise levels to and within the City based on the noise assessment study. Vale will follow-up with a noise assessment after 389 RAR is commissioned and operating.

Summary

With the adherence to mitigation measures, such as adjusting construction activities through equipment usage modification (i.e., duration, quantity), advising nearby residents of major noise generating activities on-site, and maintaining appropriate noise-abatement equipment, the potential effects of noise from construction are expected to be negligible, limited to the LAA, short-term in duration, and multiple irregular in frequency.

With adherence to the installation of equipment with sound power levels at or below the maximum noted levels, the potential effects from operation are expected to be negligible, limited to the LAA, short-term in duration, and continuous in frequency. All noise effects are expected to be reversible upon Project decommissioning.

6.1.3 Soils/Terrain

Potential effects on soils related to the Project include the disturbance and movement of previously undisturbed soils in the PDA for the development of the new 138 kV transmission line and associated ROW, for the aboveground pipelines, for the new access road development, RAR, and the paste fill plant. Construction activities have the potential to alter soil capability as a result of soil handling, admixing, compaction and rutting, and wind and water erosion of disturbed ground. These activities can also result in a loss in soil thickness and volume.

Construction activities that have the potential to alter soil quality/quantity or terrain stability in the LAA include site preparation for the overhead transmission line and underground powerlines, aboveground pipelines, RAR, switchyard/substation, access road, and paste fill plant (e.g., vegetation clearing, grubbing, uncontrolled burning of slash, earthworks, movement and operation of heavy equipment, excavation for building foundations, drilling, trenching activities for utilities, blasting, and grading for site drainage). Localized changes to drainage patterns could also affect soil movement during the operation of the Project infrastructure.

The PDA consists of a small area (approximately 1.5 ha) of previously undisturbed soil footprint that is expected to be disturbed due to construction activities for the 389 RAR and 138 kV switchyard. To the extent practically feasible, construction equipment and vehicle movement will be restricted to designated roads and pathways within and around work areas. Compaction of soils, if any, would be limited to the immediate cleared footprint for the Project and excavation activities associated building foundations.

To mitigate the effects on soils and terrain, during clearing activities for construction, overburden will be used as fill in areas where needed. Rock excavated from the sinking of the RAR will be used underground as fill, leaving minimal impact to surface properties. Topsoil will be removed and stockpiled on site to be used during site re-vegetation. Soil stockpiled on-site will be regularly inspected for evidence of erosion. Should soil erosion become evident, mitigation measures such as tarpaulin covers will be used to cover the materials. Silt fencing or other erosion control materials will be used during the construction and excavation activities to prevent soil losses associated with bank erosion and downstream sedimentation. Cleared areas outside of required footprints will be re-seeded using a native seed mixture and erosion control materials will remain in place until vegetation re-establishes.

To mitigate potential effects to soil quality, soil materials arriving on site for use during construction will originate from a clean source approved by the contract administrator. Machinery arriving on site will be free of leaks and will be regularly inspected to verify that equipment is in good working order. Should a spill or leak occur such as fuel or hydraulic fluid, emergency spill response procedures will be followed. Equipment will be maintained in a designated area to reduce risks of soil contamination.

During operation, potential effects associated with soil movement from changes to drainage patterns will be considered during the Project's design phase to avoid ponding of water on-site and to use existing established drainage ditches and channels to the extent practically feasible. No residual effects on soils and terrain stability are anticipated.

Summary

With the implementation of the mitigation measures described above, the potential effects on soil and terrain from the construction of the Project are expected to be negligible, limited to the LAA, short term in duration, and a single event, and reversible upon Project decommissioning.

6.1.4 Surface Water

The Project has the potential to affect surface water flow during construction (i.e., physical blockages to surface water patterns) and through the clearing and piling of vegetation in or near watercourses, and to affect surface water quality through the potential discharge of contact surface water to the environment.

The mine extension will not result in more surface water impacts. Surface water that could be affected by the Project will be retained on-site in the catchment of the TMA and managed as per the existing surface water management and treatment system.

Stockpiling of overburden and disposal of related debris and sediment can create physical blockages to surface water patterns and ponding of water in travel and work areas. Soil loss and erosion could reduce water quality. This disturbance was assessed as part of the hydrology study and mitigation measures will be developed to direct surface water to the TMA. Negligible and short-term impacts on surface water quality may occur as a result of construction activities for the Project including the construction of the access road, the 138 kV transmission line, aboveground pipelines, RAR, and the paste fill plant through erosion and downstream sedimentation associated with soil mobilization and destabilization, dust generation, accidental releases, and impacts to surface water drainage from heavy equipment and vehicle movement.

Ground clearing and site preparation will be entirely on Vale property and could disturb the flow of local surface water drainage. A hydrology study (Golder 2019) was conducted to assess this disturbance and its impacts. Mitigation methods are proposed to keep site water within the tailings management watershed area so that water quality effects are negligible.

To mitigate effects to surface water, excavation dewatering will include using appropriate energy arrestors (e.g., splash pads, dewatering silt bags) to prevent downstream sedimentation to surface water drainage features. The existing network of drainage ditches and the low anticipated water velocity in those drainage ditches is expected to allow for sediments to filter/settle out prior to discharging to surface water bodies off the mine site. Surface water management on-site will be addressed through construction of ditch and surface grading to direct surface contact water into the Pit watershed. Additional ditches will be constructed around the new 389 RAR to direct surface contact water towards a surface catchment basin on the north side of the RAR. The 389 RAR will be fitted with a drain system, oil separator and pump. Clarified water will be pumped to the surface drainage system in summer and diverted underground through a slurry line in the winter. Five culverts will be added underneath the new 389 access road to allow for natural surface water flow to avoid possible flooding. The aboveground pipelines will be constructed with periodic break points, each with a containment area, to capture potential spills thereby avoiding surface water contamination.

During operation, potential effects associated with soil movement from changes to drainage patterns will be considered during the Project's design phase to avoid ponding of water on-site and to use existing established drainage ditches and channels to the extent practically feasible. The hydrology study and mitigation methods noted above regarding surface water will include the power line preparation zone so that there is a reduced effect on surface water migration.

Summary

With the implementation of proposed mitigation measures and surface water management processes, the effect of the construction of proposed alterations at the Site on surface water is expected to be negligible, short-term in duration, multiple irregular, and reversible upon decommissioning of the Project. For surface water drainage effects from associated soil movement during operation, potential effects are expected to be negligible, limited to the surrounding LAA, long-term in duration, continuous in frequency, and reversible upon Project decommissioning.

6.1.5 Groundwater

The Project has the potential to affect groundwater quantity and quality through the extension of underground workings and construction of an RAR. Potential project interactions with groundwater are predominantly related to the potential lowering of groundwater levels through dewatering of the new drilled 389 RAR and extended underground workings, and the management of the discharge. A hydrogeology study was conducted as part of the development of the RAR. Mitigation methods were developed to reduce groundwater effects to underground development (Stantec 2019a).

The 389 RAR will be concrete lined over its entire length; as such, no permanent groundwater dewatering requirements are associated with the 389 RAR. Some groundwater may require management during construction. Following excavation and cleaning of sequential benches and walls within the pillar, the bottom of the pillar will be sealed into the bedrock mitigating the potential for water seepage. Water inflow into the drill hole will be checked every 120 m of drilling until breakthrough at the 3,500 Level is reached. Water, consisting of dust control water and water seepage, will be managed at the 3,500 Level. The final RAR walls will be lined with concrete, which will mitigate groundwater seepage into the RAR.

Groundwater management will be required at the T3 Mine. Before any backfilling is completed underground, openings corresponding to the extension will require dewatering. Minimum and maximum inferred groundwater inflow of existing underground workings was assumed to be on average 24 L/s for 2018 (Stantec 2019a). To keep the proposed extension area dry once the area has been totally mined out, an estimated dewatering rate of 72 L/s was estimated, without the application of mitigation measures such as backfilling the void space with paste fill (Stantec 2019a). All dewatered water will be conveyed to the existing Mine treatment plant. In terms of zone of influence associated with dewatering the mine extension, as the area is characterized by almost 1,000 m of bedrock above the proposed mine extension, overlaid by 20 m of frozen clay overburden for the majority of the year, there is unlikely to be any measurable effect on surface systems (Stantec 2019a).

Based on analytical data collected from three groundwater monitoring wells developed across overburden and shallow bedrock on-site, the groundwater quality is quite good (Stantec 2019a). Two dissolved metal parameters were found to exceed the regulatory criteria, chromium for Freshwater Aquatic Life under the Manitoba Water Quality Standards, Objectives, and Guidelines (MSOG) and manganese for the Aesthetic Objective under the Guidelines for Canadian Drinking Water Quality (CWQG-DWS). A number of parameters related to total metals were also found to exceed the MSOG and/or CWQG criteria in different wells, including total aluminum, arsenic, chromium, iron, lead, manganese, and silver (Stantec 2019a). The increase in the number of parameters found to exceed the MSOG and/or CWQG criteria related to total metals (as compared to dissolved metals) is suggestive of sediment. The dissolved phase of groundwater quality is most representative of water flowing through the aquifer and potentially discharging to a surface water feature. The total metals phase may be more representative of pumped water during construction activities and can be mitigated through the use of an effective filtration system prior to water being discharged to the environment (Stantec 2019a). It is noted that the water quality samples collected were from shallow groundwater wells and may not be representative of groundwater quality from deeper depths. However, it is likely that the deeper groundwater quality would be similar to that previously encountered in the developed portions of the T3 Mine (Stantec 2019a). Monitoring of groundwater from available and operational monitoring wells is proposed for groundwater levels and quality.

With respect to private well water supply, the nearest groundwater wells (two) are situated approximately 3 km northwest of the proposed 389 RAR, on the northside of the Burntwood River. Potential effects to these two groundwater wells were considered to be negligible given the horizontal and vertical separation distance to the proposed mining activities at the Site and the presence of the Burntwood River providing some hydraulic separation (Stantec 2019a). Potential effects on Thompson's municipal raw water supply (i.e., Burntwood River) are also considered negligible as the estimated maximum groundwater mine inflow of 0.072 m^3/s (72 L/s) represents 0.01% and 0.006% of the flow in the Burntwood River (i.e., 600 m^3/s to 1,000 m^3/s).

Summary

With the implementation of proposed mitigation measures described above, such as sealing the pillar and lining the RAR wall with concrete, and proposed monitoring of groundwater levels and quality, the effect of construction and operation of the proposed alterations at the PDA on groundwater is expected to be negligible, short to long-term in duration, continuous, and reversible upon decommissioning of the Project.

6.1.6 Vegetation

Despite the highly altered state of the PDA and LAA, native vegetation and wetlands remain and potential effects to vegetation are related to the loss or alteration of land cover types (i.e., vegetation communities) and loss or change in wetland area and function. Minimal clearing will be required for this Project as most of the Project footprint will be located on previously disturbed lands. The loss of habitat for plant SAR is not expected to occur as SAR were not detected during desktop or field investigations. Construction and operation of the Project could introduce or spread noxious and invasive species through vehicle and equipment movement.

Weed species could spread throughout the LAA during Project construction and operation as weeds tend to thrive in disturbed sites. Some riparian vegetation may be cleared to construct the 138 kV transmission line. The following mitigation measures will be implemented to reduce or avoid the potential adverse effects to vegetation and wetlands during Project construction and operation:

- Equipment must arrive to the site in a condition free of remnant soil or plant material to minimize the risk of weed introduction. Equipment that arrives containing loose or compacted oil and plant material will not be allowed on the Site until it has been cleaned using brooms, brushes, shovels, high pressure water, or compressed air.

- Weed control measures will be developed in accordance with *The Noxious Weeds Act* (GOM 2010).
- A 30-m setback or vegetated buffer around waterbodies and watercourses will be maintained for clearing and transmission line tower placement.

Summary

With the implementation of proposed mitigation measures, the effect of the Project on vegetation is expected to be negligible, limited to the PDA, long-term in duration, continuous, and reversible upon decommissioning of the Project.

6.1.7 Wildlife and Wildlife Habitat

The Project has the potential to affect wildlife and wildlife habitat through direct and indirect habitat loss or alteration and increased mortality risk. Land clearing in parts of the PDA will result in the direct loss of wildlife habitat, while noise and activity from construction equipment will result in indirect habitat loss (i.e., wildlife avoiding otherwise suitable habitat). Increased mortality risk is primarily associated with changes in collision risk for birds moving within the area of the planned transmission line and collisions with heavy construction equipment (Stantec 2019b).

Construction activities are scheduled to occur outside of the nesting period (late-April to mid-August; Environment and Climate Change Canada [ECCC] 2018b) and will accordingly reduce effects on migratory birds. Key mitigation measures to be implemented during construction and operation to limit effects on wildlife and wildlife habitat include the following:

- If vegetation clearing cannot avoid the sensitive nesting period, pre-clearing nest searches will be conducted, and appropriate setbacks applied to active nests or areas where nesting is suspected. For most birds, a 30-m buffer is applied, however, for SAR or species of management concern, setback may be applied according to guidance offered by the MB CDC (2015).
- Pre-construction nest sweeps for ground nesting common nighthawk should be conducted prior to the start of construction if proposed infrastructure sites (e.g., 371 substation, 389 access road, and 389 RAR extension area) are cleared and remain inactive into the sensitive breeding bird window.
- Construct transmission line in frozen conditions to minimize erosion and sedimentation and potential impacts to low-lying habitats.
- The Project will comply with the *Wildlife Act* and *Migratory Bird Convention Act* and Regulations.

Minimal clearing will be required for this Project as most of the Project components will be located on previously disturbed lands. Construction effects on bats are anticipated to be low as the PDA is not known to support suitable bat hibernacula or maternity roosts (Stantec 2019b). Tree clearing will occur primarily in areas where bats were not detected during baseline investigations (i.e., in the vicinity of the access road, and at the 389 RAR and the 379 substation), Similarly, the effects of vegetation clearing on

SAR bird habitat is expected to be minimal as the suitability of breeding habitat for species such as olive-sided flycatcher and common nighthawk is low due to ongoing mining noise and activity.

Construction and operation of the Project may result in an indirect loss or alteration of habitat adjacent to the PDA through sensory disturbance (i.e., noise from equipment and vehicles). Sensory disturbance may cause wildlife to avoid portions of the LAA during construction and/or operation. Given the existing level of disturbance in the PDA and LAA, wildlife inhabiting the area are likely habituated or tolerant to some of the ongoing noise and activity disturbances. Wildlife may continue to use the area during construction or avoid parts of the PDA temporarily, returning shortly after construction of the Project is complete.

The potential for increased wildlife mortality risk by wildlife coming into direct contact with equipment and vehicles may occur during Project construction and operation. Small mammals, amphibians, and ground-nesting birds are particularly susceptible; however, with mitigation the effect is anticipated to be small given the existing level of disturbance and marginalization of SAR and migratory bird habitat within the small Project footprint. The proposed transmission line has the potential to increase the mortality risk of migratory birds due to bird-wire collisions. The use of bird safe transmission designs and bird markers or diverters near waterbodies will help reduce the potential effects.

Summary

With the implementation of proposed mitigation measures, the effect of the Project on wildlife and wildlife habitat is expected to be negligible, extending to the LAA, medium-term in duration, continuous, and reversible upon decommissioning of the Project.

6.1.8 Fish and Fish Habitat

The Project's potential effects on fish and fish habitat are associated with vegetation clearing in parts of the PDA that can result in the alteration of riparian habitat.

The proposed Project alteration does not require any undertakings or activities in or near the Burntwood River; therefore, there is no effect on fish and fish habitat in the Burntwood River. There are two waterbodies, Watercourse 1 and 2, that are considered natural fish habitat within the PDA (**Figure 1-9**). Watercourse 1 and Watercourse 2 are considered Type D habitat (i.e., direct simple habitat with non-indicator (forage) fish species and perennial or intermittent flows) with a low sensitivity ranking (Milani 2013). Habitat in Watercourse 1 is not suitable for coarse or sport fish while habitat in Watercourse 2 is not suitable for forage fish; however, the fish species present in both these watercourses are expected to be moderately resilient to change.

The proposed 138 kV transmission line will cross over Watercourse 1. Some riparian vegetation may be cleared to construct the transmission line, which may result in the potential loss of habitat at the water crossing. No SAR species are expected to occur within the Biophysical LAA as none have been previously captured in the Burntwood River or its tributaries. The potential effects on fish and fish habitat are considered to be negligible given the type of habitat present at the crossing and that no work below the high-water mark is proposed. Mitigation measures will also be adhered related to minimizing clearing to the extent feasible, establishing a minimum 30 m buffer zone from the highwater mark between work areas and waterbodies on-site, and adhering to other applicable DFO standards to avoid causing harm to fish and fish habitat.

Summary

With the implementation of mitigation measures, the effect of the Project on fish and fish habitat from construction is expected to be negligible, extending to the LAA, short-term in duration, multiple irregular in frequency, and reversible upon Project decommissioning.

6.2 SUMMARY OF MITIGATION MEASURES

Air Quality

- Construction equipment will be maintained in good working order to minimize emissions.
- Dust generation from exposed or disturbed areas will be kept to a minimum; additional dust suppression will be undertaken at the construction site as required (i.e., spraying material stockpiles and work areas with water or other non-toxic measures.
- Stockpile heights will be limited on-site.
- Construction traffic speeds will be limited in specific areas of the Project as an additional measure of dust suppression.
- Vale will obtain all required blasting permits and certificates prior to blasting and drilling on-site.
- Blasting plans will be developed and wildlife surveillance undertaken prior to blasting, as required.

Noise

- Construction activity will be limited to normal daylight hours only in accordance with local municipal by-law provisions.
- Noise generation from construction activities will be addressed through equipment usage modification (i.e., timing, duration, quantity).
- Nearby residents will be advised of major noise generating activities on-site (i.e., blasting).
- Appropriate noise-abatement equipment will be maintained on-site.
- Noise level monitoring will be incorporated into the overall construction monitoring process on-site.
- Newly installed ventilation equipment will be operated below the determined sound power levels with no net increase in current noise levels to the community.

- Vale will follow-up with a noise assessment after the 389 RAR is commissioned and operating.

Soils/Terrain

- To the extent practically feasible, construction equipment and vehicle movement will be restricted to designated roads and pathways within and around work areas.
- Compaction of soils, if any, will be limited to the immediate cleared footprint for the Project and excavation activities associated with building foundations.
- Overburden will be used as fill in areas where needed. Rock excavated from the sinking of the RAR will be used underground as fill, leaving minimal impact to surface properties.
- All mineralized mine waste material generated at the Site, including drill core and construction rock, will be disposed of at an appropriate location for potentially acid generating material.
- Excavated topsoil will be stockpiled separately at the Site for future use in leveling activities and vegetating disturbed areas.
- Material stockpiles will be placed in areas identified and approved by Vale; stockpile heights will be limited.
- Soil stockpiled on site will be regularly inspected for evidence of erosion. Should soil erosion become evident, mitigation measures such as tarpaulin covers will be used to cover the materials.
- Disturbed areas will be kept to a minimum and site restoration will occur as soon as practically possible where necessary.
- Silt fencing or other erosion control materials will be used during the construction and excavation activities to prevent soil losses associated with bank erosion and downstream sedimentation.
- Buried pipes will be insulated and/or heat traced where excavation constraints exist.
- Exposed slopes will be stabilized using scarification and back-blading methods.

Surface Water and Groundwater

- Construction activities will be limited during heavy precipitation/runoff events.
- Surface water and groundwater entering any excavations will be de-watered using appropriate energy arrestors (e.g., splash pads, dewatering silt bags) to prevent downstream sedimentation to surface water drainage features.
- Surface water drainage patterns will continue to discharge to existing drainage channels.

- Equipment must arrive to the site in a condition free of remnant soil or plant material to minimize the risk of weed introduction. Equipment that arrives containing loose or compacted oil and plant material will not be allowed on the site until it has been cleaned using brooms, brushes, shovels, high pressure water, or compressed air.
- A minimum buffer zone of 30 m of natural vegetation from the highwater mark of waterbodies will be maintained around work areas; a wider buffer zone will be maintained if there are no space constraints between construction areas and watercourses.
- Construction of a cement collar through overburden, sealed into the top of bedrock prior to excavation of 389 RAR will address groundwater seepage.
- The 389 RAR wall will be lined with concrete to prevent groundwater seepage.
- Fractures encountered that transmit notable groundwater seepage will be mitigated with shotcrete.
- Groundwater levels and quality will be monitored to allow for the identification of potential hydraulic or chemical anomalies as the Project proceeds.

Vegetation

- Clearing activities will be limited to those areas required for Project activities.
- Trees will be felled inward toward the work areas to avoid damage to standing trees; slash will be piled for subsequent disposal.
- Cleared areas outside of required footprints will be re-seeded using a native seed mixture and erosion control materials will remain in place until vegetation re-establishes.
- Construction traffic and equipment movements will be limited to designated access routes within the Site.
- Weed control measures will be developed in accordance with *The Noxious Weeds Act* (GOM 2010).
- Maintain a 30-m setback or vegetated buffer around waterbodies and water courses.

Wildlife and Fish

- Pre-construction nest sweeps for ground nesting common nighthawk should be conducted prior to the start of construction if proposed infrastructure sites (e.g., 371 switchyard, 389 access road, and 389 RAR extension area) are cleared and remain inactive into the sensitive breeding bird window.
- Construct transmission line in frozen conditions to minimize erosion and sedimentation and potential impacts to low-lying habitats.
- The Project will comply with the *Wildlife Act* and *Migratory Bird Convention Act* and Regulations.

- If vegetation clearing cannot avoid the sensitive nesting period, pre-clearing nest searches will be conducted, and appropriate setbacks applied to active nests or areas where nesting is suspected. For most birds, a 30-m buffer is applied, however, for SAR or species of management concern, setback may be applied according to guidance offered by the MB CDC (2015).
- Clearing will be minimized to the extent feasible at water crossing locations; DFO standard measures to protect fish and fish habitat under the new *Fisheries Act* will be adhered to.

Access, Waste Management, Workforce

- Construction access will be limited to existing access points only; appropriate construction signage and flag persons will be used as required for work on the construction site.
- Construction wastes will be gathered and properly disposed of at a regional licensed landfill; recycling will be encouraged to the extent possible.
- Proper procedures for storage and handling of hazardous substances in designated areas will be adhered to (i.e., fuels, chemicals).
- An emergency response spill kit will be maintained and emergency response measures for spill clean-up and remediation will be implemented.
- The Site will be regularly inspected for loose debris and construction waste to maintain a clean site.
- Contractors engaged in construction activities at the Site will adhere to federal and provincial Health and Safety legislation.
- Contractors will adhere to a Project-specific environmental protection plan developed as appropriate.
- Site employees will be kept aware of safety requirements and on-site construction works for worker safety.
- Workers will be provided with appropriate personal protection equipment (PPE); hearing protection will be provided to employees/workers as required.

6.3 SUMMARY OF RESIDUAL EFFECTS CHARACTERIZATION

A summary of residual environmental effects characterization is found in **Table 6-2**.

Table 6-2 Summary of Residual Environmental Effects

Project Effects	Residual Environmental Effects Characterization							
	Project Phase	Direction	Magnitude	Geographical Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Context
Air Quality								
RAR air emissions	O	A	N	LAA	MT	C	R	D
Fugitive emissions, dust	C, O	A	N	LAA	ST	MI/C	R	D
Noise								
Outdoor noise generation	C, O	A	N	LAA	ST	MI/C	R	D
Soils/Terrain								
Soil disturbance	C	A	N	LAA	ST	S	R	D
Surface Water								
Surface water drainage	C, O	A	N	LAA	ST/LT	MI/C	R	D
Groundwater								
Dewatering, water supply alteration	C, O	A	N	PDA	ST/LT	C	R	D
Vegetation								
Flora loss and alteration	C, O	A	N	PDA	LT	C	R	D
Wildlife and Wildlife Habitat								
Fauna and habitat loss and alteration	C, O	A	N	LAA	MT	C	R	D
Fish and Fish Habitat								
Fish habitat loss and alteration	C	A	N	LAA	ST	MI	R	D

KEY

Project Phase
C Construction
O Operation

Direction
P Positive
A Adverse
N Neutral

Magnitude
N Negligible
L Low
M Moderate
H High

Geographical Extent
PDA Project Development Area
LAA Local Assessment Area
RAA Regional Assessment Area

Duration
S Short-term
M Medium-term
L Long-term

Frequency
S Single event
MI Multiple irregular event
MR Multiple regular event
C Continuous

Reversibility
R Reversible
IR Irreversible

Ecological/Socio-Economic Context:
U Undisturbed
D Disturbed

N/A Not applicable

7.0 CONCLUSION

Potential interactions of the proposed Project and the environment were evaluated with likely interactions examined to assess residual effects. Those interactions deemed to potentially generate adverse effects were described and evaluated with the assumption of typical mitigation measures representative of best practices and previous construction methods employed at the Site.

On the basis of the desktop and field studies undertaken, and information available to date as presented in this report, potential effects associated with the proposed alterations are determined to be not significant.

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Vale Canada Ltd. 2019c. Thompson Mine Extension Phase 1 Project FEL 3 Study – Environmental Protection Plan (EPP). Prepared by Vale Canada Ltd. Copper Cliff, ON.

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8.2 PERSONAL COMMUNICATIONS

Campeau, Madonna. Senior Air Quality Engineer, Vale Canada Ltd. Email correspondence with Carmen Anseeuw, Environmental Planner, Stantec Consultants Ltd. September 10, 2019.

Johnson, Nick. Project Coordinator, Stantec Consultants Ltd. Email correspondence with Carmen Anseeuw, Environmental Planner, Stantec Consultants Ltd. September 9, 2019.

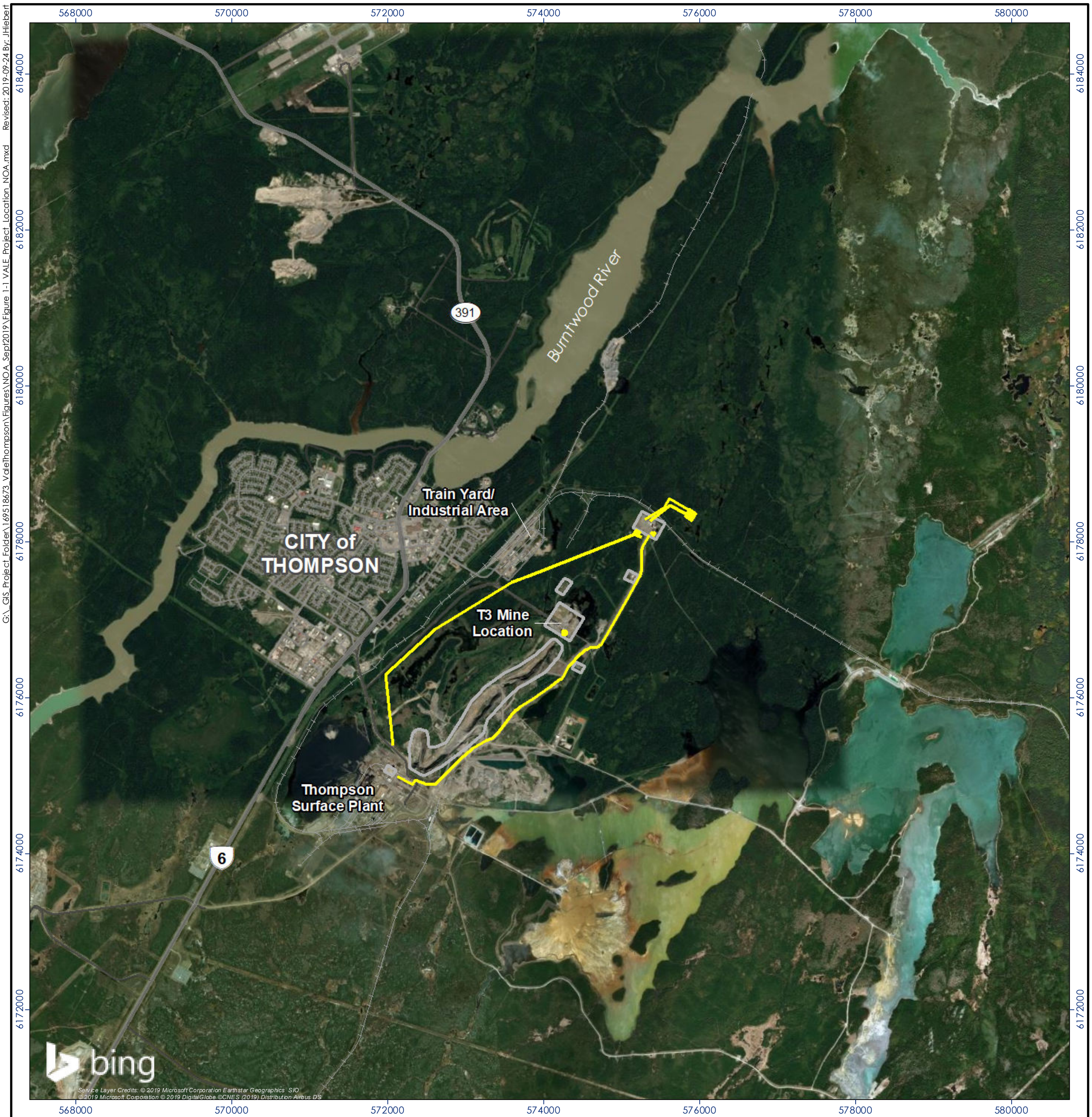
Murray, Colin. Information Manager, Manitoba Conservation Data Centre. Wildlife and Fisheries Branch. Manitoba Sustainable Development. Email correspondence with Angele Watrin-Prodaehl, Stantec Consultants Ltd. May 21, 2019.

Pitz, Andy. Chief Engineer, Stantec Consultants Ltd. Email correspondence with Nick Johnson, Stantec Consultants Ltd. September 30, 2019.

Tsukamoto, Suyoko. Senior Impact Assessment Archaeologist, Historic Resources Branch. Manitoba Sport, Culture and Heritage. Email correspondence with Carmen Anseeuw and Bill Krawchuk, Stantec Consultants Ltd. September 19, 2019.

Appendix A FIGURES

G:_GIS_Project_Folder\169518673_ValeThompson\Figures\NOA_Sept2019\Figure 1-1 VALE_Project_Location_NOA.mxd Revised: 2019-09-24 By: JHiebert



Legend

- Project Development Area (PDA) Components
- Existing Mine Features
- Highway
- Major Road
- Local Road
- Railway

0 1 2 Kilometres

(At original document size of 8.5x11)
1:75,000

N

Stantec

Project Location
Thompson,
Manitoba

Prepared by JHiebert on 2019-09-24
Reviewed by BKrawchuk on 2019-09-24

Client/Project
169518673

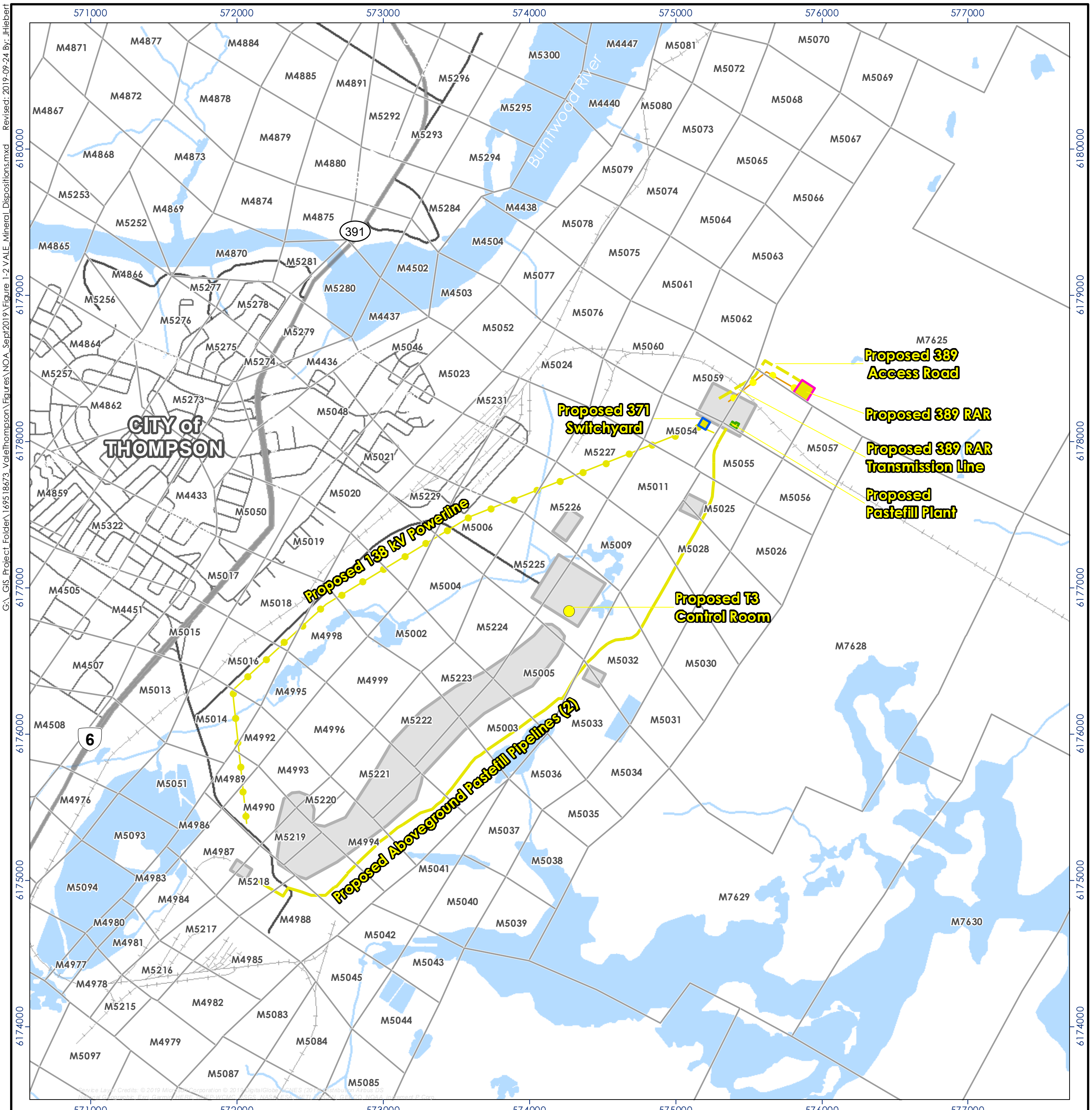
VALE
Thompson Mine Extension Phase 1
Notice of Alteration

Map No.
1-1

Title
Thompson Mine Extension Phase 1
T-3 Mine Location

Notes

1. Coordinate System: NAD 1983 UTM Zone 14N
2. Base Data Sources: Government of Manitoba
3. Aerial Imagery: Microsoft product screenshot reprinted with permission from Microsoft Canada



Legend

Project Development Area (PDA) Components

- Proposed 389 RAR
- Proposed 371 Switchyard
- Proposed Pastefill Plant
- Proposed T3 Control Room
- Proposed 138 kV Powerline
- Proposed 389 Transmission Line
- Proposed 389 Access Road
- Proposed Aboveground Pastefill Pipeline (2)
- Mineral Lease
- Existing Mine Features
- Highway
- Major Road
- Local Road
- Railway

0 0.5 1 Kilometres

(At original document size of 8.5x11)
1:40,000

N

Stantec

Project Location
Thompson, Manitoba

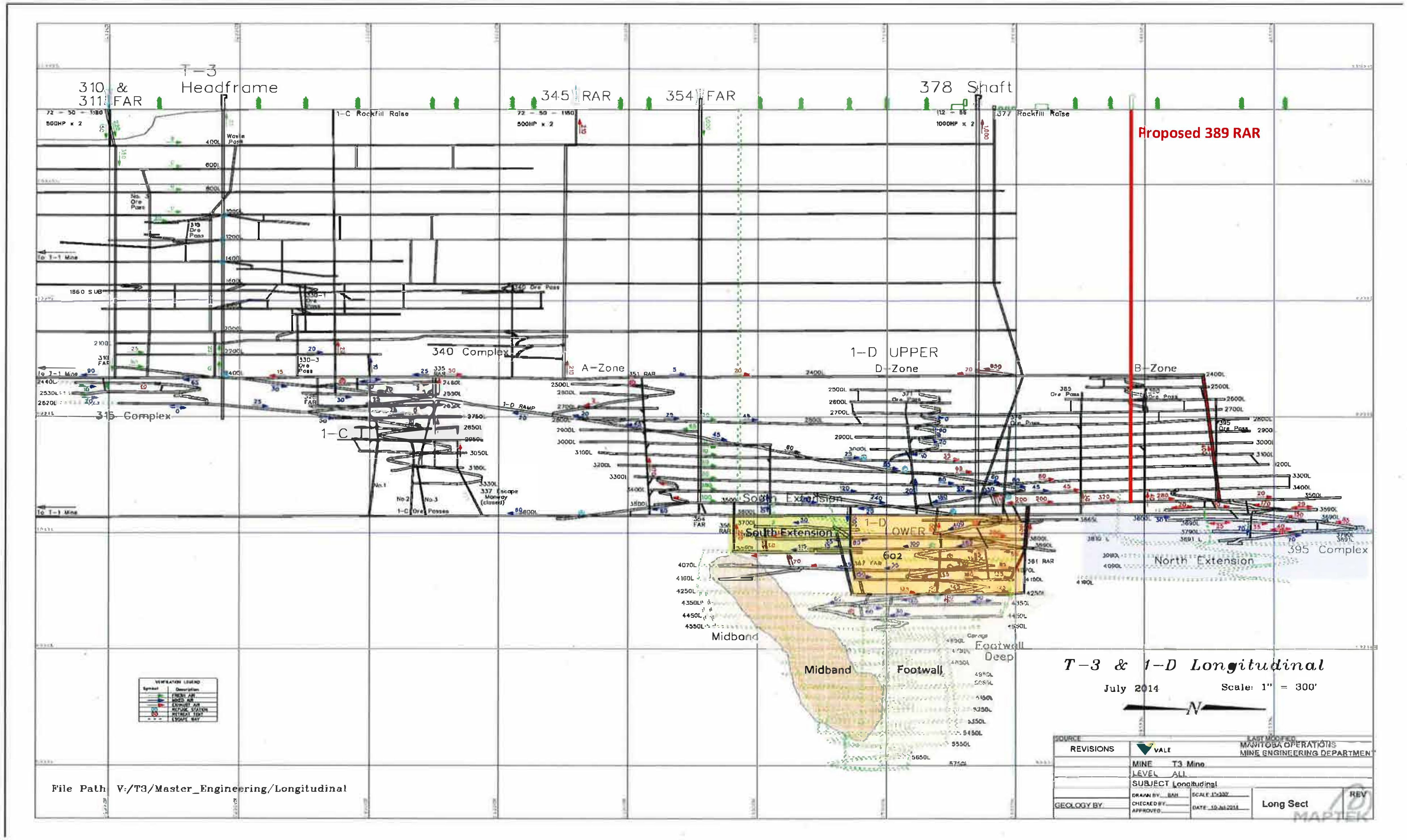
Prepared by JHiebert on 2019-09-15
Reviewed by BKrawchuk on 2019-09-15

Client/Project 169518673
VALE
Thompson Mine Extension Phase 1
Notice of Alteration

Map No.
1-2

Title
Thompson Mine Extension Phase 1
Mineral Dispositions

Notes
1. Coordinate System: NAD 1983 UTM Zone 14N
2. Base Data Sources: Government of Manitoba
3. Aerial Imagery: Microsoft product screenshot reprinted with permission from Microsoft Canada



Notes:

Mine plan provided by Vale.
Location of proposed 389 RAR is approximate
RAR - return air raise

Stantec

Client/Project

Hydrogeological Assessment
Thompson Mine Extension Phase 1 - FEL 3 Refresh
Vale

Figure No.

1-3a

Title

Longitudinal Mine Plan
T3 Mine

W:\active\169518673\planning\report\Hydrogeological Assessment\A_Figures\fig_02__longitudinal mine plan.xlsx

DWG. NO. 1384-5000-B-0201

NOTE

1. FAN INSTALLATION AT 378 RAISE & 389 RAISE MAY NOT BE EXACTLY AS SHOWN. ARRANGEMENTS TO BE UPDATED DURING DETAILS DESIGN.

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Sudbury, ON Canada
P3E 3Z8
Tel. 705 566 6891
www.stantec.com
PROJECT NO: 169518673

DWG NO.	REFERENCE DRAWINGS
1384-5000-B-0204	T1 MAIN FACILITY – STORAGE AREA – SITE PLAN
1384-5000-B-0205	GENERAL ARRANGEMENT – ACCESS ROAD LAYOUT

REV	JOB NO.	DESCRIPTION	DATE	DRAWN BY	CHECKED DRAWING	APPROVED DESIGN	REVIEWED DESIGN
B	1384	ISSUED FOR REVIEW	2019-02-04	R. DUNNE	J. BOUDREAU	A. PITZ	Y. PILON
0	1384	ISSUED FINAL FOR FEL 3 REPORT	2019-02-14	R. GAUTHIER	Y. PILON	A. PITZ	Y. PILON
1	1384	ISSUED FINAL FOR FEL 3 REPORT – REVISED AS PER CONSTRUCTABILITY REVIEW	2019-02-25	Y. PILON	J. BOUDREAU	A. PITZ	Y. PILON
2	1384	ISSUED FINAL FOR FEL 3 REPORT – REVISED AS PER VENTILATION CONST. REVIEW	2019-03-15	Y. PILON	R. LAMARCHE	A. PITZ	Y. PILON
3	1384	ISSUED FINAL FOR FEL 3 REPORT – REV'D. 378 FAR, 389 RAR, INFRASTRUCTURES	2019-08-23	P. CHARBONNEAU	Y. PILON	A. PITZ	Y. PILON

VALE
MANITOBA OPERATIONS

PLANT: T3 MINE – THOMPSON DIV.
SUB PLANT: 1D LOWER OREBODY
AREA: SURFACE INFRASTRUCTURE
CLASSIFICATION: LAYOUT
TITLE: MISCELLANEOUS FACILITIES
GENERAL ARRANGEMENT – OVERALL SITE PLAN

SCALE: 1"=125'
REV. 1 PROJECT NO.: 1384
DWG. NO.: 1384-5000-B-0201
REV.: 3

Figure 1-3b

DWG. NO. 1384-5000-B-0100

LEGEND

✖ BURIED LINES AT ROAD CROSSING

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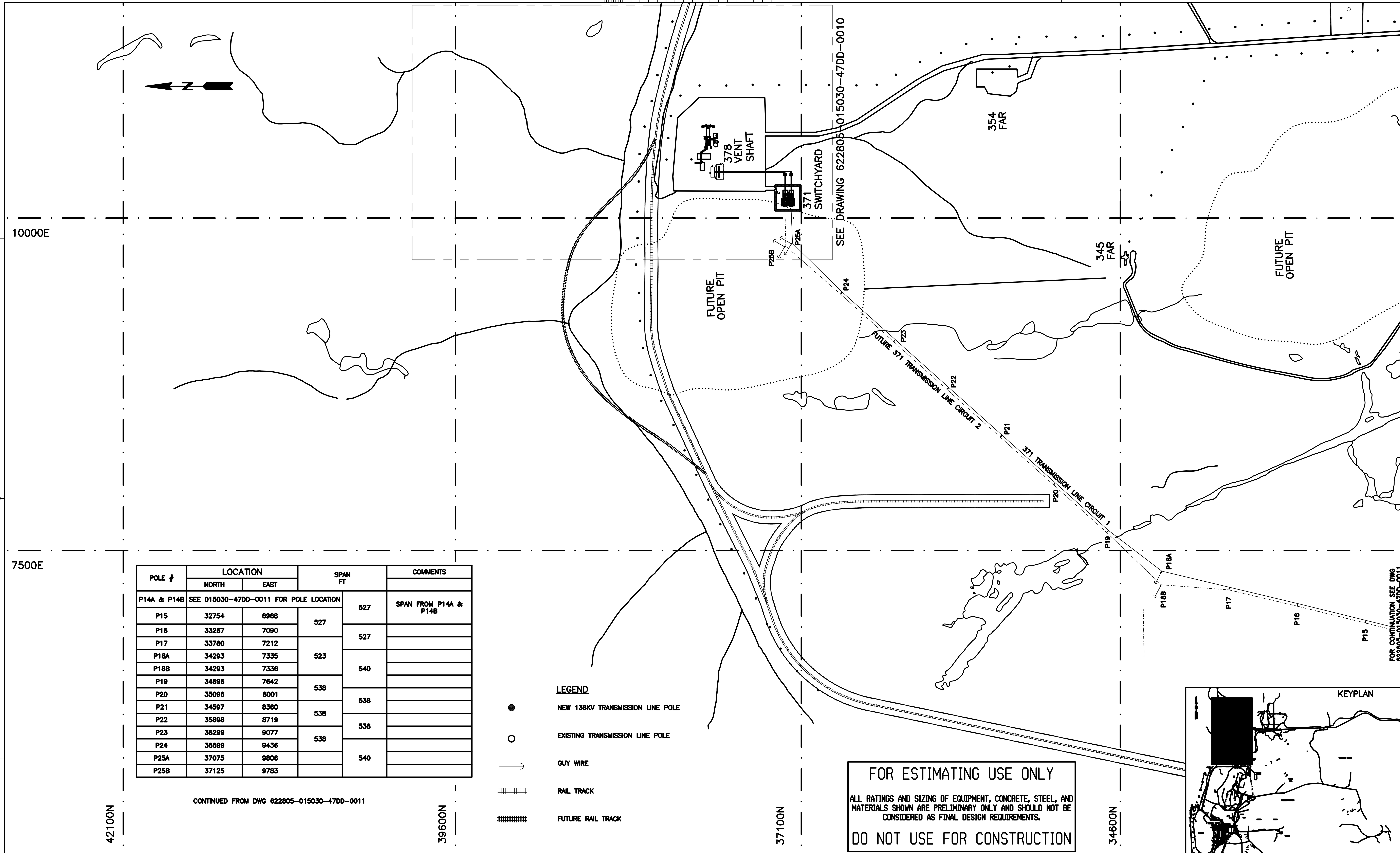
PROJECT NO: 169518673

DWG NO.	REFERENCE DRAWINGS	REV	JOB NO.	DESCRIPTION	DATE	DRAWN BY	CHECKED DRAWING	APPROVED DESIGN	REVIEWED DESIGN
		B	1384	ISSUED FOR 70% CLIENT REVIEW	2019-03-12	P. CHARBONNEAU	W. PENNO	E. DUDSON	J. THAMBY
		0	1384	ISSUED FINAL FOR FEL REPORT	2019-04-08	P. CHARBONNEAU	W. PENNO	E. DUDSON	J. THAMBY

VALE
MANITOBA OPERATIONS

PLANT: THOMPSON MINE
SUB PLANT: T3 MINE
AREA: PASTE FILL
CLASSIFICATION: LAYOUT
TITLE: SURFACE – GENERAL ARRANGEMENT
TAILINGS FEED & RETURN PIPELINE ROUTING – PLAN

SCALE: 1"=500'
REV. 1 PROJECT NO.: 1384
DWG. NO. Figure 1-3c
1384-5000-B-0100
REV. 0



POLE #	LOCATION NORTH	LOCATION EAST	SPAN FT	COMMENTS
P14A & P14B	SEE 015030-47DD-0011 FOR POLE LOCATION		527	SPAN FROM P14A & P14B
P15	32754	6968	527	
P16	33267	7090	527	
P17	33780	7212	523	
P18A	34293	7335	540	
P18B	34293	7336		
P19	34696	7642	538	
P20	35096	8001	538	
P21	34597	8360	538	
P22	35898	8719	538	
P23	36299	9077	538	
P24	36699	9436	540	
P25A	37075	9806		
P25B	37125	9783		

CONTINUED FROM DWG 622805-015030-47DD-0011

LEGEND

- ● NEW 138KV TRANSMISSION LINE POLE
- ○ EXISTING TRANSMISSION LINE POLE
- GUY WIRE
- RAIL TRACK
- FUTURE RAIL TRACK

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No	REVISION DESCRIPTION	DATE (Y/M/D)	*	**
01	THOMPSON MINE EXTENSION PHASE 1 FEL-3	18/11/30	CWB	CWB
00	ISSUED FOR FEL-3 REPORT	15/04/01	AO	CWB

INITIALS: * DESIGNED ** APPROVED

REVISION REGISTER

No	REFERENCE DRAWINGS NUMBER
	622805-015030-47DD-0011

ISSUE REGISTER

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TORONTO, ON M9C 5K1

PREPARATION	APPROVAL
DESIGNED A. OLIVER	PROJECT DISCIPLINE ENGINEER C. WEISS-BUNDY
DRAWN C. BURZYNSKI	PROJECT ENGINEERING MANAGER
CHECKED C. WEISS-BUNDY	Figure 1-3d
DATE 2015-02-25	CLIENT
SCALE N.T.S.	

CLIENT: VALE CANADA LIMITED
2060 FLAVELLE BOULEVARD
MISSISSAUGA, ON L5K 1Z9

PROJECT: FOOTWALL DEEP FEL-3 STUDY
INFRASTRUCTURE FEASIBILITY STUDY

TITLE: T3 MINE
371 SURFACE SUBSTATION
TRANSMISSION LINE
PLAN

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
622805	015030	47 DD	0012	01

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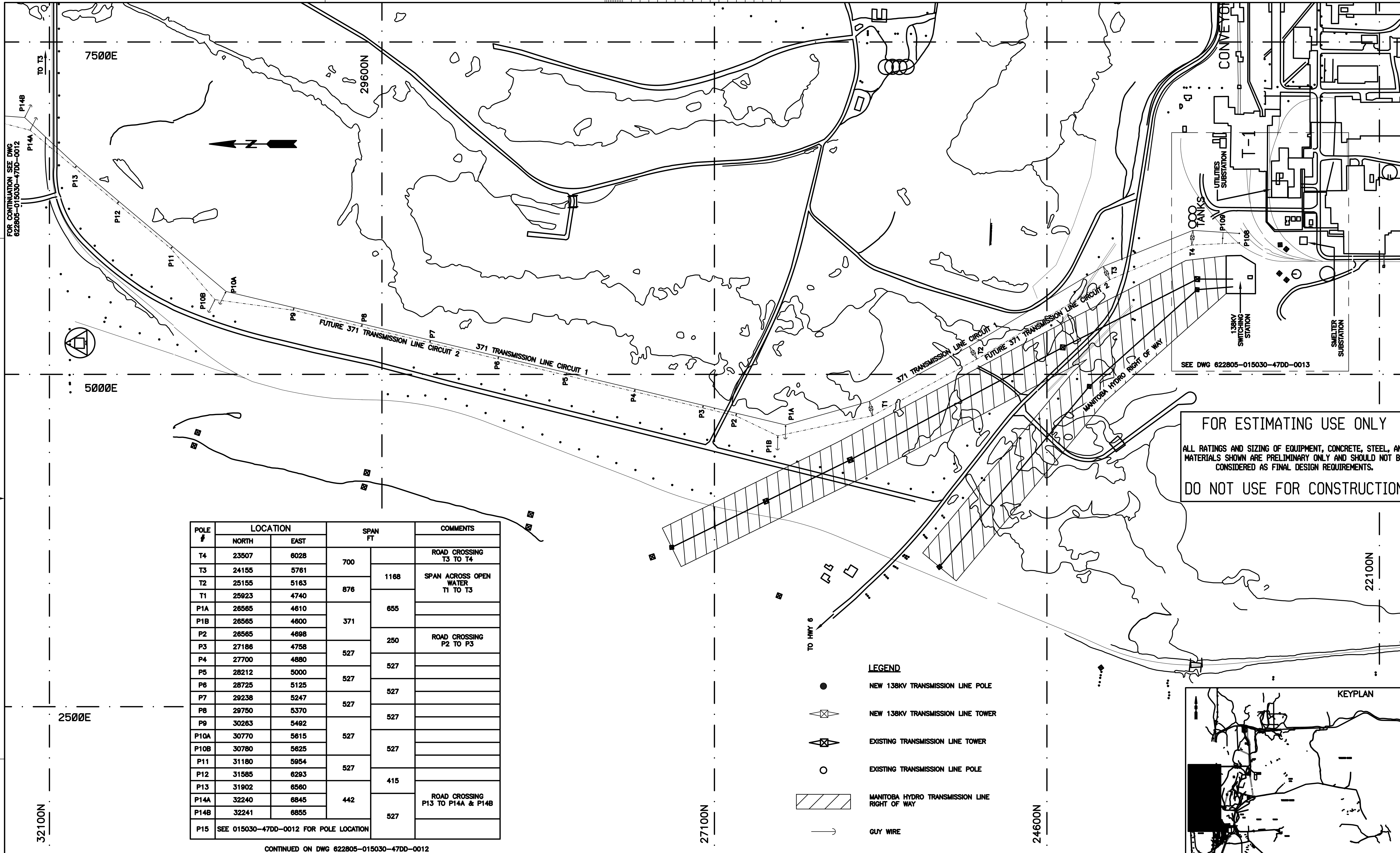

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POLE #	LOCATION NORTH	LOCATION EAST	SPAN FT	SPAN FT	COMMENTS
T4	23507	6028	700		ROAD CROSSING T3 TO T4
T3	24155	5761		1168	SPAN ACROSS OPEN WATER T1 TO T3
T2	25155	5163	876		
T1	25923	4740		655	
P1A	26565	4610	371		
P1B	26565	4600			
P2	26565	4698		250	ROAD CROSSING P2 TO P3
P3	27186	4758	527		
P4	27700	4880		527	
P5	28212	5000	527		
P6	28725	5125		527	
P7	29238	5247	527		
P8	29750	5370		527	
P9	30263	5492	527		
P10A	30770	5615		527	
P10B	30780	5625			
P11	31180	5954	527		
P12	31585	6293		415	
P13	31902	6560	442		ROAD CROSSING P13 TO P14A & P14B
P14A	32240	6845		527	
P14B	32241	6855			
P15	SEE 015030-47DD-0012 FOR POLE LOCATION				

CONTINUED ON DWG 622805-015030-47DD-0012

LEGEND

- NEW 138KV TRANSMISSION LINE POLE
- NEW 138KV TRANSMISSION LINE TOWER
- EXISTING TRANSMISSION LINE TOWER
- EXISTING TRANSMISSION LINE POLE
- MANITOBA HYDRO TRANSMISSION LINE RIGHT OF WAY
- GUY WIRE

No	REVISION DESCRIPTION	DATE (Y/M/D)	*	**
01	THOMPSON MINE EXTENSION PHASE 1 FEL-3	18/11/30	CWB	CWB
00	ISSUED FOR FEL-3 REPORT	15/04/02	AO	CWB

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DRAWN C. BURZYNSKI	PROJECT ENGINEERING MANAGER
CHECKED C. WEISS–BUNDY	Figure 1-3e
DATE 2015–02–25	CLIENT
SCALE 1'=4016'-0"	

CLIENT: VALE CANADA LIMITED
2060 FLAVELLE BOULEVARD
MISSISSAUGA, ON L5K 1Z9

PROJECT: FOOTWALL DEEP FEL–3 STUDY
INFRASTRUCTURE FEASIBILITY STUDY

TITLE: T3 MINE
371 SUREFACE SUBSTATION
TRANSMISSION LINE
PLAN

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
622805	015030	47 DD	0011	01

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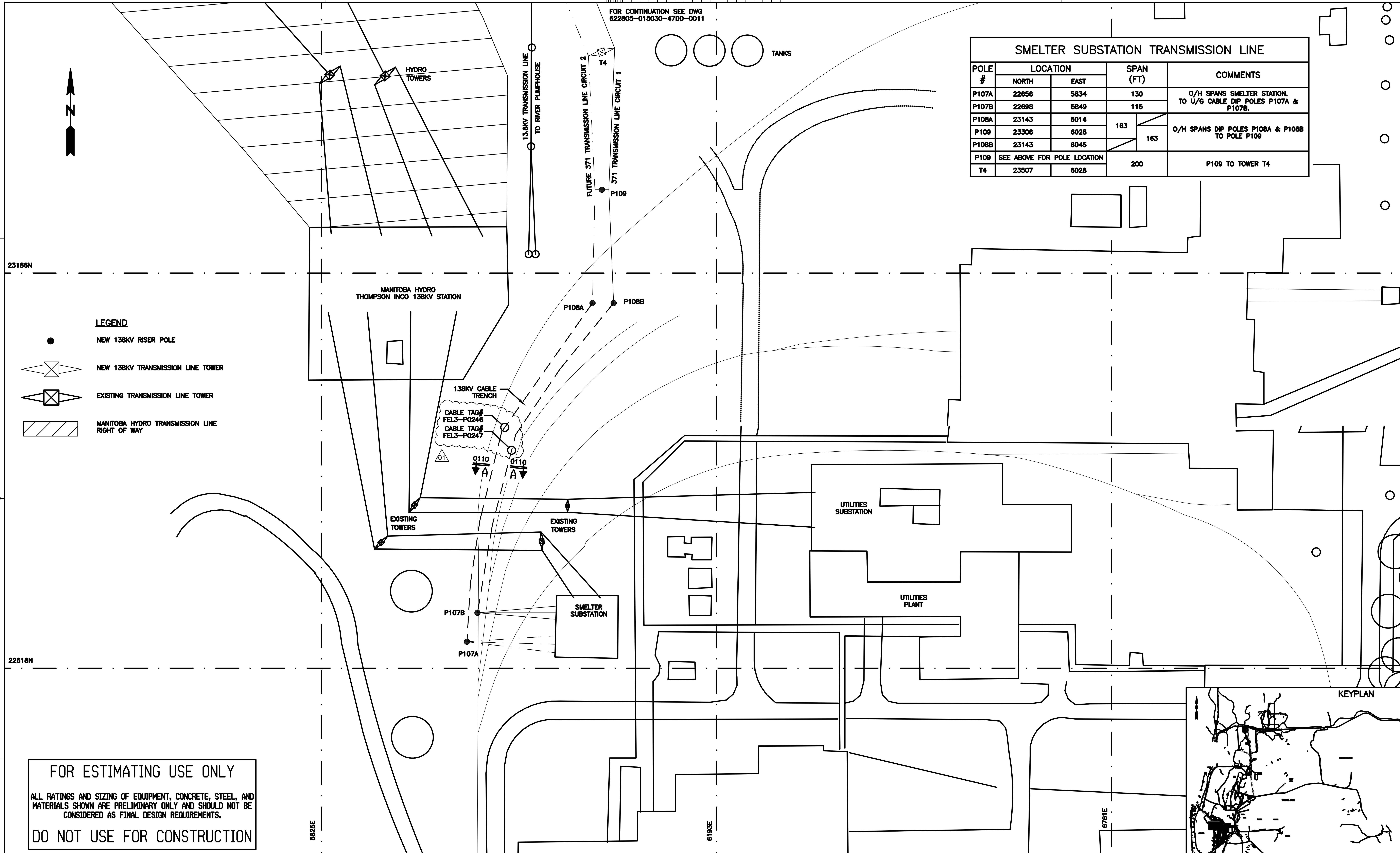

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SMELTER SUBSTATION TRANSMISSION LINE

POLE #	LOCATION NORTH	LOCATION EAST	SPAN (FT)		COMMENTS
P107A	22656	5834	130		O/H SPANS SMELTER STATION. TO U/G CABLE DIP POLES P107A & P107B.
P107B	22698	5849	115		
P108A	23143	6014	163		O/H SPANS DIP POLES P108A & P108B TO POLE P109
P109	23306	6028		163	
P108B	23143	6045			
P109	SEE ABOVE FOR POLE LOCATION		200		P109 TO TOWER T4
T4	23507	6028			

No	REVISION DESCRIPTION	DATE (Y/M/D)	*	**
02	THOMPSON MINE EXTENSION PHASE 1 FEL-3	18/11/30	CWB	CWB
01	ISSUED FOR FEL-3 REPORT	15/05/15	AO	CWB
00	ISSUED FOR FEL-3 REPORT	15/04/30	KO	CWB

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REVISION REGISTER

No	REFERENCE DRAWINGS NUMBER
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	622805-015030-47DD-0014
	622805-015030-47DD-0011

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ISSUE REGISTER (ISSUE No | REV. | DATE (Y/M/D) | PURPOSE OF ISSUE | TRANSMISSION LETTER No)

REVISION REGISTER (No | REVISION DESCRIPTION | DATE (Y/M/D) | * | **)

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SNC·LAVALIN INC.
195, THE WEST MALL
TORONTO, ON M9C 5K1

PREPARATION	APPROVAL
DESIGNED: K. OOI	PROJECT DISCIPLINE ENGINEER: C. WEISS-BUNDY
DRAWN: C. BURZYNSKI	PROJECT ENGINEERING MANAGER
CHECKED: C. WEISS-BUNDY	Figure 1-3f
DATE: 2015-02-25	CLIENT
SCALE: 1/64"=1'-0"	

CLIENT: VALE — VALE CANADA LIMITED
2060 FLAVELLE BOULEVARD
MISSISSAUGA, ON L5K 1Z9

PROJECT: FOOTWALL DEEP FEL-3 STUDY
INFRASTRUCTURE FEASIBILITY STUDY

TITLE: T3 MINE
371 SURFACE SUBSTATION
TRANSMISSION LINE
PLAN

PROJECT No	SUBDIVISION	SUBJECT	SERIAL	REV.
622805	015030	47 DD	0013	02

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Option 2 - New Pre-Fabricated Building for Control Room

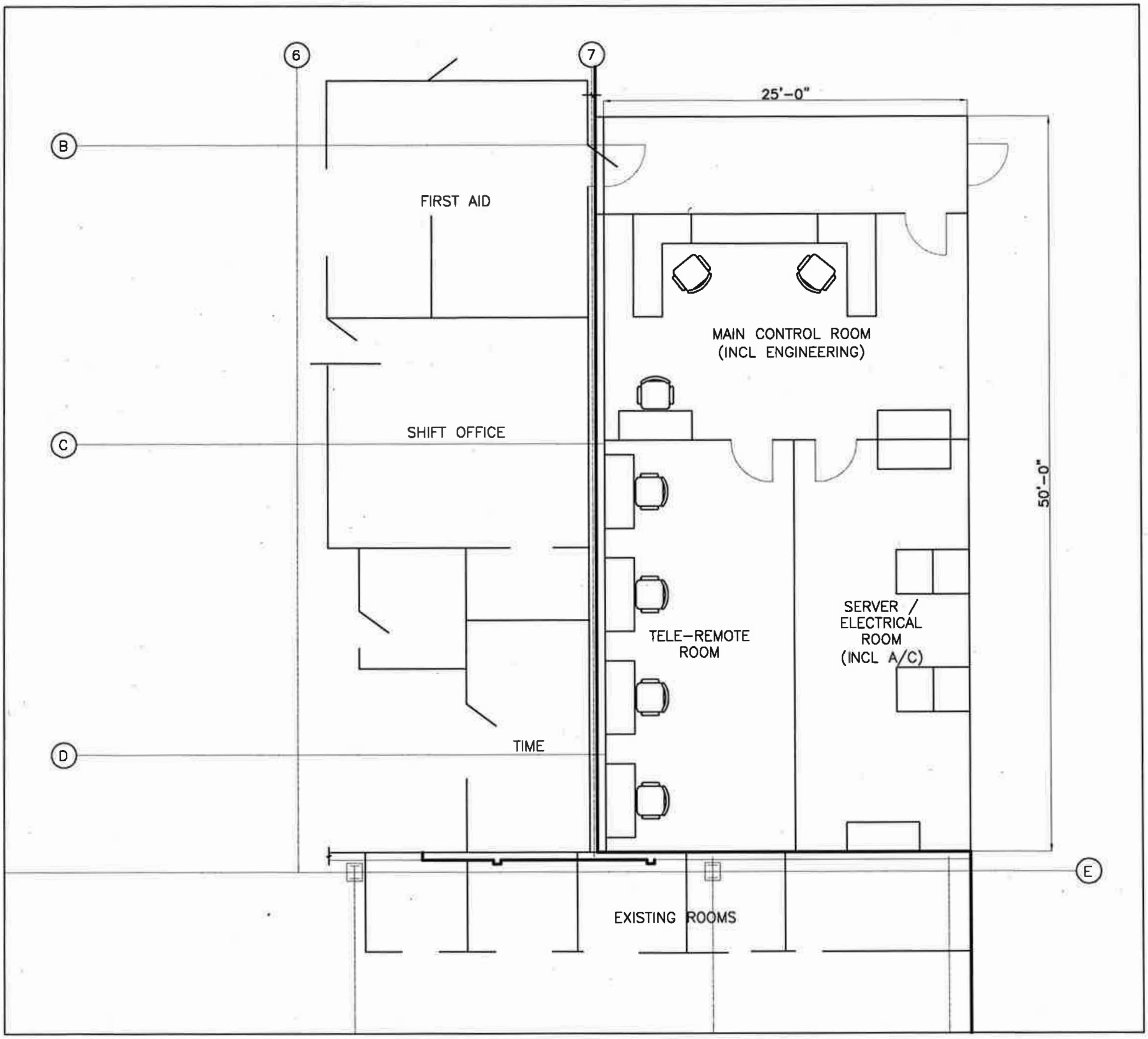
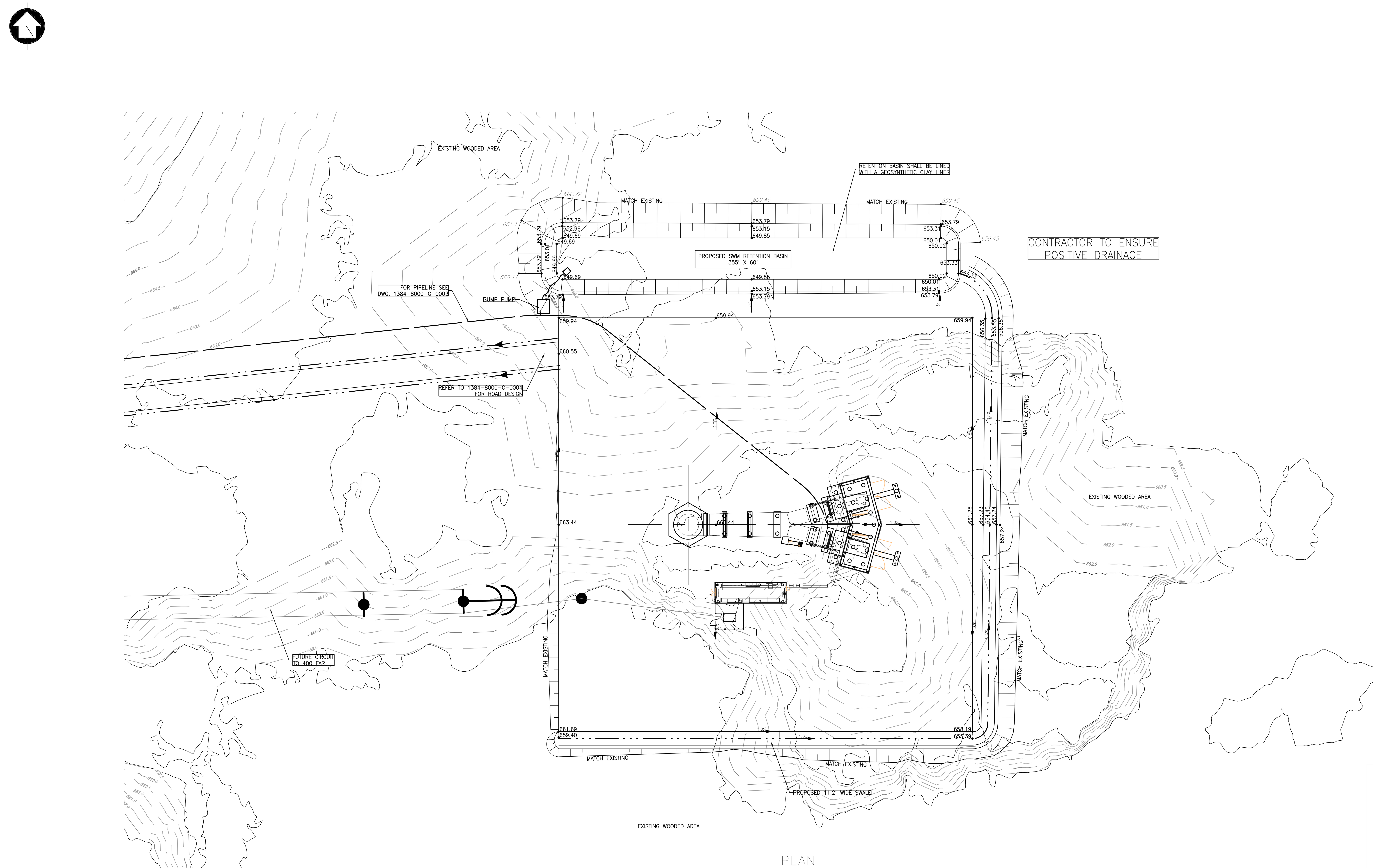


Figure 1-3g

MEM-1384-A0001
20-Mar-19

DWG. NO.1384-8000-C-0006



Legend
- 352.82 EXISTING ELEVATION
- 352.92 PROPOSED ELEVATION
- FLOW DIRECTION
- PROPOSED DRAINAGE SWALE
- EXISTING CONTOUR
- PROPOSED SLOPE (3:1 UNLESS NOTED OTHERWISE)
- OVERLAND FLOW

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PROJECT NO: 169518673

DWG NO.	REFERENCE DRAWINGS	REV	JOB NO.	DESCRIPTION	DATE	DRAWN BY	CHECKED DRAWING	APPROVED DESIGN	REVIEWED DESIGN
1384-8000-C-0007	SITE GRADING-378 OVERALL SITE&PASTEFILL AREA-DITCHING	B	1384	ISSUED FOR REVIEW	2019.05.01	J. MILLER	B. ROBB	J. CARPENTIER	
1384-8000-C-0008	SITE GRADING-378 PASTEFILL AREA	C	1384	ISSUED FOR APPROVAL	2019.05.29	J. MILLER	B. ROBB	J. CARPENTIER	
		C1	1384	RE-ISSUED FOR APPROVAL	2019.06.11	J. MILLER	B. ROBB	J. CARPENTIER	
		0	1384	ISSUED FINAL FOR FEL 3 REPORT	2019.06.13	J. MILLER	B. ROBB	J. CARPENTIER	

VALE
MANITOBA OPERATIONS

PLANT: T3 MINE – THOMPSON DIV.	SUB PLANT: 1D LOWER OREBODY	SCALE: 1" = 40'	REV. 1 PROJECT NO. 1384
AREA: SURFACE INFRASTUCTURE	CLASSIFICATION: CIVIL ENGINEERING	DWG. NO. 1384-8000-C-0006	REV. 0
TITLE: MISCELLANEOUS FACILITIES – SITE GRADING 389 SITE AND ASSOCIATED STORMWATER RETENTION FACILITY			

Figure 1-3h

DWG. NO.1384-8000-C-0007

PLAN

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PROJECT NO: 169518673

DWG NO.	REFERENCE DRAWINGS	REV	JOB NO.	DESCRIPTION	DATE	DRAWN BY	CHECKED DRAWING	APPROVED DESIGN	REVIEWED DESIGN
1384-8000-C-0006	SITE GRADING-389 SITE	B	1384	ISSUED FOR REVIEW	2019.05.01	J. MILLER	B. ROBB	J. CARPENTIER	
1384-8000-C-0008	SITE GRADING-378 PASTEFILL AREA	C	1384	ISSUED FOR APPROVAL	2019.05.29	J. MILLER	B. ROBB	J. CARPENTIER	
		0	1384	ISSUED FINAL FOR FEL 3 REPORT	2019.06.13	J. MILLER	B. ROBB	J. CARPENTIER	

VALE
MANITOBA OPERATIONS

PLANT: T3 MINE - THOMPSON DIV.
SUB PLANT: 1D LOWER OREBODY
AREA: SURFACE INFRASTUCTURE
CLASSIFICATION: CIVIL ENGINEERING
TITLE: MISCELLANEOUS FACILITIES - SITE GRADING
378 OVERALL SITE AND 378 PASTEFILL AREA - DITCHING

SCALE: 1" = 40'
REV. 1 PROJECT NO. 1384
DWG. NO. 1384-8000-C-0007
REV. 0

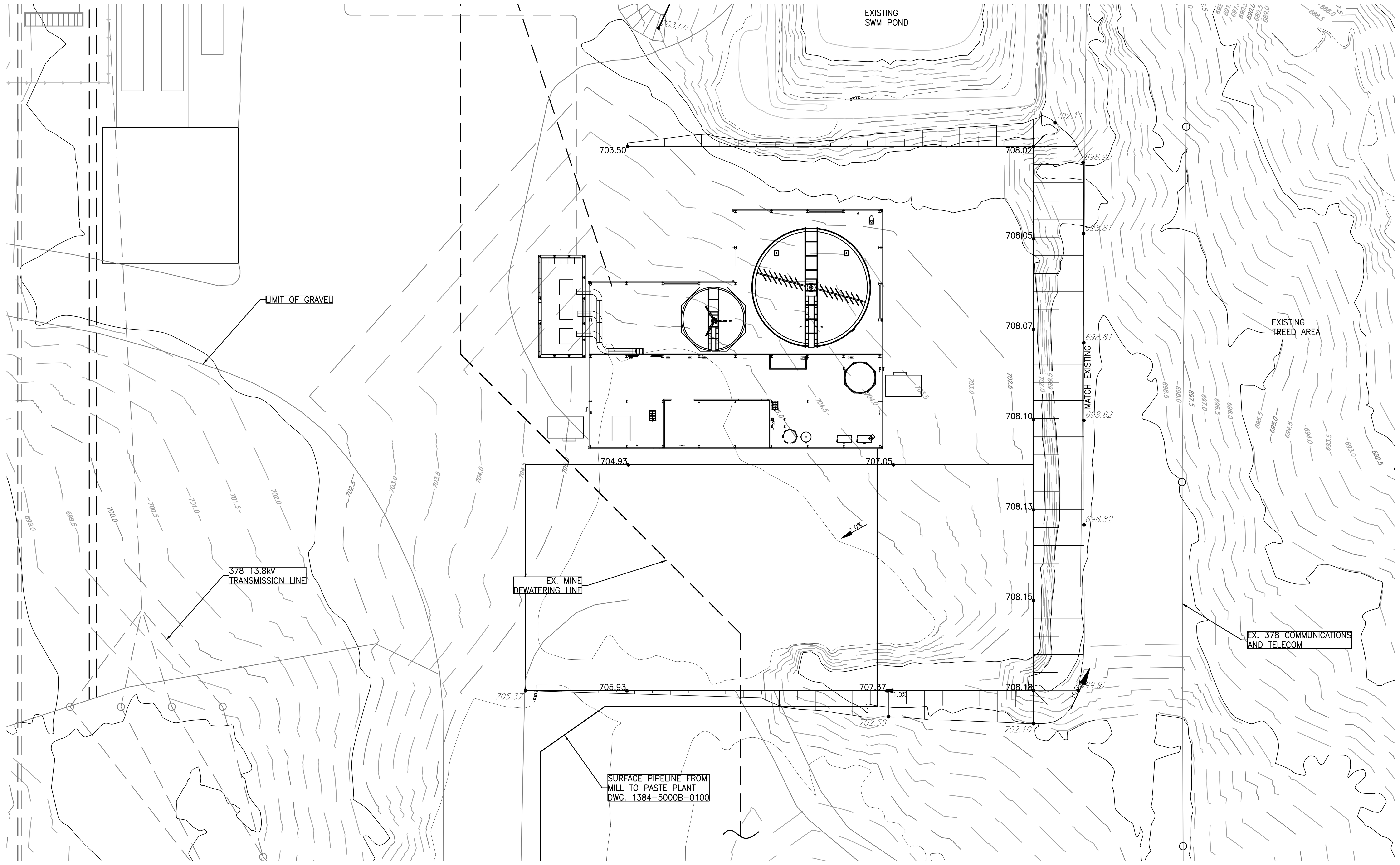
Figure 1-3i

DWG. NO.1384-8000-C-0008

N

Legend

- 352.82 EXISTING ELEVATION
- 352.92 PROPOSED ELEVATION
- 5.0% / 2.0% FLOW DIRECTION
- PROPOSED DRAINAGE SWALE
- 349.00 EXISTING CONTOUR
- PROPOSED SLOPE (3:1 UNLESS NOTED OTHERWISE)
- OVERLAND FLOW



PLAN

THIS DRAWING IS FOR ESTIMATING USE ONLY

All Ratings and Sizings of Equipment, Concrete, Steel, and Materials, Shown on This Drawing Are APPROXIMATIONS Only and Must Not Be Considered As

DO NOT USE FOR CONSTRUCTION

Stantec Consulting Ltd.
1760 REGENT ST
Sudbury, ON Canada
P3E 3Z8
Tel. 705 566 6891
www.stantec.com
PROJECT NO: 169518673

DWG NO.	REFERENCE DRAWINGS	REV	JOB NO.	DESCRIPTION	DATE	DRAWN BY	CHECKED DRAWING	APPROVED DESIGN	REVIEWED DESIGN
1384-8000-C-0006	SITE GRADING-389 SITE	B	1384	ISSUED FOR REVIEW	2019.05.01	J. MILLER	B. ROBB	J. CARPENTIER	
1384-8000-C-0007	SITE GRADING-378 OVERALL SITE&PASTEFILL AREA-DITCHING	C	1384	ISSUED FOR APPROVAL	2019.05.29	J. MILLER	B. ROBB	J. CARPENTIER	
		0	1384	ISSUED FINAL FOR FEL 3 REPORT	2019.06.11	J. MILLER	B. ROBB	J. CARPENTIER	

VALE
MANITOBA OPERATIONS

PLANT: T3 MINE – THOMPSON DIV.	SUB PLANT: 1D LOWER OREBODY
AREA: SURFACE INFRASTUCTURE	CLASSIFICATION: CIVIL ENGINEERING
TITLE: MISCELLANEOUS FACILITIES – SITE GRADING 378 PASTEFILL AREA	

SCALE 1" = 40'
REV. 1 PROJECT NO. 1384
DWG. NO. 1384-8000-C-0008
REV. 0

Figure 1-3j

START DATE
REV. 0
OLD DRAWING NO.

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DWG. NO. 1384-5000-A-0001

Stantec Consulting Ltd.
1760 REGENT ST
Sudbury, ON Canada
P3E 3Z8
Tel. 705 566 6891
www.stantec.com
PROJECT NO: 169518673

DWG NO.	REFERENCE DRAWINGS	REV	JOB NO.	DESCRIPTION	DATE	DRAWN BY	CHECKED DRAWING	APPROVED DESIGN	REVIEWED DESIGN
		B	1384	ISSUED FOR 70% CLIENT REVIEW	2019-02-22	P. CHARBONNEAU	W. PENNO	E. DUDSON	J. THAMBY
		0	1384	ISSUED FINAL FOR FEL REPORT	2019-03-18	P. CHARBONNEAU	W. PENNO	E. DUDSON	J. THAMBY

VALE
MANITOBA OPERATIONS

PLANT: THOMPSON MINE	SUB PLANT: T3 MINE
AREA: PASTE FILL PLANT	CLASSIFICATION: PROCESS
TITLE: SHEET 1 OF 2 PROCESS FLOW SHEET	

Figure 1-4a

SCALE: N.T.S.	REV. 1 PROJECT NO.: 1384	
DWG. NO.: 1384-5000-A-0001		REV.: 0

REV. 0 START DATE
OLD DRAWING NO.

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DWG. NO. 1384-5000-A-0002

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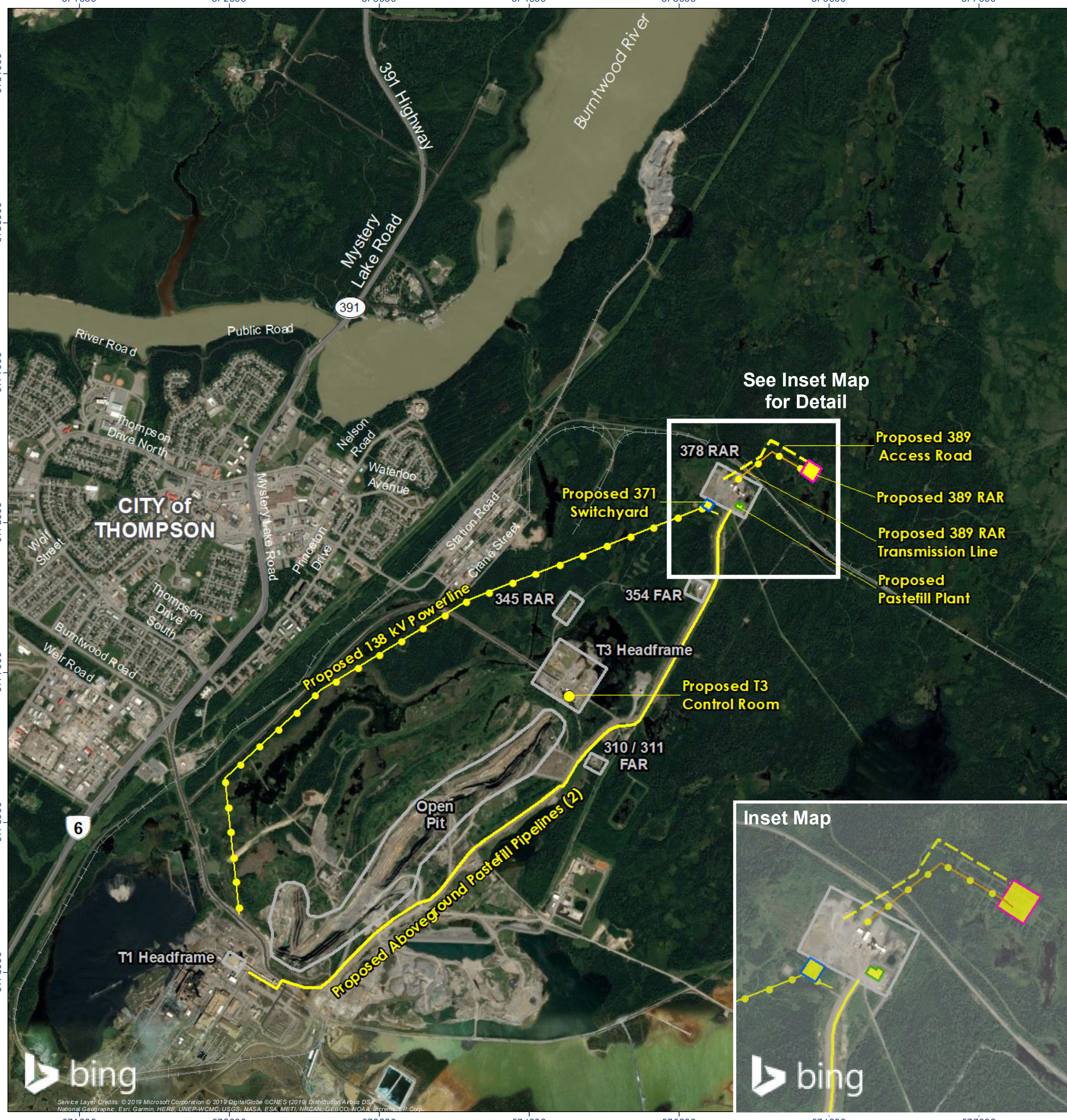
Stantec
Stantec Consulting Ltd.
1760 REGENT ST
Sudbury, ON Canada
P3E 3Z8
Tel. 705 566 6891
www.stantec.com
PROJECT NO: 169518673

DWG NO.	REFERENCE DRAWINGS	REV	JOB NO.	DESCRIPTION	DATE	DRAWN BY	CHECKED DRAWING	APPROVED DESIGN	REVIEWED DESIGN
		B	1384	ISSUED FOR 70% CLIENT REVIEW	2019-02-22	P. CHARBONNEAU	W. PENNO	E. DUDSON	J. THAMBY
		0	1384	ISSUED FINAL FOR FEL REPORT	2019-03-18	P. CHARBONNEAU	W. PENNO	E. DUDSON	J. THAMBY

VALE
MANITOBA OPERATIONS

PLANT: THOMPSON MINE	SUB PLANT: T3 MINE	SCALE: N.T.S.	REV. 1 PROJECT NO. 1384
AREA: PASTE FILL PLANT	CLASSIFICATION: PROCESS	DWG. NO. 1384-5000-A-0002	REV. 0
TITLE: SHEET 2 OF 2 PROCESS FLOW SHEET	Figure 1-4b		



Legend

Project Development Area (PDA) Components

- Proposed 389 RAR
- Proposed 371 Switchyard
- Proposed Pastefill Plant
- Proposed T3 Control Room
- Proposed 138 kV Powerline
- Proposed 389 Transmission Line
- Proposed 389 Access Road
- Proposed Aboveground Pastefill Pipeline (2)

- Existing Mine Features
- Highway
- Major Road
- Local Road
- Railway

0 0.5 1 Kilometres

(At original document size of 8.5x11)
1:40,000

N

Stantec

Project Location
Thompson,
Manitoba

Prepared by JHiebert on 2019-09-11
Reviewed by BKrawchuk on 2019-09-11

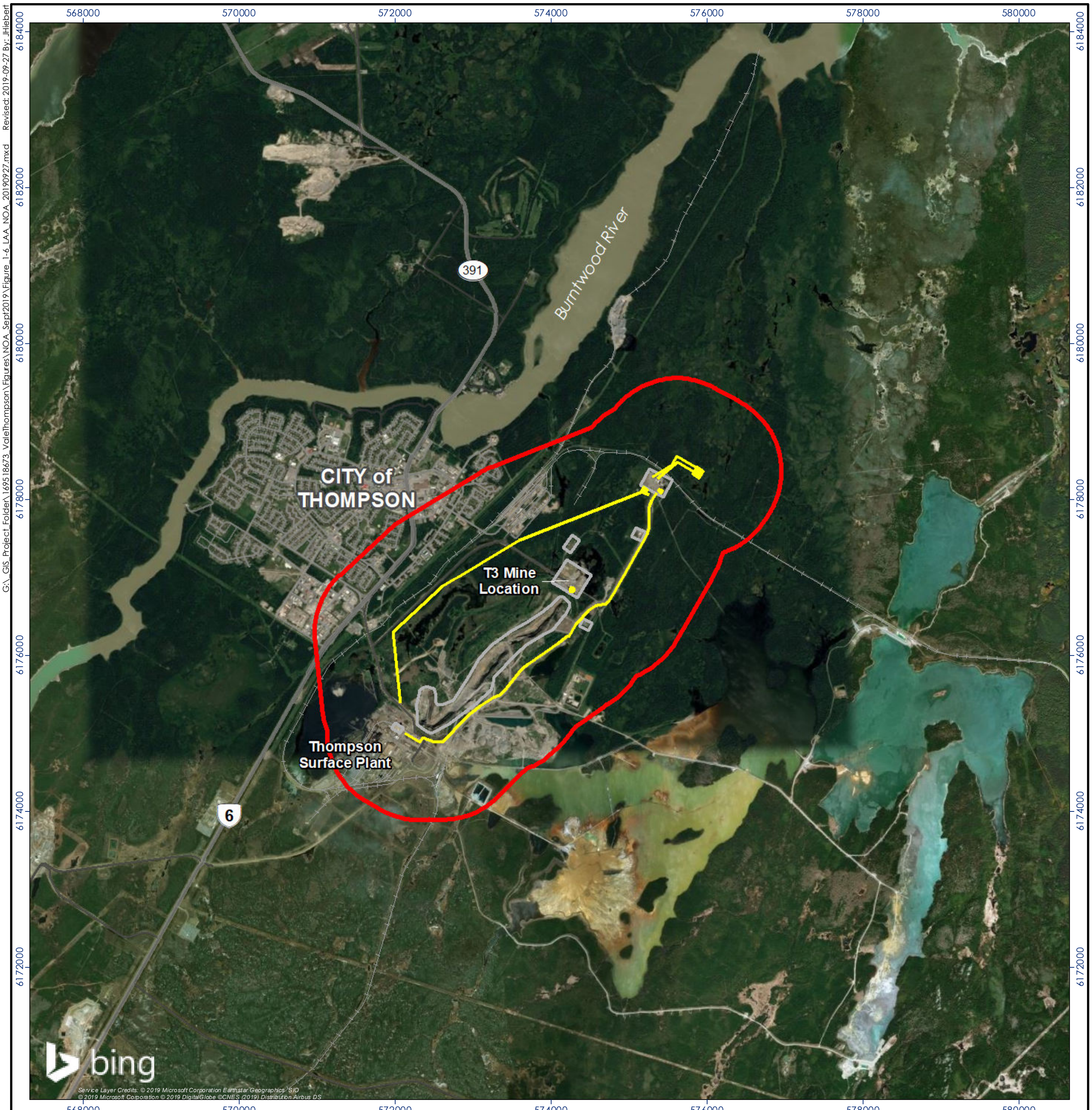
Client/Project 169518673
VALE
Thompson Mine Extension Phase 1
Notice of Alteration

Map No.
1-5

Title
Thompson Mine Extension Phase 1
Project Development Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 14N
2. Base Data Sources: Government of Manitoba
3. Aerial Imagery: Microsoft product screenshot reprinted with permission from Microsoft Canada

G:_GIS_Project_Folder\169518673_Vale\Thompson\Figures\NOA_Sept2019\Figure_1-6_LAA_NOA_20190927.mxd Revised: 2019-09-27 By: JHiebert



Legend

- Local Assessment Area
- Project Development Area (PDA)
- Components
- Existing Mine Features
- Highway
- Major Road
- Local Road
- Railway

0 1 2 Kilometres

(At original document size of 8.5x11)
1:75,000

N

Stantec

Project Location
Thompson,
Manitoba

Prepared by JHiebert on 2019-09-27
Reviewed by BKrawchuk on 2019-09-27

Client/Project
169518673

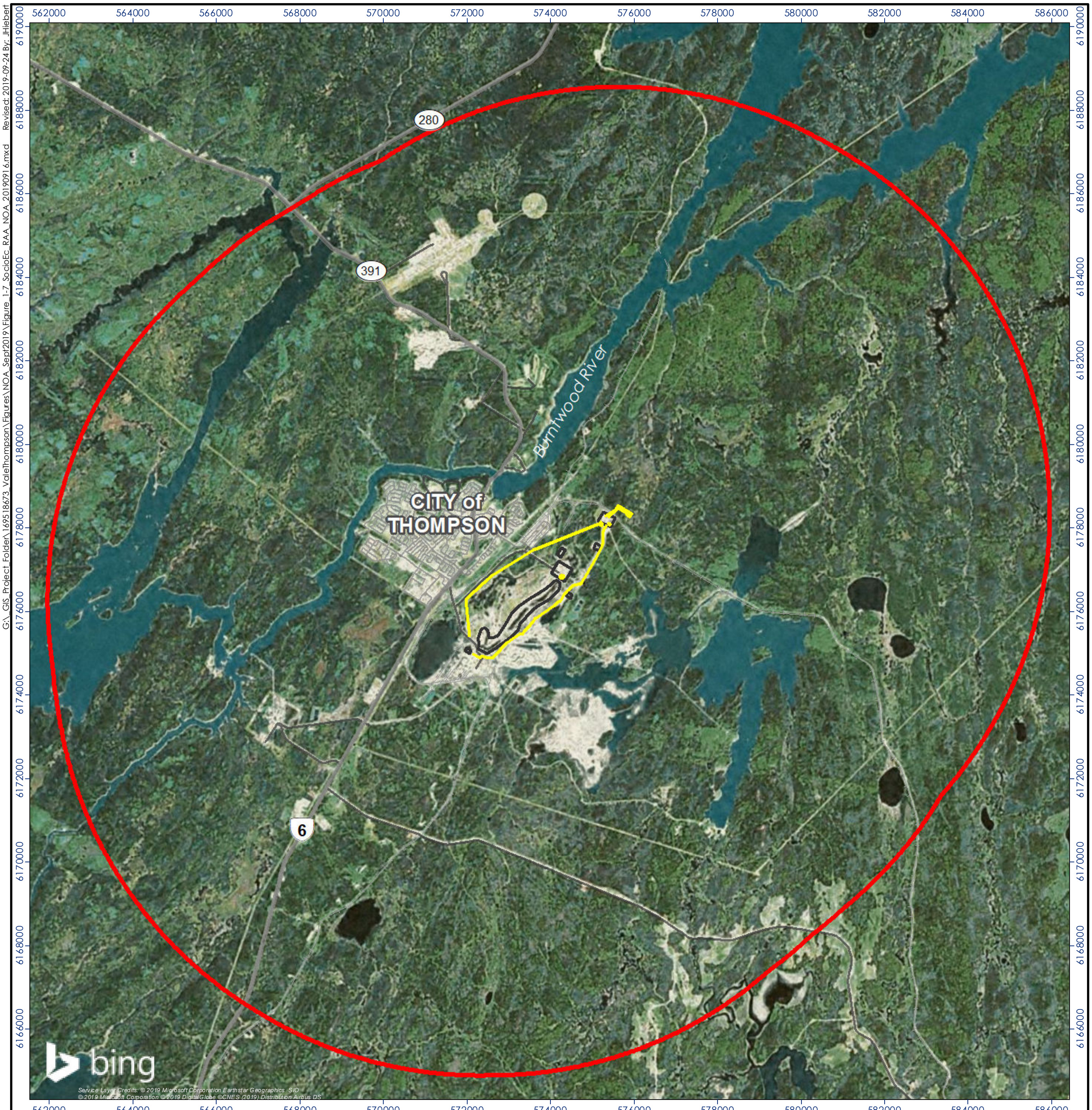
VALE
Thompson Mine Extension Phase 1
Notice of Alteration

Figure No.
1-6

Title
Local Assessment Area (1 Kilometre Buffer)

Notes
1. Coordinate System: NAD 1983 UTM Zone 14N
2. Base Data Sources: Government of Manitoba
3. Aerial Imagery: Microsoft product screenshot reprinted with permission from Microsoft Canada

G:_GIS_Project_Folder\169518673_ValeThompson\Figures\NOA_Sept2019\Figure_1-7_SocioEc_RAA_NOA_20190916.mxd Revised: 2019-09-24 By: JHebert



Legend

- Regional Assessment Area
- Project Development Area (PDA) Components
- Existing Mine Features
- Highway
- Major Road
- Local Road
- Railway

0 1.5 3 Kilometres

(At original document size of 8.5x11)
1:140,000

N

Stantec

Project Location
Thompson, Manitoba

Prepared by ACampigotto on 2019-09-24
Reviewed by BKrawchuk on 2019-09-24

Client/Project 169518673

VALE
Thompson Mine Extension Phase 1
Notice of Alteration

Figure No.
1-7

Title
Regional Assessment Area (10 Kilometre Buffer)

Notes

1. Coordinate System: NAD 1983 UTM Zone 14N
2. Base Data Sources: Government of Manitoba
3. Aerial Imagery: Microsoft product screenshot reprinted with permission from Microsoft Canada

G:_GIS_Project_Folder\169518673_ValeThompson\Figures\NOA_Sept2019\Figure 1-8_Surface Water Flow NOA_20190919.mxd Revised: 2019-09-24 By: JHiebert

Legend

- Station B Final Discharge Point
- Surface Water Flow Direction
- Highway
- Major Road
- Local Road
- Railway
- Watercourse
- Waterbody

0 0.5 1 Kilometres

(At original document size of 8.5x11)
1:50,000

N

Stantec

Project Location
Thompson,
Manitoba

Prepared by JHiebert on 2019-09-19
Reviewed by BKrawchuk on 2019-09-19

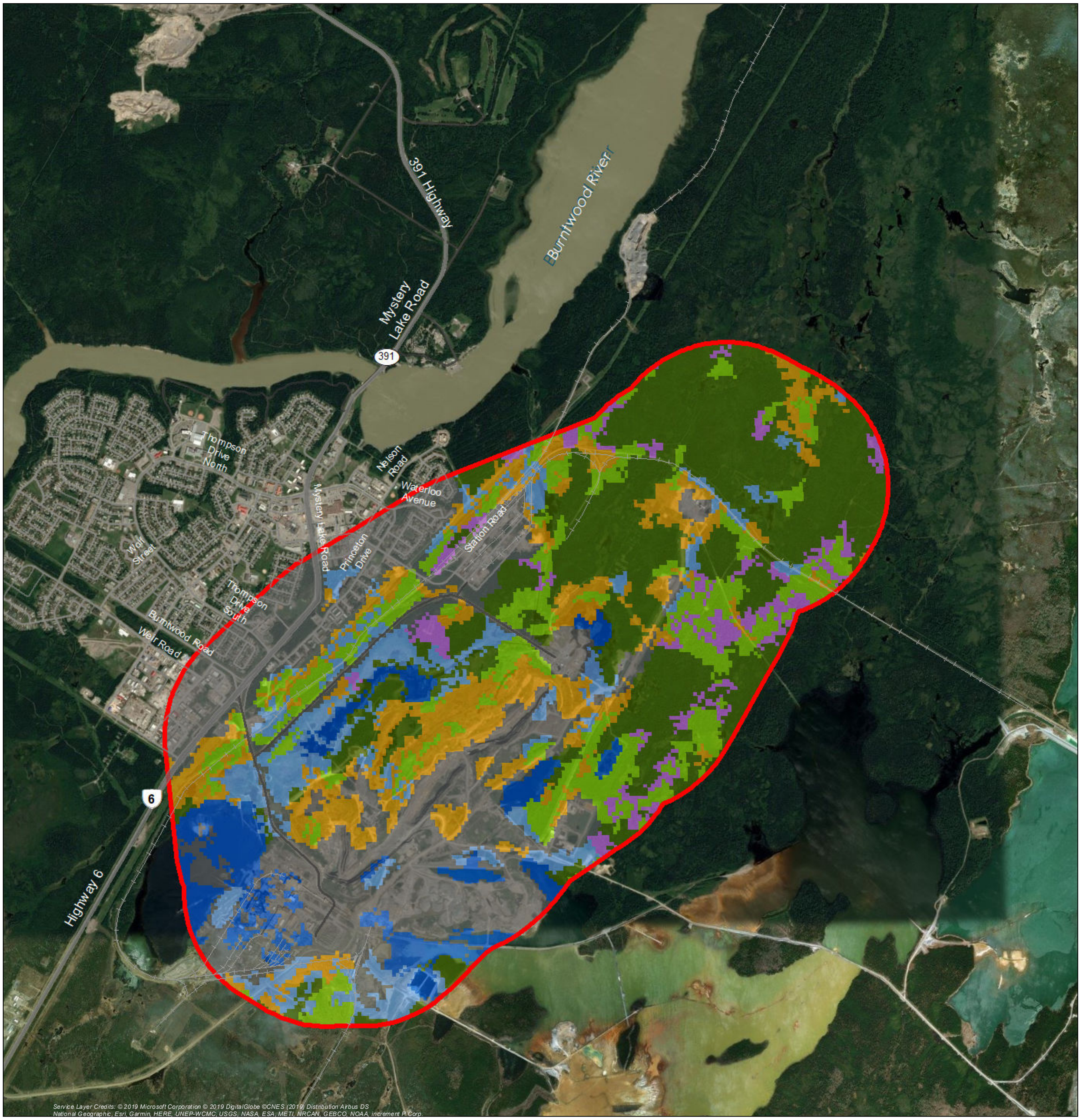
Client/Project 169518673
VALE
Thompson Mine Extension Phase 1
Notice of Alteration

Figure No.
1-8

Title
Surface Water Flow

Notes
1. Coordinate System: NAD 1983 UTM Zone 14N
2. Base Data Sources: Government of Manitoba
3. Aerial Imagery: Microsoft product screen shot reprinted with permission from Microsoft Canada

G:_GIS_Project_Folder\169518673_Vale\Thompson\Figures\NOA_Sept2019\Figure_1-9_Landcover_NOA_20190919.mxd Revised: 2019-09-24 By: JHiebert



Legend

- Highway
- Major Road
- Local Road
- Railway
- LAA

Landcover

- Coniferous
- Deciduous
- Mixedwood
- Shrubland
- Wetland
- Urban/Developed
- Water

0 0.5 1 Kilometres

(At original document size of 8.5x11)
1:50,000

N

Stantec

Project Location
Thompson, Manitoba

Prepared by JHiebert on 2019-09-19
Reviewed by BKrawchuk on 2019-09-19

Client/Project
169518673
VALE
Thompson Mine Extension Phase 1
Notice of Alteration

Figure No.
1-9

Title
Landcover within the LAA

Notes

1. Coordinate System: NAD 1983 UTM Zone 14N
2. Base Data Sources: Government of Manitoba
3. Aerial Imagery: Microsoft product screen shot reprinted with permission from Microsoft Canada
3. Land Cover data from Natural Resources Canada, Canada Centre for Remote Sensing, 2010

Appendix B TABLES

Table B1 Species at Risk with Potential to Occur in the RAA

Common Name	Scientific Name	Status	Authority[1,2,3]	MB CDC Rank[4]	Suitable Habitat Within the LAA	Occurrence Record Within the LAA	Observed in the LAA During Biophysical Surveys
Birds							
Trumpeter swan	*Cygnus buccinator*	*Endangered*	MESEA	S1S2B	-	-	-
Horned grebe	*Podiceps auritus*	*Special concern*	SARA	S3B	-	-	-
Western grebe	*Aechmophorus occidentalis*	*Special concern*	COSEWIC	S4B	-	-	-
Common nighthawk	*Chordeiles minor*	*Threatened*	SARA & MESEA	S3B	✓	✓	✓
Yellow rail	*Coturnicops noveboracensis*	*Special concern*	SARA	S3S4	-	-	-
Short-eared owl	*Asio flammeus*	*Special concern*	SARA	S2S3B	✓	-	-
Olive-sided flycatcher	*Contopus cooperi*	*Threatened*	SARA	S3S4B	✓	✓	-
Barn swallow	*Hirundo rustica*	*Threatened*	COSEWIC	S4B	✓	✓	✓
Bank swallow	*RIparia riparia*	*Threatened*	COSEWIC	S4B	-	✓	-
Evening grosbeak	*Coccothraustes vespertinus*	*Special concern*	COSEWIC	S3	✓	✓	-
Canada warbler	*Cardellina canadensis*	*Threatened*	SARA	S3B	✓	✓	-
Rusty blackbird	*Euphagus carolinus*	*Special concern*	SARA	S3S4B	✓	✓	-
Mammals							
Little brown myotis	*Myotis lucifugus*	Endangered	SARA & MESEA	S2	✓	✓	✓
Northern myotis	*Myotis septentrionalis*	Endangered	SARA & MESEA	S3S4	✓	-	-
Wolverine	*Gulo gulo*	Special Concern	SARA	S3S4	-	-	-
Woodland caribou	*Rangifer tarandus caribou*	*Threatened*	SARA & MESEA	S2S3	-	✓	-
Amphibians							
Northern leopard frog	*Lithobates pipiens*	Special Concern	SARA	S4	-	-	-
Plants							
Bodin's milkvetch	*Astragalus bodinii*	Not Listed	Not Listed	S1	-	-	-
Daisy-leaf moonwort	*Botrychium matricariifolium*	Not Listed	Not Listed	S1	-	-	-
Rye-grass sedge	*Carex loliacea*	Not Listed	Not Listed	S2	-	-	-
Seaside sedge	*Carex maritima*	Not Listed	Not Listed	S2	-	-	-

Table B1 Species at Risk with Potential to Occur in the RAA

Common Name	Scientific Name	Status	Authority[1,2,3]	MB CDC Rank[4]	Suitable Habitat Within the LAA	Occurrence Record Within the LAA	Observed in the LAA During Biophysical Surveys
False uncina sedge	*Carex microglochin*	Not Listed	Not Listed	S2	-	-	-
Ground-fir	*Diphasiastrum sitchense*	Not Listed	Not Listed	S1	-	-	-
Graceful manna grass	*Glyceria pulchella*	Not Listed	Not Listed	S2	-	-	-
Mountain club-moss	*Huperzia selago*	Not Listed	Not Listed	S2	-	-	-
Hooker's orchid	*Platanthera hookeri*	Not Listed	Not Listed	S2	-	-	-
Northern woodsia	*Woodsia alpina*	Not Listed	Not Listed	S2	-	-	-

NOTES:

[1] *Species At Risk Act* Registry (Government of Canada 2019)

[2] *Committee on the Status of Endangered Wildlife in Canada* species database (COSEWIC 2019)

[3] *The Endangered Species and Ecosystems Act* of Manitoba (Government of Manitoba 2016a)

[4] Manitoba Conservation Data Centre rankings (MBCDC) are as follows:

S = Province-wide status
1 = Very rare throughout its range or in the province (5 or fewer occurrences, or very few remaining individuals). May be especially vulnerable to extirpation.

2 = Rare throughout its range or in the province (6 to 20 occurrences). May be vulnerable to extirpation.

3 = Uncommon throughout its range or in the province (21 to 100 occurrences).
4 = Widespread, abundant, and apparently secure throughout its range or in the province, with many occurrences, but the element is of long-term concern (>100 occurrences).
5 = Demonstrably widespread, abundant, and secure throughout its range or in the province, and essentially impossible to eradicate under present conditions.
S#S# = Range of uncertainty about the exact rarity of the species.

B = Breeding status of a migratory species.

Appendix C CERTIFICATES OF TITLE AND LICENCE

Form 174A

The International Nickel Company of Canada, Limited

Real Estate (Land Titles) Record

Township -78, Range 3, West of the Principal Meridian

Parcel No. Lot Concession

Mining Claim No. Acreage — Mining Surface Waterline - pumphouse To West Side Water Treatment Plant Plan 4620

CERT. No. 125402 Date of Patent

Nature of Title Fee Simple

Acquired from The Province of Manitoba Transfer No. 20297

Consideration $ 1.00 per Acre Date December 14, 1964 Charged to Real Estate

Description of Property - Parcel Four which Parcel is shown bordered Red on a Plan of Survey of part of Townships Seventy-seven and Seventy-eight, in Ranges Two and Three, West of the Principal Meridian, in Manitoba, registered in the Neepawa Land Titles Office as No. 4745.

88 Acres

FOR INFORMATION ONLY

Remarks

Correspondence in File No. Document Reference

THIS PARCEL IS LIABLE FOR THE FOLLOWING TAXES AND IS IN ORGANIZED ☐ UNORGANIZED ☐ TERRITORY

MUNICIPAL ☐ SCHOOL ☐ ACREAGE ☐ LAND ☐

TAXES PAID	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82
MUNICIPAL & SCHOOL																										
ACREAGE																										
LAND																										

Form 174A

The International Nickel Company of Canada, Limited

Real Estate (Land Titles) Record

Township -78, Range 3, West of the Principal Meridian

Parcel No. Lot Concession

Mining Claim No. Acreage — Mining Surface

CERT.
Patent No. 125400 Date of Patent

Nature of Title Fee Simple

Acquired from The Province of Manitoba Transfer No. 20297

Consideration $ 1.00 per acre Date December 14, 1964 Charged to Real Estate

Description of Property - All those portions of Township Seventy-eight, in Range Three, West of the Principal Meridian, in Manitoba, taken for Right of Way for Power Transmission Line, as the same is shown bordered Red on a Plan registered in the Neepawa Land Titles Office as No. 4643 which lies to the South of a straight line drawn from the North East corner f parcel One to the North West corner of Parcel Two, as said Parcels and Two are shown bordered Red on a Plan registered in the Neepawa Titles Office as No. 4745.

HYDRO R.O.W.

FOR INFORMATION ONLY

Remarks

Correspondence in File No. Document Reference

THI' ARCEL IS LIABLE FOR THE FOLLOWING TAXES AND IS IN ORGANIZED ☐ UNORGANIZED ☐ TERRITORY
MUNICIPAL ☐ SCHOOL ☐ ACREAGE ☐ LAND ☐

T' 'S PAID	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	8
...L & SCHOOL																										
CREAGE																										
AND																										

Form 174A

The International Nickel Company of Canada, Limited

Real Estate (Land Titles) Record

Township - 78, Range 3, West of the Principal Meridian

Parcel No. Lot Concession

Mining Claim No. Acreage — Mining Surface

CERT.
Patent No. 125401 Date of Patent

Nature of Title Fee Simple

Acquired from The Province of Manitoba Transfer No. 20297

Consideration $ 1.00 Per Acre Date December 14, 1964 Charged to Real Estate

Description of Property - All that portion of Parcel Three, in Township Seventy-eight and Range Three, West of the Principal Meridian, in Manitoba, which Parcel is shown bordered Red on a Plan of Survey registered in the Neepawa Land Titles Office as No. 4745, lying to the West of the Western limit of the Public Road as same is shown bordered Red on a Plan registered in the said Office as No. 4782, which lies to the North East of the following described b ıdary: Commencing at the Intersection of the Western limit of the said Public Road with the North Eastern limit of Parcel One, as the same is own on a Plan registered in the said Office as No. 4599; thence North terly along the said North Eastern limit of said Parcel One to the North West corner thereof; thence North Westerly in a straight line to the most Southerly corner of Block Lettered "B" as the same is shown on a Plan registered in the said Office as No. 4620.

FOR INFORMATION ONLY

Remarks

Correspondence in File No. Document Reference

T PARCEL IS LIABLE FOR THE FOLLOWING TAXES AND IS IN ORGANIZED ☐ UNORGANIZED ☐ TERRITORY

MUNICIPAL ☐ SCHOOL ☐ ACREAGE ☐ LAND ☐

ES PAID	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	8
MUNICIPAL & SCHOOL																										
ACREAGE																										
LAND																										

Form 174A

The International Nickel Company of Canada, Limited

Real Estate (Land Titles) Record

Township - 78, Range 3, West of the Principal Meridian

Parcel No. Lot Concession

Mining Claim No. Acreage — Mining Surface

CERT.
Patent No. 125403 Date of Patent

Nature of Title Fee Simple

Acquired from The Province of Manitoba Transfer No. 20297

Consideration $ 1.00 per Acre Date December 14, 1964 Charged to Real Estate

escription of Property - Parcel Three, which Parcel is shown bordered Red on a lan of Survey of part of Townships Seventy-seven and Seventy-eight, in anges Two and Three, West of the Principal Meridian, in Manitoba, egistered in the Neepawa Land Titles Office as No. 4745.

CEPTING THEREOUT: All that portion thereof which lies to the West of astern limit of the Public Road as same is shown bordered Red on a lan registered in the said Office as No. 4782.

15025 acres.

FOR INFORMATION ONLY

Remarks

Correspondence in File No. Document Reference

THI RCEL IS LIABLE FOR THE FOLLOWING TAXES AND IS IN ORGANIZED ☐ UNORGANIZED ☐ TERRITORY
MUNICIPAL ☐ SCHOOL ☐ ACREAGE ☐ LAND ☐

S PAID	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82
UNICIPAL & SCHOOL																										
CREAGE																										
AND																										

Form 174A

The International Nickel Company of Canada, Limited

Real Estate (Land Titles) Record

Township - 78, Range 3, West of the Principal Meridian

Parcel No. | Lot | Concession

Mining Claim No. | Acreage — Mining | Surface

CERT. ~~Patent~~ No. 125404 | Date of Patent

Nature of Title Fee Simple

Acquired from The Province of Manitoba | Transfer No. 20297

Consideration $ 1.00 per Acre | Date December 14, 1964 | Charged to Real Estate

Description of Property - Parcel Two, which Parcel is shown bordered Red on a Plan of survey of part of Townships Seventy-seven and Seventy-eight, in Ranges Two and Three, West of the Principal Meridian, in Manitoba, registered in the Neepawa Land Titles Office as No. 4745.

4085 acres

FOR INFORMATION ONLY

Remarks

Correspondence in File No. | Document Reference

TH ARCEL IS LIABLE FOR THE FOLLOWING TAXES AND IS IN ORGANIZED ☐ UNORGANIZED ☐ TERRITORY
MUNICIPAL ☐ SCHOOL ☐ ACREAGE ☐ LAND ☐

S PAID	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82
UNICIPAL & SCHOOL																										
CREAGE																										
AND																										

960VC

AN ORDER OF THE CLEAN ENVIRONMENT COMMISSION

UNDER THE CLEAN ENVIRONMENT ACT

RE: THE CLEAN ENVIRONMENT COMMISSION and INCO LIMITED, Applicant,

WHEREAS on the 1st day of January, 1970, and again on the 13th day of April, 1970, pursuant to the provisions of The Clean Environment Act, Inco Limited submitted proposals to The Clean Environment Commission to prescribe limits in connection with emissions to the environment from the operation of nickel mine, mill, smelter, refinery, and tailings disposal facilities located in the general vicinity of Thompson, Manitoba;

AND WHEREAS the Commission held a hearing in Thompson on the 14th day of April, 1970, and, on the 1st day of June, 1970, issued the following licences to the Applicant:

Licence No. 20 concerning the T-3 mine,

Licence No. 21 concerning the Birchtree Mine sewage lagoon,

Licence No. 25 concerning the drainage from Thompson Lake,

Licence No. 26 concerning the discharge of sewage effluent from the Thompson mill/smelter complex via the tailings area to the Burntwood River,

Licence No. 27 concerning Thompson tailings area drainage to the Burntwood River,

Licence No. 28 concerning Thompson tailings area drainage to the Grass River, and

Licence No. 29 concerning emissions to the atmosphere from the Applicant's smelter operation,

AND WHEREAS Licence No. 28 expired on the 1st day of June, 1972, Licence No. 29 expired on the 1st day of June, 1973, and Licences No. 20, 25 and 27 expired on the 1st day of June, 1975;

AND WHEREAS on the 21st day of March, 1980, the Applicant filed with the department applications in connection with the continuation of the said operations and a proposal for the development of an open pit mine at Thompson Lake, all located in Townships 77 and 78, Ranges 2 and 3, WPM, in the Local Government District of Mystery Lake, Manitoba;

AND WHEREAS the Commission held a hearing in Thompson on the 15th day of June, 1982, and issued Order No. 960 on the 20th day of September, 1982;

AND WHEREAS the Applicant requested a variation to Order No. 960 on the 31st day of October, 1983, to increase the nickel concentration in discharges to the Burntwood River;

AND WHEREAS the Commission held a hearing in Thompson on the 2nd day of December, 1983;

AND WHEREAS the Commission considered the variation request on the 19th day of December, 1983;

IT IS HEREBY ORDERED THAT ORDER NO. 960 BE VARIED TO READ AS FOLLOWS

1. The Applicant shall not discharge effluent from the final discharge points:

(a) subject to (c), where the concentrations of the following contaminants in the effluent are in excess of the corresponding maximum allowable concentrations shown for those categories listed under Columns I, II, and III of the following table:

		Column I	Column II	Column III
	Contaminant	Maximum Monthly Arithmetic Mean Concentration	Maximum Concentration In a Composite Sample	Maximum Concentration In a Grab Sample
(i)	Total Arsenic	0.5 mg/L	0.75 mg/L	1.0 mg/L
(ii)	Total Copper	0.3 mg/L	0.45 mg/L	0.6 mg/L
(iii)	Total Lead	0.2 mg/L	0.3 mg/L	0.4 mg/L
(iv)	Total Nickel	0.5 mg/L	0.75 mg/L	1.0 mg/L
(v)	Total Zinc	0.5 mg/L	0.75 mg/L	1.0 mg/L
(vi)	Total Suspended Matter	25.0 mg/L	37.5 mg/L	50.0 mg/L

1. (b) where the pH of the effluent is below the minimum allowable values shown for those categories listed under Columns I, II and III of the following table:

Column I	Column II	Column III
Minimum Monthly Arithmetic Mean pH	Minimum pH In A Composite Sample	Minimum pH In A Grab Sample
6.0	5.5	5.0

(c) from the 21st day of December, 1983, to the 1st day of May, 1984, where the concentration of the following contaminant in the effluent from the Thompson Lake drainage channel exceeds the maximum concentrations shown for those categories listed under Columns I, II, and III of the following table:

	Column I	Column II	Column III
Contaminant	Maximum Monthly Arithmetic Mean Concentration	Maximum Concentration In a Composite Sample	Maximum Concentration In a Grab Sample
Total Nickel	2.5 mg/L	3.0 mg/L	3.5 mg/L

2. Subject to 3, the Applicant shall sample and analyze the effluent from the final discharge points:

(a) for the following substances at a frequency not less than that specified in the following table whereby the applicability of Columns I, II, III and IV for each substance listed shall be determined on the basis of the arithmetic mean concentration of that substance in the samples of effluent collected and reported in those preceding six months during which effluent discharge occurred:

	Column I	Column II	Column III	Column IV
Substance	At Least Weekly If Concentration Is Equal To Or Greater Than	At Least Every Two Weeks If Concentration Is Equal To Or Greater Than	At Least Monthly If Concentration Is Equal To Or Greater Than	At Least Every Six Months If Concentration Is Less Than
Total Arsenic	0.5 mg/L	0.2 mg/L	0.10 mg/L	0.10 mg/L
Total Copper	0.3 mg/L	0.1 mg/L	0.05 mg/L	0.05 mg/L
Total Lead	0.2 mg/L	0.1 mg/L	0.05 mg/L	0.05 mg/L
Total Nickel	0.5 mg/L	0.2 mg/L	0.10 mg/L	0.10 mg/L
Total Zinc	0.5 mg/L	0.2 mg/L	0.10 mg/L	0.10 mg/L
Total Suspended Matter	25.0 mg/L	20.0 mg/L	15.0 mg/L	15.0 mg/L

2. (b) for pH not less frequently than:

   (i) once a week where the pH of the effluent was less than 5.0 at any time in those preceding six months during which effluent discharge occurred;

   (ii) once every two weeks, where the pH of the effluent was between 5.0 and 5.5 at any time in those preceding six months during which effluent discharge occurred;

   (iii) once a month if (i) and (ii) do not apply.

3. The Applicant shall sample and analyze the effluent from one or all of the final discharge points for such additional substances or characteristics and at such frequency and duration as are specified from time to time by the Commission.

4. The Applicant shall measure the total volume of effluent discharged monthly from each of the final discharge points monthly by a method acceptable to the Environmental Management Division;

5. The Applicant shall submit to the Enviromental Management Division the data assembled pursuant to clauses 2, 3, and 4, in a form acceptable to the Division, within 30 days of the end of the month in which the samples and measurements were taken.

6. The Applicant shall from time to time provide such engineering studies, drawings, specifications, analyses of wastewater streams, and such other information relative to waste treatment, handling and disposal systems as are requested by the Commission.

7. The Applicant shall not dispose of bulky metallic waste or solid wastes, as defined in regulations issued under the said Act, except in waste disposal grounds designated and approved for that purpose.

8. The Applicant shall not cause or permit the emission of sound from dredging carried out on the premises of the said operation which, when measured at any point beyond the property line of the operation and within 15 metres of a building maintained as a dwelling, results in an hourly equivalent sound level in excess of:

   (a) 60 dBA during the daytime hours of 7:00 a.m. to 10:00 p.m., local time;

   (b) 50 dBA during the nighttime hours of 10:00 p.m. to 7:00 a.m., local time.

9. The Applicant shall not cause or permit the emission of sound from blasting at the said open pit mine which, when measured beyond the property line of the said operation, exceeds:

   (a) 130 decibels linear peak sound pressure level when measured within 15 metres of a building used as a dwelling, ;

   (b) 150 decibels linear peak sound pressure level when measured within 15 metres of any building maintained for use other than as a dwelling;

   (c) 140 decibels linear peak sound pressure level when measured in an area where any person other than an employee of the Applicant of the Applicant's contractors is exposed.

10. The Applicant shall not create or permit the creation of soil-borne vibrations which, when measured beyond the property line of the said operation and inside a building below grade or less than one metre above grade, exceed:

   (a) for a building maintained as a dwelling, 12 millimetres per second peak particle velocity in any one of three mutually perpendicular directions (vertical, radial, and transverse to the source);

   (b) for any building maintained for use other than as a dwelling, 50 millimetres per second peak particle velocity in any one of three mutually perpendicular directions (vertical, radial, and transverse to the source).

11. The Applicant shall not, with respect to blasting on the site of the said operation, cause or permit the emission of sound or soil-borne vibrations measurable beyond the property line of the said operation at any time between 4:00 p.m. of any day and 10:00 a.m. of the following day (local time), nor at any time on Sunday, except in emergency conditions.

12. The Applicant shall not permit the emission of particulate matter from any point source of the surface crusher building used in connection with the Thompson open pit mine in excess of 0.23 grams per standard cubic metre calculated at 25 degrees Celsius and 760 millimetres of mercury.

13. The Applicant shall:

(a) on or before the 1st day of August, 1984, submit to the Commission a preliminary rehabilitation scheme with regard to the said operation outlining rehabilitation plans with regard to:

(i) the eventual orderly removal and disposal of all structures, their contents and all other accumulated material on the site of the said operation;

(ii) the steps to be taken to rehabilitate the said site progressively and at the termination of the said operation in line with aesthetic considerations and enhancement of the environment;

(iii) the containment, treatment, and/or preventive measures proposed for dealing with the long-range acid generating potential of the tailings in the post-abandonment period;

which said scheme shall be subject to the consideration, possible amendment and approval, or otherwise, by the Commission;

(b) in the event of an imminent cessation of the said operation, forthwith file with the Commission a firm and detailed rehabilitation plan, to replace the preliminary rehabilitation scheme filed pursuant to (a), for consideration, possible amendment, and approval, or otherwise;

(c) upon termination of the said operation, take all steps necessary to carry out the approved detailed rehabilitation plan within a time frame agreed to by the Commission.

14. Ordinary Licence No. 26 shall be and is hereby rescinded.

15. In this order:

(a) "final discharge points" means:

(i) subject to (iii), the outflow control point adjacent to the bridge which crosses the Thompson Lake drainage channel along the access road to the T-3 minesite; and

(ii) subject to (iii), the outflow control point for the tailings disposal area at or near that location where the liquid effluent passes under the Canadian National Railway tracks; and

(iii) such alternative or additional points as are designated from time to time in writing by the Commission;

(b) "monthly arithmetic mean" for each substance means the average value of the concentrations determined for each substance in all the composite and grab samples collected and reported during that month, with the exception that, if the Applicant collects only one composite or grab sample during a month, the single set of analysis results shall be construed as being representative of the effluent quality for that month and hence shall be treated as the monthly arithmetic mean;

(c) "composite sample" means a quantity of effluent consisting of a minimum of three equal volumes of effluent collected at approximately equal time intervals over a sampling period of not less than 7 hours and not more than 24 hours, or alternatively, consisting of effluent collected continuously at an equal rate over a sampling period of not less than 7 hours and not more than 24 hours.

15. (d) "hourly equivalent sound level" means a sound level measured in terms of the equivalent continuous sound level averaged over a one hour period (60 minutes) using a sound level monitoring device which equals or surpasses the requirements of Canadian Standards Association Standard Z 107.1 - 1973 (or the equivalent) for Type 2 sound level meters, operated on the "A-weighting network" and "slow" meter response;

(e) "linear peak sound pressure level" means the maximum absolute sound pressure as measured using a sound level monitoring device which equals or surpasses the requirements of International Electrotechnical Commission (I.E.C.) Publications 179 (1973) "precision sound level meters" and 179A (1973) "Additional characteristics for the measurement of impulsive sounds", including section 4.5.1, using "linear" weighting network and "peak hold" meter response, or the equivalent;

(f) "peak particle velocity" means the maximum instantaneous velocity experienced by the particles of a medium when set into transient vibratory motion, and is the greatest velocity of any of the three mutually perpendicular directions (vertical, radial, and transverse to the source);

16. Order No. 960 as varied by the Commission is herby designated as Order No. 960VC.

Order No. 960VC

Dated at the City of Winnipeg

this 21st day of December, 1983.

Chairman,
The Clean Environment Commission.

File: 557.1

DISTRIBUTION LIST FOR ORDER NO. 960VC FILE: 557.1

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Appendix D AIR QUALITY REPORT

Thompson Mine Expansion Phase 1 Return Air Raise Dispersion Modelling Assessment

Prepared By:
Madonna Campeau, P.Eng
Senior Air Quality Engineer, Vale Canada Ltd

July 2019

Table of Contents

1.0 Introduction

Vale Canada Limited (Vale) operates two connected underground nickel mines, T1 and T3, collectively known as Thompson Mine, and a mill, at 1 Inco Road, Thompson, Manitoba. The location of the Facility is presented in Figure 1.

As part of the Thompson Mine Expansion Phase 1 (TMEP1) Project, Vale is proposing to expand the underground workings at T3. In terms of surface changes, the Project will add a new paste fill plant and electrical substation with associated distribution lines, and it will upgrade the ventilation system, including converting an existing return air raise to a fresh air raise and adding a new return air raise.

Figure 1: Location of Vale Thompson, Manitoba Operations

1.1 Project Overview (Purpose of the Study)

The purpose of this study is to predict the change in ground level concentrations that would result from the ventilation system changes to the return air raises associated with the TMEP1 Project. Emissions from other sources at Vale's Thompson Operations were specifically excluded as they are not changing due to the Project.

Dispersion modelling followed the *Draft Guidelines for Air Dispersion Modelling in Manitoba* (Manitoba Conservation and Water Stewardship, 2006), supplemented where needed by the *Procedure for Preparing an Emission Summary and Dispersion Modelling Report v.4* (Ontario Ministry of Environment, Conservation and Parks, 2017). A refined model approach was taken using the dispersion model AERMOD (v18081) and its preprocessors AERMAP (v11103), AERMET (v18081) and BPIP (v04274).

Predicted model results were compared against:

- the current standards, guidelines and screening levels listed in the Ontario *Air Contaminants Benchmarks (ACB) List: Standards, Guidelines and Screening Levels for Assessing Point of Impingement Concentrations of Air Contaminants* (Ontario Ministry of Environment, Conservation and Parks);
- the current Canadian Ambient Air Quality Standards; and
- the 2005 Manitoba Ambient Air Quality Criteria for particulate matter, PM_{10} and $PM_{2.5}$ (there are currently no published criteria for Manitoba).

1.2 Process Description

Thompson Mine is a base metal, underground mine extracting nickel and copper ores from a sulphide ore zone. The existing ore production capacity is 12,000 tonnes/day. The TMEP1 Project will allow for 3050 tonnes/day, however this production will simply make up the difference as other parts of the mine ramp down – such that the overall production capacity will remain at 12,000 tonnes/day.

At Thompson Mine, the ore is mined using a mixture of bulk mining, cut-and-fill mining and specialized methods. It is crushed underground and brought to surface via the T1 shaft and immediately delivered into the Mill. Any wasterock is used as rockfill underground and does not come to surface. Sand and/or tailings from the mill are mixed with cement and pumped underground for backfill. Ventilation for the mine workings is provided by fresh air raises (FARs) which draw the air into the mine and return air raises (RARs) which exhaust the air to the environment. The emissions associated with RARs consist of particulate matter (TSP), metals and products of combustion and result from underground operations such as material handling, blasting, diesel equipment operation, and comfort and shaft heating. The primary raw materials and products as well as potential emission sources are shown in Figure 2.

Thompson Mine operates 24 hours per day, 365 days per year.

The applicable North American Industrial Classification System (NAICS) code for Thompson Mine is 212232 Nickel-Copper Ore Mining.

Though not the focus of this study, it should be noted that Vale's Thompson operations also consist of an operating mill (shown in Figure 2) as well as a Smelter and Refinery which were both shut down in 2018. The mill receives ore from the mine and produces a concentrate for delivery to Ontario, and a tailings stream partly used for backfill but otherwise sent to onsite disposal.

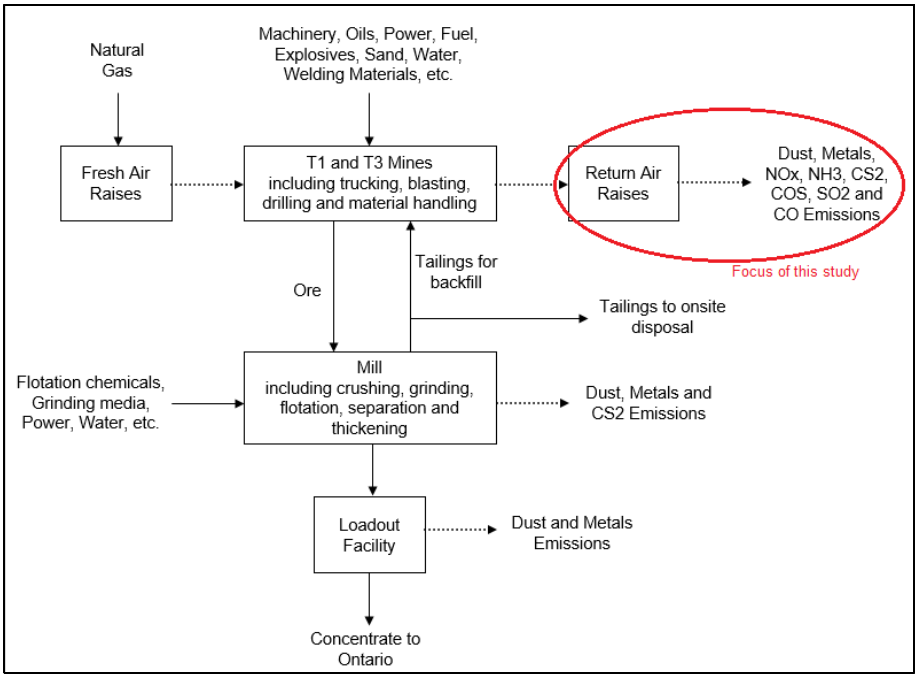

Figure 2: Vale Manitoba Operations, Simplified Process Flow Diagram

2.0 Methodology

The dispersion model used in this assessment was the US EPA AERMOD (v18081) and its preprocessors AERMAP (v11103), AERMET (v18081) and BPIP (v04274). AERMOD was selected given that the highest modelled concentrations would occur within 1km of the release point(s) and the terrain in the area is relatively simple. The model is capable of accounting for emission source characteristics and emission rates, meteorological conditions, terrain effects, building effects, and various dispersion characteristics. As outlined in the *Draft Guidelines for Air Dispersion Modelling in Manitoba*, AERMOD is an approved dispersion model in Manitoba.

The purpose of this study is to predict the change in ground level concentrations that would result from the ventilation system changes to the return air raises (RARs) associated with the TMEP1 Project. Emissions from other sources at Vale's Thompson Operations were specifically excluded as they are not changing due to the Project.

2.1 Source Data

Thompson Mine currently operates eight RARs. With the TMEP1 Project, two of those exhausts will become intakes (FARs), and there will be three new RARs.

RARs are not stacks in the traditional sense. They are not located on buildings and can have very high flowrates. Many RARs discharge horizontally, while shaft RARs effectively discharge inside a building. Following common dispersion modelling practices for mines, the RARs in this assessment were modelled as point sources and volume sources as their configuration dictated. The source parameters and parameters relevant to dispersion modelling are presented in Table 1 and Table 2. The location of the RARs relative to each other are shown in Figure 3.

Table 1: Volume Sources

Source	Modeling Source Type	UTM Coordinates Zone 14N		Base Elevation (m)	Release Height (m)	Initial Lateral Dimension (m)	Initial Vertical Dimension (m)
		X (m)	X (m)				
T1	VOLUME	572098.65	6175095.08	215.00	6.10	6.49	5.67
T3	VOLUME	574231.64	6176839.62	199.96	6.10	6.49	5.67

Table 2: Point Sources

Source	Modeling Source Type	UTM Coordinates Zone 14N		Base Elevation (m)	Release Height Above Grade (m)	Diameter / Equivalent Diameter (m)	Release Temper-ature (K)
		X (m)	Y (m)				
259	POINTHOR	572689.66	6175664.48	202.00	2.24	2.74	293
260	POINTHOR	572739.25	6175652.69	201.41	3.7	3.8	293
345W	POINTHOR	574647.74	6177558.52	202.00	1.3	2.92	293
345E	POINTHOR	574671.81	6177541.81	202.00	1.3	2.92	293
378N	POINTHOR	575436.18	6178205.55	213.96	3.3	3.9	293
378S	POINTHOR	575418.83	6178176.79	214.49	3.3	3.9	293
389_1	POINTHOR	575951.00	6178329.00	201.63	4.0	4.5	293
389_2	POINTHOR	575951.00	6178323.00	201.63	4.0	4.5	293
389_3	POINTHOR	575951.00	6178317.00	201.63	4.0	4.5	293

For all point sources, the pre-processor BPIP (v04274) was used to determine the impact of nearby buildings on the sources. This is done by characterizing the dimensions of any nearby infrastructure. Any infrastructure further than 0.8km would not impact the source(s) and was not included in the model. Figures 4 to 7 present each point source and any buildings within 0.8km of them, as well as the Good Engineering Practice (GEP) 5L 360º area of influence that those buildings have. Table 3 presents the GEP stack heights of the point sources as determined by BPIP. The actual stack heights (which were all lower than the GEP stack heights) were used in the AERMOD modelling.

Table 3: Good Engineering Practice (GEP) Stack Heights

Source	Stack height (m)	GEP Stack Height (m)	
		Equation 1 of p6 from the GEP Technical Support Document	Determinants 1&2 of the GEP Technical Support Document
259	2.24	10.36	65
260	3.7	10.79	65
345W	1.3	10.68	65
345E	1.3	10.68	65
378N	3.3	61.38	65
378S	3.3	60.85	65
389_1	4.0	19.64	65
389_2	4.0	19.64	65
389_3	4.0	19.64	65

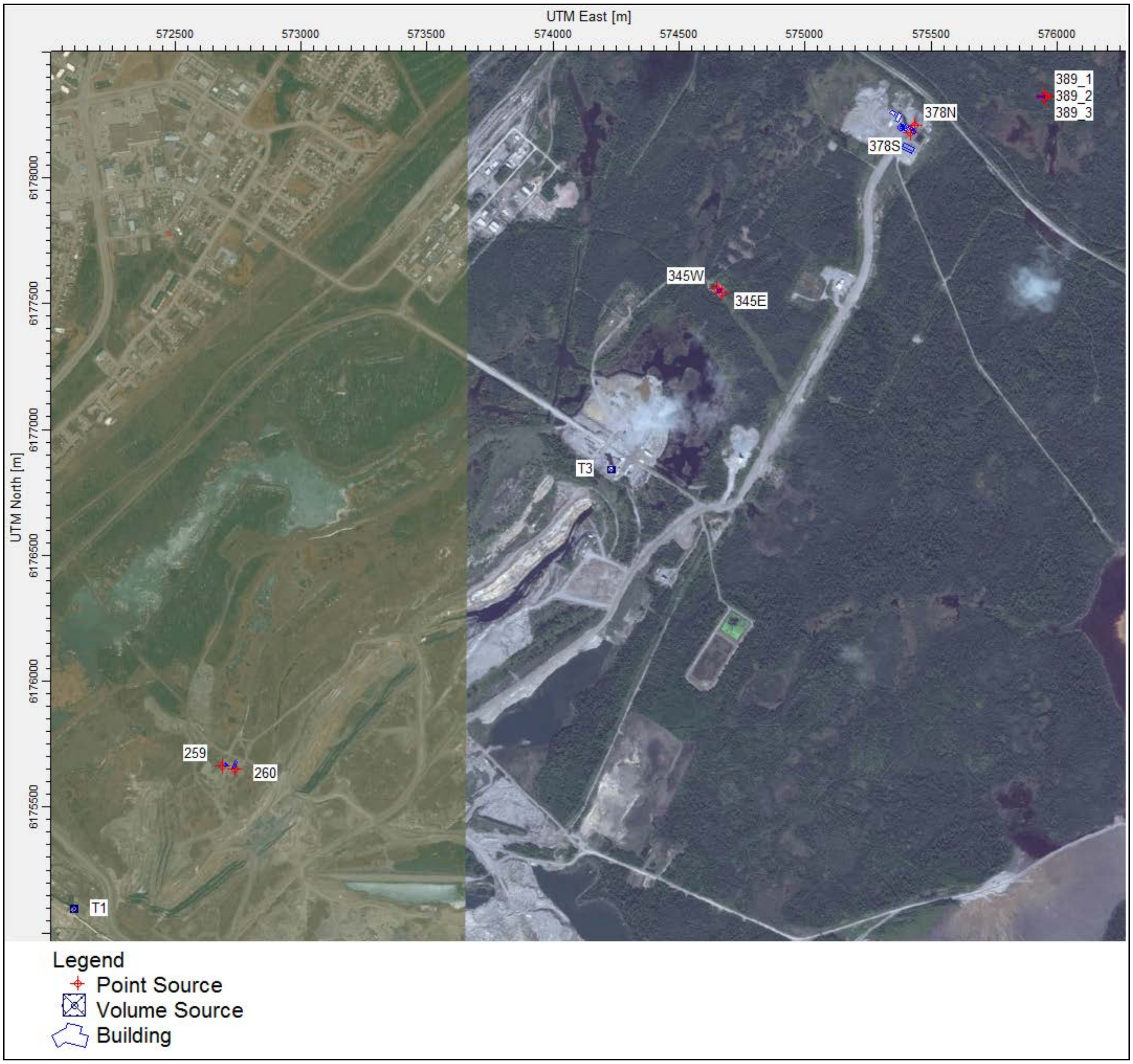

Figure 3: Site Plan, RAR Locations

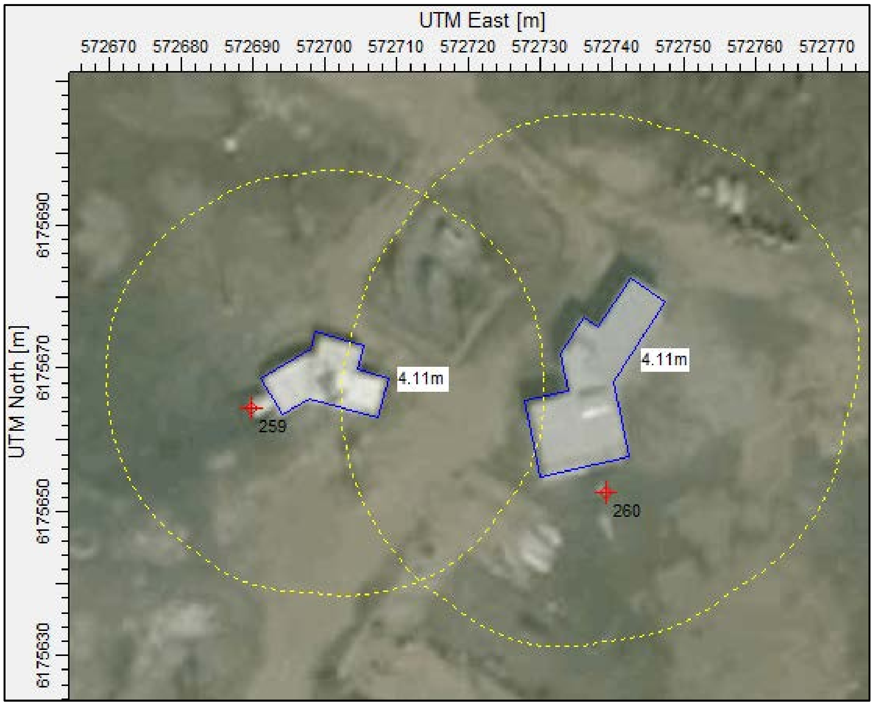

Figure 4: 259 RAR and 260 RAR

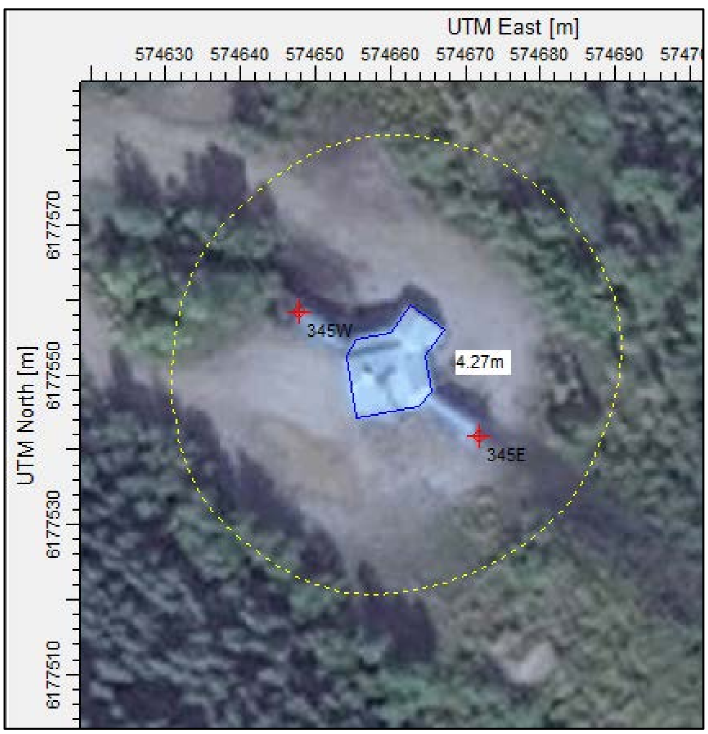

Figure 5: 345 RAR (west and east exhausts)

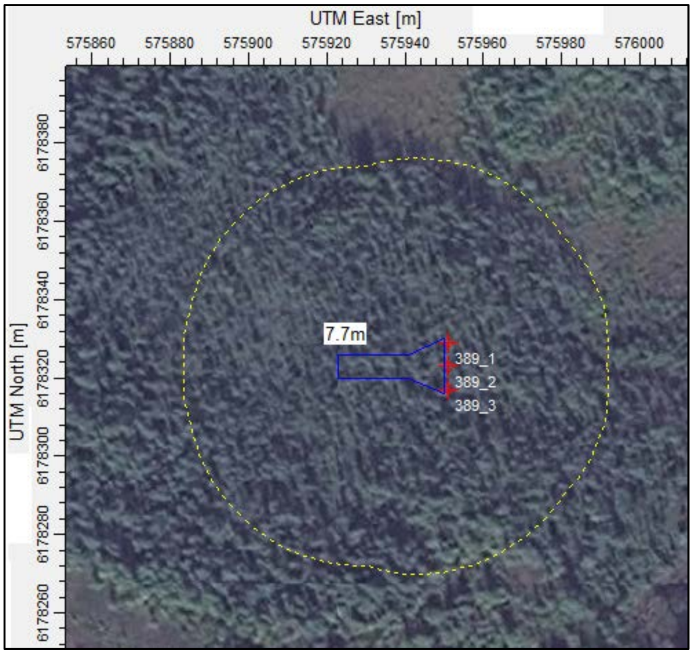

Figure 6: 389 RAR (north and south exhausts)

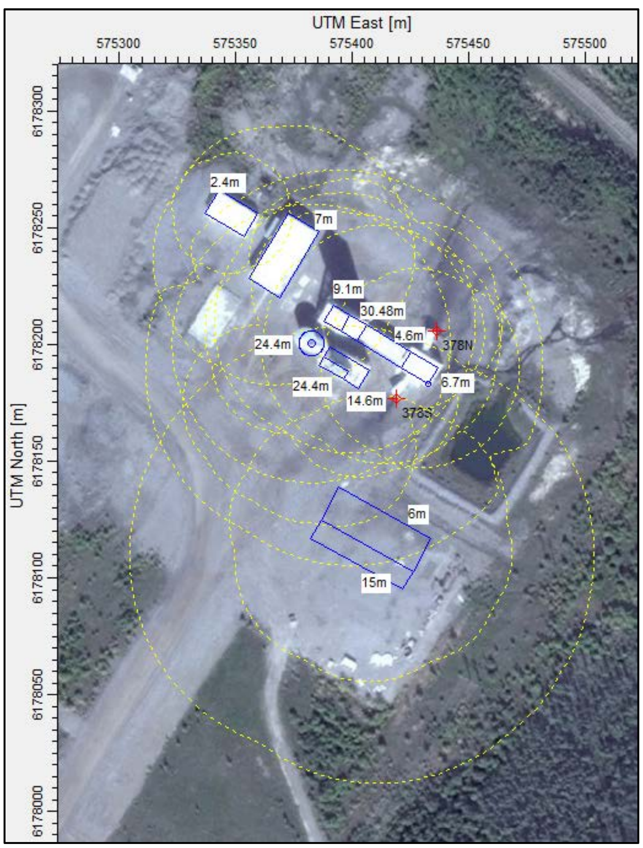

Figure 7: 378 RAR (north and south exhausts)

Emission factors (mg/m³) used to estimate emissions of dust (TSP), ammonia, carbon disulphide, carbonyl sulphide, SO_2, CO and NOx from the return air raises were taken from source testing conducted on RARs at similar mining operations in Sudbury, Ontario. The emission factors used are reflective of the averaging time for the specific contaminant (for example, 24hr emission factor for TSP, 1hr emission factor for NOx, etc).

Emissions are calculated by multiplying the emission factor by the RAR flowrate. The flowrates represent maximum flowrates possible for the fan. Most RAR fans have, or will have with the TMEP1 Project, variable frequency drives to vary the flowrate (and power requirements) depending on the immediate ventilation requirements. It is not likely that all RAR fans would operate at such high rates simultaneously, however the emission rates are calculated as if they were and so the emission rates calculated in this assessment are considered conservative.

Emission rates of metals are calculated by multiplying the TSP emission rate by the metal content of Thompson ore. This method of estimating metal emissions is conservative because dust from the return air raise would comprise of not just ore, but wasterock and diesel particulate as well, which are lower in metal concentration than ore.

Emissions, flowrates and velocities from the RARs are summarized in Table 4 and Table 5.

Table 4: Current Emission Rates

		Return Air Raise	T1	T3	259	260	345-1	345-2	378-1	378-2
		Flowrate (cfm)	40,000	40,000	220,000	350,000	140,000	140,000	400,000	400,000
		Velocity (m/s)	n/a	n/a	17.6	14.6	9.9	9.9	15.8	15.8
Contaminant	**Emission Factor**	**Units**	**Emission Rate (g/s)**							
TSP / PM_{10} / $PM_{2.5}$*	0.45	mg/m³	8.50E-03	8.50E-03	4.68E-02	7.44E-02	2.98E-02	2.98E-02	8.50E-02	8.50E-02
Ammonia	0.23	mg/m³	4.35E-03	4.35E-03	2.39E-02	3.80E-02	1.52E-02	1.52E-02	4.35E-02	4.35E-02
Carbon Disulfide	0.0021	mg/m³	3.91E-05	3.91E-05	2.15E-04	3.43E-04	1.37E-04	1.37E-04	3.91E-04	3.91E-04
Carbonyl Sulfide	0.0033	mg/m³	6.23E-05	6.23E-05	3.43E-04	5.45E-04	2.18E-04	2.18E-04	6.23E-04	6.23E-04
SO_2	0.21	mg/m³	4.05E-03	4.05E-03	2.23E-02	3.54E-02	1.42E-02	1.42E-02	4.05E-02	4.05E-02
CO	2.90	mg/m³	5.48E-02	5.48E-02	3.01E-01	4.79E-01	1.92E-01	1.92E-01	5.48E-01	5.48E-01
NOx	3.53	mg/m³	6.67E-02	6.67E-02	3.67E-01	5.84E-01	2.33E-01	2.33E-01	6.67E-01	6.67E-01
Nickel	2.05	% in ore	1.74E-04	1.74E-04	9.59E-04	1.52E-03	6.10E-04	6.10E-04	1.74E-03	1.74E-03
Copper	0.159	% in ore	1.35E-05	1.35E-05	7.43E-05	1.18E-04	4.73E-05	4.73E-05	1.35E-04	1.35E-04
Cobalt	0.029	% in ore	2.47E-06	2.47E-06	1.36E-05	2.16E-05	8.63E-06	8.63E-06	2.47E-05	2.47E-05
Arsenic	0.051	% in ore	4.34E-06	4.34E-06	2.38E-05	3.79E-05	1.52E-05	1.52E-05	4.34E-05	4.34E-05
Lead	0.013	% in ore	1.11E-06	1.11E-06	6.08E-06	9.67E-06	3.87E-06	3.87E-06	1.11E-05	1.11E-05
Silver	0.000063	% in ore	5.36E-09	5.36E-09	2.95E-08	4.69E-08	1.87E-08	1.87E-08	5.36E-08	5.36E-08
Iron	12.031	% in ore	1.02E-03	1.02E-03	5.63E-03	8.95E-03	3.58E-03	3.58E-03	1.02E-02	1.02E-02
Ferric Oxide	n/a	n/a	5.85E-03	5.85E-03	3.22E-02	5.12E-02	2.05E-02	2.05E-02	5.85E-02	5.85E-02

* No emission factor was available for particulate matter fractions, so conservatively assumed all particulate matter was PM_{10} and $PM_{2.5}$.

Table 5: Future Emission Rates

		Return Air Raise	T1	T3	259	260	345-1	345-2	389-1	389-2	389-3
		Flowrate (cfm)	40,000	40,000	220,000	350,000	140,000	140,000	600,000	600,000	600,000
		Velocity (m/s)	n/a	n/a	17.6	14.6	9.9	9.9	17.8	17.8	17.8
Contaminant	**Emission Factor**	**Units**	**Emission Rate (g/s)**								
TSP / PM_{10} / $PM_{2.5}$*	0.45	mg/m³	8.50E-03	8.50E-03	4.68E-02	7.44E-02	2.98E-02	2.98E-02	1.28E-01	1.28E-01	1.28E-01
Ammonia	0.23	mg/m³	4.35E-03	4.35E-03	2.39E-02	3.80E-02	1.52E-02	1.52E-02	6.52E-02	6.52E-02	6.52E-02
Carbon Disulfide	0.0021	mg/m³	3.91E-05	3.91E-05	2.15E-04	3.43E-04	1.37E-04	1.37E-04	5.87E-04	5.87E-04	5.87E-04
Carbonyl Sulfide	0.0033	mg/m³	6.23E-05	6.23E-05	3.43E-04	5.45E-04	2.18E-04	2.18E-04	9.34E-04	9.34E-04	9.34E-04
SO_2	0.21	mg/m³	4.05E-03	4.05E-03	2.23E-02	3.54E-02	1.42E-02	1.42E-02	6.07E-02	6.07E-02	6.07E-02
CO	2.90	mg/m³	5.48E-02	5.48E-02	3.01E-01	4.79E-01	1.92E-01	1.92E-01	8.21E-01	8.21E-01	8.21E-01
NOx	3.53	mg/m³	6.67E-02	6.67E-02	3.67E-01	5.84E-01	2.33E-01	2.33E-01	1.00E+01	1.00E+01	1.00E+01
Nickel	2.05	% in ore	1.74E-04	1.74E-04	9.59E-04	1.52E-03	6.10E-04	6.10E-04	2.61E-03	2.61E-03	2.61E-03
Copper	0.159	% in ore	1.35E-05	1.35E-05	7.43E-05	1.18E-04	4.73E-05	4.73E-05	2.03E-04	2.03E-04	2.03E-04
Cobalt	0.029	% in ore	2.47E-06	2.47E-06	1.36E-05	2.16E-05	8.63E-06	8.63E-06	3.70E-05	3.70E-05	3.70E-05
Arsenic	0.051	% in ore	4.34E-06	4.34E-06	2.38E-05	3.79E-05	1.52E-05	1.52E-05	6.50E-05	6.50E-05	6.50E-05
Lead	0.013	% in ore	1.11E-06	1.11E-06	6.08E-06	9.67E-06	3.87E-06	3.87E-06	1.66E-05	1.66E-05	1.66E-05
Silver	0.000063	% in ore	5.36E-09	5.36E-09	2.95E-08	4.69E-08	1.87E-08	1.87E-08	8.03E-08	8.03E-08	8.03E-08
Iron	12.031	% in ore	1.02E-03	1.02E-03	5.63E-03	8.95E-03	3.58E-03	3.58E-03	1.53E-02	1.53E-02	1.53E-02

* No emission factor was available for particulate matter fractions, so conservatively assumed all particulate matter was PM_{10} and $PM_{2.5}$.

Overall, the exhaust from the return air raises at Thompson Mine will increase from 1.73 Mcfm to 2.73 Mcfm, representing a 58% increase in emissions.

Annual emissions are presented in Table 6. Historical emissions from Thompson Operations from when the Smelter and Refinery were operating, as reported to the National Pollutant Release Inventory (NPRI), are also presented to demonstrate how small of a contribution the mine RARs are relative to the Operations' historic emissions.

Table 6: Annual Emissions

	Current RAR Emissions	Future RAR Emissions	2015 NPRI Report	2017 NPRI Report
Contaminant	tonnes/year			
TSP	11.60	18.30	1715	747
PM_{10}*	11.60	18.30	894	594
$PM_{2.5}$*	11.60	18.30	618	273
Ammonia	5.93	9.35	not reported	not reported
Carbon Disulfide	0.05	0.08	not reported	not reported
Carbonyl Sulfide	0.08	0.13	not reported	not reported
SO_2	5.52	8.72	151,154	117,192
CO	74.68	117.84	not reported	not reported
NOx	90.96	143.54	not reported	not reported
Nickel	0.24	0.38	65	47
Copper	0.02	0.03	5.6	3.5
Cobalt	0.0034	0.0053	1.6	1.5
Arsenic	0.0059	0.0093	6.3	3.2
Lead	0.0015	0.0024	4.8	2.97
Silver	7.30E-06	1.15E-05	not reported	not reported
Iron	1.40	2.20	not reported	not reported

* No emission factor was available for particulate matter fractions, so conservatively assumed all particulate matter was PM_{10} and $PM_{2.5}$.

2.2 Receptors

The receptor grid for this dispersion modelling assessment was created in four stages:

1. A polar grid of radius 10km was created with 10 equally spaced concentric circles with 36 radii at 10º intervals for a total of 360 receptors.
2. A uniform Cartesian grid was created to cover the community of Thompson, at 3200m x 4600m, with receptors spaced 50m apart for a total of 6045 receptors.
3. Receptors in the polar grid that fell within the uniform Cartesian grid were removed.
4. Receptors that fell within the Vale plant boundary were removed.
5. Receptors that fell outside of Vale's LiDAR data (used to determine base elevations) were removed. While this isn't typical, the results (as discussed in Section 3.1) indicate that the highest point of impingement (POI) was at the property boundary such that the receptors removed were, in the end, irrelevant.

This left 4813 receptors for the dispersion modelling assessment, as shown in Figure 8.

Because the fine Cartesian grid was defined with receptors spaced 50m apart, receptors naturally landed on or very near to all sensitive receptors such as schools, hospitals, senior homes, parks, etc. There are no particularly high buildings in Thompson which would require flag pole receptors.

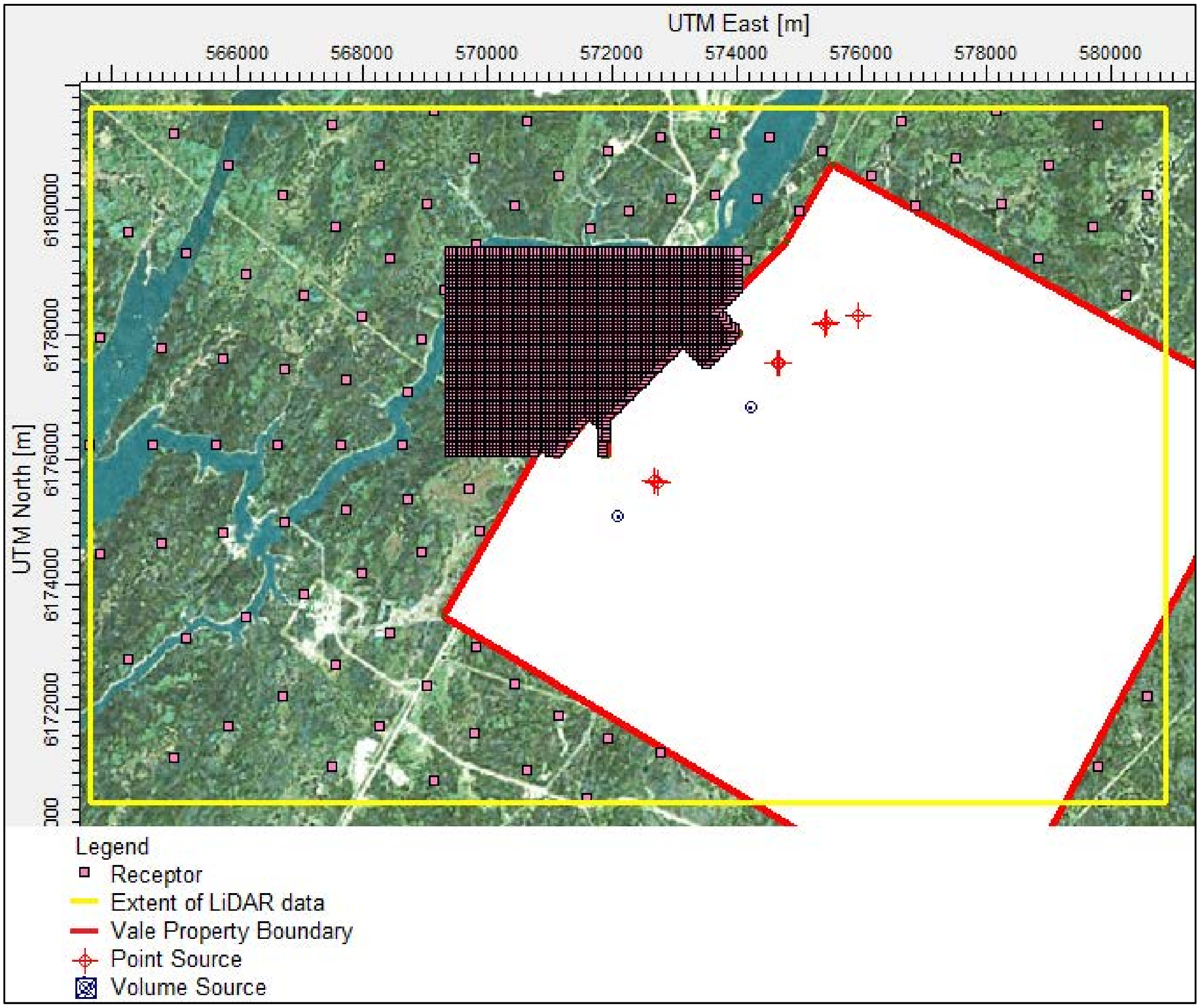

Figure 8: Receptor Grid

2.3 Meteorological Data

Consistent with the Guidelines for Air Dispersion Modelling in Manitoba, meteorological data for 5 calendar years, 2012 to 2016 was obtained for use in this dispersion modelling assessment. Surface station data was obtained from Environment Canada for the Thompson Airport Station, and upper station data was obtained from National Climatic Data Centre for the Pas Airport Station. With the exception of 2015, less than 5% hourly records were missing from the surface station, less than 10% of the hourly records were missing for 2015. Missing data were not filled for this assessment. The data was processed in AERMET (v18081) to account for seasonal surface land use. The data indicated that seasonal and hourly stability variations trended as expected, and that winds were predominantly from the west, northwest and north, with a common wind speed range of 2 to 4 m/s. Further information on the meteorological data processing is included in Appendix A – *Develop 5YR Meteorological Data Set* (RWDI, May 2019).

Fumigation, wind direction shear, lee side effects, terrain induced downwash, deposition chemical transformation of the pollutant, variable plume trajectories and long range transport were not relevant factors in this analysis and were not considered/incorporated.

2.4 Land Use Analysis

The area within a 3km radius of Thompson Operations is shown in Figure 9. The land can be classified as:

- I1 (heavy Industrial) and A3 (undeveloped wasteland) on Vale property;
- R1 (common residential) in the town of Thompson; and
- A3-A4 (undeveloped, undeveloped rural and water surface) for the surrounding areas.

The area that can be classified as I1 is very limited, and there is no land that could be classified as I2 (light-moderate industrial), C1 (commercial), R2 or R3 (compact residential). Since less than 50% of the area can be classified as I1, I2, C1, R2 and R3, the site was not modelled using urban dispersion coefficients.

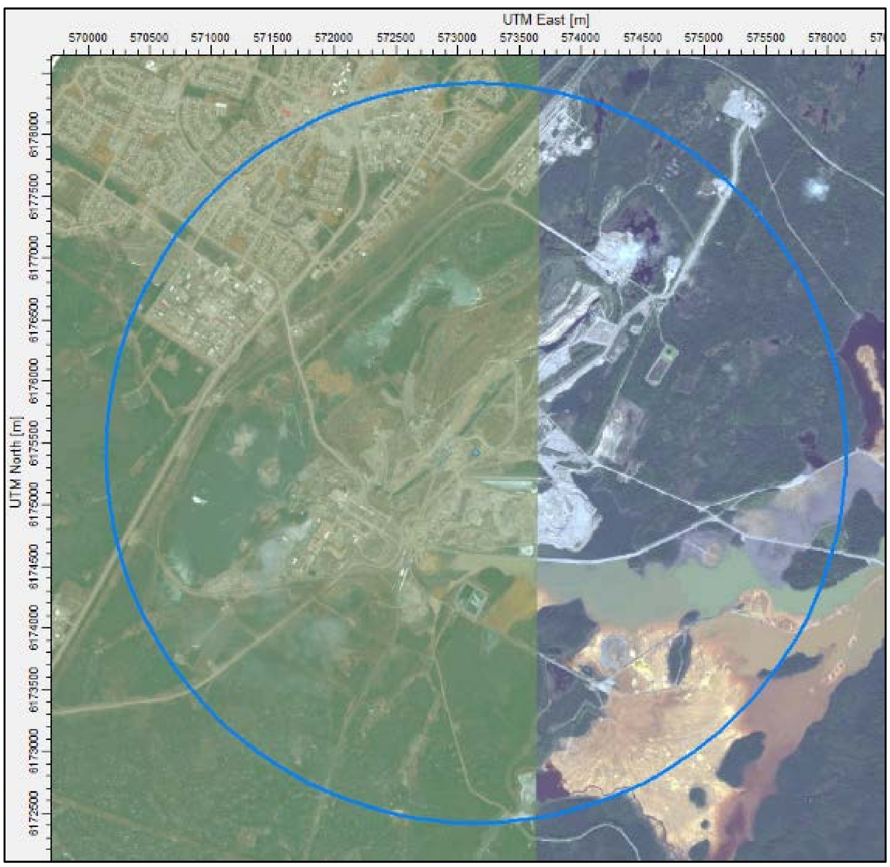

Figure 9: 3km around the Site

2.5 Topography

Vale has conducted LiDAR scans with 1m resolution of the area. This data was used to determine the base elevation of the sources, buildings and receptors in this assessment using the preprocessor

AERMAP (v11103). Figure 10 shows the topography of the area per the LiDAR scan. Figure 11 shows an aerial of the same area, which helps demonstrate significant topographical features.

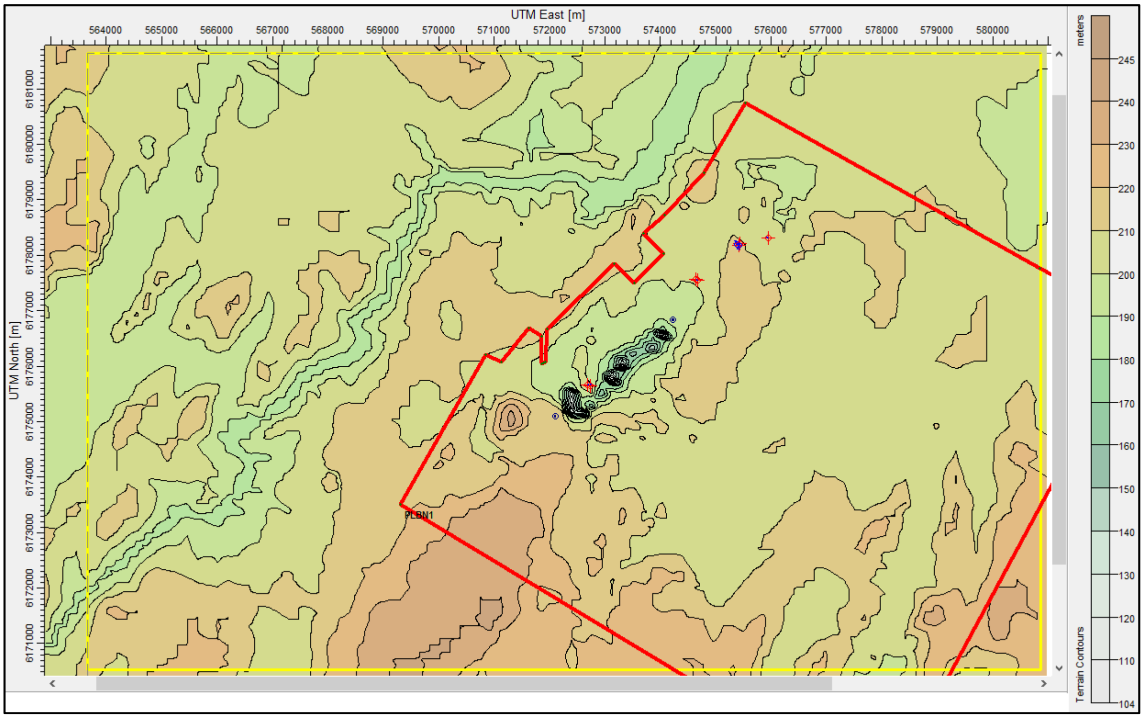

Figure 10: LiDAR Topography

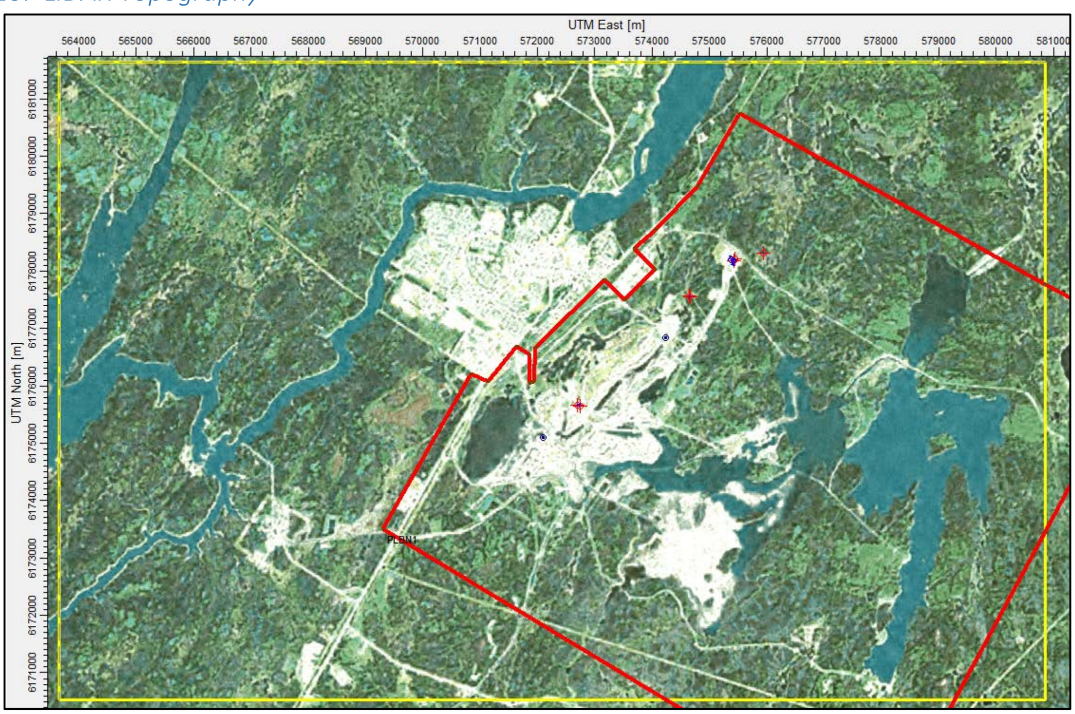

Figure 11: Aerial Topography

Due to the nature of RARs, much of the terrain within 50km is above the top of the stack(s) - this is accounted for in the AERMOD modelling. Within 3km of the source, the terrain consists of cleared land for industrial purposes including a pit and tailings ponds / management area, boreal forest and the city of Thompson. There are no high-rises or valleys (other than the onsite pit). Burntwood River located north of the city of Thompson runs from the north-east to south-west, connecting various lakes along its course. The closest provincial border is further than 200km west (Saskatchewan), and the closest international border is further than 800km south (United States).

2.6 Background Ambient Air Quality

Ambient air quality data for Thompson is only available for PM_{10}, $PM_{2.5}$ and SO_2. The 2018 data, collected at 1hr intervals, indicates:

- $PM_{2.5}$ – average of 6.1 µg/m³, 95th percentile of 20.9 µg/m³
- PM_{10} – average of 13.1 µg/m³, 95th percentile of 31.9 µg/m³
- SO_2 – average of 0.008ppm (22.5 µg/m³), 95th percentile of 0.012ppm (33.1 µg/m³)

These ambient values will be included in the results discussion as per the Manitoba guidelines. However, because this study specifically only considered the impact from RARs, and specifically did not include the impact from any other source, it should be noted that it is not necessarily appropriate to add the modelling results to the background ambient air quality.

2.7 Good Engineering Practice Stack Height Analysis

GEP stack height analysis was included in the discussion in Section 2.1.

3.0 Assessment of Air Quality Modelling Results

3.1 Environmental Assessment

The purpose of this study was to predict the change in ground level concentrations that would result from the ventilation system changes to the return air raises (RARs) associated with the TMEP1 Project.

Since all the sources in this assessment emit emissions that are proportional to each other, it was only necessary to run one model for the current scenario and one model for the future scenario. The "emission rate" used in the model files was the flowrate in cfm divided by 100, and the results simply had to be multiplied by conversion factors and contaminant specific emission factors. Appendix B is a digital appendix containing an Excel file with all calculations (emission rates and resulting POIs) and all the modelling files (input and output for AERMOD, AERMAP, AERMET and BPIP).

The dispersion modelling indicated that for any contaminant assessed using the 1-hr averaging period, the future impact would be 9% higher than the current impact; using the 8-hr averaging period, the future impact would be 55% higher than the current impact; using the 24-hr averaging period, the future impact would be 53% higher than the current impact; using the 30-day averaging period, the future impact would be 26% higher than the current impact; and using the annual averaging period, the future impact would be 13% higher than the current impact. These differences are explained by the meteorological data used in the modelling.

Table 7 presents the dispersion modelling results per contaminant relative to specific limits, including the addition of available ambient air quality data described in Section 2.6. For the ambient air quality data, the 95th percentile was used for contaminants assessed over 1 hour, and the average was used for contaminants assessed over greater time periods. Predicted model results were compared against:

- the current standards, guidelines and screening levels listed in the Ontario *Air Contaminants Benchmarks (ACB) List: Standards, Guidelines and Screening Levels for Assessing Point of Impingement Concentrations of Air Contaminants* (Ontario Ministry of Environment, Conservation and Parks);
- the current Canadian Ambient Air Quality Standards; and
- the 2005 Manitoba Ambient Air Quality Criteria for particulate matter, PM_{10} and $PM_{2.5}$ (there are currently no published criteria for Manitoba).

When only considering the RARs, the dispersion modelling indicates that both the current and future ventilation scenarios are in compliance with the Ontario, Manitoba and Canadian air quality standards, and that the difference between the current and future scenarios is relatively insignificant when compared against those standards.

When the particulate and SO_2 ambient air quality data is incorporated, modelling compliance is maintained except for the annual impact of SO_2 compared against the Canadian standard. The background level, at 22.5 µg/m^3, is already 2 times the standard. The addition of 0.02 µg/m^3 from the site's RARs does not significantly impact the compliance assessment. Note that the elevated background SO_2 level was likely due to Vale's Smelter and Refinery operations in the area, which were shut down in 2018. 2019 background levels are anticipated to be much lower.

Figures 12 to 22 show the dispersion modelling results graphically.

Table 7: Dispersion Modelling Results versus Standards

Contaminant	CAS Number	Jurisdiction	Limit (µg/m³)	Averaging Period	Dispersion Modelling Results				Dispersion Modelling Results + Ambient Air Quality			
					Current Ventilation Scenario		Future Ventilation Scenario		Current Ventilation Scenario		Future Ventilation Scenario	
					Max POI (µg/m³)	Percent of Limit	Max POI (µg/m³)	Percent of Limit	Max POI (µg/m³)	Percent of Limit	Max POI (µg/m³)	Percent of Limit
Total Particulate Matter	N/A	O	120	24-hr	0.471	0.39%	0.720	0.60%				
		M	70	Annual	0.041	0.06%	0.046	0.07%				
PM_{10} *	N/A	M	50	24-hr	0.471	0.94%	0.720	1.44%	32.4	64.7	32.6	65.2
$PM_{2.5}$ *	N/A	M	30	24-hr	0.471	1.57%	0.72	2.4%	21.4	71.3	21.6	72.2
		C	27	24-hr		1.74%		2.67%		79.2		80.2
		C	8.8	Annual	0.041	0.46%	0.046	0.52%	6.17	70.1	6.17	70.1
Ammonia	7664-41-7	O	100	24-hr	0.241	0.241%	0.368	0.368%				
Carbon Disulphide	75-15-0	O	330	24-hr	0.002	0.001%	0.003	0.001%				
Carbonyl Sulphide	473-58-1	O	13	24-hr	0.003	0.108%	0.005	0.165%				
SO_2	7446-09-5	O	690	1-hr	1.813	0.263%	1.974	0.286%	34.9	5.1%	35.1	5.1%
		C	270	1-hr		1.066%		1.161%		20.5%		20.6%
		O	275	24-hr	0.224	0.082%	0.343	0.125%	33.3	12.1%	33.5	12.2%
		C	10	Annual	0.016	0.193%	0.022	0.218%	22.5	225%	22.5	225%
CO	630-08-0	O	6000	30-min	29.8	0.496%	32.4	0.540%				
NOx	10102-44-0	O	400	1-hr	29.9	7.5%	32.5	8.1%				
		C	78	1-hr		38.3%		41.7%				
		O	200	24-hr	3.693	1.8%	5.648	2.8%				
		C	22	Annual	0.318	1.4%	0.358	1.6%				
Nickel	7440-02-0	O	0.04	Annual	0.001	2.1%	0.001	2.3%				
		O	2	24-hr	0.010	0.5%	0.015	0.7%				
Copper	7440-50-8	O	50	24-hr	0.001	0.001%	0.001	0.002%				
Cobalt	7440-48-4	O	0.1	24-hr	0.000137	0.015%	0.000209	0.023%				
Arsenic	7440-38-2	O	0.3	24-hr	0.000240	0.080%	0.000367	0.122%				
Lead	7439-92-1	O	0.5	24-hr	0.000061	0.012%	0.000094	0.019%				
		O	0.2	30-day	0.000012	0.006%	0.000015	0.007%				
Silver	7440-22-4	O	1	24-hr	0.0000003	0.00003%	0.0000005	0.00005%				
Iron	7439-89-6	O	4	24-hr	0.057	1.4%	0.087	2.2%				

* No emission factor was available for particulate matter fractions, so conservatively assumed all particulate matter was PM_{10} and $PM_{2.5}$.

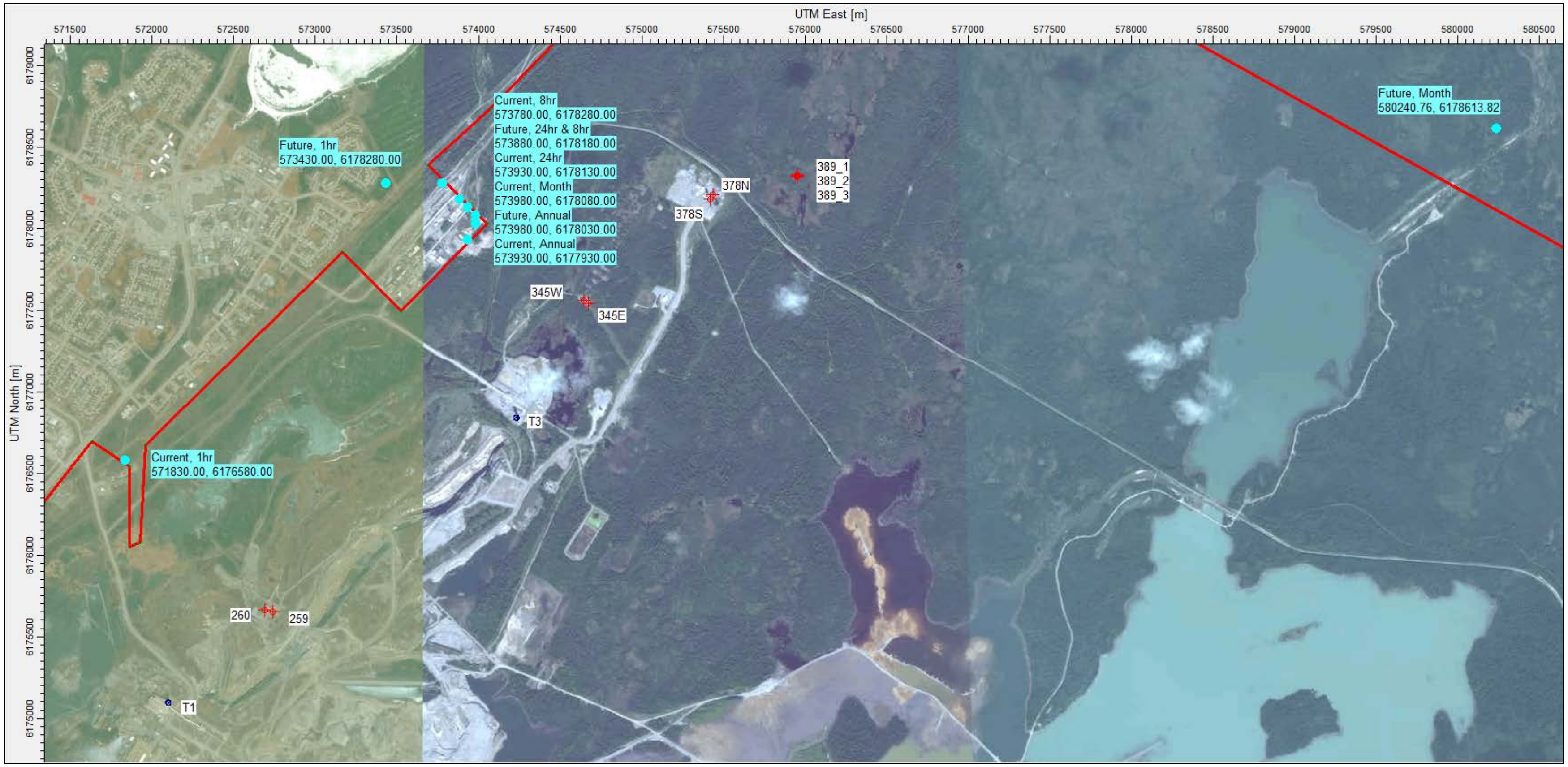

Figure 12: Location of the Maximum Points of Impingement (POIs)

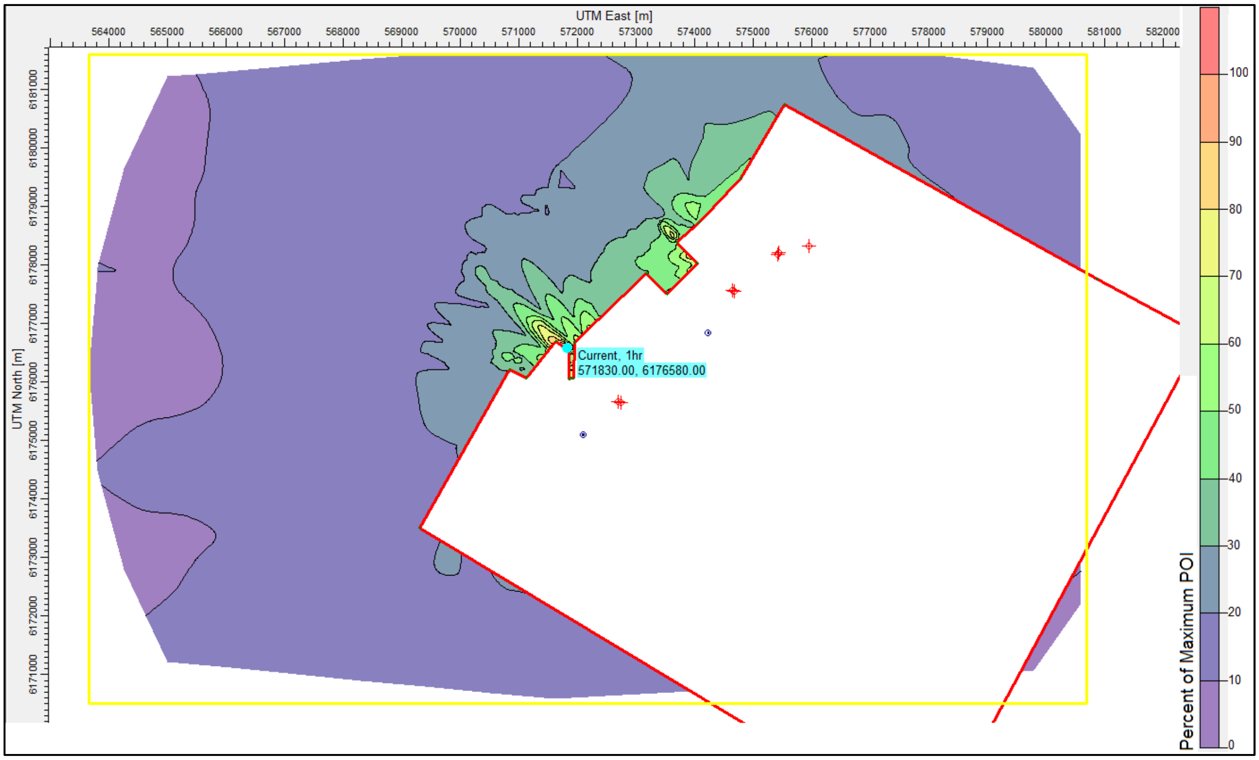

Figure 13: Isopleth – Current, 1hr

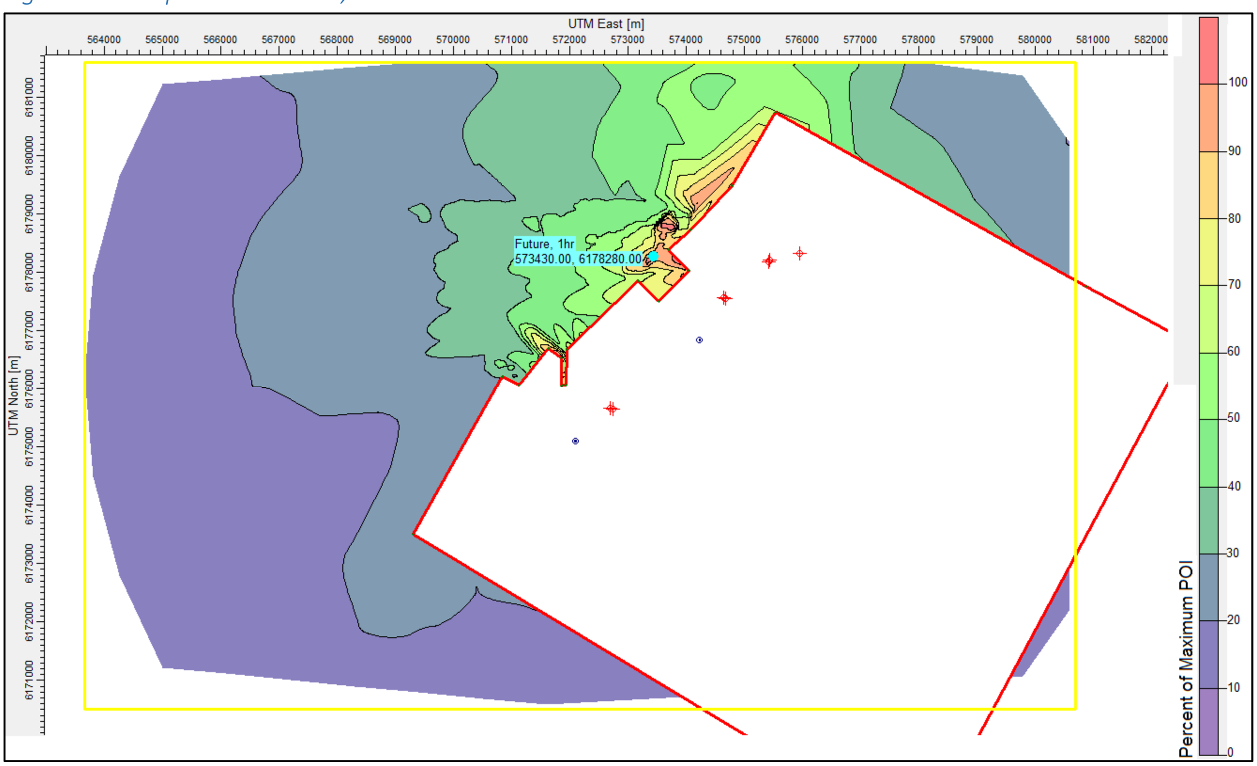

Figure 14: Isopleth – Future, 1hr

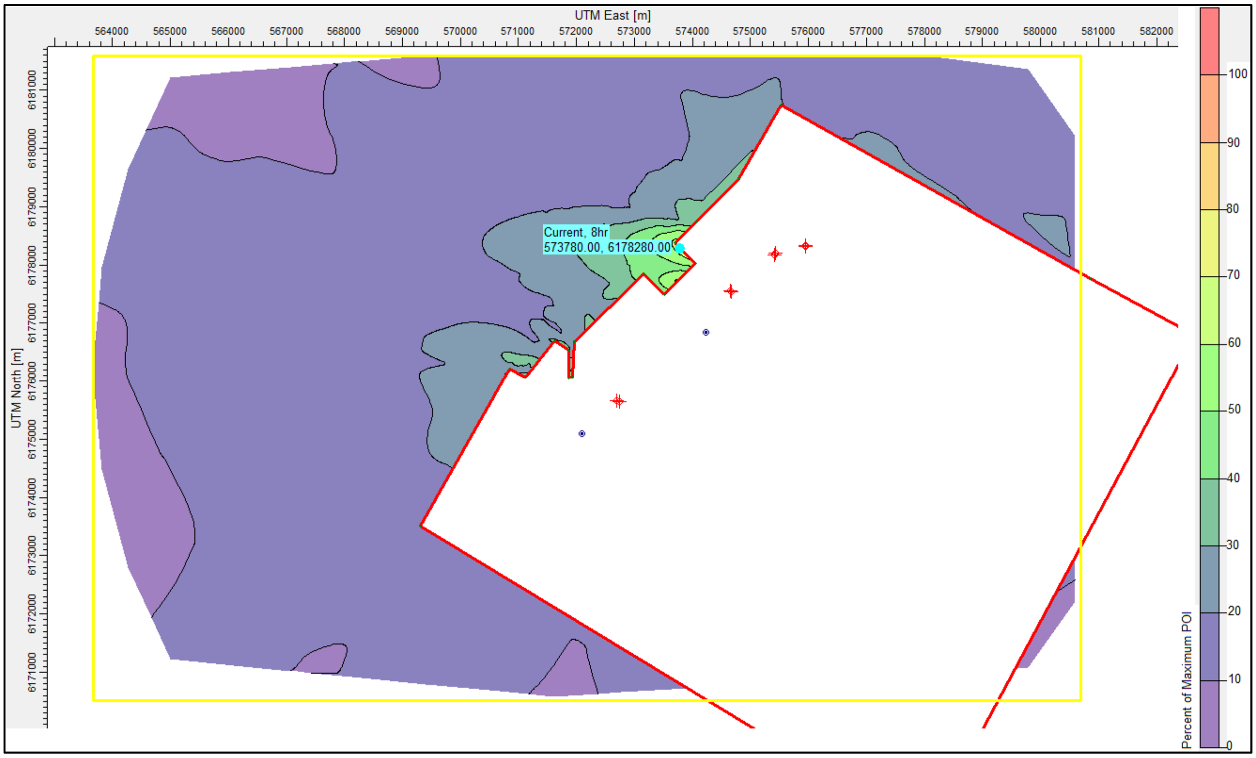

Figure 15: Isopleth – Current, 8hr

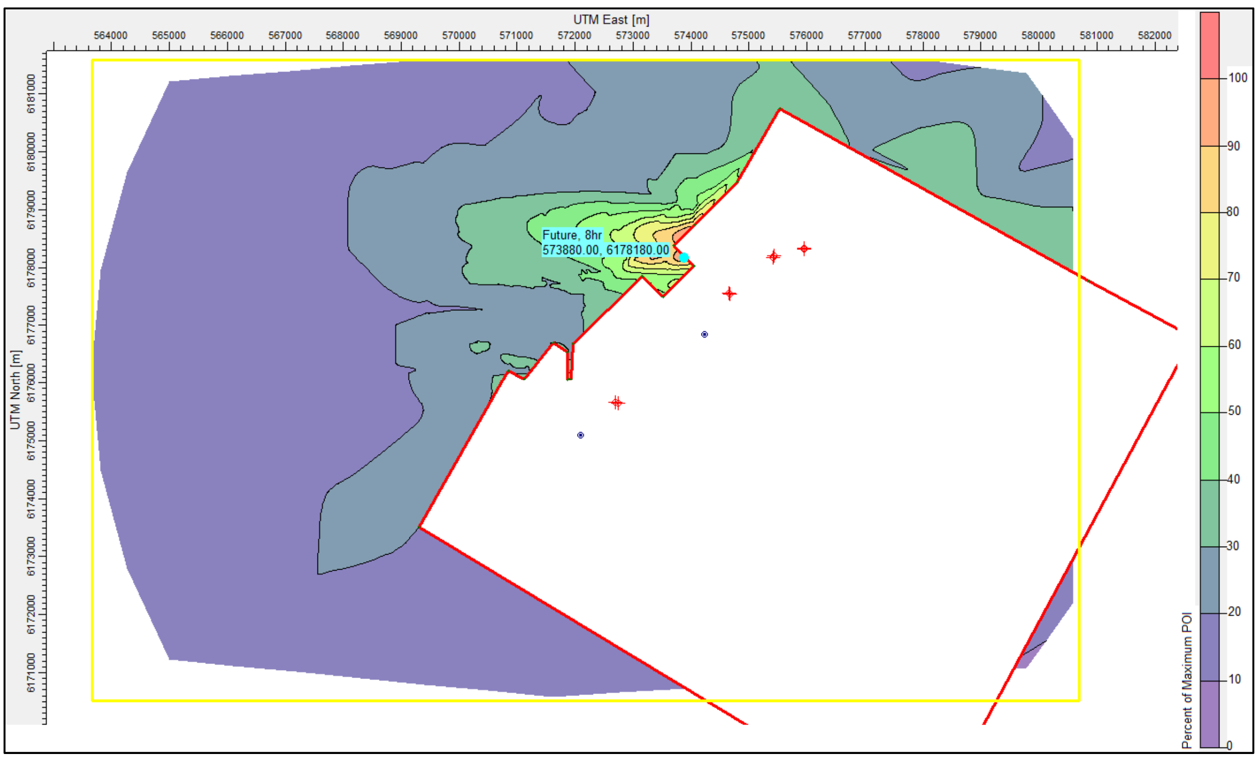

Figure 16: Isopleth – Future, 8hr

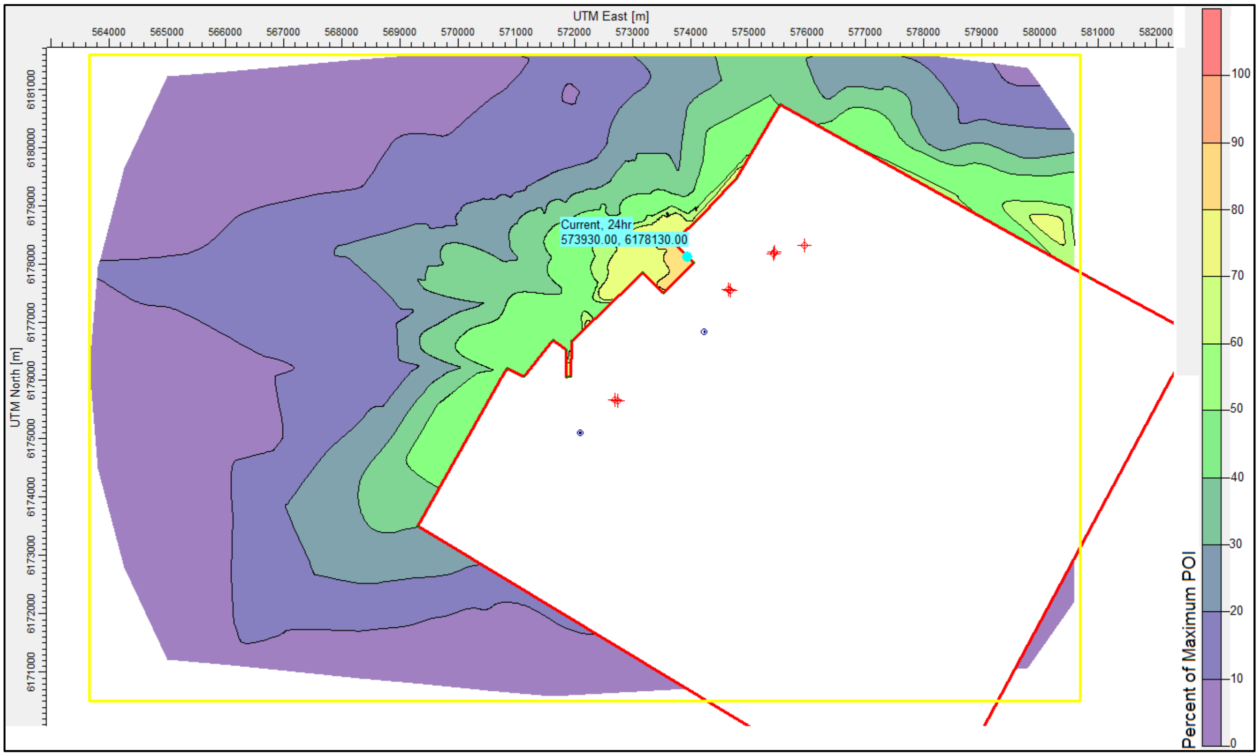

Figure 17: Isopleth – Current, 24hr

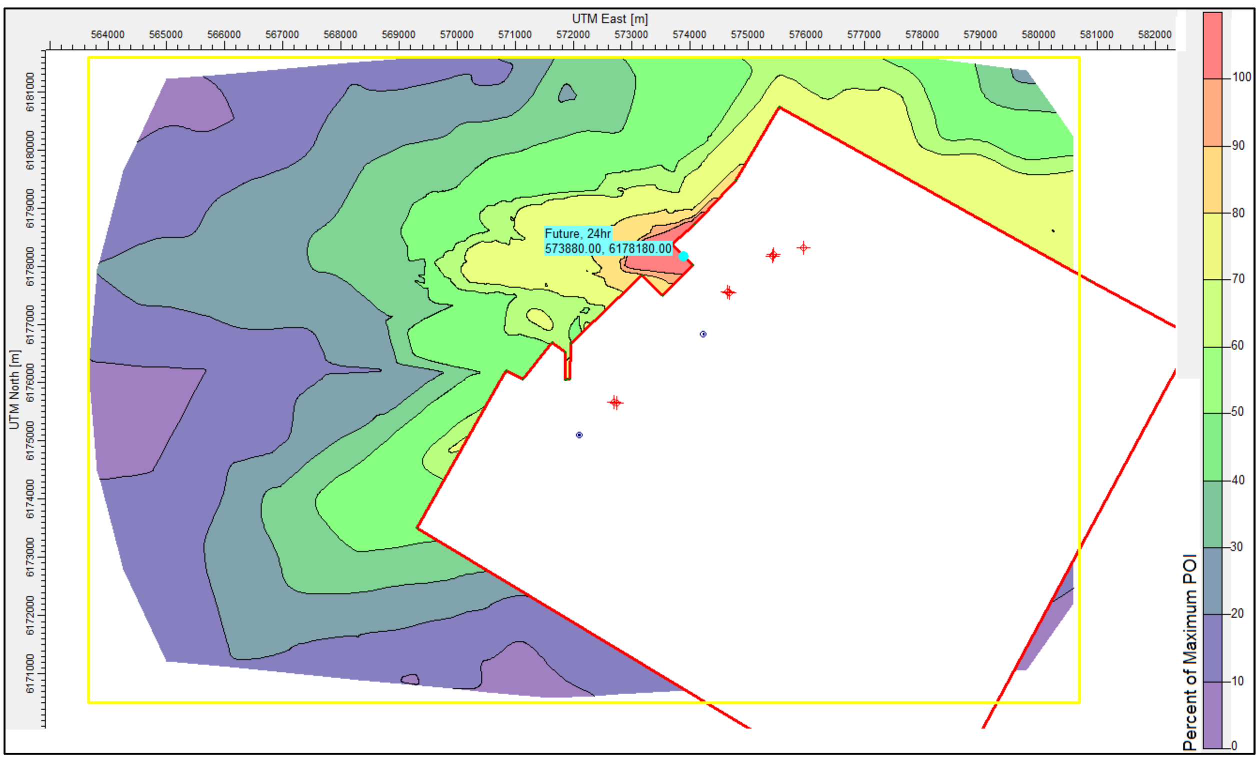

Figure 18: Isopleth – Future, 24hr

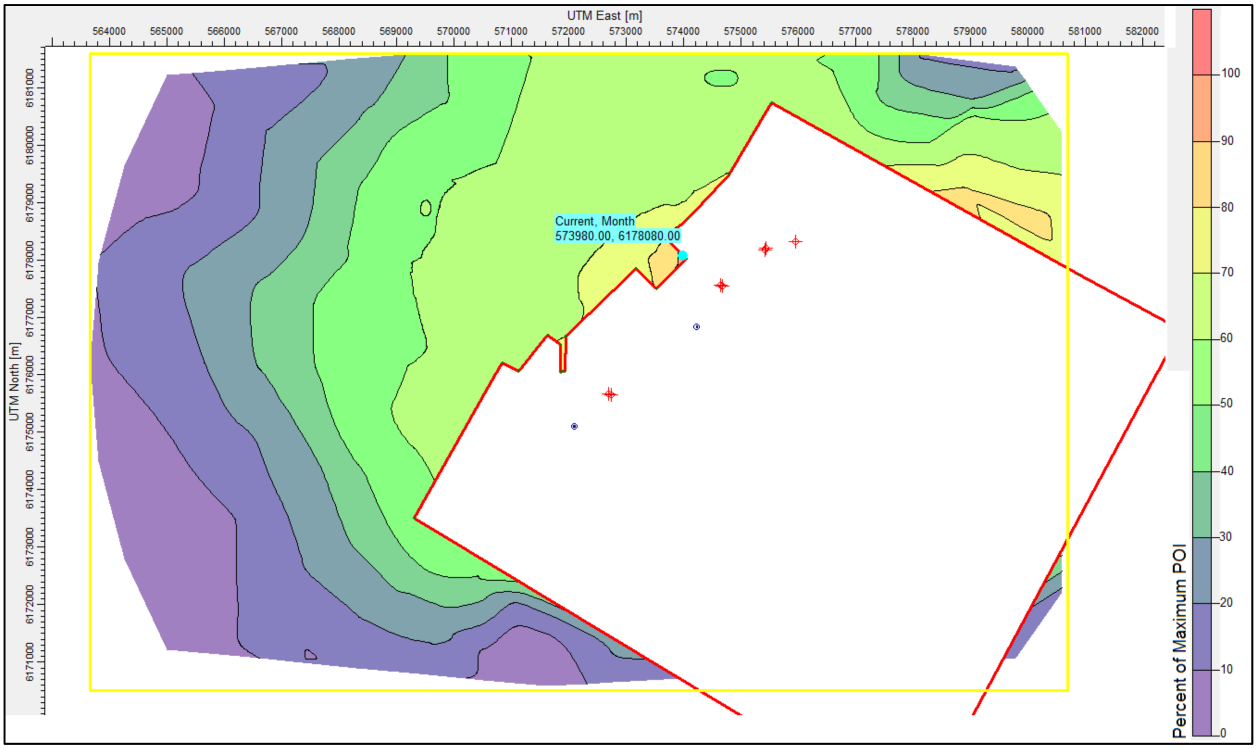

Figure 19: Isopleth – Current, Monthly

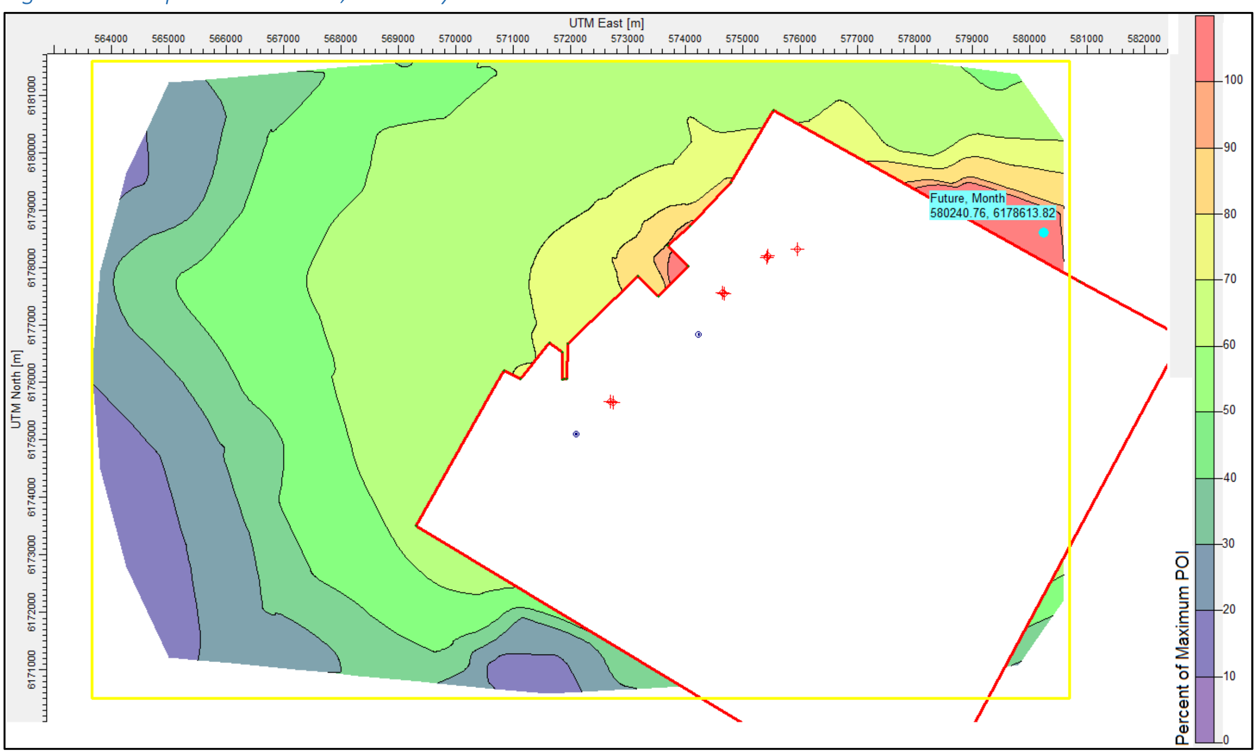

Figure 20: Isopleth – Future, Monthly

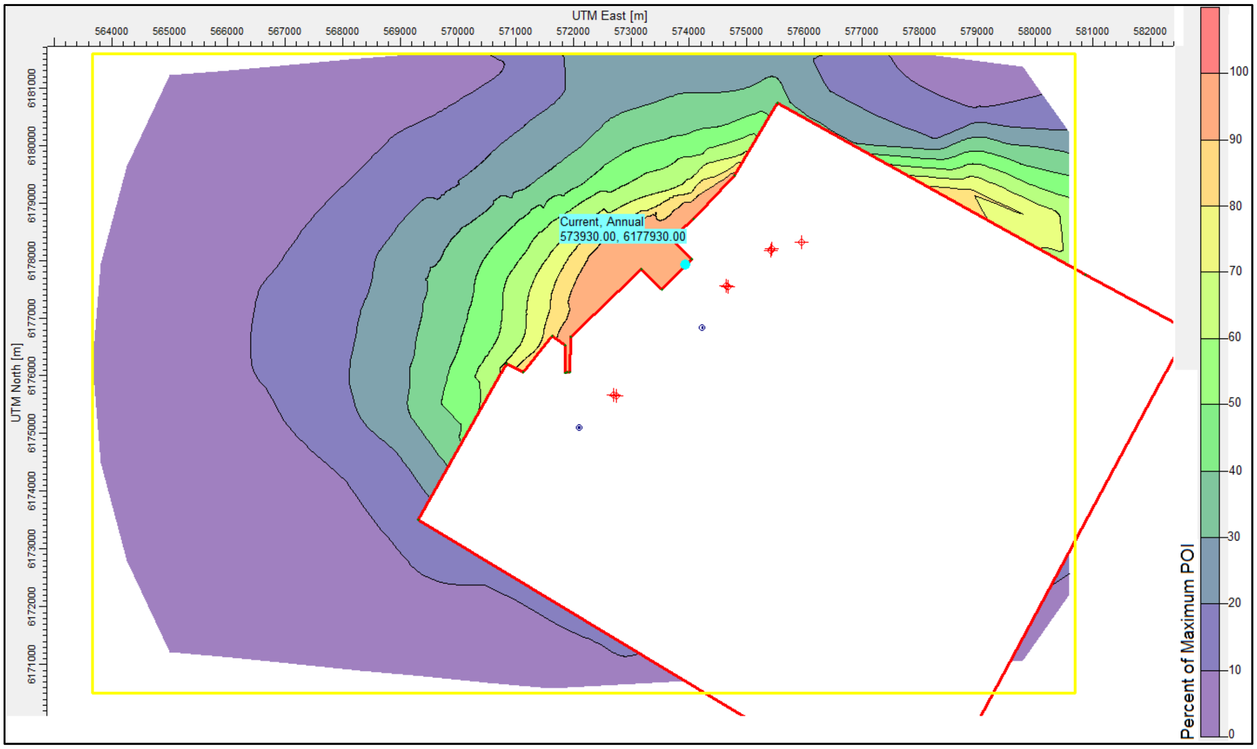

Figure 21: Isolpleth – Current, Annual

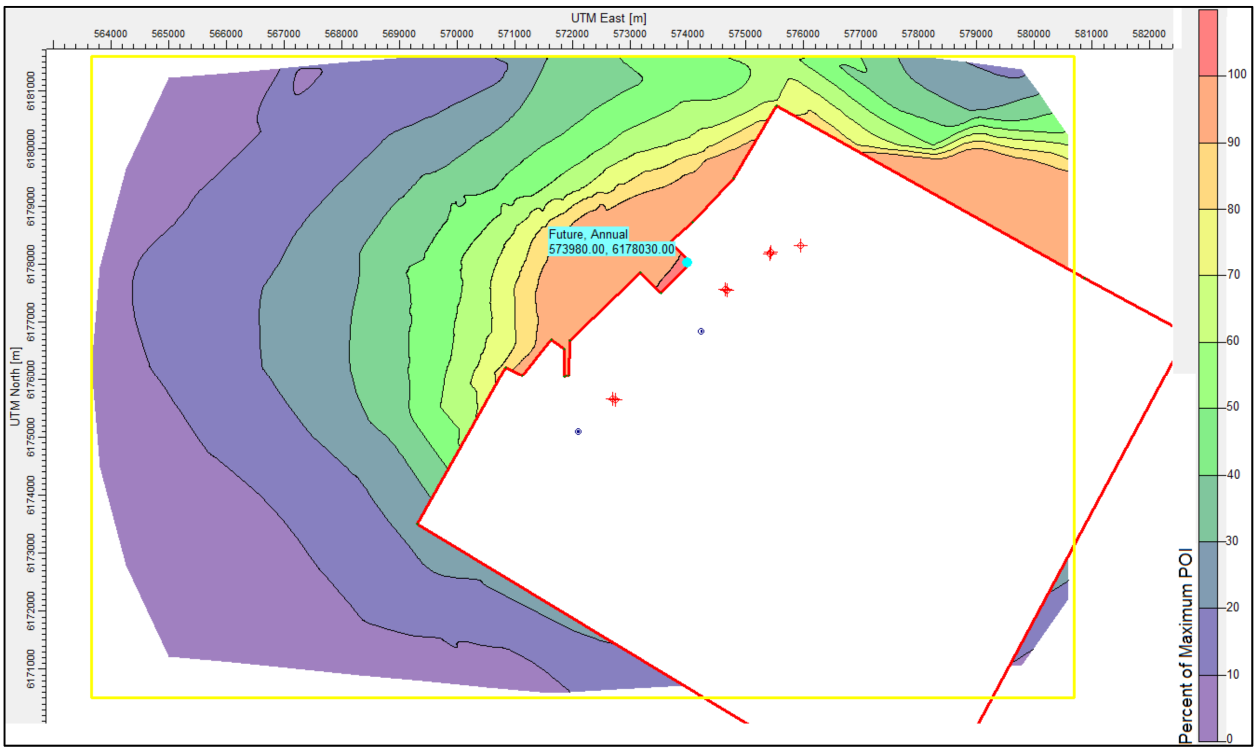

Figure 22: Isopleth – Future, Annual

3.2 Health Risk Assessment

Only required upon request. Note that although they are environmental standards, the Ontario Air Contaminant Benchmarks are generally health based.

4.0 Conclusion

This dispersion modelling assessment was conducted to determine the change in air contaminants in the community associated with the Thompson Mine Expansion Project Phase 1. The only source of emissions associated with the Project were Return Air Raises, and so the focus of this study was on Return Air Raises only.

The dispersion modelling indicated that for any contaminant assessed using the 1-hr averaging period, the future impact would be 9% higher than the current impact; using the 8-hr averaging period, the future impact would be 55% higher than the current impact; using the 24-hr averaging period, the future impact would be 53% higher than the current impact; using the 30-day averaging period, the future impact would be 26% higher than the current impact; and using the annual averaging period, the future impact would be 13% higher than the current impact.

Looking at the future scenario, compared against the Ontario Air Contaminant Benchmarks, the highest impact relative to the standard was NOx (1hr) at 8%; compared against the Canadian Ambient Air Quality Standards, the highest impact relative to the standard was NOx (1hr) at 42%. When background particulate and SO_2 were incorporated in the assessment, compliance against the Ontario, Manitoba and Canadian standards was maintained except for the annual impact of SO_2 compared to the Canadian standard. The background level, at 22.5 µg/m^3, is already 2 times the standard and the SO_2 emission impact from the mine return air raises was negligible in comparison.

The assessment found that the air emission changes associated with the Thompson Mine Expansion Project would not present any additional risk to the environment.

Appendix A – Develop 5YR Meteorological Data Set, RWDI, 2019

REPORT

DEVELOP 5-YR METEOROLOGICAL DATASET

THOMPSON, MANITOBA

RWDI # 1501664

May 9, 2019

SUBMITTED TO

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VERSION HISTORY

Index	Date	Pages	Author
1	May 7, 2019	All	Julia Veerman, EIT

1 INTRODUCTION

RWDI was retained by Vale to process and analyze five years of meteorological data to use in AERMOD dispersion modelling. The data were for the Thompson, Manitoba facility. This report presents the methodology to process the data and provides a short discussion of the data analysis.

This methodology is an update to previous work conducted for Vale that was reported in "Thompson Footwall Deep FEL 3 Study; Ventilation Feasibility Study; Dispersion Modelling" (Stantec, June 2015), provided as an appendix to this report (Appendix A).

2 METEOROLOGICAL DATA SOURCE

Meteorological data were obtained for five calendar years, 2012 to 2016. This is consistent with the guidance for a refined assessment in *Draft Guidelines for Air Dispersion Modelling in Manitoba* (Manitoba Clean Environment Commission, November 2006). Surface station data were obtained from Environment Canada at the Thompson Airport station. Upper Air Data were obtained from NCDC for The Pas Airport. Table 1 summarizes the site information for the data from each station.

Table 1: Meteorological Station Information

Station Parameter	Surface Station	Upper Air Station
Station Name	Thompson Airport	The Pas Airport
Station ID	5062922 (2012 to Nov. 5, 2014) 5062921 (Nov. 5, 2014 onwards)	25004
Station Operator	Environment Canada	Environment Canada
Location (Latitude, Longitude)	55.80°N, 97.86°W	53.97°N, 101.1°W
Elevation	218 (2012 to Nov. 5, 2014) 224 (Nov 5, 2014 onwards)	-
Data Period	January 2012 to December 2016	January 2012 to December 2016
Parameters	Wind speed, Wind direction, Total opacity[1], Dry bulb temperature	Dry bulb temperature
Data Format	SAMSON met file	FSL met file

Note: [1] As the Thompson Airport surface data were missing cloud cover data, cloud opacity data were used to substitute the cloud cover data.

3 METEORLOGICAL DATA PROCESSING

Site-specific meteorological data are influenced by various parameters, such as surface land use. The surface and upper air data were processed to account for seasonal surface land use using AERMET version 18081 (US EPA, April 2018). The same land use sector data that were used in the 2015 Stantec report (Appendix A) were used to process these data. For the purpose of this study, winter was considered to be November to March; spring was considered to be April to May; Summer was considered to be June to August; and Autumn was considered to be September to October. Table 2 summarizes the surface sectors applied to the site data.

Table 2: Summary of Surface Parameters for Each Sector, by Season

Sector	Season	Albedo	Bowen Ratio	Surface Roughness (m)
353° to 72°	Winter	0.400	1.500	0.720
	Spring	0.123	0.595	0.923
	Summer	0.120	0.295	1.045
	Autumn	0.127	0.785	0.841
72° to 195°	Winter	0.375	1.500	0.488
	Spring	0.165	0.625	0.650
	Summer	0.155	0.675	0.725
	Autumn	0.165	0.975	0.600
195° to 257°	Winter	0.429	1.500	0.788
	Spring	0.147	0.745	1.023
	Summer	0.144	0.555	1.150
	Autumn	0.144	1.065	0.938
257° to 353°	Winter	0.393	1.500	0.790
	Spring	0.128	0.700	0.943
	Summer	0.131	0.730	1.035
	Autumn	0.141	1.100	0.881

4 ANALYSIS OF THE DATA

A discussion on the processed meteorological data is provided in this section.

4.1 Missing Data

The *Draft Guidelines for Air Dispersion Modelling in Manitoba* (Manitoba Clean Environment Commission, November 2006) require "any meteorological data gaps to be identified as well as how they were dealt with". Table 3 summarizes the total number of hours missing from the surface station data. Ceiling height data from 2015 were the most incomplete, missing data for about 10% of the year. Data for the other years were missing less than 5% of the year. The periods with six or more consecutive hours missing were:

- March 20, 2012 (15:00) to March 21, 2012 (06:00);
- July 12, 2014 (08:00) to July 12, 2014 (19:00);
- August 2, 2014 (16:00) to August 2, 2014 (22:00) (missing 6 hours of ceiling height only);
- April 7, 2015 (19:00) to April 28, 2015 (18:00);
- May 6, 2015 (24:00) to May 7 (06:00) (missing 6 hours of ceiling height only);
- October 30, 2015 (24:00) to October 31, 2015 (06:00) (missing 6 hours of ceiling height only);
- Feb 3, 2016 (10:00) to Feb 3, 2016 (15:00);
- March 22, 2016 (18:00) to March 23, 2016 (03:00)
- July 5, 2016 (04:00) to July 5, 2016 (13:00) (missing 6 hours of ceiling height only);
- October 5, 2016 (09:00) to October 5, 2016 (23:00) (missing 6 hours of ceiling height only);
- December 20, 2016 (12:00) to December 20, 2016 (19:00) (missing 6 hours of ceiling height only).

Missing data were not filled for this assessment.

Table 3: Total Hours the Surface Station was Missing Data, by Year

Year	Dry Bulb Temperature	Wind Direction	Wind Speed	Ceiling Height
2012	244	219	219	301
2013	247	221	221	294
2014	295	268	268	375
2015	761	741	741	865
2016	261	244	244	370
Total	***1808***	***1693***	***1693***	***2205***

4.2 Atmospheric Stability

PCRAMMET was used to analyze the atmospheric stability for the five-year period. Table 4 summarizes the distribution of atmospheric stability by season. Figure 1 shows the average distribution over the five-year period. In general, the stability trends follow what is expected, with stable conditions at night and colder seasons, and less stable during daytime and warmer seasons.

Table 4: Distribution of Atmospheric Stability, by Season

Season	Highly Convective (A)	Moderately Convective (B-C)	Neutral (D)	Stable (E-F)
Winter	0.00%	0.87%	6.21%	92.92%
Spring	0.26%	8.45%	17.24%	74.05%
Summer	0.29%	9.70%	17.76%	72.25%
Autumn	0.03%	1.59%	8.17%	90.22%
Annual	***0.12%***	***4.50%***	***11.31%***	***84.07%***

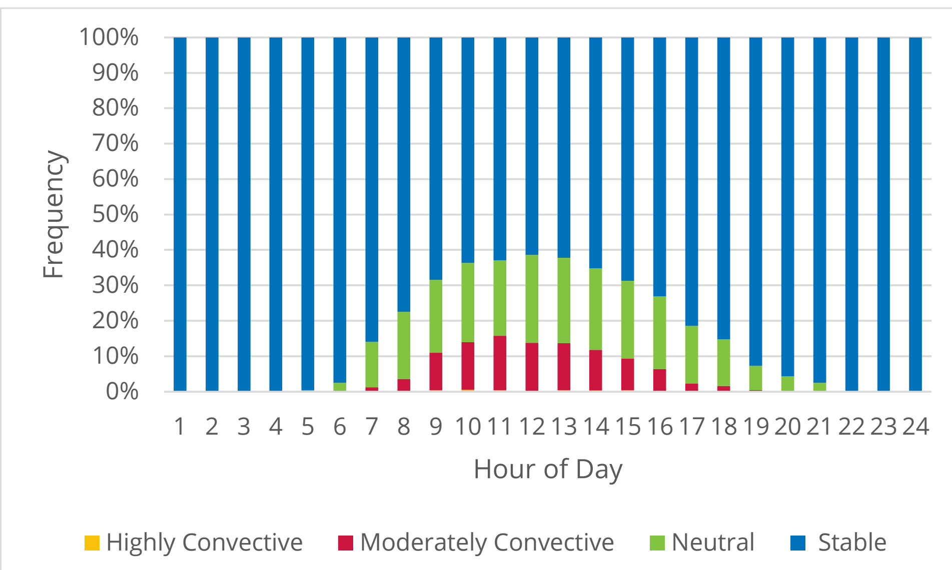

Figure 1: Distribution of Atmospheric Stability by Hour of Day

4.3 Wind Speed and Direction

A wind rose of the five years of surface data is shown in Figure 2. A wind rose is a bar chart in polar format used to depict the frequency of occurrence of various wind speed classes and wind directions. It shows the direct that winds are blowing from. Winds were most frequently from the west. They are commonly from the northwest and north. The most common wind speeds were 2.0 to 4.0 m/s.

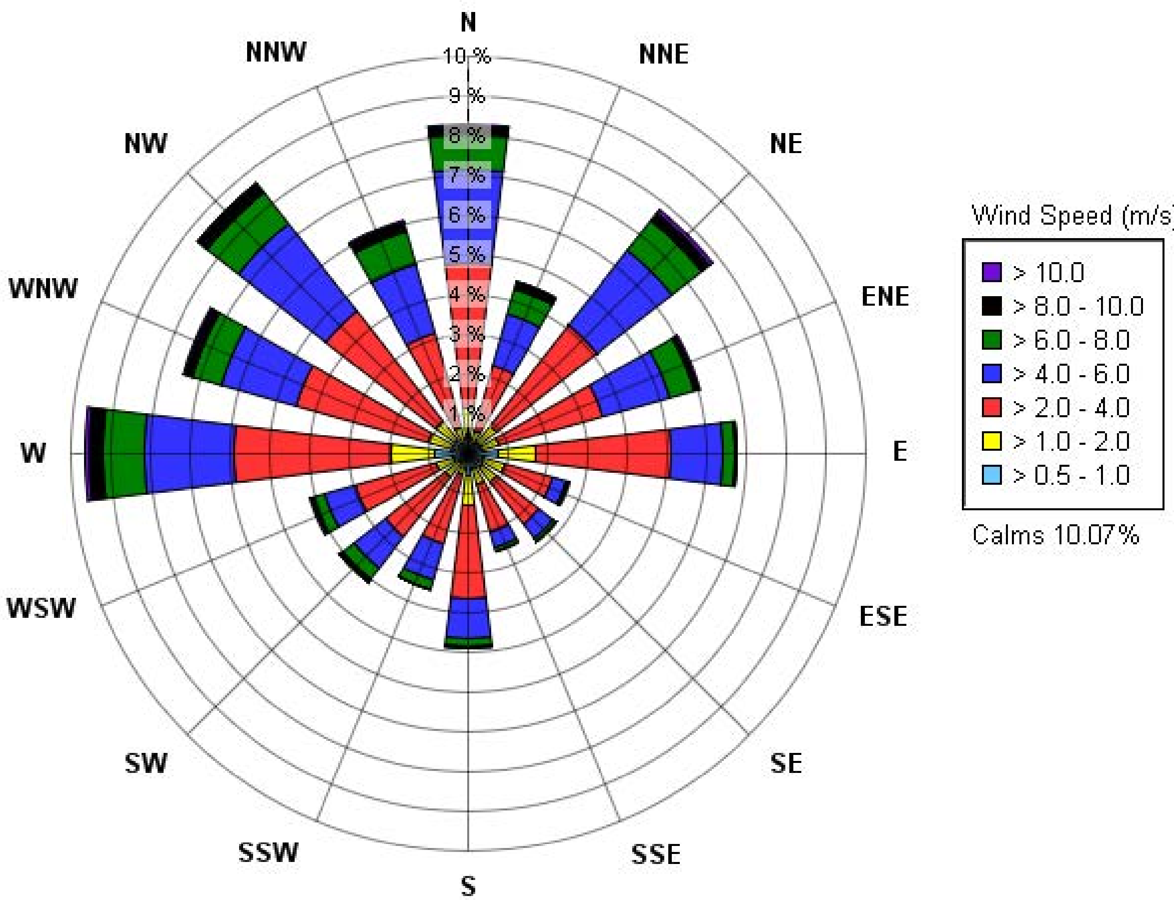

Figure 2: Wind Rose of 5-years of Data from Thompson Airport

5 CONCLUSION

RWDI was retained by Vale to process and analyze five years of meteorological data to use in AERMOD dispersion modelling for the Thompson, Manitoba facility. Meteorological data were obtained for five calendar years, 2012 to 2016. With the exception of 2015, less than 5% hourly records were missing from the surface station. Less than 10% of the hourly records were missing for 2015. Missing data were not filled for this assessment.

Atmospheric stability and wind speed and direction were examined for this assessment. In general, seasonal and hourly stability variations trend as expected, with stable conditions at night and colder seasons, and less stable during daytime and warmer seasons. Winds were predominantly from the west, northwest and north, with a common wind speed range of 2.0 to 4.0 m/s.

6 REFERENCES

Air Quality Section, Programs Division, Manitoba Clean Environment Commission. (November 2006). *Draft Guidelines for Air Dispersion Modelling in Manitoba*. Retrieved from: https://gov.mb.ca/sd/pubs/climate-air-quality/mb-air-dm-guidelines.pdf.

Stantec – Mining. (June 15, 2015). *Thompson Footwall Deep FEL 3 Study; Ventilation Feasibility Study; Dispersion Modelling*.

APPENDIX A

Project No. 169514559 16 June 2015

PREPARED FOR:

Vale Canada Limited

CONCERNING:

Thompson Footwall Deep FEL 3 Study
Ventilation Feasibility Study
Dispersion Modelling

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DISPERSION MODELLING

REVISION NOTES

Revision	Date	Description	Originator
A	20-May-2015	Document Initiated	Allan Prits
A1	20-May-2015	Issued for Internal Review	Allan Prits
A2	21-May-2015	Comments Incorporated	Allan Prits
B	25-May 2015	Issued for Vale Review	Allan Prits
B1	8-June-2015	Issued for Approval	Allan Prits
C	16-June-2015	Issued as Final	Allan Prits

REVISION APPROVAL

Revision	Designation	Reviewer	Date	Signature
C	Originator	Connie Lim	16-June-2015	
C	Environment Specialist	Allan Prits	16-June-2015	
C	Ventilation Specialist	Jacques Jodouin	16-June-2015	
C	Project Manager	Noris Del Bel Belluz	16-June-2015	
C	Vale Approval			

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List of Tables and Figures

Tables

Figures

1.0 INTRODUCTION

Stantec Consulting Ltd (Stantec) was retained by Vale Canada Limited (Vale) to investigate the potential for re-entrainment of mine exhaust air for the Thompson Footwall Deep FEL3 Study for the Thompson Mine located in Thompson, Manitoba. The site of the Vale Thompson Mine is located to the southeast of the City of Thompson, Manitoba. Based on the Ventilation Concept Design, there are four stages of the ventilation design. Table 1.1 presents the current and the proposed four stages of the ventilation design and the exhausts and intakes associated with each stage.

Table 1.1 Ventilation Design Stages and Associated Exhausts and Intakes

<table>
<tr><th>Stage</th><th>Period</th><th>Exhausts</th><th>Intakes</th></tr>
<tr><td>Current</td><td>Current</td><td rowspan="2">T1
T3
259 RAR
260 RAR
345 RAR (2 exhausts – west and east) [a]
378 RAR
(2 exhausts – north and south)</td><td>234 FAR
235 FAR
310 FAR
311 FAR
354 FAR</td></tr>
<tr><td>Stage 1</td><td>2015 - 2018</td><td>234 FAR
235 FAR
310 FAR
311 FAR
354 FAR</td></tr>
<tr><td>Stage 2</td><td>2019 - 2020</td><td rowspan="3">T1
T3
259 RAR
260 RAR
378 RAR
(2 exhausts – north and south)
389 RAR
(2 exhausts – north and south) [c]</td><td rowspan="3">234 FAR
235 FAR
310 FAR
311 FAR
354 FAR
377 FAR [b]
345 FAR
(2 exhausts – west and east) [a]</td></tr>
<tr><td>Stage 3</td><td>2021 - 2022</td></tr>
<tr><td>Stage 4</td><td>2023 - 2025</td></tr>
</table>

Notes:

a. Currently and for Stage 1, 345 is an exhaust (Return Air Raise (RAR)). From Stage 2 to Stage 4, 345 is an intake (Fresh Air Raise (FAR)).

b. 377 is currently a RFR (Rock Raise) for moving material. From Stages 2 to 4, it is a FAR.

c. 389RAR is a new exhaust, and is used in Stages 2 to 4.

Exhaust and intake locations and parameters (such as flow rates, elevations etc.) are presented in Section 2 Tables 2.1 to 2.6. The locations of the various exhausts and intakes are presented in Figures 2.1 to 2.4 in Section 2.

1.1 Purpose and Scope

The use of dispersion techniques was proposed for the analysis on how the exhaust stream from the Return Air Raises (RAR) bearing the contaminants from below grade operations may impact the supply air intakes of the Fresh Air Raises (FARs).

For the proposed dispersion analysis of the exhaust stream, the design of no re-entrainment was not a practical design target benchmark. By exhausting to the outdoor environment, the contaminant disperses and becomes part of the background air concentration. Even for dust/particulate, where larger particles effectively “drop out” gravimetrically with a decrease in along-the-plume velocity as they drift away from the initial plume delivered to the atmosphere, extremely fine particulates remain buoyant in the complex atmospheric flow streams. Buoyancy of fine particles depends on more complex movement than just wind direction and speed. Ultimately, particulates in some smaller concentration that remains invisible to the naked eye can be carried far into the atmosphere. In any analysis of the constituents of a mine exhaust stream, it is a reality that in any particulate size analysis, very fine “smoke” like particulates will exist, and those have the potential for transport far from the discharge point.

Site information regarding the anticipated speciated make-up of the exhaust stream for the Vale Thompson mine to enable understanding of the specific airborne contaminants of concern for any possible re –entrainment was not available.

It was agreed that the dilution factor analysis approach with conventional dispersion tools was to be utilized as per Request for Information RFI-008-014559 (refer to Appendix B for the Vale Request for Information response). The geometry set up will model the exhaust shafts as the discharges, and critical receptors will be established and analyzed at each of the intake locations associated with each stage of the ventilation design. The receptor elevation is set at the top of the intake based on information provided by the project team. The model will predict dispersion of the exhaust discharges as it encounters a representative 5-year (hour by hour) meteorological dataset. The maximum impingement of exhaust on the intake receptor occurring during the 5 year meteorological conditions will be identified. Further analyses on the source contribution at selected intake receptors will be carried out if necessary. For example, it may be of benefit to identify the impact of each exhaust on any intakes that could be identified to potentially be of concern.

This report provides an explanation of how the dilution model results provided by Stantec, of the currently proposed exhaust and inlet locations can be used by Vale to assess and quantify the potential for the inlets to be contaminated by the exhausts. Refer to further discussion of the use of the dilution factor in Section 4.0 Summary and Conclusions. The project team for the Vale Thompson mine can consider the dilution of the exhaust stream, as it would impact the intakes, when determining potential issues of re-entrainment of mine exhaust.

2.0 DISPERSION MODELLING

2.1 Source Parameters and Emission Rates

A site layout identifying the location of the exhaust fans and fresh air intakes are provided in Appendix A. Dispersion modelling was done based on ventilation at full capacity. At full capacity, all exhaust fans will be operating. Table 2.1 presents a summary of the parameters used in the modelling for the exhaust fans based on Request for Information RFI-011-14559 received from Vale (refer to Appendix B for the Vale Request for Information response). To identify potential intakes of concern for exhaust re-entrainment without detail exhaust stream speciation for contaminants, intakes are compared with exhausts modelled at a uniform 1 unit discharge rate. Air flowrates and emission rates used for the modelling are summarized in Tables 2.2 to 2.6.

Table 2.1 Source Parameters

ID	Description	Coordinates		Base Elevation (m)	Height above base (m)	Stack Type/ Configuration	Stack Diameter/ Equivalent Diameter (m)	Exit Temperature (°C)
		UTM E (m)	UTM N (m)					
T1	T1 Shaft	572100	6175094	213.1	106.7	Rectangular Vertical	6.5	20
T3	T3 Shaft	574239	6176839	197.6	99.1	Rectangular Vertical	5.3	20
259RAR	259 Return Air Raise	572694	6175662	200.0	3.7	Round Horizontal	2.9	20
260RAR	260 Return Air Raise	572751	6175679	200.0	3.7	Round Horizontal	3.8	20
345RAR_W[a]	345 Return Air Raise – only currently and for Stage 1 (2 exhausts – west and east)	574647	6177558	200.3	1.8	Round Horizontal	2.7	20
345RAR_E[a]		574672	6177542	200.3	1.8	Round Horizontal	2.7	20
378RAR_N	378 Return Air Raise (2 exhausts – north and south)	575432	6178207	212.2	3.3	Round Horizontal	3.9	20
378RAR_S		575416	6178179	212.2	3.3	Round Horizontal	3.9	20
389RAR_N[b]	New Return Air Raise (2 exhausts north and south)	575914	6178326	201.2	12.1	Rectangular Horizontal	3.2	20
389RAR_S[b]		575903	6178311	201.2	12.1	Rectangular Horizontal	3.2	20

Notes:

a. Currently and for Stage 1, 345 is an exhaust (Return Air Raise). From Stage 2 to Stage 4, 345 is an intake (Fresh Air Raise).

b. 389RAR is a new exhaust, and is used in Stages 2 to 4.

Table 2.2 Source Air Volumes and Emission Rates – Current

ID	Description	Current		
		Air Volume (cfm)	Exit Velocity (m/s)	Emission Rate (g/s)
T1	T1 Shaft	70000	0.99	1
T3	T3 Shaft	40000	0.85	1
259RAR	259 Return Air Raise	280000	20.1	1
260RAR	260 Return Air Raise	280000	11.9	1
345RAR_W	345 Return Air Raise (2 exhausts)	140000	11.2	1
345RAR_E		140000	11.2	1
378RAR_N	378 Return Air Raise (2 exhausts)	500000	19.4	1
378RAR_S		500000	19.4	1
389RAR_N	New 389 Return Air Raise (2 exhausts)	N/A	N/A	N/A
389RAR_S		N/A	N/A	N/A

Table 2.3 Source Air Volumes and Emission Rates – Stage 1

ID	Description	Stage 1		
		Air Volume (cfm)	Exit Velocity (m/s)	Emission Rate (g/s)
T1	T1 Shaft	70000	0.99	1
T3	T3 Shaft	40000	0.85	1
259RAR	259 Return Air Raise	280000	20.1	1
260RAR	260 Return Air Raise	280000	11.9	1
345RAR_W	345 Return Air Raise (2 exhausts)	109500	8.7	1
345RAR_E		109500	8.7	1
378RAR_N	378 Return Air Raise (2 exhausts)	400000	15.5	1
378RAR_S		400000	15.5	1
389RAR_N	New 389 Return Air Raise (2 exhausts)	N/A	N/A	N/A
389RAR_S		N/A	N/A	N/A

Notes:

a. Air flows for shafts and RARs for all stages were provided in the "Vale Canada Limited, Thompson Footwall Deep FEL 3 Study, 100% Ventilation Concept" Presentation.

b. Emission rates at all shafts and RARs are assumed to be a unit emission rate of 1 g/s for modelling purposes.

c. A combined air flow was provided for 259 RAR and 260 RAR. The air flow is assumed to be equally split between the two RARs for modelling purposes.

Table 2.4 Source Air Volumes and Emission Rates – Stage 2

ID	Description	Stage 2		
		Air Volume (cfm)	Exit Velocity (m/s)	Emission Rate (g/s)
T1	T1 Shaft	70000	0.99	1
T3	T3 Shaft	40000	0.85	1
259RAR	259 Return Air Raise	250000	17.9	1
260RAR	260 Return Air Raise	250000	10.6	1
345RAR_W	345 Return Air Raise (2 exhausts)	N/A	N/A	N/A
345RAR_E		N/A	N/A	N/A
378RAR_N	378 Return Air Raise (2 exhausts)	386500	15.0	1
378RAR_S		386500	15.0	1
389RAR_N	New 389 Return Air Raise (2 exhausts)	431000	25.3	1
389RAR_S		431000	25.3	1

Table 2.5 Source Air Volumes and Emission Rates – Stage 3

ID	Description	Stage 3		
		Air Volume (cfm)	Exit Velocity (m/s)	Emission Rate (g/s)
T1	T1 Shaft	70000	0.99	1
T3	T3 Shaft	40000	0.85	1
259RAR	259 Return Air Raise	250000	17.9	1
260RAR	260 Return Air Raise	250000	10.6	1
345RAR_W	345 Return Air Raise (2 exhausts)	N/A	N/A	N/A
345RAR_E		N/A	N/A	N/A
378RAR_N	378 Return Air Raise (2 exhausts)	375000	14.5	1
378RAR_S		375000	14.5	1
389RAR_N	New 389 Return Air Raise (2 exhausts)	434000	25.5	1
389RAR_S		434000	25.5	1

Notes:

a. Air flows for shafts and RARs for all stages were provided in the “Vale Canada Limited, Thompson Footwall Deep FEL 3 Study, 100% Ventilation Concept" Presentation.

b. Emission rates at all shafts and RARs are assumed to be a unit emission rate of 1 g/s for modelling purposes.

c. A combined air flow was provided for 259 RAR and 260 RAR. The air flow is assumed to be equally split between the two RARs for modelling purposes.

Table 2.6 Source Air Volumes and Emission Rates – Stage 4

ID	Description	Stage 4		
		Air Volume (cfm)	Exit Velocity (m/s)	Emission Rate (g/s)
T1	T1 Shaft	70000	0.99	1
T3	T3 Shaft	40000	0.85	1
259RAR	259 Return Air Raise	250000	17.9	1
260RAR	260 Return Air Raise	250000	10.6	1
345RAR_W	345 Return Air Raise (2 exhausts)	N/A	N/A	N/A
345RAR_E		N/A	N/A	N/A
378RAR_N	378 Return Air Raise (2 exhausts)	387000	15.0	1
378RAR_S		387000	15.0	1
389RAR_N	New 389 Return Air Raise (2 exhausts)	413000	24.3	1
389RAR_S		413000	24.3	1

Notes:

a. Air flows for shafts and RARs for all stages were provided in the "Vale Canada Limited, Thompson Footwall Deep FEL 3 Study, 100% Ventilation Concept" Presentation.

b. Emission rates at all shafts and RARs are assumed to be a unit emission rate of 1 g/s for modelling purposes.

c. A combined air flow was provided for 259 RAR and 260 RAR. The air flow is assumed to be equally split between the two RARs for modelling purposes.

As indicated in section 1.1 this study was based on determining a dilution factor indicating the amount of dilution under worst case conditions before the plume from the exhaust fans reaches the fresh air intake. Therefore the emission rates of each of the sources were assumed to be a unit emission rate (1.0 g/s). Based on this approach, the concentrations predicted at the receptor locations will be relative to the unit emission rates of the exhaust fans.

2.2 Model Domain and Receptor Grid

AERMOD dispersion model was used for this study. Dispersion modelling is typically based on a setup of sources and receptors where the model predicts concentration of contaminants at the receptor points based on the source parameters used in the model.

The main purpose of the study was to determine concentrations at the fresh air intakes, which require a single receptor point at the location and height of the intakes. The receptor heights were placed at the top of their respective air intake height above ground level. Therefore, the concentrations predicted at each receptor in this study are estimated at their respective intake height.

The elevation of the exhausts and intakes were provided by the Vale Thompson project team.

The table below presents the location and parameters of each receptor used in the model geometry. Figures 2.1 to 2.3 present the sources and intake (receptor) locations used in the modelling.

Table 2.7 Receptor Locations and Parameters

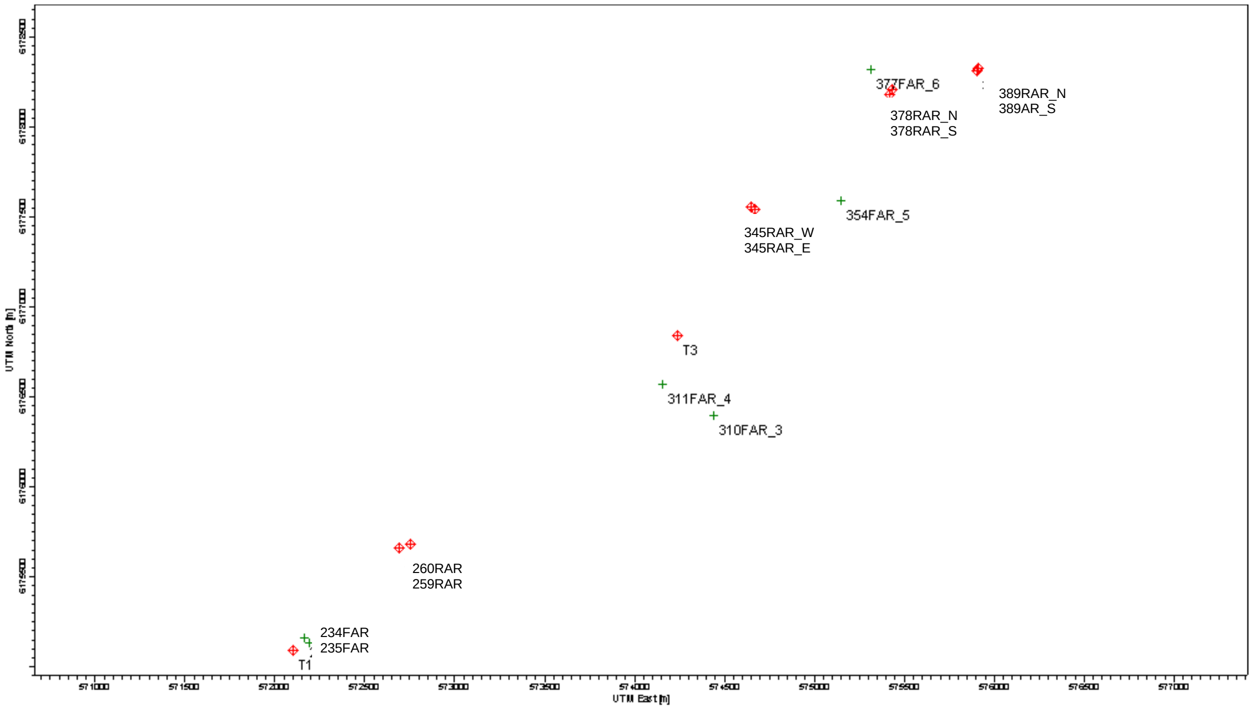
ID	Description	Coordinates		Base Elevation	Top of Intake	Height above grade
		UTM E (m)	UTM N (m)	(m)	(m)	(m)
234FAR	234 Fresh Air Raise	572166	6175163	213.1	215.9	2.7
235FAR	235 Fresh Air Raise	572194	6175137	213.1	217.4	4.3
310FAR	310 Fresh Air Raise	574437	6176400	200.3	207.6	7.3
311FAR	311 Fresh Air Raise	574154	6176568	179.7	184.0	4.3
354FAR	354 Fresh Air Raise	575151	6177591	212.2	215.2	3.0
377FAR [a]	377 Fresh Air Raise	575314	6178318	209.5	212.5	3.0
345FAR_West [b]	345 Fresh Air Raise – only for Stages 2 to 4	574648	6177557	200.3	202.1	1.8
345FAR_East [b]		574672	6177542	200.3	202.1	1.8

Notes:

a. 377FAR is currently a RFR, and will be a FAR from Stages 2 to 4.

b. 345FAR_West and 345FAR_East are RARs at Current and Stage 1 scenarios.

Figure 2.1Source and Receptor Locations



Legend: ⊕ Source + Receptor

Figure 2.2 Source and Receptor Locations – Closeup T1 Area

Figure 2.3 Source and Receptor Locations – Closeup T3 Area

Legend: ⊕ Source + Receptor Reference: Bing map

Figure 2.4 Source and Receptor Locations – Closeup 378RAR Area

Legend: ⊕ Source + Receptor **Reference:** Bing map

2.3 Building Downwash

Building wake effects were considered in this assessment using the U.S. EPA Building Profile Input Program (BPIP), a pre-processor to AERMOD. The inputs into this pre-processor include the coordinates and heights of the buildings and source stacks. The output data from BPIP is used in the AERMOD building wake effect calculations. Figures 2.5, 2.6, and 2.7 present three-dimensional representations of the buildings at selected areas, including the main plant area, the T3 area, and 378RAR area. It should be noted that only the structures with a potential of downwash effects were included in this modelling. For some of the equipment a conservative structure representing the external boundaries of the collection of the equipment was used.

Figure 2.5 Three-Dimensional Building Layout at Main Plant Area

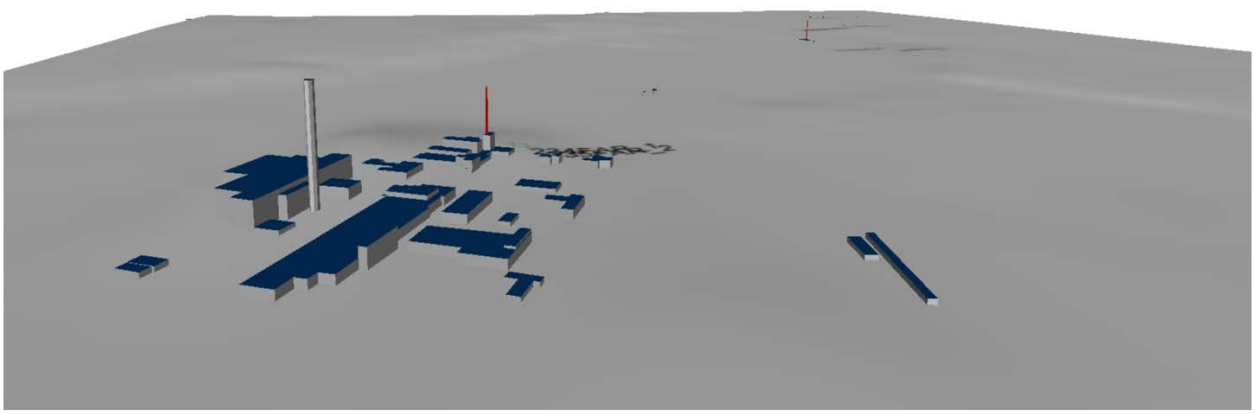


Figure 2.6 Three-Dimensional Building Layout at T3 Area

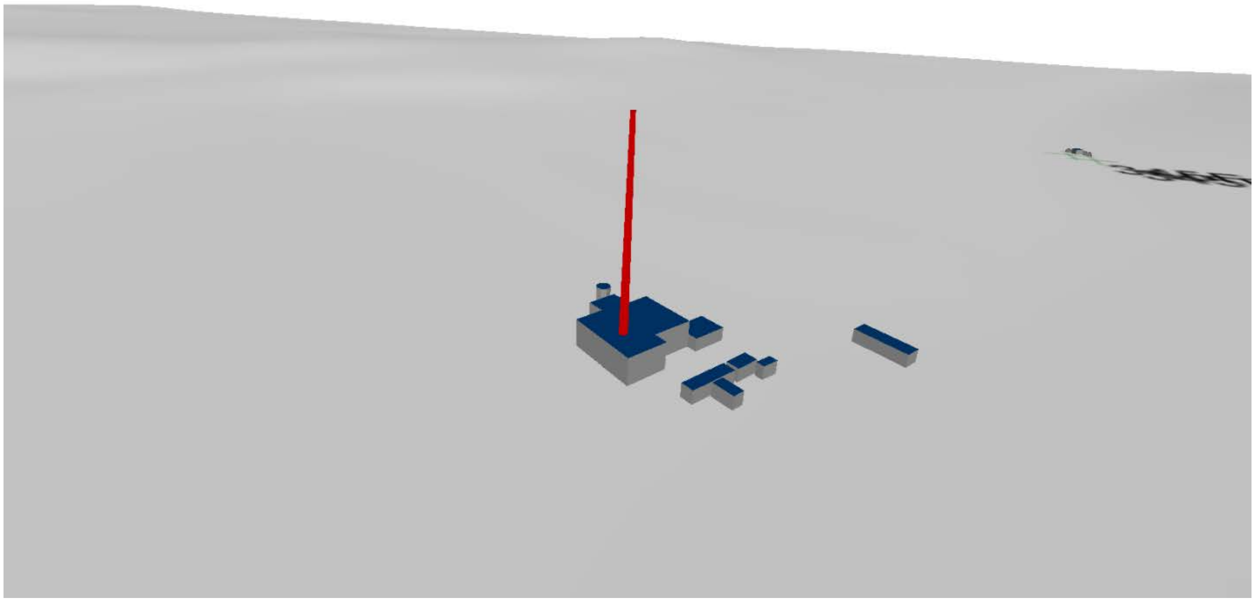
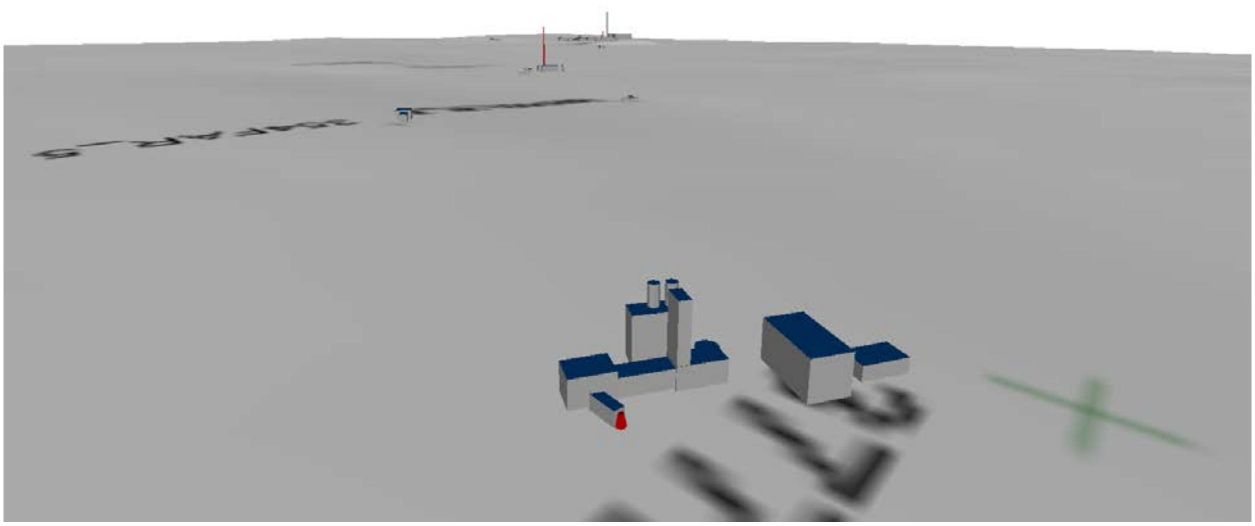


Figure 2.7 Three-Dimensional Building Layout at 378RAR Area



2.4 Meteorological Data

Meteorological data used in the modelling was obtained from Meteorological Service of Canada. Five years of meteorological data from January 1, 2010 to December 31, 2014 were used in the dispersion modelling. The AERMOD meteorological pre-processor, AERMET, was used to process the meteorological dataset used in dispersion modelling. AERMET is run using the following sources: 1) standard hourly regional meteorological data available from Environment Canada's Meteorological Service of Canada for the closest available meteorological station, 2) morning soundings of winds, temperature, and dew point from the closest upper air station (available on the National Oceanic and Atmospheric Administration Radiosonde Database Access website). The surface and upper air stations that were used in this study are presented in Table 2.8.

Table 2.8 Meteorological Station Data

Type of Station	Surface Station		Upper Air Station
Station ID	5062922	5062921	71867
Station Name	Thompson Airport	Thompson Airport	The Pas Airport
Location	97.86°W, 55.80°N	97.86°W, 55.80°N	101.10°W, 53.97°N
Elevation (Above Sea Level)	224 m	224 m	271 m
Years	Jan. 2010 to Nov. 2014	Nov. 2014 to Dec. 2014	Jan. 2010 to Dec. 2014
Parameters	Pressure, Altitude, Temperature, Wind Direction and Speed, Relative Humidity, Cloud Cover	Pressure, Altitude, Temperature, Wind Direction and Speed, Relative Humidity, Cloud Cover	Height, Wind Direction and Speed, Wind Fluctuations

This data is processed for land covers based on site specific land use surrounding the mine area which is further discussed in Section 2.4.1.

Parameters that directly influence the dispersion of pollutants include: wind speed and direction, atmospheric stability, and mixing layer depths.

Meteorological conditions that may lead to high Ground Level Concentrations (GLCs) from elevated point sources are typically those involving either convective atmospheric stability with light wind speeds or neutral conditions with high wind speeds. High predicted GLCs arise most frequently from sources close to the ground, elevated sources with building or topography effects, and volume sources due to stable conditions with light winds.

2.4.1 Site Specific Surface Characteristics

AERMET is used to estimate two stability parameters, friction velocity and Monin-Obukhov length, to characterize the amount of turbulence in the atmosphere. The friction velocity is a measure of mechanical effects alone, such as wind shear at ground-level. The Monin-Obukhov length indicates the relative strengths of mechanical and buoyancy effects on atmospheric turbulence. Thus, AERMOD can account for turbulence both from wind shear and from buoyancy effects due to solar heating during the day and radiational cooling at night. To properly account for these effects, AERMET requires three land use parameters: albedo, Bowen ratio, and surface roughness. Albedo is defined as the fraction of total incident solar radiation reflected by a particular surface without absorption. Bowen ratio is an indicator of surface moisture conditions and can be defined as the ratio of the sensible heat flux to the latent heat flux. Surface roughness is a length scale that characterizes the roughness of the earth’s surface.

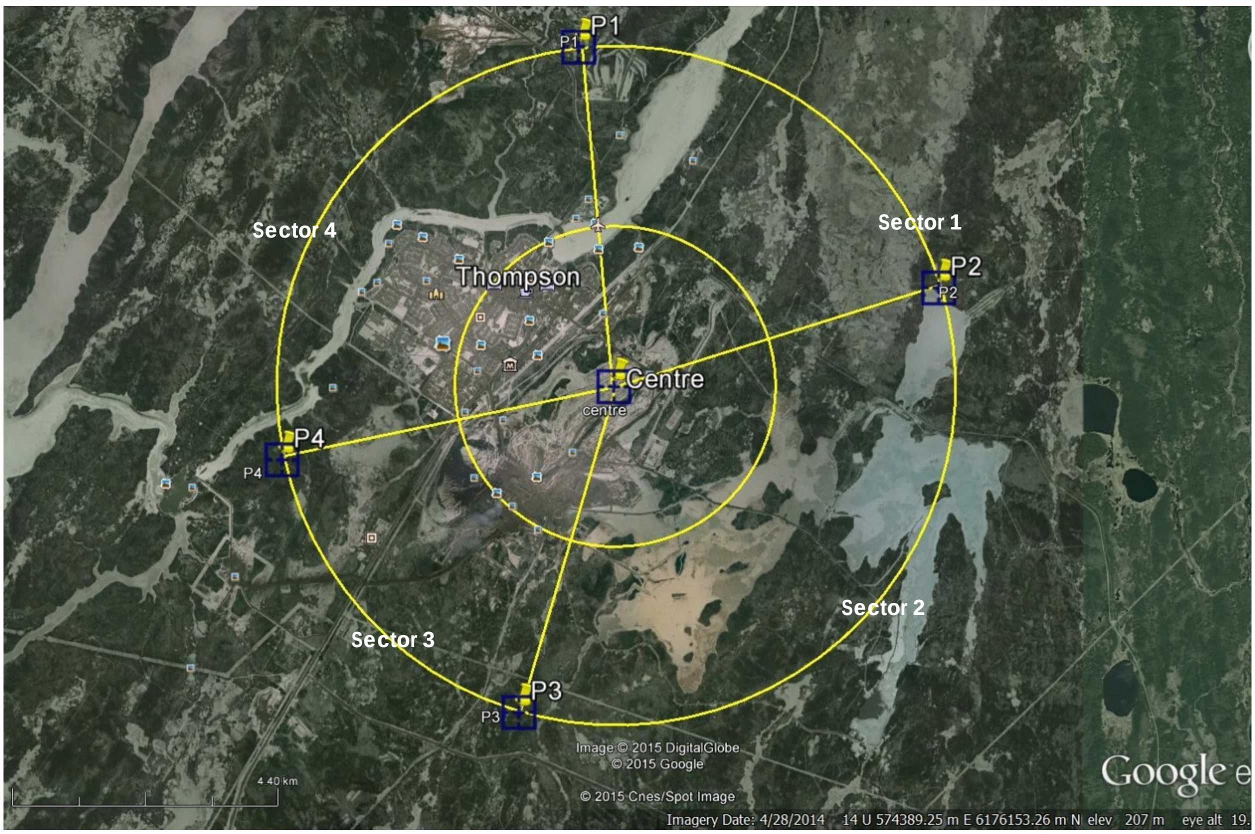
For this study, site-specific values for albedo, Bowen ratio, and surface roughness were selected based on land use within 3 km of the facility based on the Guidelines for Air Dispersion Modelling in Manitoba (Manitoba Conservation 2006). Considering the surface characteristics surrounding the facility, four wind direction sectors were used in the AERMET stage 3 run. Monthly dependent values of the site characteristics were calculated based on a weighted average of land use categories in each sector. The values of each parameter were varied as a function of the month to account for the changing surface characteristics of the growing seasons and snow cover. Considering the longer winters that are typical for the Thompson area, the months corresponding to the four seasons were categorized as presented in Table 2.9.

Figure 2.8 presents the upwind directional sectors used to parameterize surface properties in AERMET within a 3 km radius of the facility. Table 2.10 outlines the fractional land use coverage (based on the U.S. EPA categories for AERMET), which were assigned to each of the directional sectors presented in Figure 2.8. The resultant calculated site-specific parameters are summarized in Table 2.11.

Table 2.9 Seasons and Corresponding Months

Season	Months
Winter	November, December, January, February, March
Spring	April, May
Summer	June, July, August
Autumn	September, October

Figure 2.8 Sectors used for Defining Site-Specific Surface Characteristics



Reference: Google Earth image

Table 2.10 Land Use Categories

Land-Use	Sector 1	Sector 2	Sector 3	Sector 4
Water (fresh and sea)	15.0%	25.0%	0.0%	10.0%
Deciduous Forest [a]	40.0%	25.0%	42.5%	30.0%
Coniferous Forest [a]	40.0%	25.0%	42.5%	30.0%
Swamp	0.0%	0.0%	0.0%	0.0%
Cultivated Land [b]	0.0%	0.0%	0.0%	0.0%
Grassland	5.0%	0.0%	0.0%	5.0%
Urban	0.0%	0.0%	0.0%	25.0%
Desert Shrubland [c]	0.0%	25.0%	15.0%	0.0%
Total	100%	100%	100%	100%

Notes:

a. Assume forest is 50% Deciduous, 50% coniferous.

b. Assume Farmland as EPA Category 'cultivated land'.

c. For Barren Land (quarry operations, etc), EPA desert shrubland category for all parameters but Bowen Ratio is used. Use Urban category for Bowen Ratio.

Table 2.11 Site Specific Inputs for Aermet

Sector	Parameter1	Winter	Spring	Summer	Autumn
Sector 1 (353 to 72)	Albedo	0.400	0.123	0.120	0.127
	Bowen Ratio	1.500	0.595	0.295	0.785
	Surface Roughness	0.720	0.923	1.045	0.841
Sector 2 (72 to 195)	Albedo	0.375	0.165	0.155	0.165
	Bowen Ratio	1.500	0.625	0.675	0.975
	Surface Roughness	0.488	0.650	0.725	0.600
Sector 3 (195 to 257)	Albedo	0.429	0.147	0.144	0.144
	Bowen Ratio	1.500	0.745	0.555	1.065
	Surface Roughness	0.788	1.023	1.150	0.938
Sector 4 (257 to 353)	Albedo	0.393	0.128	0.131	0.141
	Bowen Ratio	1.500	0.700	0.730	1.100
	Surface Roughness	0.790	0.943	1.035	0.881

2.4.2 Atmospheric Stability

The stability of the atmosphere is defined as its tendency to resist or enhance vertical motion in the boundary layer. Three states of atmospheric stability are distinguished according to the vertical temperature profile or "lapse rate"; convective, neutral and stable. Atmospheric stability is commonly parameterized in terms of Pasquill-Gifford (P-G) Stability categories. These categories are presented in Table 2.2.

Table 2.12 Classification of P-G Stability with Atmospheric Conditions

Surface Wind Speed (m/s)	Daytime Insolation			Nighttime Conditions	
	Strong	Moderate	Light	Thin Overcast of 4/8 Cloudiness	3/8 Cloudiness
<2	A	A-B	B	-	-
2	A-B	B	C	E	F
4	B	B-C	C	D	E
6	C	C-D	D	D	D
>6	C	D	D	D	D

Notes:
A. highly convective
B. moderately convective
C. slightly convective
D. neutral
E. slightly stable
F. stable

Vertical dispersion of pollutants is greatest under convective atmospheric conditions, where the temperature decrease with height is greater than the accepted adiabatic lapse rate of - 0.98˚C/100 m. An air parcel that is forced to rise in a convective atmosphere will cool adiabatically and hence remain warmer than the surrounding atmosphere and continue to rise. Convective conditions tend to enhance the vertical growth of the plume, causing an elevated plume to intersect the ground more rapidly.

In a neutral atmosphere, the temperature lapse rate is equal to the adiabatic lapse rate of -0.98˚C/100 m and dispersion is mechanically rather than thermally dominated. A rising/descending air parcel will remain at the same level once the force causing the movement has been removed. Horizontal and vertical dispersion will be of similar magnitude in neutral conditions.

Vertical dispersion of pollutants is least effective in a stable atmosphere when the temperature lapse rate is less than the adiabatic lapse rate. An air parcel forced to rise under such conditions will become cooler than the surrounding air and tend to sink back to its original level, once the force has been removed. This limits the vertical growth of the plume. Light winds frequently accompany stable conditions, reducing the horizontal and vertical dispersion even more, and further increasing the air pollution potential.

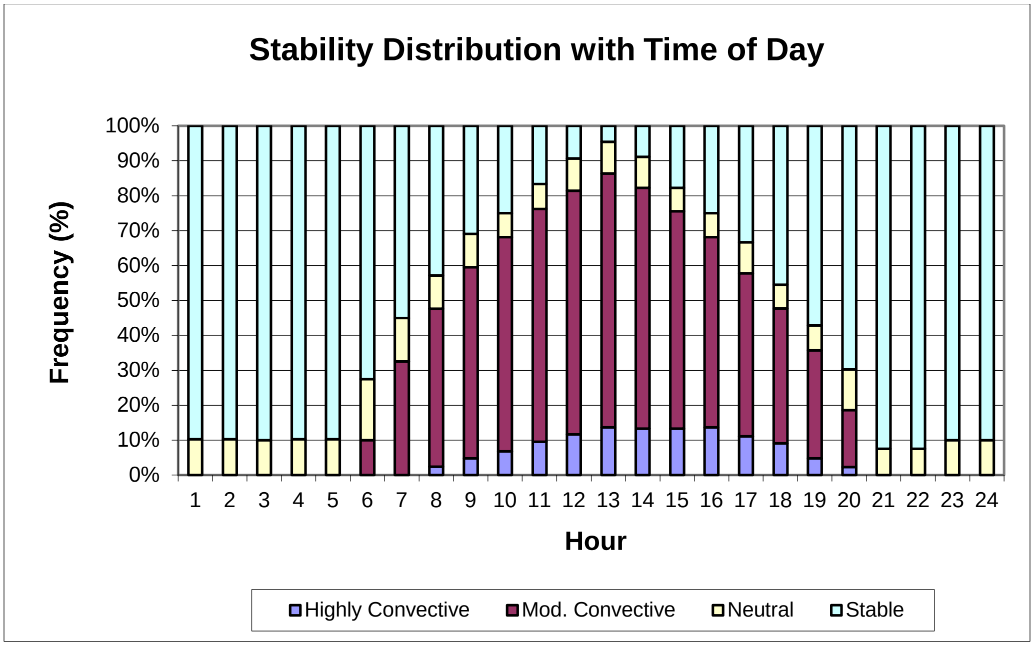
The seasonal distribution of the hourly atmospheric stability from the meteorological data (2010 to 2014), based on the AERMET processed data set, is presented in Table 2.13. Stable conditions occur most frequently during the winter, which can be attributed to the increased snow cover (and subsequent lack of surface heating) during this period. Convective conditions occur at a higher frequency during the summer than other seasons, which can be attributed to increased solar radiation and the absence of snow cover.

Table 2.13 Seasonal Distribution (%) of Atmospheric Stability

Season	Highly Convective	Moderately Convective	Neutral	Stable
Winter	0.04	2.14	3.23	18.98
Spring	1.48	10.79	1.78	11.5
Summer	3.02	12.1	1.57	8.37
Fall	0.61	6.73	2.53	15.14
Annual	5.1	31.8	9.1	54.0

The AERMET-predicted diurnal variation of atmospheric stability with time of day is presented in Figure 2.9. The occurrence of convective conditions is limited to between 6:00 a.m. to 8:00 p.m., with the highest frequency of events occurring around 1:00 p.m. Neutral and stable conditions show the opposite trend, with a higher frequency of occurrence during the nighttime period due to lower solar insolation.

Figure 2.9 Diurnal Variation of Stability with Time of Day



2.4.3 Wind Speed and Direction

The wind rose and the frequency distribution of wind speeds of the Thompson Airport input data for the 2010 to 2014 period is presented in the figures below.

The average joint frequency distribution of wind speed and direction for the 2010 to 2014 period (based on the Thompson Airport dataset) is presented in Figure 2.10. Winds in the area blow in all directions but more frequently from north-westerly, westerly, and north-easterly directions. Figure 2.11 presents a frequency distribution of wind speeds using the same dataset over the same period. Wind speeds of 2.0 to 3.0 m/s occur most frequently in the dataset.

Figure 2.10 Wind Rose – Based on Thompson Airport from Meteorological Service of Canada for the 5-year Period of 2010 to 2014

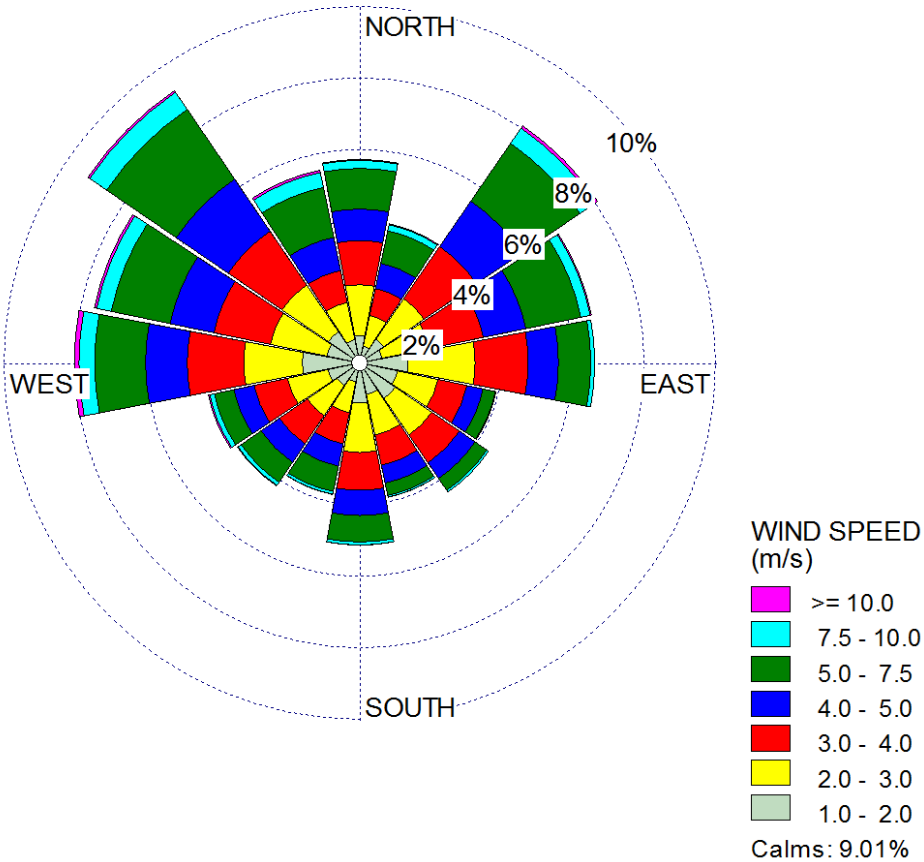
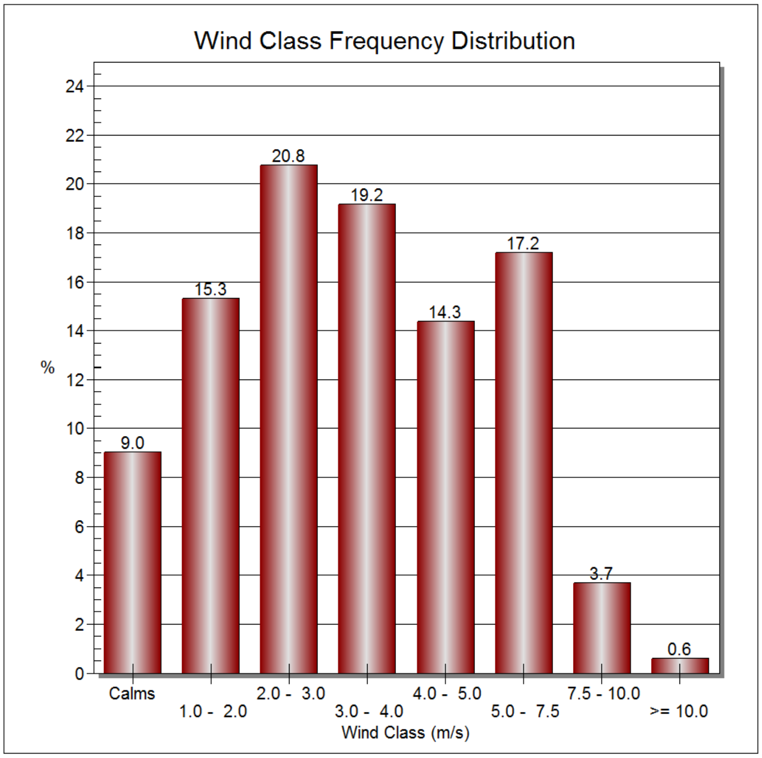


Figure 2.11 Wind Class Frequency Distribution



3.0 RESULTS AND ANALYSIS

3.1 Predicted Results

The model was run for the 5-year meteorological data. Results of the dispersion modelling are typically predicted for the required averaging periods based on the applicable ambient air quality standards. For this study, as the model results are not predicted for a particular contaminant, the results for an hourly averaging period are presented.

Maximum hourly concentrations are calculated based on the maximum of the predicted concentrations for each hour (about 43,800 hours in the 5-year period). Table 3.1 presents the predicted maximum concentrations at each of the intake receptor.

Based on the model prediction, the maximum 1-hour concentration occurs at the intake 377FAR for Stage 2 to Stage 4 scenarios. Currently and for Stage 1, 377 is not a FAR. The maximum is also observed to be two orders of magnitude greater than the other predicted maximums.

Table 3.1 Predicted Maximum Concentrations at Intake Receptors

Intake	Predicted Maximum 1-hour Concentrations ($\mu g/m^3$)				
	Current	Stage 1	Stage 2	Stage 3	Stage 4
234FAR	75.4	77.2	74.3	74.4	74.5
235FAR	61.7	63.4	58.9	59.0	59.0
310FAR	50.5	63.0	54.4	54.4	54.4
311FAR	48.3	56.7	44.8	44.8	44.8
354FAR	86.6	106.5	27.1	27.3	27.3
377FAR	N/A	N/A	3276.4	3276.2	3276.4
345FAR_West [a]	N/A	N/A	41.8	42.8	43.1
345FAR_East [a]	N/A	N/A	40.4	41.3	41.8

Note:

a. 377 is a FAR only for Stage 2 to Stage 4 scenarios.

b. 345FAR_West and 345FAR_East are RARs at Current and Stage 1 scenarios

3.2 Source Contribution

Additional model runs were conducted to assess the impact of each exhaust at intake 377FAR for Stages 2 to 4 where the maximum concentrations were predicted to occur. Source emission rates were assumed to be 1.0 g/s from each exhaust fan. Based on the air flow from each fan (as presented in Section 2 Tables 2.2 to 2.6 above), the in-stack concentration of each exhaust at each stage are presented in Table 3.2. For the purposes of this study the dilution factor is defined as the ratio of "in-stack concentration" divided by "Predicted concentration" (for an hourly averaging period) at the receptor location. Therefore based on the predicted maximum concentrations, the minimum dilution factors are presented in Table 3.2 for an hourly averaging period at the intake 377FAR for each exhaust stream.

Table 3.2 Predicted Maximum Concentrations from Each Source at Intake 377FAR

Exhaust (Source)	Predicted Maximum 1-hour Concentrations from Each Source at 377FAR [a] (μg/m³)			In Stack Concentrations at Each Source (μg/m³)			Dilution Factor (at intake 377FAR [a])		
	Stage 2	Stage 3	Stage 4	Stage 2	Stage 3	Stage 4	Stage 2	Stage 3	Stage 4
T1	0.9	0.9	0.9	30246	30246	30246	34905	34905	34905
T3	2	2	2	52931	52931	52931	30253	30253	30253
259RAR	9	9	9	8469	8469	8469	959	959	959
260RAR	8	8	8	8469	8469	8469	998	998	998
345RAR_E [b]	0	0	0	0	0	0	N/A	N/A	N/A
345RAR_W [b]	0	0	0	0	0	0	N/A	N/A	N/A
378RAR_N	**3162**	**3162**	**3162**	**5478**	**5646**	**5471**	**1.7**	**1.8**	**1.7**
378RAR_S	**688**	**688**	**688**	**5478**	**5646**	**5471**	**8.0**	**8.2**	**7.9**
389RAR_N [c]	178	178	178	4912	4878	5127	28	27	29
389RAR_S [c]	172	172	172	4912	4878	5127	29	28	30

Notes:

a. 377 is a FAR only for Stage 2 to Stage 4 scenarios.
b. From Stage 2 to Stage 4, 345RAR_E and 345RAR_W are intakes.
c. 389RAR_N and 389RAR_S are new exhausts, and are used in Stages 2 to 4

.

As presented in Table 3.2, the source predicted to have the largest impact at 377FAR is 378 RAR, with 378RAR_N having a bigger impact than 378RAR_S due to closer proximity and building wake effects of nearby buildings. 378RAR_N is located approximately 160 m from 377FAR, and 378RAR_S is located approximately 170 m from 377FAR. Impact at 377FAR due to 378RAR_S is affected by the buildings located between the source and the intake. The dilution factors for source 378RAR_N range from 1.7 to 1.8 for the three ventilation design stages, Stages 2 to 4. The dilution factors for source 378RAR_S range from 7.9 to 8.2 for the three stages.

The source with the second largest impact is 389RAR (389RAR_N and 389RAR). The dilution factors for 389RAR_N and 389RAR_S range from 27 to 30 for the three stages. The separation distance between 389RAR and 377FAR is approximately 590 m.

3.3 Sensitivity Analysis

In order to determine the sensitivity of the results to the exhaust discharge configuration and height, three additional combinations of exhaust configuration and release heights were modelled for Stages 2 to 4. Both 389RAR and 378RAR are horizontal exhausts. Typically, plumes from vertical stacks have a higher plume rise than from a horizontal discharge, and therefore will disperse more before reaching ground level. Based on the BPIP pre-processor calculations, released plumes are not affected by downwash if the release height is higher than 2.5 times the height of the surrounding structures. Also, at higher release heights the plume is typically dispersed more before reaching the ground. A combination of these effects causes the maximum concentrations to decrease at the Intake receptor.

Three additional scenarios of different combinations of exhaust stack configuration and release heights were modelled:

1. 378RAR_N and 378RAR_S were modelled with vertical stacks instead of horizontal discharges, with their release heights at their original elevations (3.3 m from base elevation). 389 RAR_N and 389 RAR_S configuration and release heights remain the same;
2. 378 RAR_N and 378 RAR_S were modelled with vertical stacks at 10 m height. 389 RAR_N and 389 RAR_S were modelled with vertical stacks instead of horizontal discharges, with release heights at their original elevations (12.1 m from base elevation); and
3. 378 RAR_N and 378 RAR_S were modelled with vertical stacks at 15 m height. 389 RAR_N and 389 RAR_S are modelled with vertical stacks at 15 m height.

Table 3.3 present the changes in the hourly averaging period, with the different combinations of a vertical stack and various increases in stack height of the exhausts at the intake receptor 377RAR. Note for these scenarios, the base separation distances between exhaust and intake is maintained.

By reconfiguring the exhaust discharges to a vertical stack, the predicted maximum hourly concentration contributed by 378RAR_N decreases by almost one third, from 3162 µg/m³ to 1138 µg/m³ for all three stages, as presented in Figure 3.1. An increase in release height to 10 m above ground from the original 3.3 m, further reduces the maximum hourly concentration to 541 µg/m³ (an approximate dilution factor of 10). Further reduction is achieved with an increase in release height to 15 m above ground to 220 µg/m³ (an approximate dilution factor of 25). These are presented graphically in Figure 3.2.

With the reconfiguration of exhaust discharge 378RAR_S to a vertical stack, the predicted maximum hourly concentration decreases by a quarter to 188 µg/m3. Increases in the release height of 378RAR_S have relatively low impact to the predicted concentrations at the intake. At a release height of 10 m above base elevation, there is no improvement in predicted concentrations at 377FAR. At a release height of 15 m, the predicted maximum hourly concentration is 120 µg/m³ for Stages 2 to 4. Comparing this to the predicted hourly maximum of 188 µg/m³ (for all three stages) at the original release height of 3.3 m, there is a reduction of approximately 30%.

Table 3.3 also presents the predicted hourly concentrations at intake 377FAR for the original and three re-modelled scenarios for exhausts 389RAR_N and 389RAR_S for Stages 2 to 4. The reconfiguration and various increases in release heights do not have a significant impact in reducing maximum hourly concentrations predicted at this intake.

Table 3.3 Predicted Maximum 1-Hour Concentrations at Intake 377FAR for Stages 2 to 4

	Predicted Maximum 1-hour Concentrations at 377FAR (µg/m³) for Stages 2 to 4			
Source	**Original**	**1. 378RAR - Vertical, Original stack height (3.3 m) 389RAR - Original (Horizontal, stack height 12.1 m)**	**2. 378RAR - Vertical, Stack height 10 m 389RAR - Vertical, Stack height (12.1 m)**	**3. 378RAR - Vertical, Stack height 15 m 389RAR - Vertical, Stack height 15 m**
378RAR_N	3162	1138	541	220
378RAR_S	688	188	194	120
389RAR_N	178	178	175	135
389RAR_S	172	172	169	130

Figure 3.1 Predicted Hourly Averaged Maximum Concentrations based on Changes in 378RAR_N Stack Configuration from Horizontal to Vertical Stack

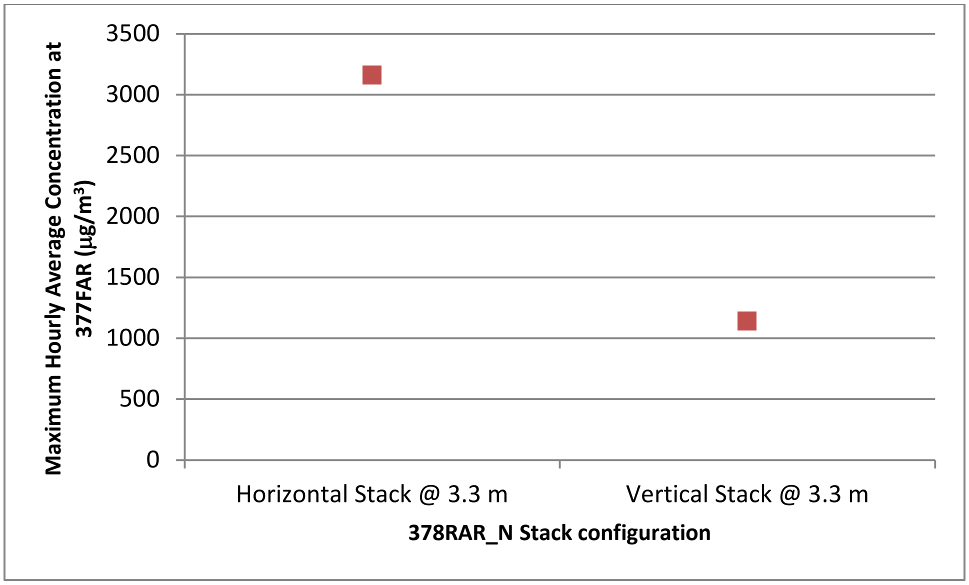
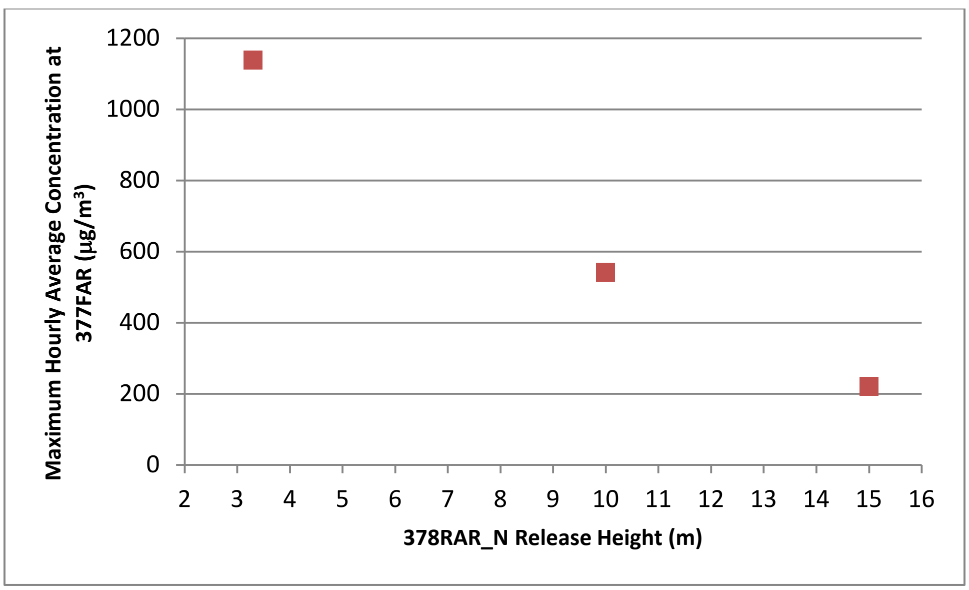


Figure 3.2 Predicted Hourly Averaged Maximum Concentrations based on Changes in 378RAR_N Release Height



Note:

378RAR_N is a vertical stack in the scenarios presented in Figure 3.2.

3.4 Discussion

Tables 3.4 to 3.6 present a summary of predicted dilution factors for exhausts 378RAR and 389RAR based on previously discussed scenarios at intake 377FAR for Stages 2 to 4 ventilation design stages.

It should be noted that for all scenarios, values are based on worst case model predictions for the 5-year meteorological conditions. In regulatory compliance modelling where predictions are compared to air quality criteria to assess compliance, some of the highest concentrations are removed as meteorological anomalies. The number of concentrations removed varies based on jurisdiction. However, in this study, no outliers were removed for conservatism.

The most significant impact was reconfiguring 378RAR_N and 378RAR_S to vertical stacks. The dilution factor at 377FAR increased from approximately 2 to 5 with the 378RAR_N exhaust stack reconfigured from a horizontal discharge to a vertical stack, and from 8 to 29 with the 378RAR_S exhaust discharge reconfigured to a vertical stack.

The increase in the exhaust release heights of 378RAR_N and 378RAR_S also made a significant impact. Increasing the release height from the original 3.3 m to 10 m (as vertical stacks), the dilution factor from the exhaust stream 378RAR_N doubled to 10; and at 15 m release height, the dilution factor increased to about 25. For 378RAR_S, increasing the release height to 10 m made a negative impact by decreasing the dilution factor slightly. However, by increasing the height to 15 m, the dilution factor increased from 29 to approximately 45.

The reconfiguration and increase in stack heights for 389RAR_N and 389RAR_S did not have a significant impact on increasing the dilution factors predicted at 377FAR.

Table 3.4 Summary of Predicted Minimum Dilution Factors at Intake Receptor 377FAR–Stage 2

Source	Predicted Dilution Factor at Intake 377FAR for Stage 2: Original	1. 378RAR - Vertical, Original stack height (3.3 m) 389RAR - Original (Horizontal, stack height 12.1 m)	2. 378RAR - Vertical, Stack height 10 m 389RAR - Vertical, Stack height (12.1 m)	3. 378RAR - Vertical, Stack height 15 m 389RAR - Vertical, Stack height 15 m
378RAR_N	1.7	5	10	25
378RAR_S	8.0	29	28	45
389RAR_N	28	28	28	36
389RAR_S	29	29	29	38

Table 3.5 Summary of Predicted Minimum Dilution Factors at Intake Receptor 377FAR–Stage 3

Source	Predicted Dilution Factor at Intake 377FAR for Stage 3: Original	1. 378RAR - Vertical, Original stack height (3.3 m) 389RAR - Original (Horizontal, stack height 12.1 m)	2. 378RAR - Vertical, Stack height 10 m 389RAR - Vertical, Stack height (12.1 m)	3. 378RAR - Vertical, Stack height 15 m 389RAR - Vertical, Stack height 15 m
378RAR_N	1.8	5	10	26
378RAR_S	8.2	30	29	47
389RAR_N	27	27	28	36
389RAR_S	28	28	29	38

Table 3.6 Summary of Predicted Minimum Dilution Factors at Intake Receptor 377FAR–Stage 4

Source	Predicted Dilution Factor at Intake 377FAR for Stage 4: Original	1. 378RAR - Vertical, Original stack height (3.3 m) 389RAR - Original (Horizontal, stack height 12.1 m)	2. 378RAR - Vertical, Stack height 10 m 389RAR - Vertical, Stack height (12.1 m)	3. 378RAR - Vertical, Stack height 15 m 389RAR - Vertical, Stack height 15 m
378RAR_N	1.7	5	10	25
378RAR_S	7.9	29	28	45
389RAR_N	29	29	29	38
389RAR_S	30	30	30	39

4.0 SUMMARY AND CONCLUSIONS

There was no detailed analysis available of the outlet exhaust stream make up that included speciated identification of the airborne contaminants of concern. The dilution of the exhaust stream, as it would impact the intakes, was the approach selected for this study. By considering the dilution of any contaminant of concern, the project team for the Vale Thompson mine can then draw the required conclusions to determine if there are indeed any issues regarding the potential re-entrainment of mine exhaust. One obvious aspect to consider is the potential for increased and unacceptable worker exposure to airborne contaminants.

In dispersion modelling studies based on local or regional meteorological datasets, certain extreme, rare and transient meteorological data may be present in the dataset that may be considered outliers. It is important to note that it is a typical modelling practice for dispersion modelling of airborne contaminant in competent jurisdictions for air compliance concerns to discard these outliers. As this study does not compare any predicted concentrations with air quality criteria, no outliers are discarded for conservatism.

AERMOD dispersion modelling was performed for the study in order to predict dilution factors for the dilution of concentrations released by the exhaust fans of the Vale Thompson Mine for the four stages of the ventilation design (presented in Tables 2.2 to 2.6). The worst-case hourly concentration was predicted at the intake 377FAR, at 3276 $\mu g/m^3$ for the three ventilation design stages. Note that 377 is not a FAR at Stage 1 ventilation design. The maximum at 377FAR is observed to be two orders of magnitude greater than the other predicted maximums. This means there is also a predicted potential for higher order concentration of contaminants at the 377 FAR intakes. Careful consideration of the specifics of the contaminants should be evaluated for this intake as the facility design progresses.

Additional model runs were conducted to assess the impact of each exhaust at intake 377FAR where the maximum concentrations were predicted to occur, and to determine the dilution factors for each exhaust.

The sources predicted to have the largest impact at 377FAR are 378RAR_N with a dilution factor ranging from 1.7 to 1.8, and 378RAR_S with a dilution factor of 7.9 to 8.2 for the three ventilation design stages. This means that the exhaust stream would be mixed with the atmosphere and impact on the intake approximately 2 times and 8 times more dilute than the actual discharge concentration, respectively for 378RAR_N and 378RAR_S.

The source with the second largest impact is 389RAR (389RAR_N and 389RAR). The dilution factors for 389RAR_N and 389RAR_S range from 27 to 30 for the three stages.

The sensitivity of the results to the discharge configuration and release height of the exhausts was also investigated to give some guidance of the impact of making any changes. This analysis was carried out to enable the Vale Thompson project team to extrapolate the benefits of making changes should they find that they are required. In order to determine the sensitivity of the results to the exhaust configuration and height, three additional combinations of exhaust configuration and release heights for 378RAR and 389RAR were modelled:

1. 378RAR_N and 378RAR_S were modelled as vertical discharges instead of horizontal discharges, with their release heights at their original elevations (3.3 m from base elevation). 389RAR_N and 389RAR_S configuration and release heights remain the same;

2. 378RAR_N and 378RAR_S were modelled as vertical discharges at 10 m height.

389 RAR_N and 389RAR_S were modelled as vertical discharges instead of horizontal discharges, with release heights at their original elevations (12.1 m from base elevation); and

3. 378RAR_N and 378RAR_S were modelled as vertical discharges at 15 m height.

389 RAR_N and 389RAR_S are modelled as vertical discharges at 15 m height.

The most significant impact was reconfiguring 378RAR_N and 378RAR_S to vertical discharges, as well as increasing the discharge release height. The dilution factor at 377FAR increased from approximately 2 to 5 with the 378RAR_N exhaust discharge reconfigured from a horizontal discharge to a vertical discharge. The dilution factor increased to about 25 with the discharge release height increased to 15 m from the original 3.3 m. With the 378RAR_S exhaust discharge reconfigured to a vertical discharge, the dilution factor at 377FAR increased from approximately 8 to 29. With an increase of the release height to 15 m, the dilution factor further increased to 45.

The reconfiguration and increase in discharge heights for 389RAR_N and 389RAR_S did not have a significant impact on increasing the dilution factors predicted at 377FAR.

In conclusion, the dilution factor for impact on 377FAR is two orders of magnitude less than at other intakes in the facility. These intakes can be therefore identified as requiring careful consideration as the design is completed, and may be of concern for potential human health risk.

The concern at the identified FAR intakes can be significantly reduced by simply implementing elevated vertically oriented discharges at 378RAR_N and S. This quickly and easily provides a nominal one order of magnitude improvement. The currently proposed design should at minimum include this amendment as there is no significant associated cost with making the change at this time.

Once the species of contaminants anticipated to be exhausted are quantified, the dilution factor appropriate for the human health risk concern (typically the one hour averaging time for chemical constituents) can be used to assess any specific health risk issues.

If specific re-ingestion concerns are identified based on specific contaminants, optimization of the ventilation plant discharge and supply locations and geometries can be finalized. For current design considerations, the expected dispersion improvements associated with changes to exhaust reconfiguration and discharge and intakes can be estimated by review of the alternate modelled scenarios carried out for this assessment. The expected dispersion improvements can be determined with greater certainty by subsequent model runs with the updated design conditions should that level of detail be required.

Based on the current modelling work carried out, once the anticipated discharge contaminant concentrations are known, it will then be possible to determine if there is any anticipated human health risk.

It is also assumed that Vale will be monitoring the work environment within the mine during operations at the four different stages of ventilation design. This is consistent with their typical current work practice. No changes to that practice should be considered.

Appendix A
Site Plans

No.	REFERENCE DRAWINGS	No.	REFERENCE DRAWINGS	REV.	DESCRIPTION	DATE	BY	REV.	DESCRIPTION	DATE	BY	REV.	DESCRIPTION	DATE	BY
				11.				6.				1.			
				12.				7.				2.			
				13.				8.				3.			
				14.				9.				4.			
				15.				10.				5.			

THE INTERNATIONAL NICKEL COMPANY OF CANADA, LIMITED
MANITOBA DIVISION
THOMPSON, MANITOBA
ENGINEERING DEPARTMENT

THOMPSON PLANT
SITE PLAN
WASTE DISPOSAL SYSTEMS

SCALE 1" = 2000' DRAWN BY P SCH. TRACED BY
CHECKED BY APPROVED DATE MAY 5, 1975

25-001-B-05031

REV.

85-401-C-06051

NUMBER	REFERENCE DRAWINGS	NO.	REVISION	DATE	BY	CHD	CORD	PROJ
		4	RELOCATE T2 POWERLINE AS BUILT ER9085	06-01-10	FC	BW		
		3	ARCHIVED WITH A MAPPING BORDER	04-12-01	AH	HS		
		2	T.O.P. WASTE DUMPS AREA UPDATED	12-09-99	HS	HT		
		1	ISSUED FOR CONSTRUCTION	02-18-98	HOH	HT		

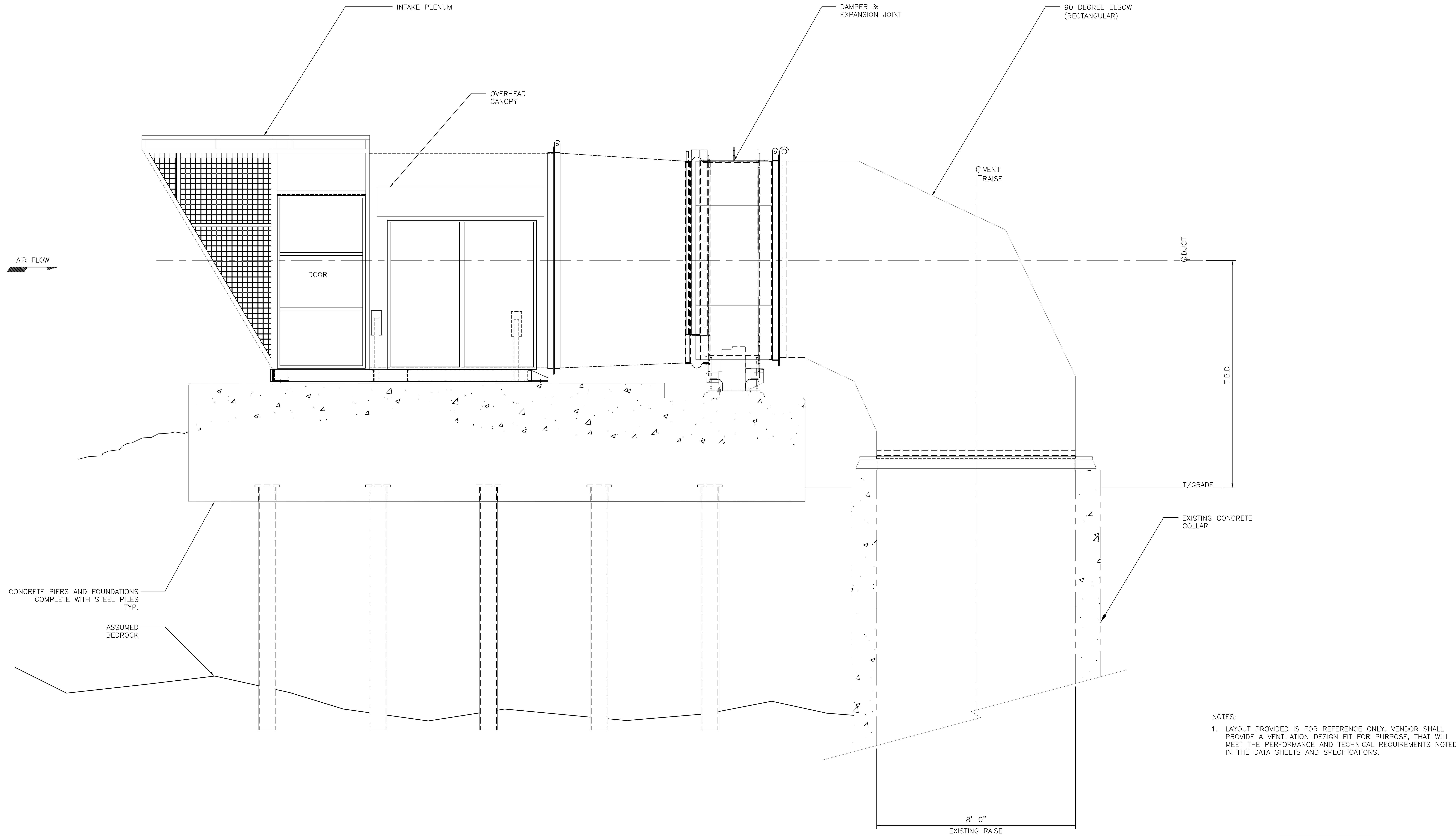
INCO LIMITED
CANADIAN AND U.K. OPERATIONS, THOMPSON

	NAME	DATE
DRAWN	K. TAYLOR	02-16-98
CHECKED	H. O'HANDLEY	02-18-98
DESIGNED	SURVEY	
CHECKED		
REVIEWED	H. TSOI	02-18-98

THOMPSON PLANT — PLANT NAME: DIVISIONAL
PLANT AREA: ALL PLANTS — KEY WORD: MAP
DESCRIPTION: SITE PLAN
SCALE 1"=600'
85-401-C-06051
PROJ. REF. N/A
REVISION 04

CADD DRAWING

DWG. NO. 1384_7042_B_0002



SECTION – 377 FA HEATER

NOTES:

1. LAYOUT PROVIDED IS FOR REFERENCE ONLY. VENDOR SHALL PROVIDE A VENTILATION DESIGN FIT FOR PURPOSE, THAT WILL MEET THE PERFORMANCE AND TECHNICAL REQUIREMENTS NOTED IN THE DATA SHEETS AND SPECIFICATIONS.

FOR REVIEW

PRELIMINARY

Stantec Consulting Ltd.
1760 Regent Street
Sudbury, ON Canada
P3E 3Z8
Tel. 705 566 6891
Fax. 705 566 5589
www.stantec.com
PROJECT NO 169514559

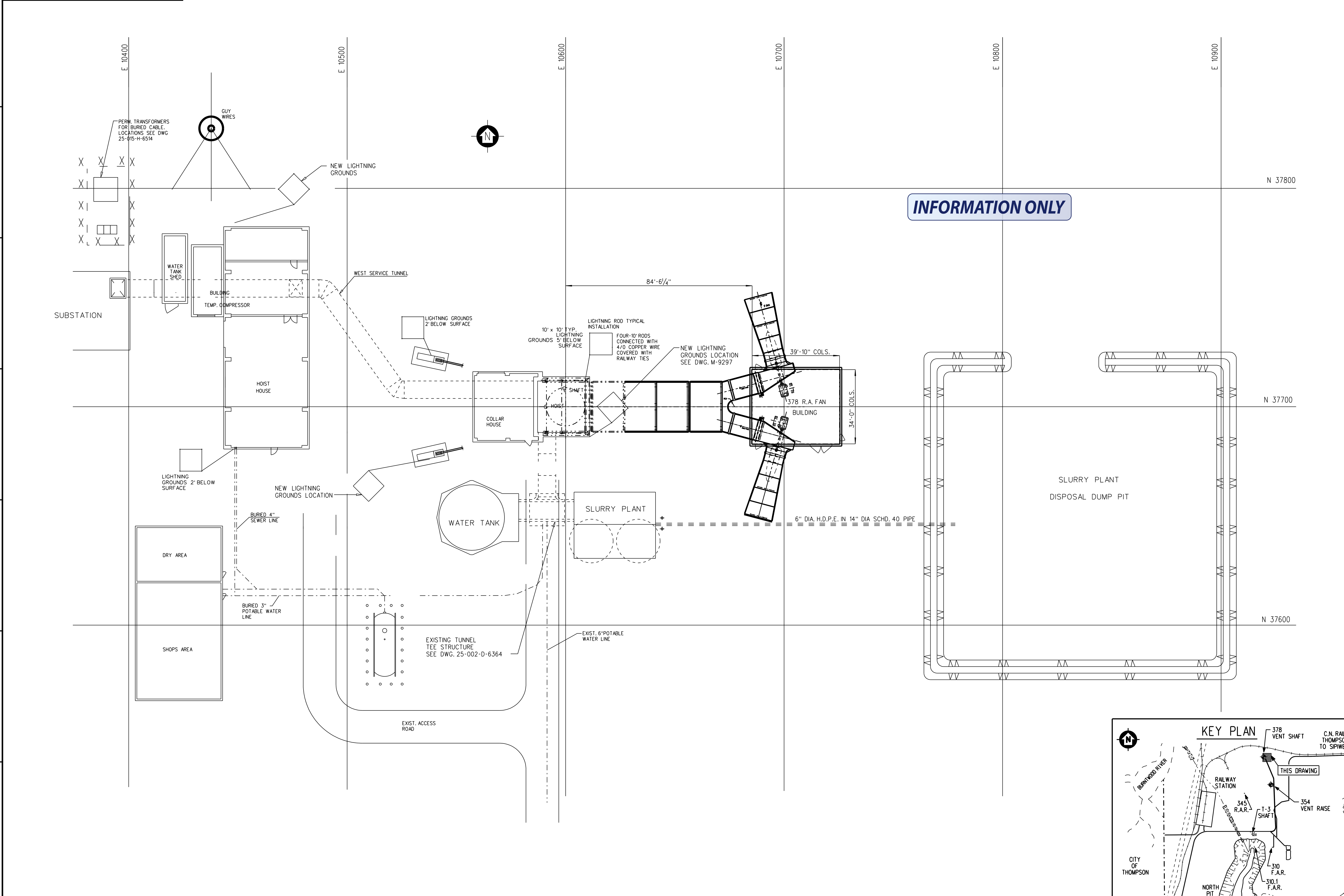
DWG NO.	REFERENCE DRAWINGS	REV	JOB NO.	DESCRIPTION	DATE	DRAWN BY	CHECKED DRAWING	APPROVED DESIGN	REVIEWED DESIGN
		A1	1384	PRELIMINARY – ISSUED FOR INTERNAL REVIEW	2015-03-24	K. MCDOUGALL		A. CHUTE	J. JODOUIN
		B	1384	PRELIMINARY – ISSUED FOR CLIENT REVIEW	2015-04-23	K. MCDOUGALL			
		B1	1384	PRELIMINARY –					

VALE
MANITOBA OPERATIONS

PLANT: THOMPSON	SUB PLANT: FOOTWALL DEEP
AREA: VENTILATION	CLASSIFICATION: LAYOUT
TITLE: 377 FA HEATERS GENERAL ARRANGEMENT SECTION	

SCALE: 1/2" = 1'-0"	REV. 1 PROJECT NO.: 1384	REV. B / START DATE
DWG. NO.: 1384_7042_B_0002	REV.: B1	OLD DRAWING NO.

25-072-B-08941



NUMBER	REFERENCE DRAWINGS	NO.	REVISION	DATE	BY	CH'D	CORD	PROJ
25-072-D-08948	FAN BUILDING-EQUIPMENT GEN. LAYOUT							
25-072-D-08946	FAN BUILDING-FOUNDATION DETAILS							
25-072-D-08943	DUCTWORK/FAN-PIER & ANCHOR LAYOUT							
25-072-D-08942	DUCTWORK/FAN/BUILDING PILE LAYOUT	2	ISSUED FOR CONSTRUCTION	97-05	RDC			

INCO LIMITED

CANADIAN AND U.K. OPERATIONS, THOMPSON

	NAME	DATE
DRAWN	R.D.CARRIERE	96-12
CHECKED		
DESIGNED	R.D.CARRIERE	97-03
CHECKED		
REVIEWED	K.TSOI	97-03

PLANT NAME: THOMPSON I-D

PLANT AREA: 378 RETURN AIR RAISE — KEY WORD: EXHAUST FANS

DESCRIPTION: SITE PLAN

SCALE 1"=20'-0"

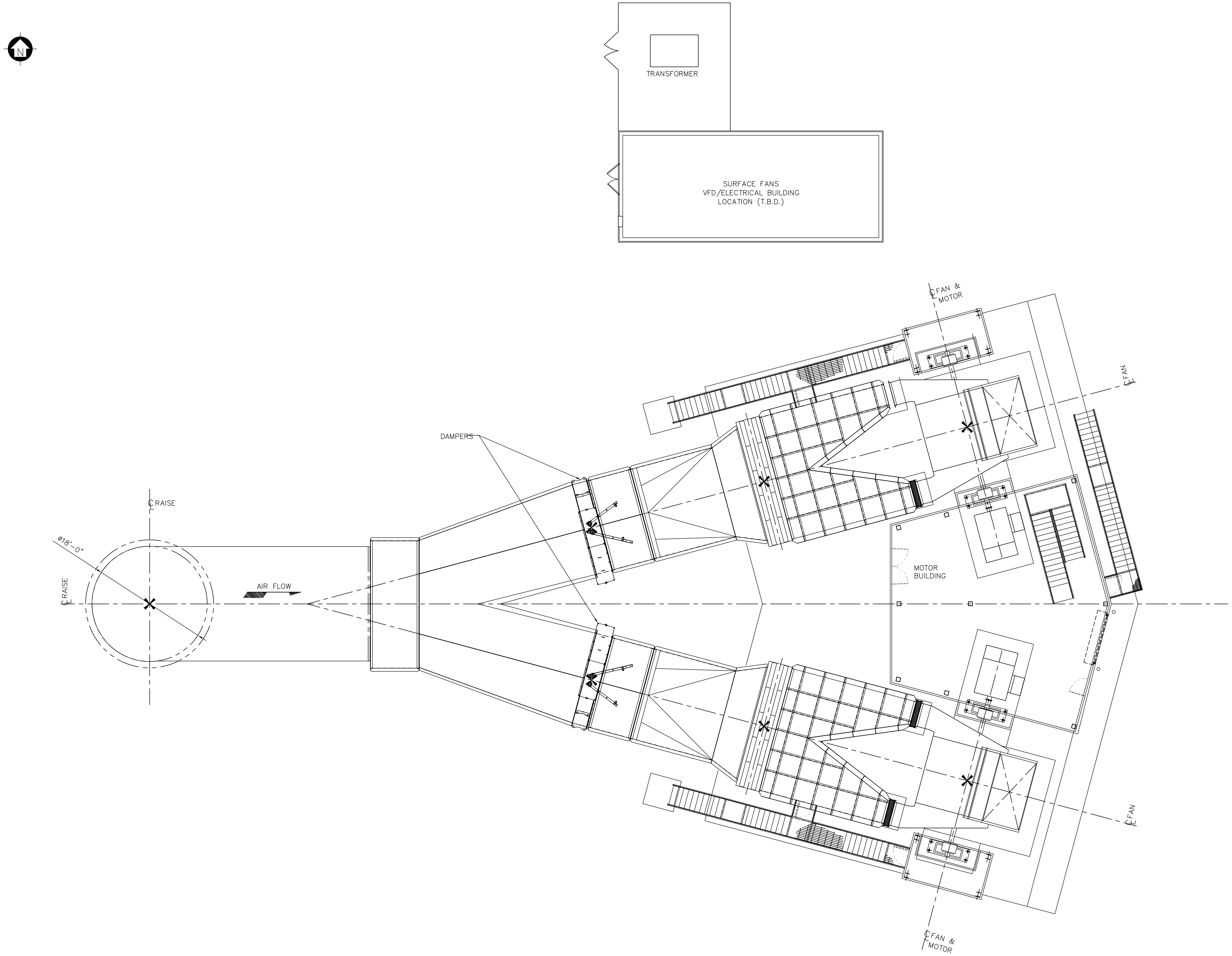
25-072-B-08941

PROJ. REF.

REVISION 2

CADD DRAWING

DWG. NO. 1384-7043-B-0001



PLAN – 389 RETURN AIR FANS

NOTES:
1. LAYOUT PROVIDED IS FOR REFERENCE ONLY. VENDOR SHALL PROVIDE A VENTILATION DESIGN FIT FOR PURPOSE, THAT WILL MEET THE PERFORMANCE AND TECHNICAL REQUIREMENTS NOTED IN THE DATA SHEETS AND SPECIFICATIONS.

FOR REVIEW

PRELIMINARY

DWG NO.	REFERENCE DRAWINGS	REV	JOB NO.	DESCRIPTION	DATE	DRAWN BY	CHECKED DRAWING	APPROVED DESIGN	REVIEWED DESIGN
		A	1384	PRELIMINARY – ISSUED FOR INTERNAL REVIEW	2015-03-17	K. MCDOUGALL			
		A1	1384	PRELIMINARY – ISSUED FOR INFORMATION	2015-03-24	K. MCDOUGALL		A. CHUTE	J. JODOUIN
		B	1384	PRELIMINARY – ISSUED FOR CLIENT REVIEW	2015-04-23	K. MCDOUGALL			
		B1	1384	PRELIMINARY –					

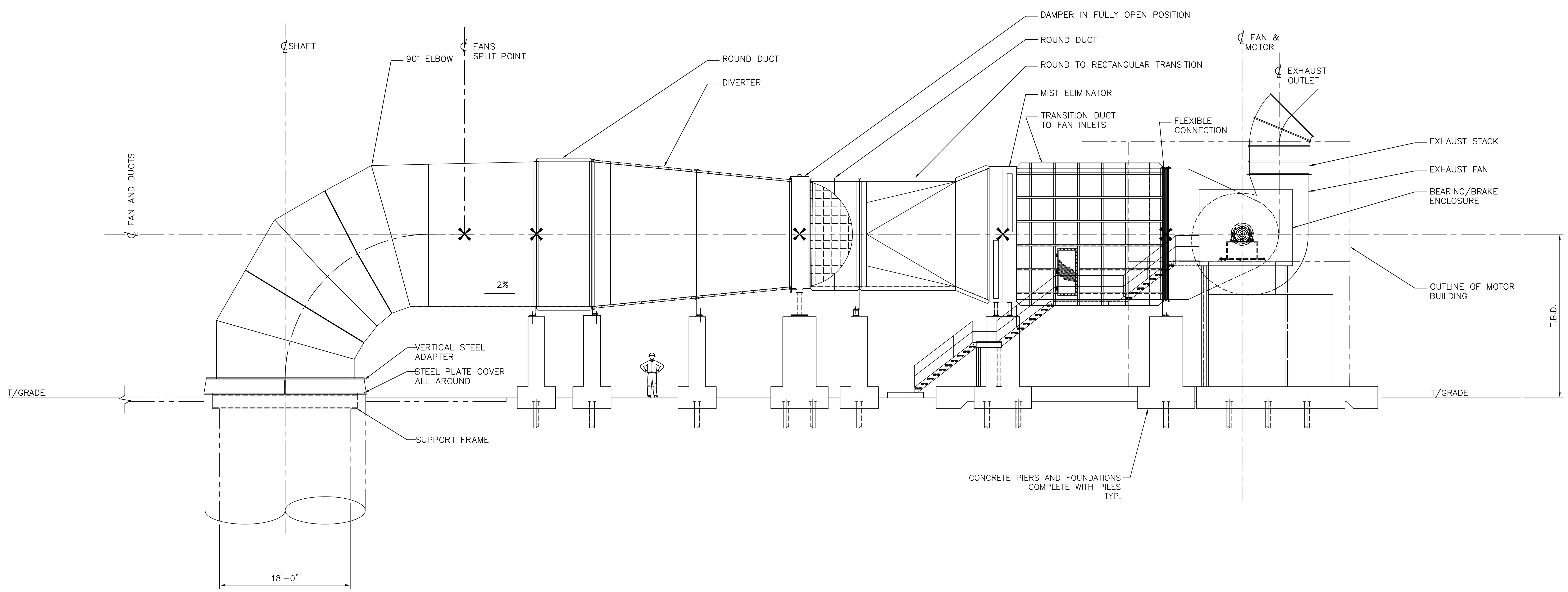
Stantec Consulting Ltd.
1760 Regent Street
Sudbury, ON Canada
P3E 3Z8
Tel. 705 566 6891
Fax. 705 566 5589
www.stantec.com
PROJECT NO 169514559

VALE
MANITOBA OPERATIONS

PLANT: THOMPSON	SUB PLANT: FOOTWALL DEEP	SCALE: 3/16" = 1'-0"	REV. 1 PROJECT NO.: 1384
AREA: VENTILATION	CLASSIFICATION: LAYOUT	DWG. NO.: 1384-7043-B-0001	REV.: B1
TITLE: 389 RA FANS GENERAL ARRANGEMENT PLAN			

START DATE
REV. B1
OLD DRAWING NO.

DWG. NO. 1384-7043-B-0002



SECTION – 389 RETURN AIR FANS

NOTES:

1. LAYOUT PROVIDED IS FOR REFERENCE ONLY. VENDOR SHALL PROVIDE A VENTILATION DESIGN FIT FOR PURPOSE, THAT WILL MEET THE PERFORMANCE AND TECHNICAL REQUIREMENTS NOTED IN THE DATA SHEETS AND SPECIFICATIONS.

FOR REVIEW

PRELIMINARY

Stantec

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DWG NO.	REFERENCE DRAWINGS	REV	JOB NO.	DESCRIPTION	DATE	DRAWN BY	CHECKED DRAWING	APPROVED DESIGN	REVIEWED DESIGN
		A	1384	PRELIMINARY – ISSUED FOR INTERNAL REVIEW	2014-03-17	K. MCDOUGALL			
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		B	1384	PRELIMINARY – ISSUED FOR CLIENT REVIEW	2015-04-23	K. MCDOUGALL			
		B1	1384	PRELIMINARY –					

VALE
MANITOBA OPERATIONS

PLANT: THOMPSON	SUB PLANT: FOOTWALL DEEP
AREA: VENTILATION	CLASSIFICATION: LAYOUT
TITLE: 389 RA FANS GENERAL ARRANGEMENT SECTION	

SCALE: 3/16" = 1'-0"	REV. 1 PROJECT NO. 1384
DWG. NO. 1384-7043-B-0002	REV. B1

REV. B1 START DATE

OLD DRAWING NO.

Appendix B
Request for Information

Stantec

REQUEST FOR INFORMATION

RFI-008-14559

To:	Mark McCelland, John Drapack	**Date:**	Jan 30, 2015
Company:	Vale	**Project No.:**	169514559
Email:	Mark.McClelland@vale.com John.Drapack@vale.com	**Project Name:**	Vale Footwall Deep FEL 3 Study
Reference:	Background information for Dispersion Modelling Assessment of Mine Exhaust Re-entrainment	**Number of Pages:**	2

Priority: X Urgent (<1 day) ☐ 1 week ☐ 2 weeks ☐ Low Priority

Respond by: February 2, 2015

RFI Nature: ☐ Decision needed ☐ Confirm/Refute ☐ Multi-Person Review ☒ Other

Documents/Drawings in Question (N/A if not required):

N/A

INQUIRY:

Please provide the following:

1. Background
   a. Supporting information for FEL3 blasting emissions and associated plans for maintaining operator safe breathing atmosphere.
   b. Drawings of elevations for surrounding buildings, structures and built up terrain elevations for a nominal 3km radius around the vent plants.
   c. Zoning maps, if applicable
   d. Existing (ie as available from MOE or regional airport) meteorological data sets for a nominal 5 year period. Stantec AE will source this data. This is input for the AERMOD modelling background conditions.
   e. Background data from any existing onsite meteorological tower. It is best to include this information if it is available. If an onsite meteorological tower is not available please confirm. We will then proceed on the basis of standard regional meteorological data as in f).
   f. Any ambient monitoring data available for background air quality conditions. If this is not available, please confirm, we will then proceed on the basis of regional information as in f).
   g. Existing Emissions Summary and Dispersion Modelling (ESDM) as would be carried out for environmental permitting activities for the existing operation. This would enable identification of worst case anticipated contaminants in exhaust stream.
2. Clarification - Basis of assessment for re-entrainment. Detailed information requested in item (g) are necessary if we are to predict specific exhaust contaminant species concentrations impinging at inlet location. If that specific contaminant data is not available for us at this time, we can also complete our predicted re-entrainment assessment by developing a dilution factor that can be applied to known contaminant concentrations when that information is available for assessment in future. Please confirm the speciated emissions concentrations, or alternatively, acknowledge we are to proceed on the basis of developing a dilution ratio for the proposed exhaust and intake geometry.
3. Clarification - The draft working title for our project report has been shown to date as "Dispersion Modelling". We propose to amend this title for the final deliverable to "Re-entrainment Investigation Using Dispersion Modelling". This better reflects the deliverable and scope of work, and avoids confusion with other potential environmental permitting work. Please confirm that this is acceptable.

Estimated Effect on Schedule or Budget (Forward to Project Controls):

Allan Prits
Name
(Originator)

January 30, 2015
Date

RESPONDENT

Response:

Background information request:
- a. - no information available
- b. - DM#1025709
- c. - no information available
- d. - Stantec to source information as stated in the RFI
- e. - no information available
- f. - no information available
- g. - no information available

Clarification for assessment with regards to re-entrainment:
Proceed on the basis of developing a dilution ratio for propsed exhaust and intake geometry

Clarification of working title for project report:
"Re-entrainment Investigation using Dispersion Modelling" is an acceptable title

Digitally signed by Inge Robinson
DN: cn=Inge Robinson, o=Vale Canada Limited, ou=Base Metals, email=inge.robinson@vale.com, c=CA
Date: 2015.02.03 14:42:49 -06'00'

Inge Robinson
Name (Respondent)

Signature (Respondent)

3 February 2015
Date

Response Attachments: ☐ No / ☒ Yes → List: DM# 1025709

Distribution/ Circulation List: Noris Del Bel Belluz, Jacques Jodouin, Allan Prits

Thompson Footwall Deep Project
Vale Manitoba Operations
General Office - PO Box 500
Thompson, MB R8N 1P3
Tel: 204-778-2290

DOCUMENT TRANSMITTAL NOTICE
Project #1384 Thompson Footwall Deep FEL 3 Study
Transmittal No.: **DTN-326**

To: Noris Del Bel Belluz – Stantec
Mike Mayhew – Stantec
Darryl Wacker – Stantec
Jacques Jodouin – Stantec
Allan Pritts - Stantec

Issue Date: March 19, 2015
Quantity: 25
Reason for issue: For Your Information

From: donann.green@vale.com

Copies To: john.drapack@vale.com
mark.mcclelland@vale.com
inge.robinson@vale.com
Lori Paul - Stantec

Subject: **Response to Stantec Request for Information 011**

Contract No.: **1384-FS-002**

Contract Title: **Ventilation Study**

Document No.	Description / Title	Rev.
1040058	Request for Information 011 Dispersion Modelling – Additional Details (RFI-011-14559)	V1B
1043667	378 Return Air Raise, Fan Building Plan and Elevations	V1
1043669	259 Return Air Raise, Plan and Section General Arrangement	V1
1043670	259 Return Air Raise, Layout Plan, Sections and Details	V1
1043676	259 Return Air Raise, Roof Plan, Section and Details	V1
1043677	378 Return Air Raise, Site Plan	V1
1043678	259 Return Air Raise, Fan Foundation	V1
1043679	259 Return Air Raise, Fan Foundation Details	V1
1043680	259 Return Air Raise, Foundation Plan, Sections and Details	V1
1043681	378 Return air Raise, Ductwork, Fan Pier and Anchor Concrete Layout	V1
1043682	378 Return Air Raise, Concrete Details for Ductwork, Fan and Motor Piers and Piles	V1
1043683	259 Return Air Raise, Steelwork Plan, Section and Details	V1
1043684	259 Return Air Raise, Steelwork Sections and Details	V1
1043685	378 Return Air Raise, Fan Building Equipment General Layout	V1
1043686	260 Return Air Raise, Building and Equipment Foundations	V1
1043688	310 Fresh Air Raise, Surface – 400 Level Section	V1
1043689	354 Fresh Air Raise, Equipment Layout	V1

Thompson Footwall Deep Project
Vale Manitoba Operations
General Office - PO Box 500
Thompson, MB R8N 1P3
Tel: 204-778-2290

Document No.	Description / Title	Rev.
1043691	354 Fresh Air Raise, Burner Building General Arrangement	V1
1043692	Thompson Plant, Plant Site Boundary	V1
1043755	259 Return Air Raise, Propane Conservation Building	V1
1043785	259 Return Air Raise, Duct Extension Details	V1
1043788	234 Fresh Air Raise, Site Plan and Transformer Foundation	V1
1043824	234 Fresh Air Raise, Fan and Burner Arrangement	V1
1043826	234 Fresh Air Raise, Burner Fan Duct Relocation and Details	V1
1043828	234 Fresh Air Raise, Vent Pipe Header Details	V1

Once received, this transmittal letter must be signed and dated by the receiver, scanned and emailed back to donann.green@vale.com

Processed By: Donann Green

Date: March 19, 2015

Comments: **Via Email (or FTP)**

Signature: ______________________

Received By: ______________________
(Print Name)

Date: ______________________

Stantec

REQUEST FOR INFORMATION

RFI-011-14559

To:	Mark McCelland, John Drapack	**Date:**	March 10, 2015
Company:	Vale	**Project No.:**	169514559
Email:	Mark.McClelland@vale.com John.Drapack@vale.com	**Project Name:**	Vale Footwall Deep FEL 3 Study
Reference:	Dispersion Modelling – Additional Details	**Number of Pages:**	3

Priority: ☒ Urgent (<1 day) ☐ 1 week ☐ 2 weeks ☐ Low Priority

Respond by: March 12, 2015

RFI Nature: ☐ Decision needed ☐ Confirm/Refute ☐ Multi-Person Review ☒ Other

Documents/Drawings in Question (N/A if not required):

N/A

INQUIRY:

Please provide the following or plans showing the following: (X – info required)

	Location UTM E / UTM N	Elevation –Top of Intake/Discharge Above Grade	Grade elevation	Intake/Discharge - type horizontal or vertical?	Intake/Discharge- Round or Rectangular?	Intake/Discharge dimensions - (L x W) or radius
	m	ft / m	ft / m			ft / m
Exhausts / Returns						
T1 Shaft	6175076N, 572094E		699'	Vertical	Rectangular	15' x 24'
T3 Shaft	6176841N, 574242E		648'	Vertical	Rectangular	15' x 16'
378 RAR			696'	Horizontal		
259 RAR	6175737N, 572593E	668' to CL	656'	Horizontal	Round	114" ID
260 RAR	6175672N, 572746E	668' to CL	656'	Horizontal	Round	148" ID
345 RAR	6177551N, 574668E	663' to CL	657'	Horizontal		
New RAR	6178317N, 575910E	TBD	660'	TBD	TBD	TBD

	Location UTM E / UTM N	Elevation –Top of Intake/Discharge Above Grade	Grade elevation	Intake/Discharge - type horizontal or vertical?	Intake/Discharge dimensions – (L x W) or radius
	m	ft / m	ft / m		ft / m
Intakes					
234 FAR	6175163N, 572166E	708' to Top	699'	Vertical	84" ID
235 FAR	6175137N, 572194E	713' to Top	699'	Vertical	66" ID x 2
310 FAR	6176400N, 574437E			Vertical	72" ID x 2
311 FAR	6176568N, 574154E			Vertical	84" ID
354 FAR		706' to CL	696'	Horizontal	112" ID x 2
377 FAR			687'	TBD	TBD
345 FAR	6177551N, 574668E	TBD	657'	TBD	TBD

Site plan showing mine property in UTM coordinates

Original to Project File
3/11/2015

Plans showing all on-site building/structure dimensions and elevations Site plan showing property line

Estimated Effect on Schedule or Budget (Forward to Project Controls):

Allan Prits	March 10, 2015
Name (Originator)	Date

RESPONDENT

Response:

1. Data provided in table above.
2. Site plan of property in UTM coords, not available.
3. Plans showing on site buildings / structure dimensions and elevations, refer to the following:

T3 Mine Structures:	T1 Mine Structures:
T3 Headframe	T1 Headframe
310 DTN#s 014, 112,	234
311 DTN#s 111,	235
345 DTN#s 005, 110,	259
354 DTN#s 005,	260
377 DTN#s 005, 076,	
378 DTN#s 014, 077,	
389 DTN#s 150 (DM# 495673)	

4. Site plan showing property line, refer to DM# 1043692

I Robinson — Name (Respondent)

Digitally signed by Inge Robinson
DN: cn=Inge Robinson, o=Vale Canada Limited, ou=Base Metals, email=inge.robinson@vale.com, c=CA
Date: 2015.03.18 15:28:38 -05'00'

Signature (Respondent)

18 March 2015 — Date

Response Attachments: ☐ No / ☒ Yes → List: see below

Distribution/ Circulation List: Noris Del Bel Belluz, Jacques Jodouin

DM#s included in response to RFI-011:

1043667	1043669	1043755
1043670	1043676	1043785
1043677	1043678	1043788
1043679	1043680	1043824
1043681	1043682	1073826
1043683	1043684	1073828
1043685	1043686	
1043688	1043689	
1043691	1043692	

Appendix B – Digital Appendix – Calculations and modelling files