

**KINROSS**

**Great Bear**

# **Great Bear Gold Project Impact Statement**

## **Appendix F:**

### **Blasting Vibration and Overpressure Modelling Report**





# **Great Bear Project Blasting Vibration and Overpressure Modelling Report**

Great Bear Resources Ltd.  
Project # CA03912

Prepared for:

**Great Bear Resources Ltd.**

17<sup>th</sup> Floor 25 York Street, Toronto, Ontario, Canada. M5J 2V5

September 2025



# Great Bear Project

## Blasting Vibration and Overpressure Modelling Report

Project # CA03912

### Prepared for:

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September 2025

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# ADDENDUM

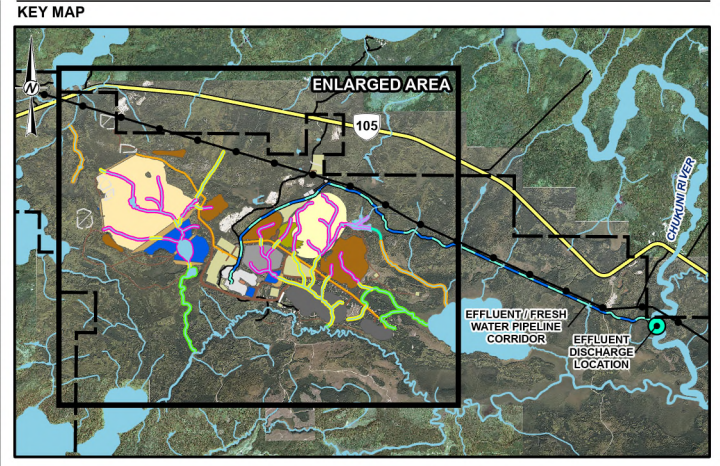
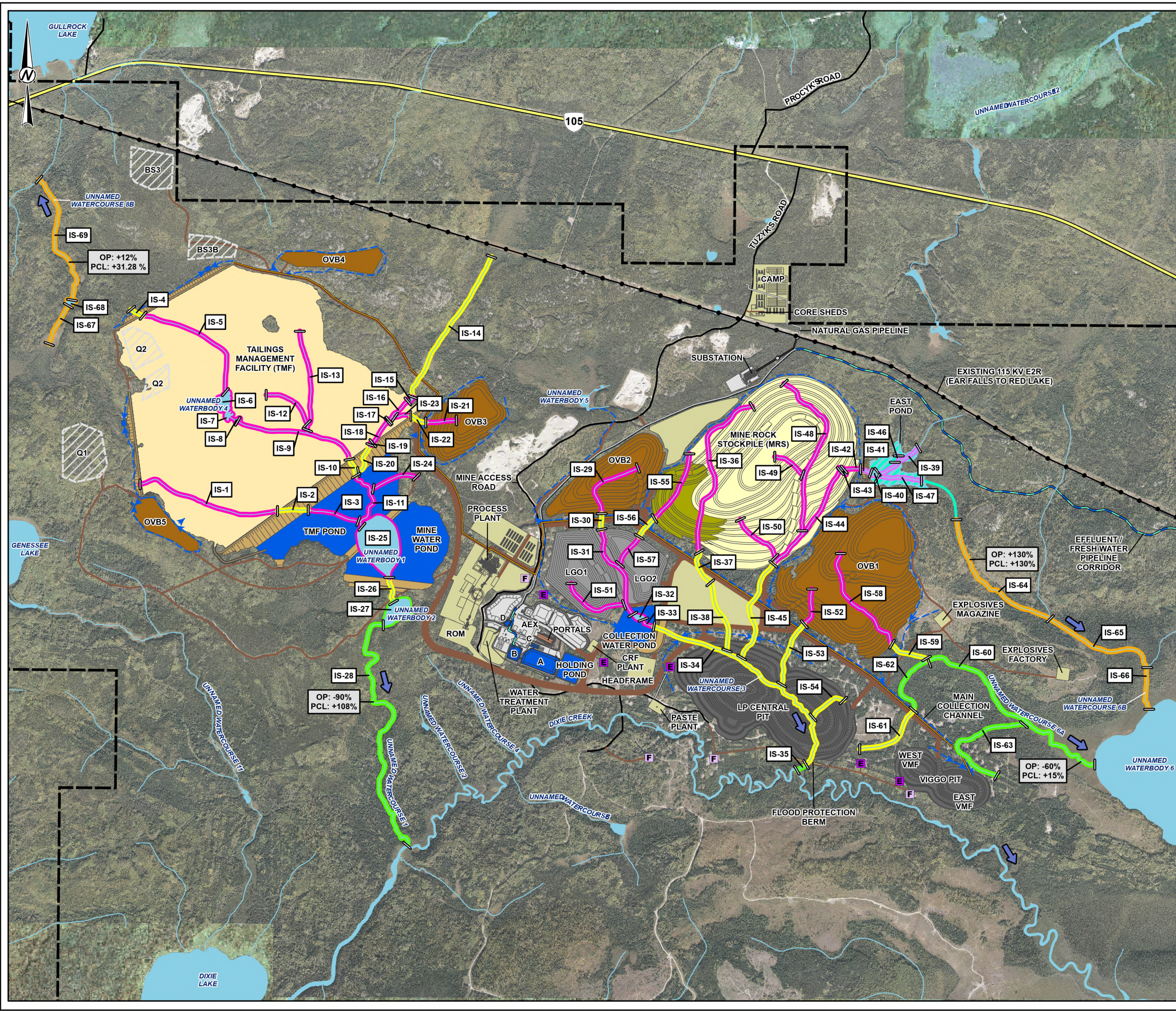
This is an addendum prepared by WSP Canada Inc. with the Wood Group, to the Blasting Vibration and Overpressure Modelling Report (prepared by Wood PLC dated September 2025) for the Great Bear Project. This modelling report was distributed as part of consultation efforts and was part of the Impact Statement Submission #2 provided to the Impact Assessment Agency of Canada in December 2025.

This addendum has resulted from continued communications with Fisheries and Oceans Canada and Environment and Climate Change Canada, who requested clarity on the waters frequented by fish. The content of the original Blasting Vibration and Overpressure Modelling Report (dated September 2025) remains valid except for changes specifically as follows:

- Waterbodies and watercourses previously classified as not fish frequented where no fish were previously captured or observed in that report, were re-evaluated under a precautionary and conservative approach and federal guidance, to be considered as potentially fish frequented. Attached Figure ADD-01 replaces Figure 4-5 of the Blasting Vibration and Overpressure Modelling Report (dated September 2025).
- Tables, analyses and statements within the Blasting Vibration and Overpressure Modelling Report (dated September 2025) have not been updated to account for watercourses newly classified as potentially fish frequented. Discussion with Fisheries and Oceans Canada have confirmed that should these watercourses contain fish at the time of blasting, the potential harm to fish can be mitigated through a fish relocation program as described in the *Fisheries Act* Offset Plan and MDMER Schedule 2 Fish Habitat Compensation Plan – Updated Draft (WSP 2026).

## References:

- WSP Canada Inc. 2026. Great Bear Project, Fisheries Act Offset Plan and MDMER Schedule 2 Fish Habitat Compensation Plan – Updated Draft.



**LEGEND**

- PROPERTY BOUNDARY
- HIGHWAY
- LOCAL ROAD
- EXISTING TRANSMISSION LINE
- WATERCOURSE
- WATERBODY
- FLOW DIRECTION

**ANTICIPATED FISHERIES IMPACTS (LABELLED WITH IMPACT SEGMENT ID AND PERCENT FLOW INCREASE/DECREASE)**

- SCHEDULE 2
- PARAGRAPH 35 (DIRECT IMPACT)
- PARAGRAPH 35 (FLOW INCREASE)
- PARAGRAPH 35 (ALTERED HABITAT)
- PARAGRAPH 35 (FLOW REDUCTION)

**PROPOSED MINE FEATURE**

- OPEN PIT
- MINE ROCK STOCKPILE (NPAG)
- MINE ROCK STOCKPILE (PAG)
- LOW GRADE ORE STOCKPILE (LGO)
- OVERBURDEN STOCKPILE (OVB)
- TAILINGS MANAGEMENT FACILITY (TMF)
- DAM
- POND
- COLLECTION DITCH
- MINE FACILITIES / INFRASTRUCTURE
- ROAD
- PORTAL
- ADVANCED EXPLORATION SITE (AEX)
- ROCK QUARRY (Q) / SAND AND GRAVEL PIT (B)
- FISH HABITAT
- OFFSETTING WATERBODY
- DIVERSION CHANNEL
- FRESH AIR VENT RAISE
- EXHAUST VENT RAISE
- TRANSMISSION LINE
- TAILINGS PIPELINE
- PASTE PLANT PIPELINE
- EFFLUENT / FRESH WATER PIPELINE CORRIDOR
- EFFLUENT DISCHARGE LOCATION

0 0.25 0.5 1  
1:30,000 KILOMETRES

**NOTE(S)**

- ALL LOCATIONS ARE APPROXIMATE
- VMF: VIGGO MANAGEMENT FACILITY
- ROM: RUN OF MINE ORE
- AEX PONDS: A-AEX MINE WATER POND, B-AEX TREATED WATER POND, C-AEX SETTLING POND, D-AEX SEDIMENT POND
- OP: OPERATIONS, PCL: POST-CLOSURE
- + : FLOW INCREASE, - : FLOW DECREASE

**REFERENCE(S)**

- CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENCE - ONTARIO
- AERIAL IMAGERY PROVIDED BY GREAT BEAR RESOURCES (SCENE DATE: SEPTEMBER 2022).
- PROPERTY BOUNDARY PROVIDED BY GREAT BEAR RESOURCES, AUGUST 2024.
- ROADS INFORMATION PROVIDED BY GREAT BEAR RESOURCES, AUGUST 2022.
- SITE PLAN BASED ON INFORMATION PROVIDED BY GREAT BEAR RESOURCES, DECEMBER 2024 / JUNE 2025.
- COORDINATE SYSTEM: NAD 1983 UTM ZONE 15N.

CLIENT  
**GREAT BEAR RESOURCES**

PROJECT  
**GREAT BEAR PROJECT**

TITLE  
**ANTICIPATED FISHERIES IMPACTS**

CONSULTANT	YYYY-MM-DD	2026-03-20
DESIGNED	MR	
PREPARED	MD	
REVIEWED	---	
APPROVED	---	

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## Change Record

Revision	Date	Section	Description

## Summary of Holds

Revision	Area	Reason for hold

## Executive Summary

Great Bear Resources Ltd., a wholly owned subsidiary of Kinross Gold Corporation, is planning to develop, operate, and eventually reclaim an underground mine and two open pits for its gold mining “Great Bear Gold” Project (“the Project”). Wood was retained to predict vibration and overpressure levels emitted by the different phases of the Project. The Project is located in the Red Lake mining district; approximately 25 kilometres (km) southeast of the Municipality of Red Lake in northwestern Ontario.

The Project is expected to move a maximum of 120,000 tonnes of material per day during the entire life of the mine until Closure. The three phases of the Project were evaluated and modelled as four periods: Construction Phase (3 years), Operations phase - Peak Production (8 years), Operations phase - Underground Production (18 years) and Closure Phase (3 years, active closure period). During Operations, the Project site is expected to operate continuously for 24 hours per day, 7 days per week.

The Project’s blasting impact was evaluated with respect to ground vibration, air overpressure and water overpressure. The applicable guidelines used for this modelling report are the *Ontario Ministry of the Environment, Conservation and Parks (MECP) Model Municipal Noise Control By-law for Blasting in Mines and Quarries (NPC-119)* [1], the *HC Noise Guideline (Health Canada, 2017)* [2], *Canadian Department of Fisheries and Oceans (DFO) Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters (Wright & Hopky, 1998)* [3] as well as the technical paper *Monitoring Explosive-based Winter Seismic Exploration in Waterbodies, NWT 2000-2002* [4].

For the evaluation with respect to the NPC-119 and Health Canada, twenty-nine (29) representative Points of Reception (PORs) were identified and considered for this assessment. The PORs include seasonal cabins/outfitters, cottages and unoccupied private properties. By considering the planned nominal explosive charges per blast location, provided by Great Bear Resources, the Project is expected to be compliant with limits established by the NPC-119 and the Health Canada at all PORs. The compliance limits of NPC-119 also require that periodic vibration and air overpressure monitoring be performed during the blasting operations.

The impact of the Project on the nearest fish habitats was evaluated using the methodology established by the DFO Guidelines. Herein, the effects were assessed with respect to fish habitats ground-borne vibration and instantaneous water overpressure. Considering the planned nominal explosive charges per blast location, which was provided by Great Bear Resources, without control measures in place, the predicted levels fall above the DFO limits at select fish habitats in the vicinity of the Project. To ensure compliance, a Blast Management Plan will be developed for the blasting operations. This plan will include ongoing monitoring and opportunities for adaptive management. Potential residual effects to fish and fish habitat will be addressed in the Fish Habitat Compensation and Offsetting Plan.

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## List of Abbreviations

Abbreviation	Description
AEX	Advanced Exploration
ANFO	Ammonium Nitrate Fuel-Oil
APP	Air Pressure Pulse
BSR	Baseline Receptor
CRF	Cemented Rock Fill
CWP	Contact Water Pond
dBA	A-weighted Decibels
dBL	Decibels (no weighting)
DFO	Department of Fisheries and Oceans
GBP	Great Bear Project
GBR	Great Bear Resources
HC	Health Canada
ISEE	International Society of Explosive Engineers
ISID	Impact Segment ID
kg	Kilogram
km	Kilometres
LGO	Low-grade Ore
m	Metres
m.a.s.l	Metres Above Sea Level
MECP	Ontario Ministry of Environment, Conservation and Parks
mm	Millimetres
MRS	Mine rock stockpile
NPAG	Non-Potentially Acidic Ground
NPC	Noise Pollution Control
OVB	Overburden stockpile
PAG	Potentially Acidic Ground
POR	Point of Reception
PPV, ppv	Peak Particle Velocity
Q1	Quarry Source 1
Q2	Quarry Source 2
ROM	Run Of Mine
SD	Scaled Distance
SRP	Stemming Release Pulse
TLRU	Traditional Land and Resource Use
TMF	Tailings Management Facility
tpd	Tonnes per day
USBM	United States Bureau of Mines

Abbreviation	Description
UTM	Universal Transverse Mercator
VMF	Viggo Management Facility

# 1.0 Introduction

## 1.1 Overview

Great Bear Resources Ltd. (Great Bear Resources), a wholly owned subsidiary of Kinross Gold Corporation, is planning to develop, operate, and reclaim a gold mine (the Great Bear Project or Project) on the Great Bear Property (the Property). The Project will consist of an onsite ore processing facility, two (2) open pits, underground mining, auxiliary operations and administrative activities will also take place on the Property. The Property is located approximately 25 kilometres (km) southeast from the Municipality of Red Lake in Ontario, and northwest of the Township of Ear Falls, see Figure 1-1.

An Impact Assessment pursuant to the *Impact Assessment Act, 2019* is required to be completed for the Project. This Blasting Vibration and Overpressure Modelling report is one of a series of documents prepared on behalf of Great Bear Resources to establish the potential environmental effects of the Project.

The ore body is primarily hosted in the LP Fault Zone where the two open pits will be mined. Ore from the open pits will be processed in an onsite process plant. The main components of the Project include:

- LP Central pit, Viggo pit;
- Underground mine, accessed via portals, ramps, shaft;
- Flood protection berm;
- Tailings management facility (TMF);
- Viggo management facility (VMF);
- Run of mine stockpile (ROM);
- Low grade ore stockpile (LGO);
- Mine rock stockpile (MRS);
- Overburden stockpile (OVB);
- Process plant;
- Buildings and supporting infrastructure;
- Water management and treatment facilities;
- Construction camp, permanent camp, and;
- Quarries, and sand and gravel pits.

The Project is expected to be constructed over a three-year period during which the Viggo pit will be mined to extract high ratios of non-potentially acid generating (NPAG) mine rock for construction purposes. Advanced Exploration (AEX) activities will be occurring during the construction phase and then stop once mining operations start. The operations phase of the Project will focus on LP Central pit and underground mining and ore processing with the expected duration of 9 years, followed by only underground mining for a period of 26 years.

The primary active decommissioning and closure is expected to occur over 3 years and will be followed by a period of passive site management while the LP Central pit fills with water after which the remaining infrastructure will be removed. A site plan, provided by Great Bear Resources, identifying the key components of the Project is shown in Figure 1-2.

## 1.2 Objective

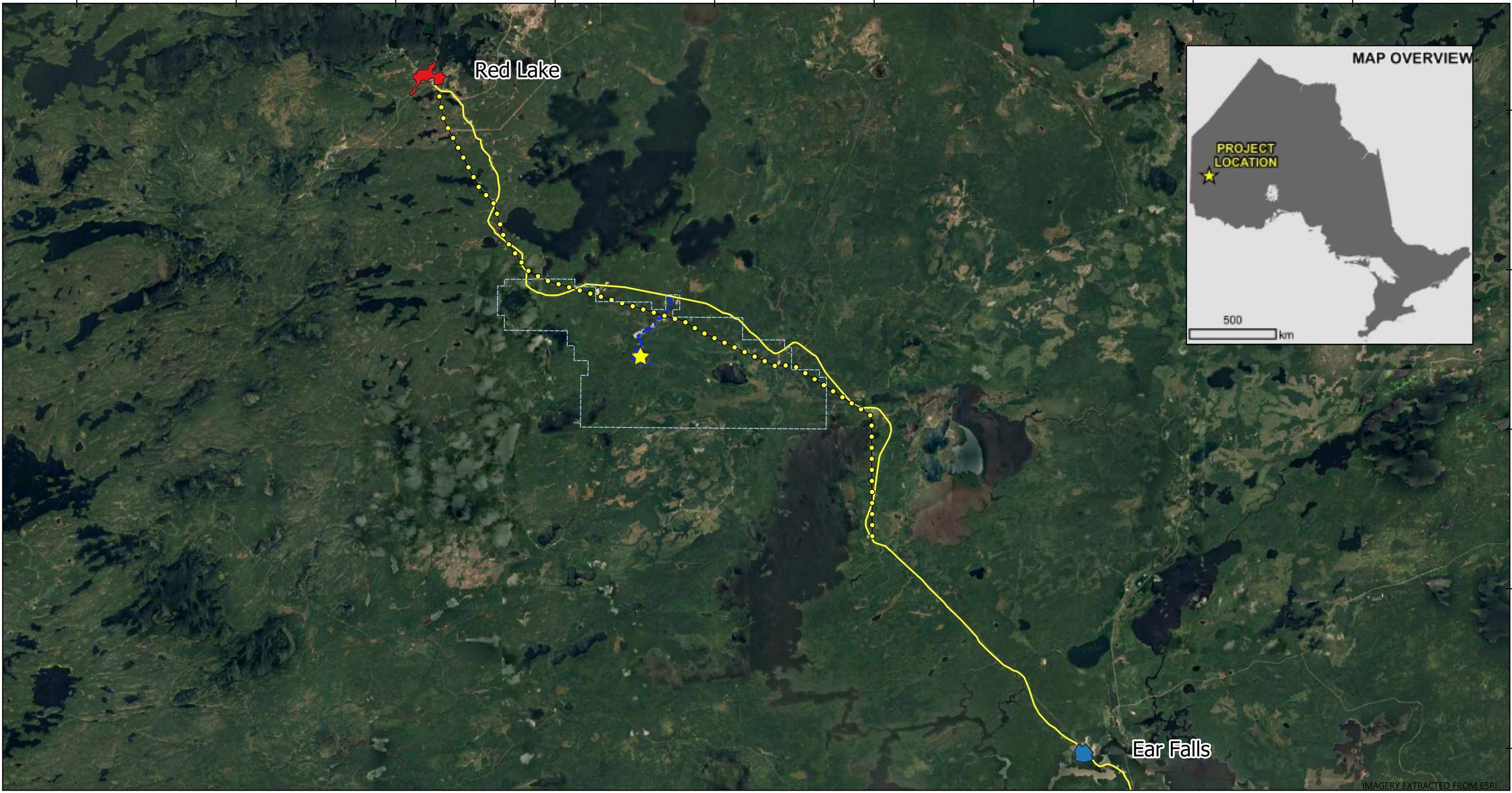
The Blasting Vibration and Overpressure Modelling Report has been prepared to assess the potential effects of the construction, operations, and closure phases of the Project. To evaluate these effects of the Project, this assessment has been prepared to predict impact based primarily on documentation provided by Great Bear Resources, as well as onsite investigations (i.e., Wood's baseline programs) conducted in 2022 and 2023.

The following guidelines were used for the evaluation of the Project's blasting vibration and overpressure emissions:

- Ontario Ministry of the Environment, *Conservation and Parks (MECP) Model Municipal Noise Control By-law for Blasting in Mines and Quarries* (NPC-119) (MECP, 1982) [1];
- Health Canada - "*Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise*" (Health Canada, 2017) [2];
- Canadian Department of Fisheries and Oceans (DFO) *Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters* (Wright & Hopky, 1998) [3], and
- Technical Paper: "*Monitoring Explosive-Based Winter Seismic Exploration in Waterbodies, NWT 2000-2002*" (Cott & Hanna, 2005) [4].

During construction, the Project site and associated activities are planned to occur for 12 hours per day, 7 days a week. During operations, the site is expected to operate continuously for 24 hours per day, 7 days per week. Blasting is planned to occur during the construction and operations phases of the Project.

This Blasting Vibration and Overpressure Modelling Report evaluates the impacts associated with blasting during the construction and operations phases using generic empirical calculations against the applicable provincial and federal guideline limits. Once onsite blasting data is available, the blasting calculations will be calibrated, and the Blast Management Plan will be adjusted as needed.



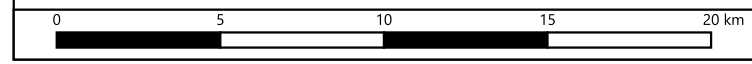
**LEGEND**

Highway 105	Property Boundary	Project_Location
Red Lake Municipality	Tuzyks Road	
Ear Falls Township	Powerline 115 kV	

Notes:  
 - Site Plan provided by Kinross  
 February 2025

Datum & Projection:  
 NAD83 / UTM zone 15N

<b>Great Bear Resources</b>	
Project Location	
PROJECT NO: CA03912	FIGURE 1-1
SCALE: 1:230946	DATE: August 2025



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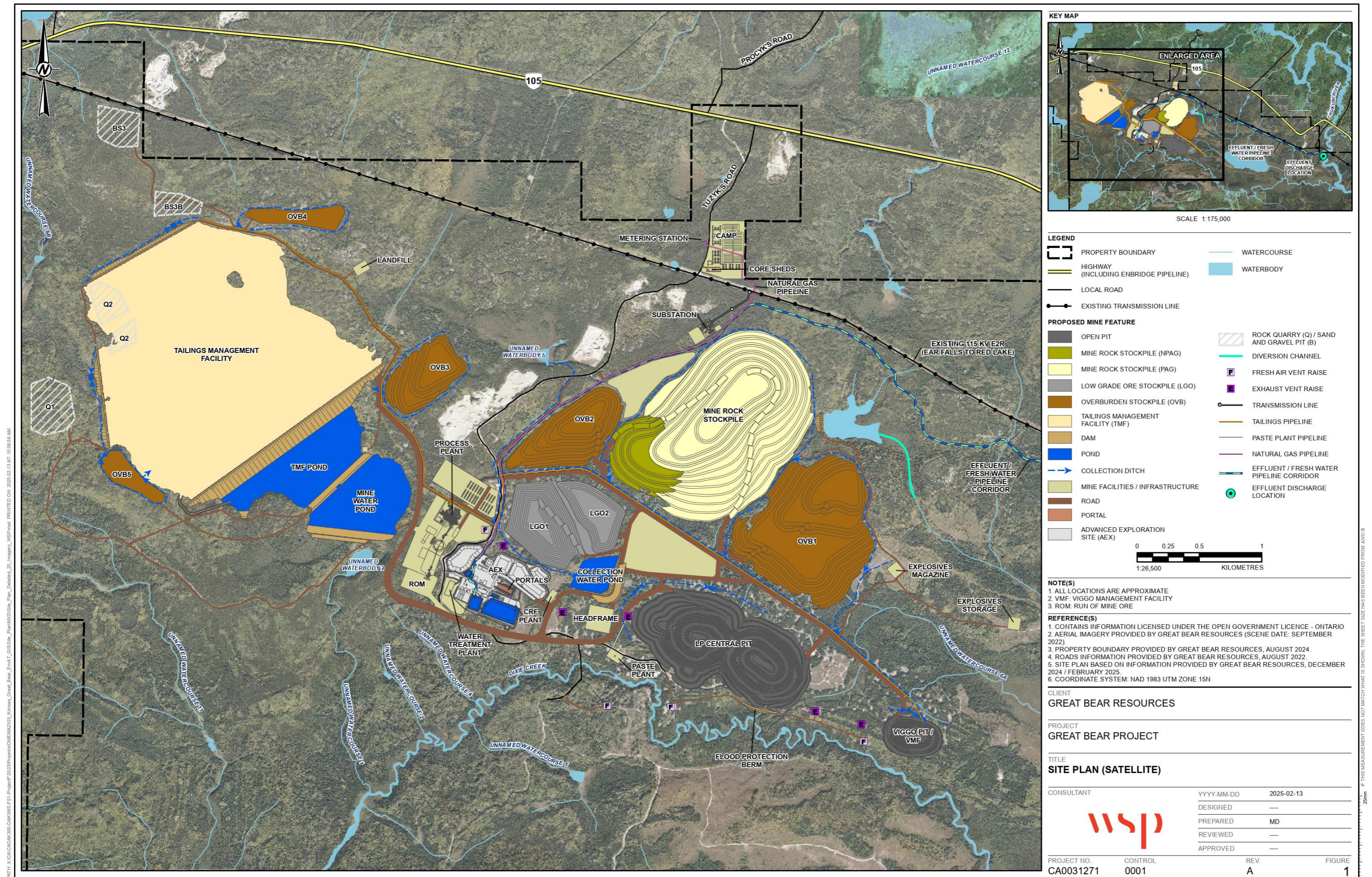


Figure 1-2: Site Plan

## 2.0 Points of Reception

Receptor locations of interest according to the Health Canada Noise Guideline [2] and MECP NPC-119 guideline [1] include the following noise sensitive land uses:

- Permanent, seasonal, or rental residences;
- Hotels, motels and campgrounds;
- Schools, universities, libraries, and daycare centers;
- Hospitals and clinics, nursing / retirement homes; and
- Churches and places of worship.

The Project site and surrounding area are mainly characterized by gentle hills, forests, lakes, and rivers. Twenty-nine (29) Points of Reception (PORs) were identified and considered in this assessment. These consist of properties (residential, cabins, lodges and campsites) not owned by Great Bear Resources and the potential traditional land and resource uses (TLRUs) around the Project site. The TLRUs assumed herewith are subject to revision pending further information. A brief description of the representative PORs considered is listed below and summarized in Table 2-1. The locations of the modeled receptors with respect to the Project site are shown in Figure 2-1.

These receptor locations are considered for the blasting impact evaluation with respect to the NPC-119 and Health Canada guidelines.

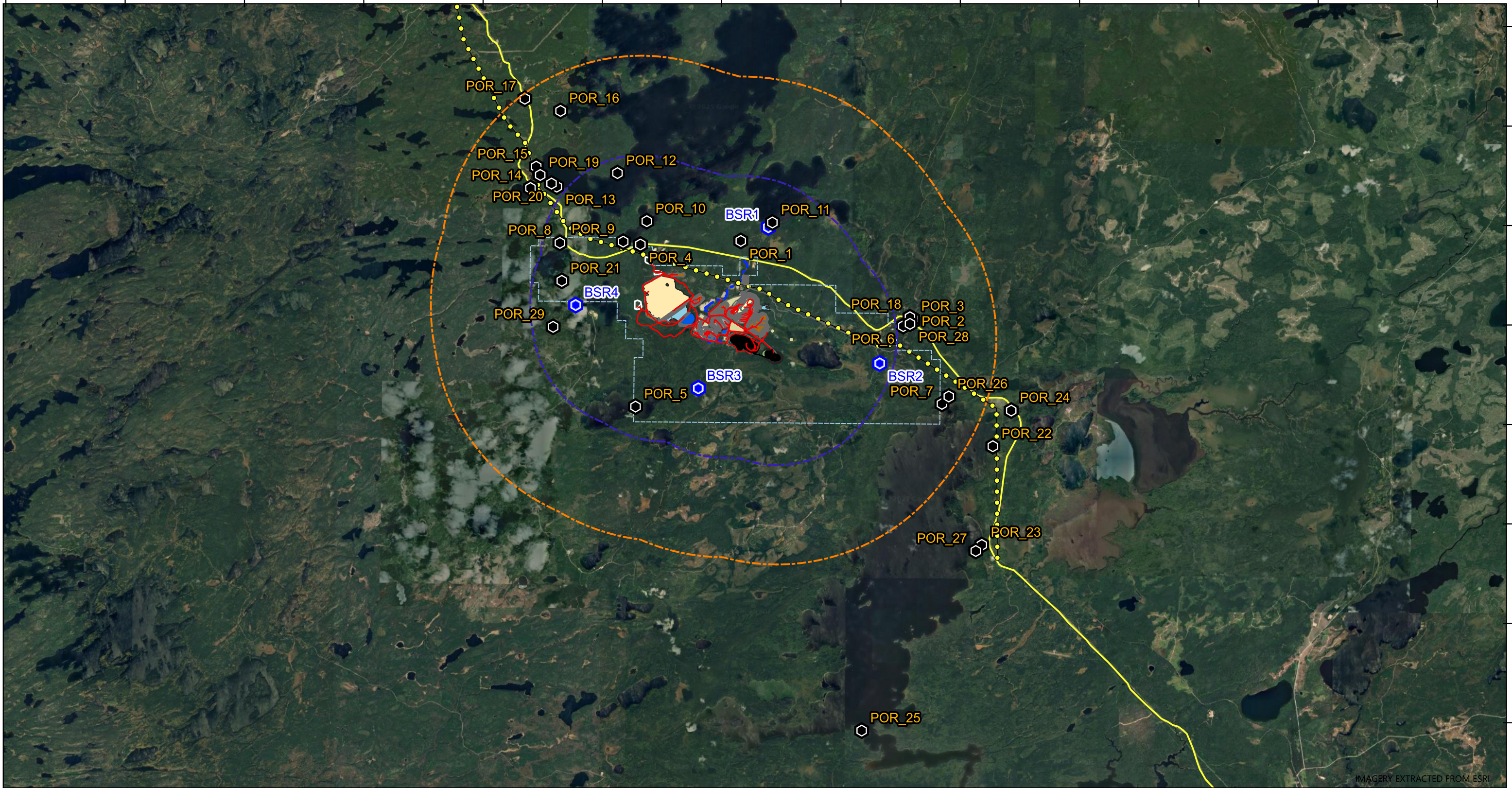
**Table 2-1: Points of Reception Summary**

ID	POR Group	UTM Coordinates Zone 15U NAD-83 Datum	
		Easting (m)	Northing (m)
<b>POR1</b>	Residence/Cabin/Lodge/Camp	456965	5639223
<b>POR2</b>	Residence/Cabin/Lodge/Camp	465624	5635180
<b>POR3</b>	Residence/Cabin/Lodge/Camp	465611	5635303
<b>POR4</b>	Residence/Cabin/Lodge/Camp	451915	5639044
<b>POR5</b>	Residence/Cabin/Lodge/Camp	451671	5630891
<b>POR6</b>	Residence/Cabin/Lodge/Camp	465139	5634939
<b>POR7</b>	Residence/Cabin/Lodge/Camp	467085	5631026
<b>POR8</b>	Residence/Cabin/Lodge/Camp	447866	5639124
<b>POR9</b>	Residence/Cabin/Lodge/Camp	451051	5639187
<b>POR10</b>	Residence/Cabin/Lodge/Camp	452237	5640215
<b>POR11</b>	Residence/Cabin/Lodge/Camp	458555	5640149
<b>POR12</b>	Residence/Cabin/Lodge/Camp	450762	5642634
<b>POR13</b>	Residence/Cabin/Lodge/Camp	447708	5641952
<b>POR14</b>	Residence/Cabin/Lodge/Camp	446385	5641886
<b>POR15</b>	Residence/Cabin/Lodge/Camp	446675	5642960
<b>POR16</b>	Residence/Cabin/Lodge/Camp	447897	5645762
<b>POR17</b>	Commercial	446102	5646375
<b>POR18</b>	Residence/Cabin/Lodge/Camp	465476	5635383
<b>POR19</b>	Empty Lot, Non-mining Land Area	446876	5642540

ID	POR Group	UTM Coordinates Zone 15U NAD-83 Datum	
		Easting (m)	Northing (m)
<b>POR20</b>	Residence/Cabin/Lodge/Camp	447444	5642109
<b>POR21</b>	Commercial	447961	5637216
<b>POR22</b>	Residence/Cabin/Lodge/Camp	469646	5628897
<b>POR23</b>	Residence/Cabin/Lodge/Camp	469091	5623932
<b>POR24</b>	Residence/Cabin/Lodge/Camp	470572	5630691
<b>POR25</b>	Residence/Cabin/Lodge/Camp	463047	5614594
<b>POR26</b>	Residence/Cabin/Lodge/Camp	467430	5631399
<b>POR27</b>	Residence/Cabin/Lodge/Camp	468788	5623627
<b>POR28</b>	Residence/Cabin/Lodge/Camp	465478	5635052
<b>POR29</b>	Residence/Cabin/Lodge/Camp	447525	5643902

420000 426000 432000 438000 444000 450000 456000 462000 468000 474000 480000 486000 492000

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5645000  
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5635000  
5630000  
5625000  
5620000  
5615000



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**LEGEND**

Highway 105	Baseline Receptor	Mine Site 10km Buffer
Powerline 115 kV	Point of Receiver	Mine Site 5km Buffer
Property Boundary		
Truck Haul Routes		

0 5 10 15 20 25 km

Notes:  
 - "POR" (Point Of Reception) provided by Kinross May 2025  
 - "BSR" (Baseline Receptor) from Wood baseline reports  
 - Site Plan provided by Kinross in June 2025

Datum & Projection:  
 NAD83 / UTM zone 15N

<b>Great Bear Resources</b>	
Aerial Map with Point of Reception Locations	
PROJECT NO: CA03912	FIGURE 2-1
SCALE: 1:184768	DATE: August 2025

### 3.0 Applicable Guidelines

#### 3.1 Provincial Noise Guideline

The MECP *Model Municipal Noise Control By-law for Blasting in Mines and Quarries* (NPC-119) [5] provides guideline blasting limits for air overpressure and ground-borne vibration. These limits are applicable at sensitive land uses and in particular residential dwellings. The applicable compliance air overpressure and ground-borne vibration limits for blasting from NPC-119 are outlined in Table 3-1. Note that these limits require the Project to carry out routine air overpressure and vibration monitoring as per the Publication NPC-103, "Procedure for Measurement of Sound and Vibration due to Blasting Operations".

**Table 3-1: MECP Vibration Limits (NPC-119)**

Assessment Type	Assessment Metric	Compliance Limit
Air-Overpressure	Peak Pressure Level ( $L_{peak}$ )	$\leq 128$ dBL
Vibration	Peak Particle Velocity (PPV)	$\leq 12.5$ mm/s

#### 3.2 Federal Noise Guideline

The Health Canada *Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise* (HC Noise Guideline) [2] also provides guideline limits for blasting air-overpressure which are based on the World Health Organization (WHO) [6] recommendations for hearing loss protection. The HC Noise Guideline considers that while hearing loss impacts are not typically considered in the context of a federal impact assessment because project-related sound levels rarely reach these high levels at potential receptor locations, noise-induced hearing loss may be a concern when project activities involve impulsive noise emission such as from blasting. As such, it is suggested that the WHO recommendation be followed to avoid hearing loss resulting from impulsive noise exposure and the applicable limits are outlined in Table 3-2.

**Table 3-2: HC Noise Guideline Limits**

Assessment Type	Assessment Metric	Limit
Air-Overpressure	Peak Pressure Level ( $L_{peak}$ )	$\leq 140$ dBL, Adults
		$\leq 120$ dBL, Children

#### 3.3 Department of Fisheries and Oceans

The *Canadian Department of Fisheries and Oceans (DFO) Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters* (Wright & Hopky, 1998) [3] complemented with the technical paper *Monitoring Explosive-based Winter Seismic Exploration in Waterbodies, NWT 2000-2002* [4] provide guideline limits for blasting water-overpressure and ground-borne vibration when in proximity to Canadian Fisheries Waters. These limits are applicable at the land-water interface (shoreline). The applicable water-overpressure and vibration limits for blasting from these guidelines are outlined in Table 3-3.

**Table 3-3: DFO Blasting near Canadian Fisheries Water Limits**

Assessment Type	Assessment Metric	Limit
Instantaneous Water-Overpressure <sup>1</sup>	Peak Pressure ( $P_{peak}$ )	$\leq 50$ kPa
Vibration <sup>2</sup>	Peak Particle Velocity (PPV)	$\leq 13$ mm/s

Notes:

1. Original DFO Guidelines set a limit of 100 kPa. However, the Federal Authority Advice Record for the Great Bear Gold Project recommends evaluating impact with respect to 50 kPa as defined in Reference [4]. Also, note that the underwater overpressure limit only tends to become a measurable metric when blasting occurs within the water body itself.
2. The vibration limit applies with a maximum PPV level of 13 mm/s in a spawning bed during the period of egg incubation.

## 4.0 Blasting Assessment

### 4.1 Introduction

Among the unavoidable and undesirable byproducts from blasting operations as a mining method, ground vibration and air overpressure are the two vibration effects that have been studied the most from their early empirical beginnings in the 1930's to present time. In the prediction of these side effects from blasting operations, the former United States Bureau of Mines ("USBM") was the first entity soliciting a series of scientific research investigations from the 1930's to the 1980's to consultant experts in blasting topics.

The calculations provided in this report follow the recommendations for ground vibration and air overpressure suggested in the *Blaster's Handbook, 18th Edition* [7] by the *International Society of Explosive Engineers* (ISEE) to corroborate the correct interpretation and usage of the empirical propagation law equations developed by the USBM for prediction of these effects.

For air overpressure predictions, USBM constants and exponents were used to calculate the prediction of this air-borne effect, which follow the consistent and observed attenuation decay of 6 dB to 7.2 dB per doubling the distance. The range of attenuation decay was observed by the USBM and ISEE from actual recorded blasts over a span of at least three decades [8] [9] [10].

For ground vibration predictions, the propagation effects depend on specific site conditions influenced by site geological composition and lithology characteristics. There is no historic seismograph information available for the Project site area to calibrate the decay effect of ground-borne vibration from the blasting operations, therefore generic constants and exponents from ISEE were used for these predictions.

### 4.2 Blasting Parameters

The list below summarizes the planned nominal blast parameters shared by Great Bear Resources. These values are preliminary and may change during the actual execution of the Project.

#### **Open Pits – LP Central pit and Viggo pit**

Explosive weight per hole, ammonium nitrate with fuel oil ("ANFO") based emulsion = 207.6 kg

Hole Depth (with 1 m subdrilling) = 11 m

Collar stemming = 3 m

Drillhole Diameter = 171 mm

Blast frequency = 1 per day

#### **Quarry Source 1 (Q1) and Quarry Source 2 (Q2)**

Explosive weight per hole ammonium nitrate with fuel oil ("ANFO") based emulsion = 41.2 kg

Hole Depth (with 1 m subdrilling) = 6 m

Collar stemming = 1.5 m

Drillhole Diameter = 101.6 mm

Blast frequency = 1 per day

#### **Underground Mine (Fisheries Impact only)**

Explosive weight per hole ammonium nitrate with fuel oil ("ANFO") based emulsion = 10.1 kg

Hole Depth = 4.4 m

Collar stemming = No collar stemming

Drillhole Diameter = 50.8 mm

Blast frequency = 29.3 per day

## 4.3 Ground Vibration and Air Overpressure

### 4.3.1 Receptors Location

The nearest receptor to where blasting operations will occur at LP Central pit is "POR1", which is located approximately 5,233 m away from the pit, north of the process plant. The nearest receptor to blasting at Quarry 2 is "POR4", which is located 2,221 m north from the quarry. "POR21" is the nearest receptor to Quarry 1 which is located 4,015 m northwest from the center of the Quarry.

As mentioned in Section 3.0, the applicable guidelines for blasting ground vibration and air overpressure from mines and quarries are defined in the NPC-119 [1] and Health Canada Noise Guideline [2].

### 4.3.2 Predicted Ground Vibration Effect

Ground-borne vibration caused by blasting operations is an undesired side effect from the use of explosives to fragment rock in mining, quarrying, excavation, and construction. This ground vibration (or seismic energy) is essentially the speed of excitation of ground particles resulting from vibratory motion, produced by the instantaneous release of energy, that propagates through an elastic medium such as the ground, and logarithmically attenuates from its originating point. This motion is governed by an equation known as *propagation law*.

Ground vibration due to blasting activities can be estimated for a specific location using the following propagation law:

$$ppv = K \left( \frac{D}{Q^{\frac{1}{2}}} \right)^{-n} \quad \text{Equation 1}$$

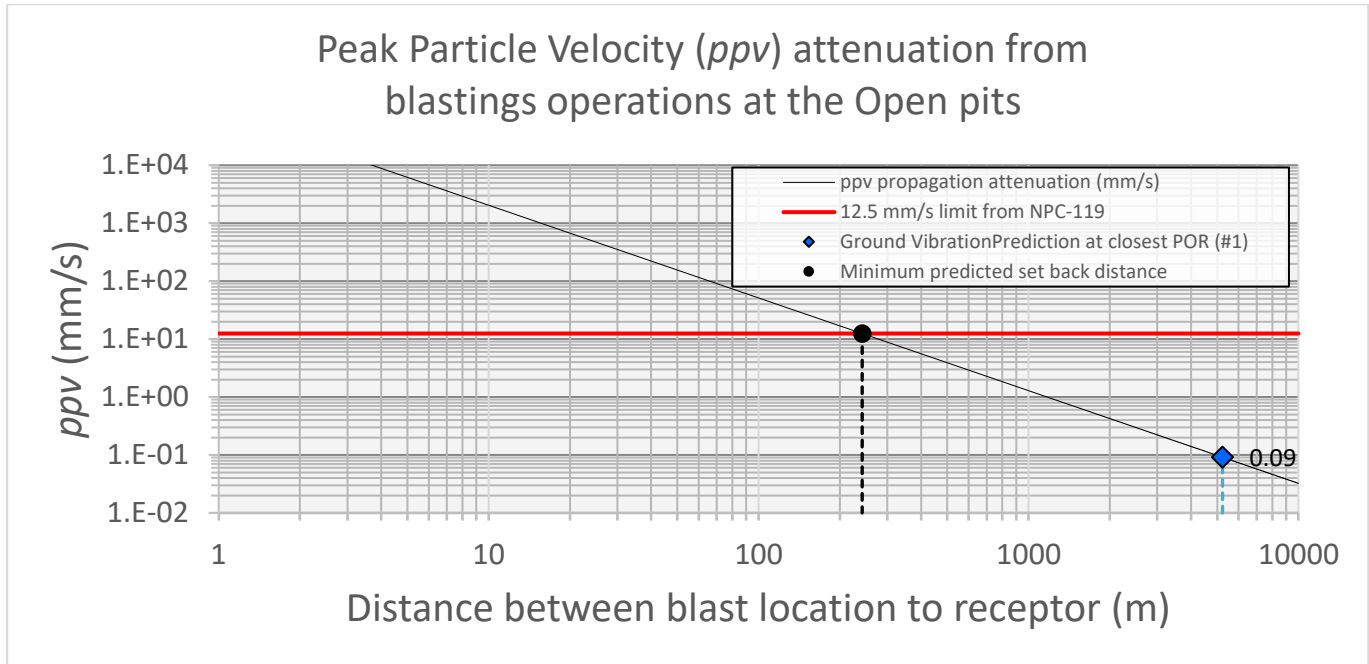
where:

- $ppv$  = Peak Particle Velocity (mm/s)
- $D$  = minimum linear distance between blast hole and receptor (m)
- $Q$  = maximum instantaneous charge of explosives per hole (kg)
- $K$  = site law constant, or equation intercept
- $n$  = site law exponent, or equation slope exponent

The  $D/Q^{1/2}$  fraction originates from early development work done between the 1950's to late 1960's to predict ground vibration effect from blasting operations, started mostly by H. R. Nicholls, W. I. Duvall, and D.E. Fogelson, and is known as the "scaled distance" for ground vibration ( $SD_{gv}$ ).  $K$  and  $n$  are components of the ground vibration equation that were developed and studied for the former USBM between the 1970's and 1980's by D. E. Siskind, M.S. Stagg, J.W. Kopp, and C.H. Dowding.

When no specific site constants are generated or known for ground vibration effects prediction, ISEE's provided site law constant value of 1140 for  $K$  and the site law exponent value of 1.6 for  $n$ , can be employed for open pit free face blasting in average conditions [11] (normal confinement). For Quarries ISEE's provided site law constant value of 1090 for  $K$  and site law exponent of 1.82 in average conditions can be employed.

The blasting design parameters provided for the Project were evaluated using Equation 1. Figure 4-1 below shows the predicted ground vibration decay for 207.6 kg of explosives as distance increases from the open pits blasting operations. Ground vibration prediction for closest receptor POR-1 location from the open pits is shown with a blue diamond. MECP's ground vibration limit of 12.5 mm/s is plotted with a red line.



**Figure 4-1: Ground Vibration Propagation Curve – Open Pits**

Ground vibration predicted values at all PORs by shortest distance to the Project’s open pits blasting operations are found in Table 4-1. The values have been sorted to show the closest receptor at the top of the table. From Table 4-1, ground-borne vibration levels at all PORs from the open pits blasting operations are predicted to be in compliance with applicable MECP limits.

**Table 4-1: Predicted Peak Particle Velocity at PORs from Open Pits**

Location	Distance (m)	ppv (mm/s)
Minimum predicted setback distance	242	12.5
POR 1 to LP Central	5233	0.09
POR 11 to LP Central	6276	0.07
POR 5 to LP Central	6431	0.07
POR 6 to Viggo Pit	6788	0.06
POR 28 to Viggo Pit	7143	0.06
POR 18 to Viggo Pit	7223	0.05
POR 2 to Viggo Pit	7315	0.05
POR 3 to Viggo Pit	7332	0.05
POR 4 to LP Central	7378	0.05
POR 10 to LP Central	8016	0.05
POR 9 to LP Central	8121	0.05
POR 7 to Viggo Pit	8905	0.04
POR 26 to Viggo Pit	9147	0.04
POR 21 to LP Central	9877	0.03
POR 8 to LP Central	10736	0.03
POR 12 to LP Central	10830	0.03

Location	Distance (m)	ppv (mm/s)
POR 22 to Viggo Pit	12025	0.02
POR 24 to Viggo Pit	12368	0.02
POR 13 to LP Central	12460	0.02
POR 20 to LP Central	12763	0.02
POR 14 to LP Central	13466	0.02
POR 19 to LP Central	13475	0.02
POR 15 to LP Central	13899	0.02
POR 29 to LP Central	13914	0.02
POR 27 to Viggo Pit	14213	0.02
POR 23 to Viggo Pit	14228	0.02
POR 16 to LP Central	15059	0.02
POR 17 to LP Central	16689	0.01
POR 25 to Viggo Pit	19394	0.01

Following the same prediction methodology for the blasting operations at the quarries to all PORs, shows the predicted ground vibration decay for 41.2 kg of explosives as distance increases from blasting operations at the Quarries. Predicted ground vibration for closest receptor POR4 location is plotted with a green diamond. MECP's ground vibration limit of 12.5 mm/s is plotted with a red line.

Predicted ground vibration levels at all PORs from the Project Quarries blasting operations are found in Table 4-2 The values have been sorted to show the closest receptor at the top of the table. From Figure 4-2, the predicted ground vibration magnitudes at all PORs are in compliance with the MECP applicable limits.

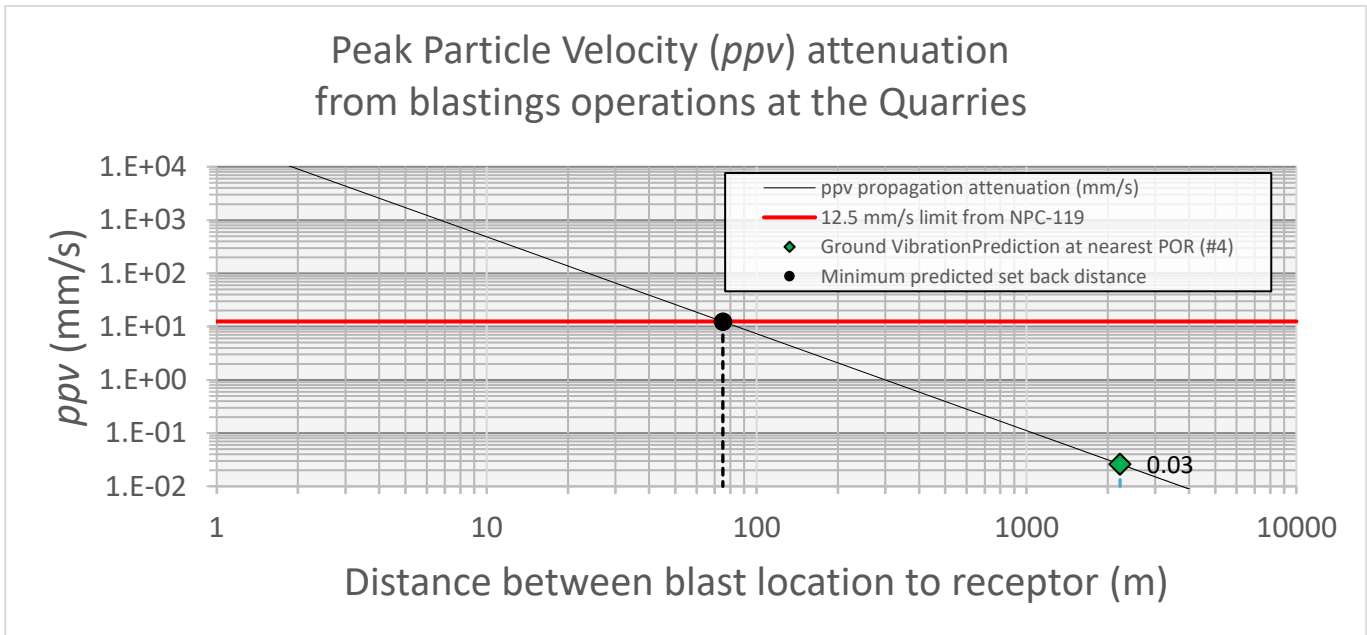


Figure 4-2: Ground Vibration Propagation Curve – Quarries

**Table 4-2: Predicted Peak Particle Velocity at PORs from Quarries**

Location	Distance (m)	ppv (mm/s)
Minimum predicted set back distance	75	12.5
POR 4 to Quarry 2	2221	0.026
POR 9 to Quarry 2	2622	0.019
POR 10 to Quarry 2	3369	0.012
POR 21 to Quarry 1	4015	0.009
POR 8 to Quarry 2	4925	0.006
POR 5 to Quarry 1	5093	0.006
POR 1 to Quarry 2	5296	0.005
POR 12 to Quarry 2	5972	0.004
POR 13 to Quarry 2	6822	0.003
POR 20 to Quarry 2	7115	0.003
POR 11 to Quarry 2	7134	0.003
POR 14 to Quarry 2	7719	0.003
POR 19 to Quarry 2	7817	0.003
POR 15 to Quarry 2	8262	0.002
POR 29 to Quarry 2	8482	0.002
POR 16 to Quarry 2	9914	0.002
POR 17 to Quarry 2	11330	0.001
POR 6 to Quarry 2	13047	0.001
POR 18 to Quarry 2	13325	0.001
POR 28 to Quarry 2	13367	0.001
POR 3 to Quarry 2	13468	0.001
POR 2 to Quarry 2	13495	0.001
POR 7 to Quarry 2	15952	0.001
POR 26 to Quarry 2	16145	0.001
POR 22 to Quarry 2	19142	0.001
POR 24 to Quarry 2	19345	0.001
POR 27 to Quarry 1	21020	0.000
POR 23 to Quarry 1	21090	0.000
POR 25 to Quarry 1	24173	0.000

### 4.3.3 Ground Vibration Baseline Levels

Two baseline vibration monitoring campaigns were conducted in 2022 and 2023 to characterize the existing ground vibration for site conditions that are representative of the seasonal changes in the project area.

Ground Vibration data was collected by Wood in 2022 and 2023, timed for when leaves were on the trees (termed “Leaves-On” program), and timed for when leaves were off the trees (termed “Leaves-Off” program). Each program occurred over a 7-day period at four (4) monitoring locations. The monitors’ coordinates were selected to be representative of potential PORs based on proximity and location to the Project, as shown in Figure 2-1.

The baseline ground vibration levels were characterized using a variety of vibration metrics for daytime and nighttime. A summary of the baseline levels obtained for both the Leaves-Off and Leaves-On programs are presented in Table 4-3. It is worth noting that while the locations monitored during the Leaves-Off and Leaves-On programs were relatively consistent, the exact locations differed due to access constraints during the field work. Locations are provided in UTM zone 15N NAD83 as follows:

- BSR1 (Baseline Receptor 1): Easting 458426, Northing 5639996;
- BSR2 (Baseline Receptor 2): Easting 464002, Northing 5633047;
- BSR3 (Baseline Receptor 3): Easting 454830, Northing 5631786; and,
- BSR4 (Baseline Receptor 4): Easting 448092, Northing 5635837.

Details of the baseline ground vibration monitoring field programs as well as the collected data can be found in the baseline reports (Wood 2022 a, b) [6] [7] and 2023 a, b) [8] [9] under separate covers.

It is observed that none of the ground vibration levels from the baseline campaign exceed NPC-119 limits. Note, however, that for certain PORs the ground vibration due to blasting operations may be above the existing baseline conditions.

**Table 4-3: Ground Vibration Baseline Levels**

Monitoring Location	Baseline Ground Vibration Metrics Collected (mm/s)							
	2022				2023			
	Leaves-On Program		Leaves-Off Program		Leaves-On Program		Leaves-Off Program	
	Daytime	Nighttime	Daytime	Nighttime	Daytime	Nighttime	Daytime	Nighttime
BSR1	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.002
BSR2	0.002	0.002	0.002	0.002	0.002	0.003	0.004	0.002
BSR3	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
BSR4	0.003	0.002	0.002	0.002	0.002	0.002	0.002	0.002

#### 4.3.4 Predicted Air Overpressure Effect

Air overpressure is an airborne shock pressure wave that travels through the atmosphere from the detonation location of the explosives. Similar to ground vibration, the amplitude (or intensity) of air decays with distance, but at a lower rate. This means overpressure waves travel slower than seismic waves because air (the atmosphere) is a greater elastic medium than ground.

In the late 1970's Wiss and Linehan conducted thorough analyses with focus in air overpressure from blasting operations as a mining method. A refinement of the general empirical propagation law was developed for air overpressure after observing from their experiments that charge depth plays a relevant role in air overpressure prediction. Thus, air overpressure prediction can be estimated for a specific location using the following overpressure propagation law equation:

$$\Delta P = H e^{-1B} \left( \frac{D}{Q^{\frac{1}{3}}} \right)^{-n} \quad \text{Equation 2}$$

where:

- $\Delta P$  = predicted maximum air overpressure peak amplitude (kPa)
- $D$  = minimum linear distance between blast hole and receptor (m)
- $Q$  = maximum instantaneous charge per hole (kg)
- $n$  = slope exponent with least slope error percentage

$H$  = linear regression overpressure intercept  
 $e$  = base of natural logarithm  
 $B$  = cube root of scaled depth of charge burial

The  $D/Q^{1/3}$  is known as the cube root scaled distance "SD<sub>ab</sub>" for air. The component  $H e^{-1B}$  represents the overpressure amplitude corrected for the scaled depth of charge burial, which primarily considers the effect of the air pressure pulse (APP) and the stemming release pulse (SRP), main contributors of the total air overpressure. Determination of  $H$ ,  $B$ , and  $n$  is found following the procedures and considerations found in the work from Wiss and Siskind for the former USBM. To obtain the air sound pressure level in decibels, the following standardized relationship can be used:

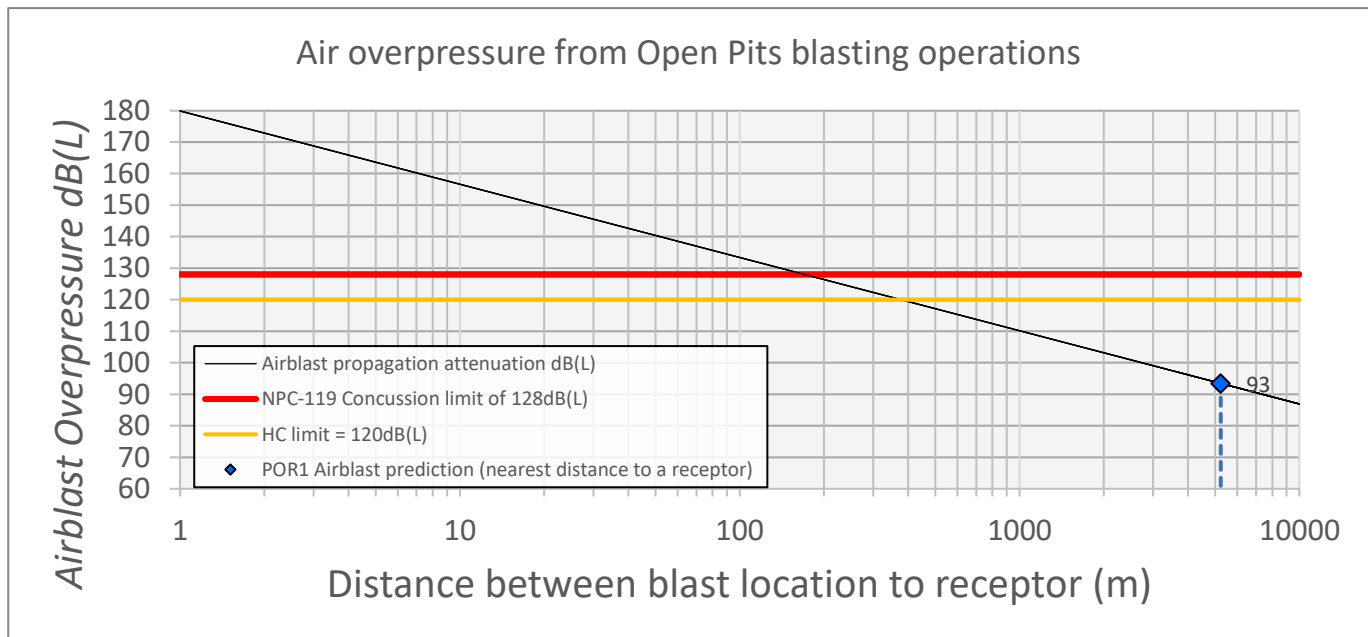
$$AB_{SPL} = 20 \log_{10} \frac{\Delta P}{P_0} \quad \text{Equation 3}$$

where:

$\Delta P$  is the air overpressure peak amplitude and  $P_0$  is the reference pressure =  $20 \times 10^{-6}$  N/m<sup>2</sup> or  $2.9 \times 10^{-9}$  lb/in<sup>2</sup>.

Note that Wiss "Depth of burial effect" work is based on air prediction work by B. Perkins, L.J. Vortman, and C.M. Snell performed during the mid 1960's to early 1970's. For the parameters used in this report, please refer to pages 68 to 71 from Volume I [12] for intercept  $H$ , page 207 and page 218 from Volume II [13] for  $B$  and  $\Delta P$  equation respectively, and pages 190 and 191 from Volume III [14] for  $n$ .

The Project's provided blasting design parameters were evaluated with the propagation law equation for air overpressure. Figure 4-3 below shows the predicted air overpressure propagation attenuation decay for 207.6 kg of explosives per hole as distance increases from the Open pits blasting operations. Air overpressure prediction for closest receptor POR1 location from the open pits is plotted with a blue triangle. MECP's air overpressure limit of 128 dB(L) is plotted with a red line and HC limit of 120 dB(L) with an orange line.



**Figure 4-3: Air Overpressure Propagation Curve**

Air overpressure values at all other PORs by shortest distance from the Project's open pits blasting operations are found in Table 4-4. The values have been sorted to show the closest receptor at the top of the table.

**Table 4-4: Predicted Air Overpressure at PORs from open pits**

Location	Distance (m)	Air Overpressure (dBL)
Minimum predicted set back distance [MECP]	170	128
Minimum predicted set back distance [HC]	359	120
POR 1 to LP Central	5233	93
POR 11 to LP Central	6276	92
POR 5 to LP Central	6431	91
POR 6 to Viggo Pit	6788	91
POR 28 to Viggo Pit	7143	90
POR 18 to Viggo Pit	7223	90
POR 2 to Viggo Pit	7315	90
POR 3 to Viggo Pit	7332	90
POR 4 to LP Central	7378	90
POR 10 to LP Central	8016	89
POR 9 to LP Central	8121	89
POR 7 to Viggo Pit	8905	88
POR 26 to Viggo Pit	9147	88
POR 21 to LP Central	9877	87
POR 8 to LP Central	10736	86
POR 12 to LP Central	10830	86
POR 22 to Viggo Pit	12025	85
POR 24 to Viggo Pit	12368	85
POR 13 to LP Central	12460	85
POR 20 to LP Central	12763	84
POR 14 to LP Central	13466	84
POR 19 to LP Central	13475	84
POR 15 to LP Central	13899	84
POR 29 to LP Central	13914	84
POR 27 to Viggo Pit	14213	83
POR 23 to Viggo Pit	14228	83
POR 16 to LP Central	15059	83
POR 17 to LP Central	16689	82
POR 25 to Viggo Pit	19394	80

Following the same methodology for the blasting operations at the Quarries for all PORs, Figure 4-4 shows the predicted air overpressure attenuation for 41.2 kg of explosives as distance increases from the blast area. Predicted air overpressure for closest receptor POR4 location from the quarries is plotted with a green triangle. MECP air

overpressure limit of 128 dB(L) that must not be exceeded is plotted with a red line and HC limit of 120 dB(L) with an orange line.

Air overpressure predicted values at all PORs by shortest distance from the Project quarries blasting operations are found in Table 4-6. The values have been sorted to show the closest receptor at the top of the table.

**Table 4-5: Predicted Air Overpressure at PORs from Quarries**

Location	Distance (m)	Air Overpressure (dBL)
Minimum predicted set back distance [MECP]	131	128
Minimum predicted set back distance [HC]	353	120
POR 4 to Quarry 2	2221	102
POR 9 to Quarry 2	2622	102
POR 10 to Quarry 2	3369	100
POR 21 to Quarry 1	4015	100
POR 8 to Quarry 2	4925	98
POR 5 to Quarry 1	5093	98
POR 1 to Quarry 2	5296	96
POR 12 to Quarry 2	5972	95
POR 13 to Quarry 2	6822	94
POR 20 to Quarry 2	7115	94
POR 11 to Quarry 2	7134	93
POR 14 to Quarry 2	7719	92
POR 19 to Quarry 2	7817	91
POR 15 to Quarry 2	8262	90
POR 29 to Quarry 2	8482	89
POR 16 to Quarry 2	9914	89
POR 17 to Quarry 2	11330	89
POR 6 to Quarry 2	13047	87
POR 18 to Quarry 2	13325	85
POR 28 to Quarry 2	13367	84
POR 3 to Quarry 2	13468	84
POR 2 to Quarry 2	13495	84
POR 7 to Quarry 2	15952	82
POR 26 to Quarry 2	16145	82
POR 22 to Quarry 2	19142	80
POR 24 to Quarry 2	19345	80
POR 27 to Quarry 1	21020	79
POR 23 to Quarry 1	21090	79
POR 25 to Quarry 1	24173	78

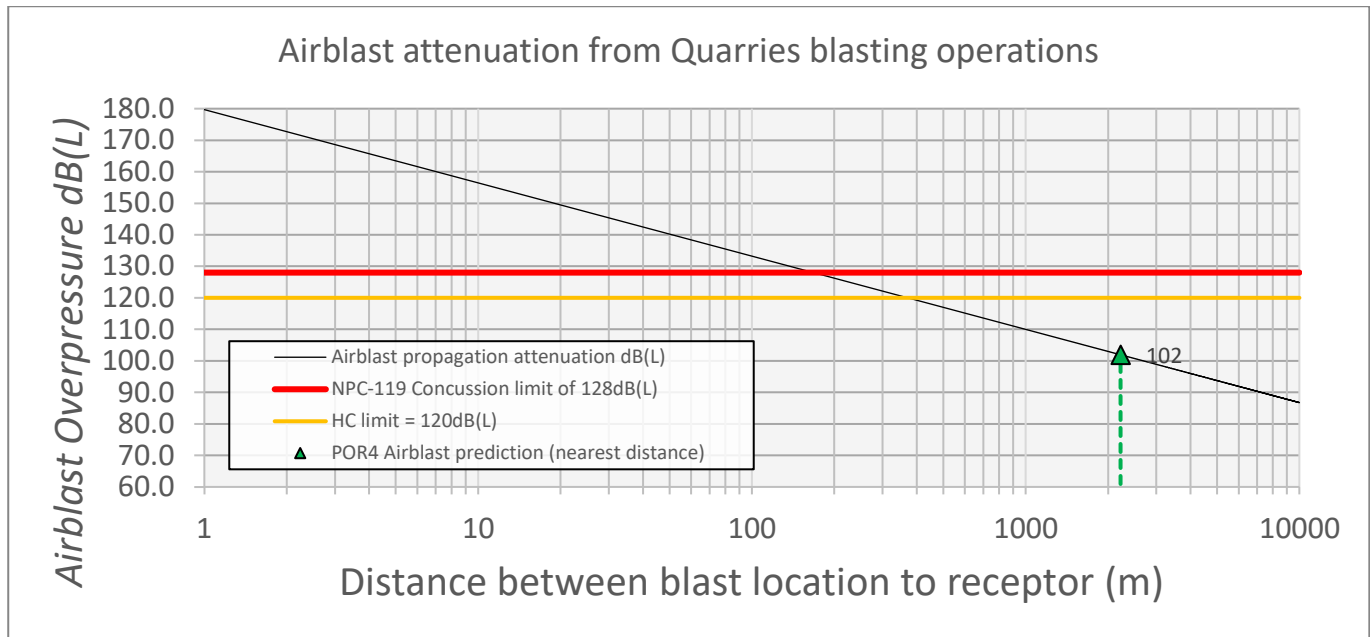


Figure 4-4: Air Overpressure Propagation Curve - Quarries

#### 4.3.5 Predicted Air Overpressure Effect

The blasting operations are predicted to be compliant with the regulatory requirements in the provincial guideline NPC-119 for the ground vibration and air overpressure, and federal guideline for the air overpressure only. The limits in the provincial guideline require the Project to carry out routine overpressure and vibration monitoring as per the Publication NPC-103, *Procedure for Measurement of Sound and Vibration due to Blasting Operations*.

As observed in Figures 4-1 to 4-6, all receptors are more than 2,000 metres away from the Project's blasting locations. The predicted PPV shown on their respective figures are below the 12.5mm/s ground vibration compliance limit established by the MECP. Similarly, for air overpressure the PORs are below the allowable provincial and federal regulatory limits. Summary results tables are presented in Appendix A.

## 4.4 Effects on Fish Habitats

In addition to evaluating the impact on human health as per NPC-119 [5] and Health Canada [2], presented in Section 4.3, the DFO has a requirement to assess the impact of blasting operations on fish habitats. The present section discusses the predicted impacts to the Canadian fish habitats in the vicinity of a blast location planned by Great Bear Resources.

### 4.4.1 Relevant Fish Habitats

Great Bear Resources provided the general blasting locations that are planned during the Construction and Operations phases of the Project. These were considered for the evaluation of the impact on fish habitats:

- **Construction Phase:**
  - Limits of LP Central pit and Viggo pit, as well as;
  - Centre of Quarry Source 1 (Q1) and Quarry Source (Q2), and;
  - Underground Mine.
- **Operations Phase:**
  - Limits of LP Central pit and Viggo pit;
  - Limits of Quarry Source 1 (assuming Quarry Source 2 is covered by TMF), and;
  - Underground Mine

Based on the blasting locations, the nearest watercourses and waterbodies were identified, which may be impacted by the blasting operations. Table 4-6 summarizes the waterbodies that contain fish habitat and the blast locations that were assessed for water-overpressure and ground-borne vibration against the criteria provided in Section 3.3.

The Impact Segment ID (ISID) correlates with Figure 4-5: Anticipated Fisheries Impacts created by WSP's aquatics experts supporting the Project. This figure indicates which segments of the watercourses will be redirected or flow reduced, and the current understanding is the segments shown in pink and yellow color are completely removed/redirected before any Construction or Operations activities start.

**Table 4-6: Fish Bearing Waterbodies and Watercourses**

Type of Receptor	Name	Impact Segment ID	Impacted by
Waterbody	Dixie Creek	-	LP Central Pit, Viggo Pit, Underground Mine Operations
Waterbody	Genesee Lake	-	Quarry Source 1, Quarry Source 2
Waterbody	Unnamed Waterbody 4	-	Quarry Source 2
Waterbody	Unnamed Waterbody 6	-	Viggo Pit
Watercourse	Unnamed Watercourse 1B	IS-4	Quarry Source 2
Watercourse	Unnamed Watercourse 3	IS-35	LP Central Pit

For surface blasting, geo-referenced site plans of the Construction phase and Operations phase were used to select the shortest path between a general blast area (referred to as Blasting Location) and a fish habitat (referred to as Fish Habitat Location). For a conservative estimate, the worst-case blasting location was assumed to occur at the limits of the bedrock of the general blast area. For underground blasting, Great Bear Resources provided a geo-referenced file of the Underground Mine. The shortest path between a Blasting Location and a Fisheries Receiver Location was calculated using an in-house calculation tool.

Figures depicting the Blasting Locations and Fish Habitat Locations are shown in Appendix B:

- **Construction Phase:**
  - Figure B-1: Blasting Locations and Fish Habitat Locations, Construction Phase, Open Pits Area
  - Figure B-2: Blasting Locations and Fish Habitat Locations, Construction Phase, Quarries Area
  - Figure B-3: Blasting Locations and Fish Habitat Locations, Construction Phase, Underground Mine
  
- **Operations Phase:**
  - Figure B-4: Blasting Locations and Fish Habitat Locations, Operations Phase, Open Pits Area
  - Figure B-5: Blasting Locations and Fish Habitat Locations, Operations Phase, Quarries Area
  - Figure B-6: Blasting Locations and Fish Habitat Locations, Operations Phase, Underground Mine

Table 4-7 and Table 4-8 show the relevant pairs of a Blasting Location and a Fish Habitat Location along with their UTM coordinates, elevation and distance between them for Construction and Operations phases respectively. The distances were calculated using the Easting and Northing coordinates, the top of bedrock and the elevation of the terrain.

To account for the shortest path between two points, the Euclidean distance approach was utilized—this represents the worst-case scenario. This approach does not account for topographical changes between two points. The georeferenced terrain elevation profile, provided by Great Bear Resources, was based on a 1 m elevation grid resolution obtained via LiDAR scanning of the Project site.

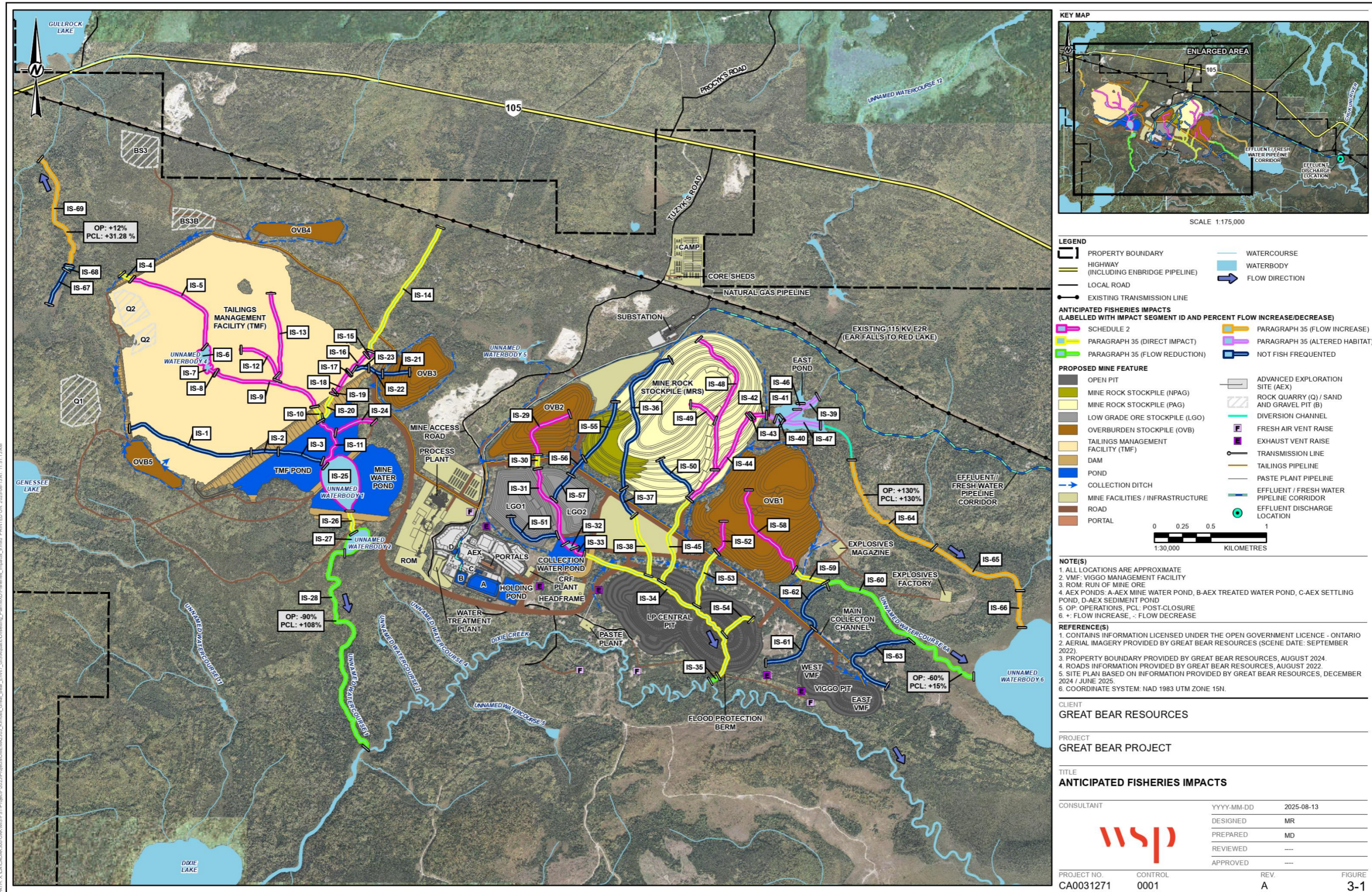


Figure 4-5: Anticipated Fisheries Impacts

**Table 4-7: Blasting Locations and Fish Habitat Locations – Construction Phase**

Blast No.	Blasting Location						Fish Habitat Location								Distance (m) <sup>1,2,3</sup>
	Blast Type	Point ID	Location	Easting (UTM Coordinates), m	Northing (UTM Coordinates), m	Elevation, Bedrock, m	Point ID	Location	Type of Receptor	Impact Segment ID	Fish Bearing (Y/N)	Easting (UTM Coordinates), m	Northing (UTM Coordinates), m	Elevation, m.a.s.l.	
1	Surface	1	LP Central	457404.76	5633644.70	352.00	1	Dixie Creek	Waterbody	-	Y	457388.68	5633517.47	348.41	128.4
3	Surface	2	Viggo Pit	458577.11	5633219.76	354.00	2	Dixie Creek	Waterbody	-	Y	458527.72	5633103.96	346.44	127.2
5	Surface	3	Viggo Pit	458645.12	5633202.42	254.00	3	Dixie Creek	Waterbody	-	Y	458617.04	5633068.48	346.69	137.7
14	Surface	8	Q1	451779.90	5636001.79	427.00	9	Genesee Lake	Waterbody	-	Y	450922.08	5635963.23	379.08	859.8
15	Surface	8	Q1	451779.90	5636001.79	427.00	10	Genesee Lake	Waterbody	-	Y	451342.05	5635457.89	379.08	699.6
17	Surface	11	Q2	452466.86	5636522.31	398.00	11	Unnamed Waterbody 4	Waterbody	-	Y	452838.95	5636426.19	391.91	384.5
19	Surface	9	Q2	452178.09	5636994.51	406.75	13	Unnamed Watercourse 1B	Watercourse	IS-4	Y	452203.81	5637109.66	400.41	118.2
21	Surface	22	LP Central	456917.23	5633871.82	344.00	14	Dixie Creek	Waterbody	-	Y	456675.31	5633728.17	349.44	281.6
23	Surface	17	Viggo Pit	458920.54	5633379.63	356.00	15	Unnamed Waterbody 6	Waterbody	-	Y	459782.31	5633466.34	347.20	866.4
29	Surface	27	LP Central	457489.25	5633640.12	352.00	21	Unnamed Watercourse 3	Watercourse	IS-35	Y	457483.23	5633550.30	363.00	90.7
33	Surface	31	Viggo Pit	458490.44	5633287.32	359.00	23	Dixie Creek	Waterbody	-	Y	458368.19	5633203.19	348.09	149.5
35	Surface	32	Viggo Pit	458235.67	5633472.17	359.45	24	Dixie Creek	Waterbody	-	Y	458086.11	5633329.07	347.69	207.06
36	Surface	33	Viggo Pit	458371.38	5633392.31	366.16	25	Dixie Creek	Waterbody	-	Y	458253.21	5633242.99	347.8	190.56
39	Underground	23	Hinge	456564.00	5633319.00	360.00	17	Dixie Creek	Waterbody	-	Y	456601.8	5633337.0	348.0	43.6
40	Underground	24	Viggo Zone	458304.00	5633318.00	357.00	18	Dixie Creek	Waterbody	-	Y	458275.0	5633234.0	348.0	89.3

Note:

1. Calculated using Euclidean Distance Formula  $d(A, B) = \sqrt{(EastingB - EastingA)^2 + (NorthingB - NorthingA)^2 + (ElevationB - ElevationA)^2}$
2. The elevation at the top of bedrock is factored into the distance calculations for blasting operations at the pits
3. The elevation of the terrain is considered in the distance calculations for blasting activities at the quarries

Table 4-8: Blasting Locations and Fish Habitat Locations – Operations Phase

Blast No.	Blasting Location						Fish Habitat Locations									Distance (m) <sup>1,2,3</sup>
	Blast Type	Point ID	Location	Easting (UTM Coordinates), m	Northing (UTM Coordinates), m	Elevation, m.a.s.l.	Point ID	Location	Type of Receptor	Impact Segment ID	Fish Bearing (Y/N)	Easting (UTM Coordinates), m	Northing (UTM Coordinates), m	Elevation, m.a.s.l.		
2	Surface	12	LP Central	456791.27	5633794.69	363.33	14	Dixie Creek	Waterbody	-	Y	456675.3	5633728.1	349.4	134.4	
4	Surface	13	LP Central	457418.68	5633606.45	352.05	1	Dixie Creek	Waterbody	-	Y	457388.6	5633517.4	348.4	94.0	
6	Surface	14	Viggo Pit	458934.84	5633371.45	358.00	15	Unnamed Waterbody 6	Waterbody	-	Y	459801.8	5633424.6	347.2	868.6	
8	Surface	15	Viggo Pit	458849.63	5633473.46	359.00	4	Dixie Creek	Watercourse	-	Y	458368.1	5633203.1	361.9	552.1	
16	Surface	18	Viggo Pit	458572.95	5633214.78	354.00	2	Dixie Creek	Waterbody	-	Y	458528.8	5633103.5	363.3	119.9	
20	Surface	19	Viggo Pit	458644.06	5633201.26	358.00	3	Dixie Creek	Waterbody	-	Y	458617.0	5633068.4	346.6	135.9	
22	Surface	20	Q1	451630.41	5635815.4	404.28	10	Genesee Lake	Waterbody	-	Y	451342.0	5635457.8	379.0	460.0	
25	Underground	23	Hinge	456564.00	5633319.00	360.00	17	Dixie Creek	Waterbody	-	Y	456601.8	5633337.0	348.0	43.6	
30	Surface	28	LP Central	457499.09	5633601.48	349.35	21	Unnamed Watercourse 3	Watercourse	IS-35	Y	457483.2	5633550.3	364.0	55.6	
34	Underground	24	Viggo Zone	458304.00	5633318.00	357.00	18	Dixie Creek	Waterbody	-	Y	458275.0	5633234.0	348.0	89.3	
37	Surface	34	Viggo Pit	458235.67	5633472.17	359.45	26	Dixie Creek	Waterbody	-	Y	458086.1	5633329.0	347.6	207.0	
38	Surface	35	Viggo Pit	458371.38	5633392.31	366.16	27	Dixie Creek	Waterbody	-	Y	458253.2	5633242.99	347.8	190.5	

- <sup>s</sup>  
Note:
1. Calculated using Euclidean Distance Formula  $d(A, B) = \sqrt{(EastingB - EastingA)^2 + (NorthingB - NorthingA)^2 + (ElevationB - ElevationA)^2}$
  2. The elevation at the top of bedrock is factored into the distance calculations for blasting operations at the pits
  3. The elevation of the terrain is considered in the distance calculations for blasting activities at the quarries

## 4.4.2 Modelling Methodology

The *Canadian Department of Fisheries and Oceans (DFO) Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters* (Wright & Hopky, 1998) [3] defines in Appendix II the general equations to determine setback distance for confined explosive to meet their guideline criteria of 50 kPa for underwater instantaneous overpressure and 13 mm/s for Peak Particle Velocity (PPV) to protect spawning beds during egg incubation.

The article by Cott & Hanna [4] indicates that the equations given in [3] provide a high-level assessment of the potential impact to fish habitats. This article concludes that the unpredictability of water overpressure is due to the differences in substrate type, substrata, water depth, equipment failure and human subjectivity. This article recommends that site-specific propagation relationships are developed to minimize impact to fish habitats.

DFO guidelines define the relationship between acoustic impedance and the density and velocity of the medium through which the compression wave travels:

### Equation 3

$$Z_W/Z_R = \frac{D_W \times C_W}{D_R \times C_R}$$

where:

- $D_W$  = density of water =  $1 \text{ g} \times \text{cm}^{-3}$
- $D_R$  = density of the substrate in  $1 \text{ g} \times \text{cm}^{-3}$
- $C_W$  = compressional wave velocity in water  $146,300 \text{ cm} \times \text{s}^{-1}$
- $C_R$  = compressional wave velocity in substrate in  $\text{cm} \times \text{s}^{-1}$

Table 4-9, found in [3], lists the common substrate density and compression wave velocity for various substrates.

**Table 4-9: Typical Values for Substrate Density and Compression Wave Velocity**

Substrate	$D_R (\text{g} \cdot \text{cm}^{-3})$	$C_R (\text{cm} \cdot \text{s}^{-1})$
Rock	2.64	457,200
Frozen Soil	1.92	304,800
Ice	0.98	304,800
Saturated Soil	2.08	146,300
Unsaturated soil	1.92	45,700

The transfer of shock pressure from the substrate to the water is defined by the following formula:

### Equation 4

$$P_W = \frac{2 \times (Z_W/Z_R) \times P_R}{1 + (Z_W/Z_R)}$$

where:

- $P_W$  = pressure (kPa) in water
- $P_R$  = pressure (kPa) in substrate
- $Z_W$  = acoustic impedance of water
- $Z_R$  = acoustic impedance of substrate

The equation can be reworked to solve for the pressure in the substrate ( $P_R$ ) from a known pressure in water ( $P_W$ ), as

$$P_R = P_W \times \frac{(1 + (Z_W/Z_R))}{(2 \times ((Z_W/Z_R)))}$$

To meet the DFO guidelines for instantaneous water overpressure, the equation is solved by setting  $P_W$  to 50 kPa (limit defined by Cott & Hanna, 2005 [4]). This will yield the substrate pressure  $P_R$  needed to achieve the water overpressure limit set by the DFO. The value for  $P_R$  is used to determine the Peak Particle Velocity,  $V_R$  ( $\text{cm} \times \text{s}^{-1}$ ), in the substrate for the given conditions based on the following (note that  $P_R$  must be converted to dynes [ $\text{g} \times \text{cm} \cdot \text{s}^{-2}$ ] first).

**Equation 5**

$$V_r = \frac{2 \times P_r}{D_R \times C_R}$$

The relationship between the Peak Particle Velocity,  $V_R$  explosive charge weight and distance is given by:

**Equation 6**

$$V_r = 100 \left( \frac{R}{\sqrt{W}} \right)^{-1.6}$$

where:

- $R$  = distance (m) to the detonation point,
- $W$  = explosive weight (kg) per delay

From a known water overpressure of 50 kPa and using Great Bear Resources’ nominal explosive charges, listed in Table 4-10, the distance to a detonation point  $R$  is calculated using Equation 5. This value establishes the minimum setback distance to not exceed the 50 kPa overpressure guidance for non-spawning fish habitats. To meet the PPV limit for spawning beds, Equation 6 is used to calculate the setback distance  $R$  by setting  $V_r$  to the DFO limit of 13 mm/s. This value establishes the minimum setback distance to protect spawning fish habitats.

**Table 4-10: Blasting Parameters for DFO Evaluation**

Blasting Location	Blasting Charge kg/delay <sup>1</sup>
Viggo Pit	207.6
LP Central Pit	207.6
Quarry Sources Q1 + Q2	41.2
Underground	10.1

Note:

1. DFO guidelines require that time delays for discrete explosions should be greater than 25 milli-seconds.

The calculations used in this report consider a rock substrate with density and compressional wave velocity defined in the DFO guideline.

**4.4.3 Predicted Effects on Fish Habitats**

For each of the Blasting Locations and corresponding Fish Habitats identified, the Euclidean distances were used as the  $R$  value in the equations above to calculate the maximum allowable charges for PPV and Instantaneous Water Overpressure. These metrics are compared against the limits established in Section 3.3. The results are summarized in Table 4-13 and Table 4-14 where the calculated maximum charges for PPV and instantaneous water overpressure are compared to the Great Bear Resources nominal explosive charges listed in Table 4-10. The results show that the waterbodies and watercourses that will be affected by the nominal charge are: Dixie Creek (no ISID), Unnamed Watercourse 3 (ISID=IS-35).

The predicted effects, shown as a blast impact area using the planned nominal charge, are depicted in Figure 4-6 and Figure 4-7 for the Construction Phase, as well as Figure 4-8 and Figure 4-9 for the Operations Phase. These blast impact areas are measured from boundaries of the blast location footprint by considering the setback distances shown in Table 4-11 obtained via DFO's approach. These figures show that the above-mentioned fish habitats are within the blast impact areas of the LP Central pit and Viggo Pit during the construction and operations phase.

In addition to the effects of surface blasting, it can also be concluded from Table 4-11 that the underground blasting operations will impact the Dixie Creek by blast number 25, refer to Table 4-8. This underground blast location is observed to be very close to the Dixie Creek.

**Table 4-11: Setback Distance for Planned Nominal Charge**

Blasting Location	Planned Nominal Blasting Charge (kg/delay)	Non-Spawning Season Setback Distance (m) Limit = 50kPa	Spawning Season Setback Distance (m) Limit = 13mm/s
Viggo Pit	207.6	110.7	217.5
LP Central Pit	207.6	110.7	217.5
Quarry Sources Q1 + Q2	41.2	49.3	96.9
Underground	10.1	24.4	47.9

Figure 4-5 shows that the segment IS-67 and Dixie Creek will not be redirected; hence, the impact can be reduced by reducing the explosive charge weight. For reference only, Table 4-12 summarizes the effects on the setback distance by changing the explosive charge weight (kg) for a rock substrate. As observed, a modification of the explosive charge weight affects the blast impact area. These effects are displayed in Appendix B.

**Table 4-12: Changes in Setback Distances for Different Explosive Charges**

Blasting Charges (kg/delay)	Non-Spawning Season Setback Distance (m) Limit = 50kPa / Rock Substrate	Spawning Season Setback Distance (m) Limit = 13mm/s / Rock Substrate
10	24.3	47.7
20	34.3	67.5
30	42.1	82.7
40	48.6	95.5
50	54.3	106.7
100	76.8	150.9
150	94.1	184.9
200	108.6	213.5
250	121.4	238.6
300	133.0	261.4

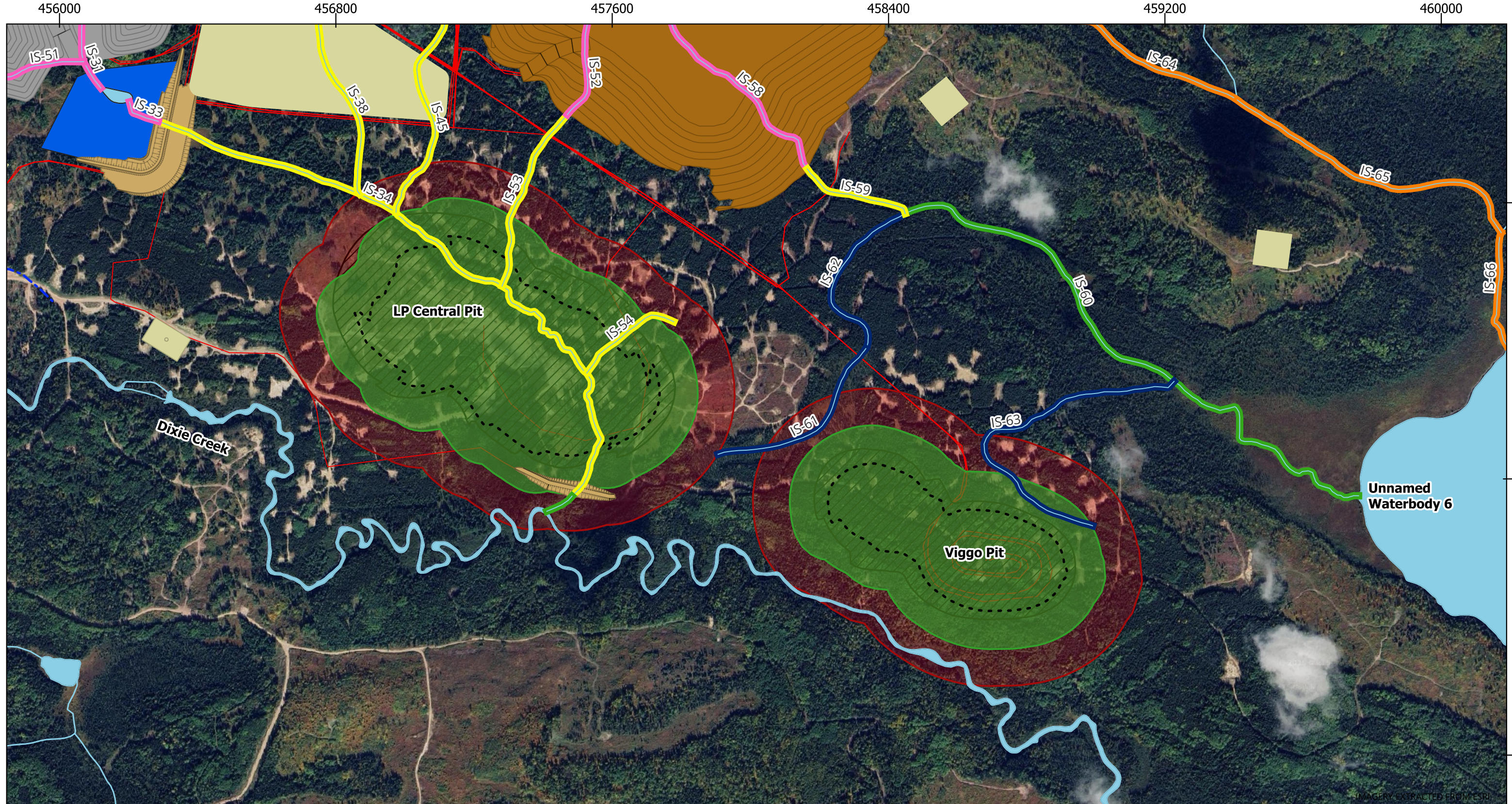
The explosive charges evaluated in Table 4-12 show that compliance with respect to the DFO limits is achievable by modifications to the blast design. It is the responsibility of the blast designer to be aware of the potential impacts and ensure compliance with respect to the DFO limits. General mitigation recommendations are discussed in the subsequent section.

**Table 4-13: Compliance Assessment – Construction Phase**

Blast No.	Blast General Location	Blast Location	Receptor Location	Type of Receptor	Substrate	Blasting Coordinates		Receiver Coordinates		Distance (m)	Max. Allowable Charge (kg)	Max. Allowable Charge (kg)	Nominal Charge (kg/delay)	PPV Exceedance?	Water Overpressure Exceedance?
						(UTM Coordinates)					Ground Vibration PPV (Limit=13mm/s) Spawning Season	Water Overpressure (Limit = 50kPa) Non-Spawning Season			
						Easting (UTM Coordinates), m	Northing (UTM Coordinates), m	Easting (UTM Coordinates), m	Northing (UTM Coordinates), m						
1	Surface	LP Central Pit	Dixie Creek	Waterbody	Rock	457404.7	5633644.6	457388.6	5633517.4	128.4	72	280	207.6	Y	N
3	Surface	Viggo Pit	Dixie Creek	Waterbody	Rock	458577.1	5633219.7	458527.7	5633103.9	127.2	71	274	207.6	Y	N
5	Surface	Viggo Pit	Dixie Creek	Waterbody	Rock	458645.1	5633202.4	458617.0	5633068.4	137.7	83	322	207.6	Y	N
14	Surface	Q1	Genesee Lake	Waterbody	Rock	451779.9	5636001.7	450922.0	5635963.2	859.8	3,245	12,534	41.2	N	N
15	Surface	Q1	Genesee Lake	Waterbody	Rock	451779.9	5636001.7	451342.0	5635457.8	699.6	2,149	8,298	41.2	N	N
19	Surface	Q2	Unnamed Watercourse 1B	Watercourse	Rock	452178.0	5636994.5	452203.8	5637109.6	118.2	61	237	41.2	N	N
21	Surface	LP Central Pit	Dixie Creek	Waterbody	Rock	456917.2	5633871.8	456675.3	5633728.1	281.5	348	1,344	207.6	N	N
23	Surface	Viggo Pit	Unnamed Waterbody 6	Waterbody	Rock	458920.5	5633379.6	459782.3	5633466.3	866.3	3,295	12,725	207.6	N	N
29	Surface	LP Central Pit	Unnamed Watercourse 3	Watercourse	Rock	457489.2	5633640.1	457483.2	5633550.2	90.7	36	140	207.6	Y	Y
33	Surface	Viggo Pit	Dixie Creek	Waterbody	Rock	458490.4	5633287.3	458368.1	5633203.1	149.4	98	379	207.6	Y	N
35	Surface	Viggo Pit	Dixie Creek	Waterbody	Rock	458235.67	5633472.17	458086.11	5633329.07	207.1	188	727	207.6	Y	N
39	Underground	Hinge	Dixie Creek	Waterbody	Rock	456564.0	5633319.0	456601.8	5633337.0	43.6	8	32	10.1	Y	N
40	Underground	Viggo Zone	Dixie Creek	Waterbody	Rock	458304.0	5633318.0	458275.0	5633234.0	89.3	35	135	10.1	N	N
36	Surface	Viggo Pit	Dixie Creek	Waterbody	Rock	458371.38	5633392.31	458253.21	5633242.99	190.6	159	616	207.6	Y	N

**Table 4-14: Compliance Assessment – Operations Phase**

Blast No.	Blast General Location	Blast Location	Receptor Location	Type of Receptor	Substrate	Blast Coordinates		Receiver Coordinates		Distance (m)	Max. Allowable Charge (kg)	Max. Allowable Charge (kg)	Nominal Charge (kg/delay)	PPV Exceedance?	Water Overpressure Exceedance?
						UTM Coordinates					Ground Vibration PPV (Limit=13mm/s) Spawning Season	Water Overpressure (Limit = 50kPa) Non-spawning Season			
						Easting (UTM Coordinates), m	Northing (UTM Coordinates), m	Easting (UTM Coordinates), m	Northing (UTM Coordinates), m						
2	Surface	LP Central Pit	Dixie Creek	Waterbody	Rock	456791.2	5633794.6	456675.3	5633728.1	134.4	<b>79</b>	306	207.6	<b>Y</b>	N
4	Surface	LP Central Pit	Dixie Creek	Waterbody	Rock	457418.6	5633606.4	457388.6	5633517.4	93.9	<b>39</b>	<b>150</b>	207.6	<b>Y</b>	<b>Y</b>
6	Surface	Viggo Pit	Unnamed Waterbody 6	Waterbody	Rock	458934.8	5633371.5	459801.8	5633424.7	868.7	3312	12793	207.6	N	N
8	Surface	Viggo Pit	Dixie Creek	Watercourse	Rock	458849.6	5633473.5	458368.2	5633203.2	552.1	1338	5168	207.6	N	N
16	Surface	Viggo Pit	Dixie Creek	Waterbody	Rock	458573.0	5633214.8	458528.8	5633103.6	120.0	<b>63</b>	244	207.6	<b>Y</b>	N
20	Surface	Viggo Pit	Dixie Creek	Waterbody	Rock	458644.1	5633201.3	458617.0	5633068.5	136.0	<b>81</b>	313	207.6	<b>Y</b>	N
22	Surface	Q1	Genesee Lake	Waterbody	Rock	451630.4	5635815.4	451342.0	5635457.8	460.0	929	3,588	207.6	N	N
25	Underground	Hinge	Dixie Creek	Waterbody	Rock	456564.0	5633319.0	456601.8	5633337.0	43.6	<b>8</b>	32	10.1	<b>Y</b>	N
30	Surface	LP Central Pit	Unnamed Watercourse 3	Watercourse	Rock	457499.0	5633601.4	457483.2	5633550.2	55.5	<b>14</b>	<b>52</b>	207.6	<b>Y</b>	<b>Y</b>
34	Underground	Viggo Zone	Dixie Creek	Waterbody	Rock	458304.0	5633318.0	458275.0	5633234.0	89.3	35	135	10.1	N	N
37	Surface	Viggo Pit	Dixie Creek	Waterbody	Rock	458235.67	5633472.17	458086.11	5633329.07	207.1	<b>188</b>	727	207.6	<b>Y</b>	N
38	Surface	Viggo Pit	Dixie Creek	Waterbody	Rock	458371.38	5633392.31	458253.21	5633242.99	190.6	<b>159</b>	616	207.6	<b>Y</b>	N




**LEGEND**

- Tuzyks Road
- Redirected Watercourses
- Redirected Watercourses
- Flow Reduction Watercourses
- Flow Increased Watercourse
- Not Fish Frequented
- Truck Haul Routes
- Open Pit Footprint
- Overburden/Bedrock Interface
- Blast Impact Area for Non Spawning Periods (Limit = 50 kPa, Charge = 207.6 kg/delay)
- Blast Impact Area for Spawning Periods (Limit = 13 mm/s, Charge = 207.6 kg/delay)

Notes:  
 - Blast Impact Area is calculated using the elevation of the top of Bedrock  
 - Site Plan provided by Kinross June 2025  
 - Fisheries Impacted Watercourses provided by WSP April 2025

Datum & Projection:  
 NAD83 / UTM zone 15N

	
<b>Great Bear Mine</b> <b>Blasting Impact Assessment</b>	
Blast Impact Area for Nominal Charge - Construction Phase - Open Pits Area	
PROJECT NO: CA03912	FIGURE 4-6
SCALE: 1:10611	DATE: August 2025

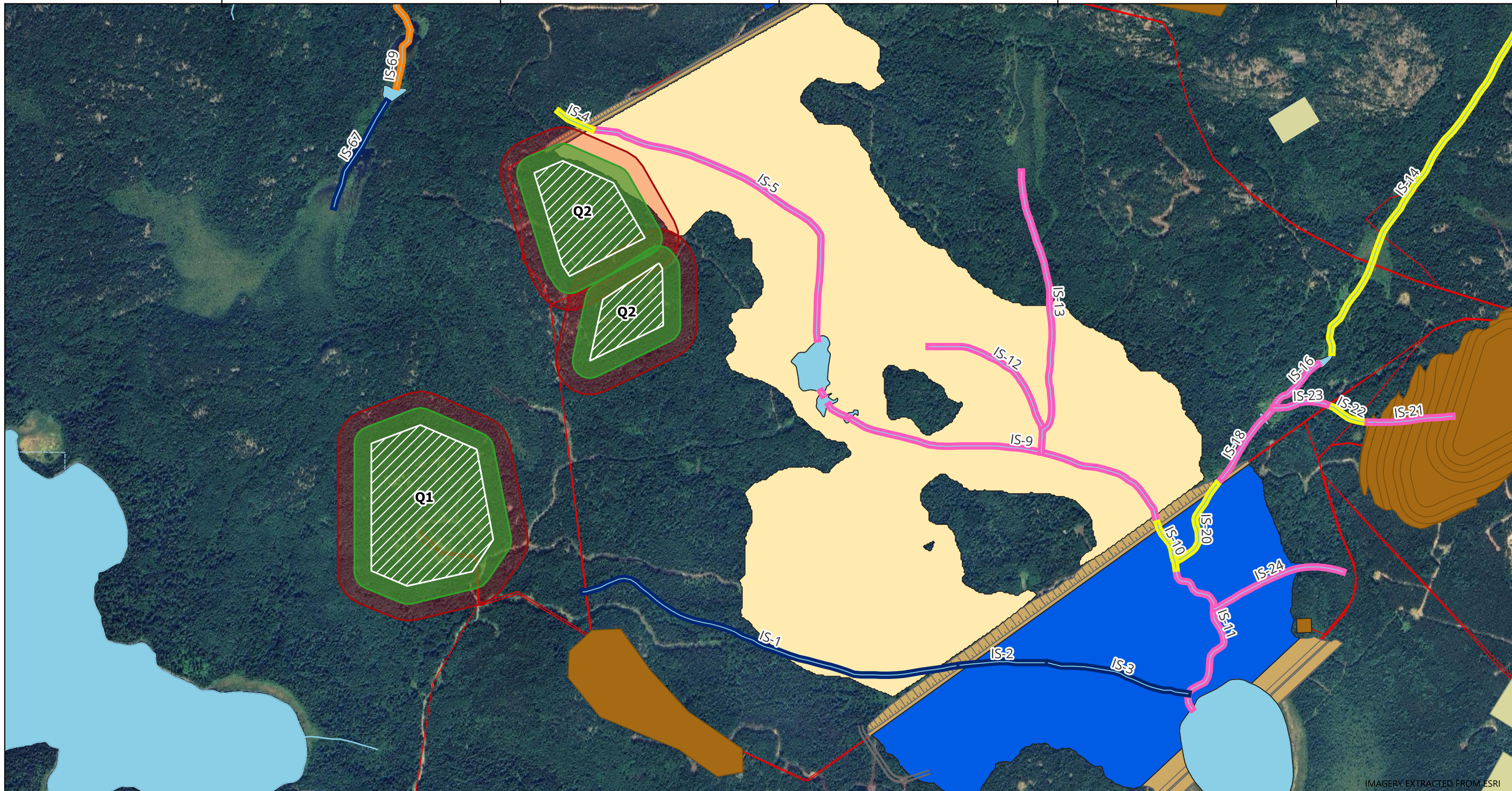
451200

452000

452800

453600

454400



5636800

5636000

5635200

**LEGEND**

--- Tuzyks Road

Redirected Watercourses

Redirected Watercourses

Flow Reduction Watercourses

Flow Increased Watercourse

Not Fish Frequented

Truck Haul Routes

Blast Impact Area for Spawning Periods (Limit = 50 kPa, Charge = 41.2 kg/delay)

Blast Impact Area for Non Spawning Periods (Limit = 13 mm/s , Charge = 41.2 kg/delay)

**Notes:**

- Blast Impact Area is calculated using the elevation of the top of Bedrock

- Site Plan provided by Kinross February 2025

- Fisheries Impacted Watercourses provided by WSP April 2025

- Fisheries Impacted Watercourses provided by WSP April 2025

- Fisheries Impacted Watercourses provided by WSP April 2025

- Fisheries Impacted Watercourses provided by WSP April 2025

Datum & Projection: NAD83 / UTM zone 15N



**Great Bear Mine  
Blasting Impact Assessment**

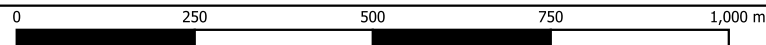
Blast Impact Area for Nominal Charge -  
Construction Phase - Quarries Area

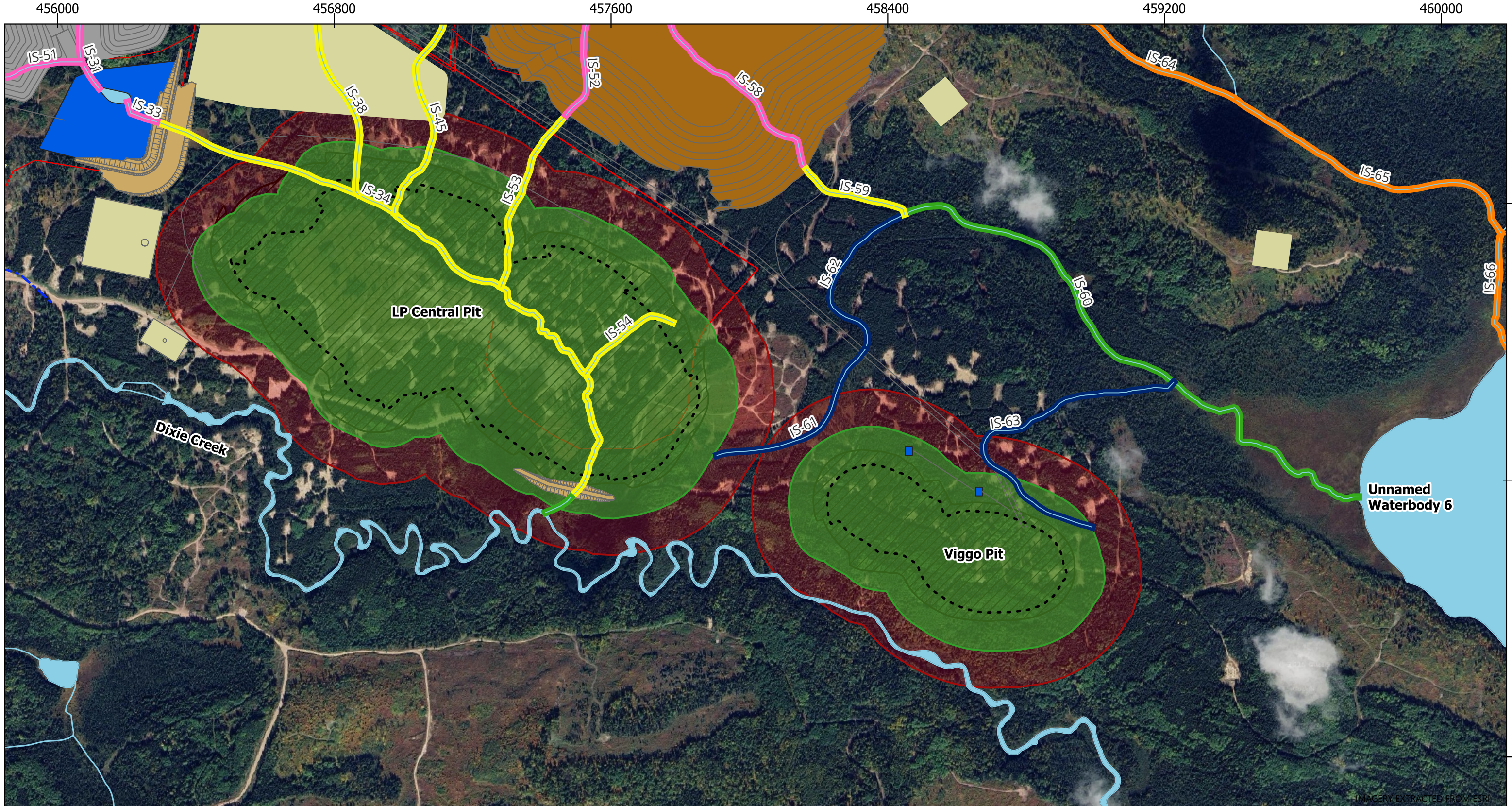
PROJECT NO: CA03912

FIGURE 4-7

SCALE: 1:10611

DATE: August 2025






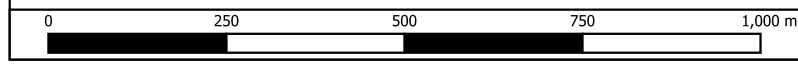
**LEGEND**

- Tuzyks Road
- Redirected Watercourses
- Redirected Watercourses
- Flow Reduction Watercourses
- Flow Increased Watercourse
- Not Fish Frequented
- Truck Haul Routes
- Open Pit Footprint
- Overburden/Bedrock Interface
- Blast Impact Area for Non Spawning Periods (Limig = 50 kPa, Charge = 207.6 kg/delay)
- Blast Impact Area for Spawning Periods (Limit = 13 mm/s, Charge = 207.6 kg/delay)

Notes:  
 - Blast Impact Area is calculated using the elevation of the top of Bedrock  
 - Site Plan provided by Kinross June 2025  
 - Fisheries Impacted Watercourses provided by WSP April 2025

Datum & Projection:  
 NAD83 / UTM zone 15N

	
<b>Great Bear Mine</b> <b>Blasting Impact Assessment</b>	
Blast Impact Area for Nominal Charge - Operations Phase - Open Pits Area	
PROJECT NO: CA04440	FIGURE 4-8
SCALE: 1:10611	DATE: August 2025



IMAGERY EXTRACTED FROM ESRI

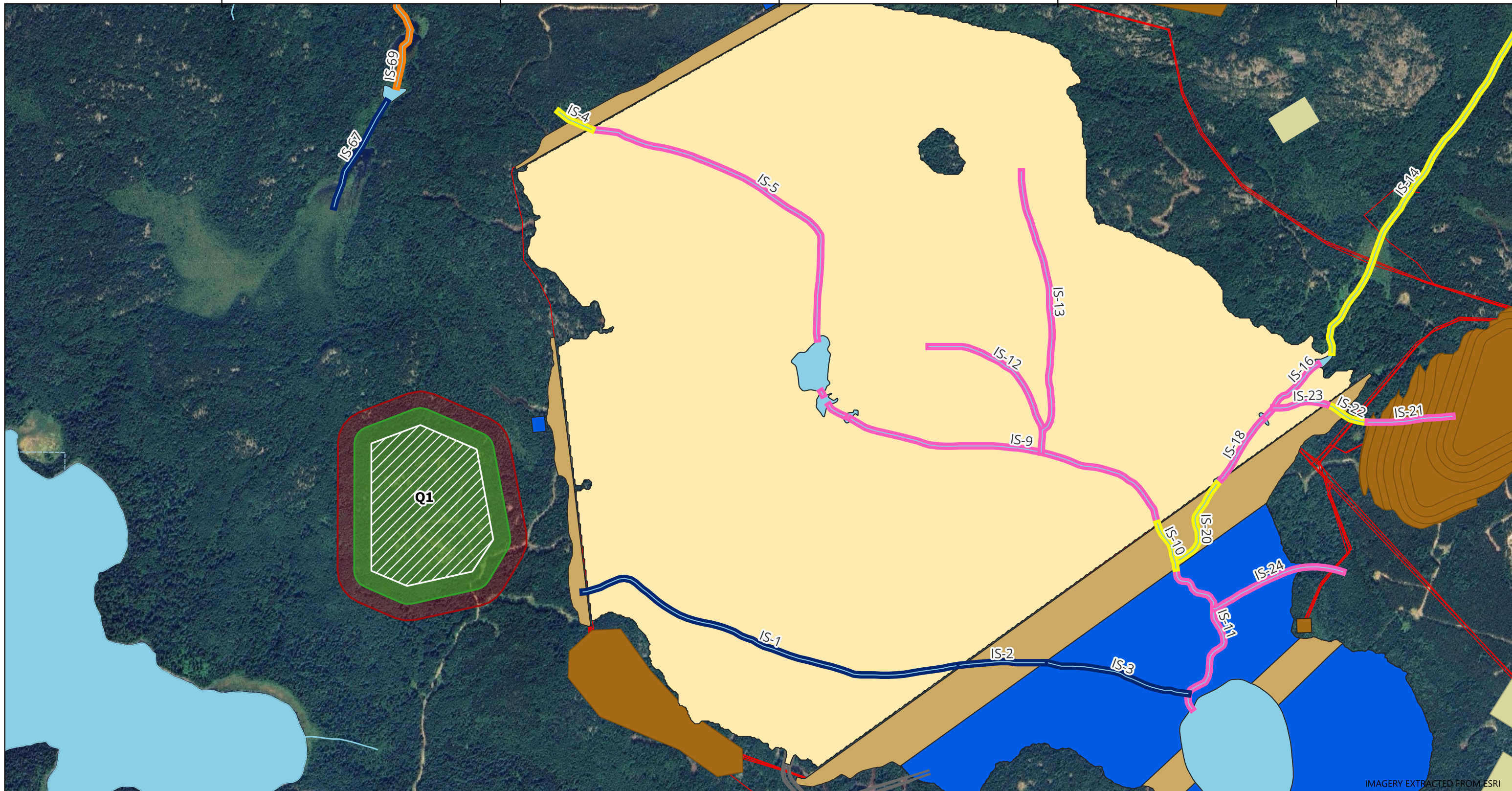
451200

452000

452800

453600

454400



5636800

5636000

5635200

**LEGEND**

--- Tuzyks Road

Yellow line Redirected Watercourses

Pink line Redirected Watercourses

Green line Flow Reduction Watercourses

Orange line Flow Increased Watercourse

Blue line Not Fish Frequented

Red line Truck Haul Routes

Green area Blast Impact Area for Spawning Periods (Limit = 50 kPa, Charge = 41.2 kg/delay)

Red area Blast Impact Area for Non Spawning Periods (Limit = 13 mm/s, Charge = 41.2 kg/delay)

**Notes:**

- Blast Impact Area is calculated using the elevation of the top of Bedrock
- Site Plan provided by Kinross February 2025
- Fisheries Impacted Watercourses provided by WSP April 2025

Datum & Projection:  
NAD83 / UTM zone 15N



**Great Bear Mine  
Blasting Impact Assessment**

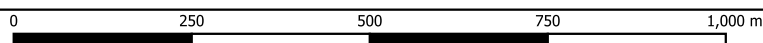
Blast Impact Area for Nominal Charge -  
Operation Phase - Quarries Area

PROJECT NO: CA03912

FIGURE 4-9

SCALE: 1:10611

DATE: August 2025



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## 5.0 Mitigation Measures

The blasting parameters, utilized to obtain the results presented in this report, are preliminary and subject to change. No historic seismograph data was available for the Project site area to determine the actual decay effect of ground-borne vibration from the blasting operations. Therefore, generic empirical decay parameters found in publicly available literature were used for the blasting calculations presented herewith.

A detailed blasting management plan shall be prepared prior to the Project commencing to identify and review all potential blast locations, define mitigation measures, and detail the inspection and record keeping required to demonstrate that impact levels are being effectively managed. The blasting management plan shall include opportunities for adaptive management, in which the intensity of the control measures would be increased if site inspections and continuous monitoring indicate that implemented measures are insufficient. In addition, steps for community consultation and complaints management shall be included. Health Canada states that the residents' concern about blasting can be addressed through community consultation.

Table 5-1 summarizes the recommendations to reduce the impact of blasting operations as per the provincial and federal guidelines described in Section 3.0.

**Table 5-1: Recommendations for the Control of Blasting Vibration and Overpressure**

Standard	Recommendation
<p><b>Ontario Ministry of Environment, Conservation and Parks (MECP)</b></p> <p><b>Health Canada (HC)</b></p>	<ul style="list-style-type: none"> <li>As per the NPC-119, maintain a routine/periodic vibration and air overpressure monitoring during blasting operations. Multiple monitoring stations to monitor the nearest PORs at all directions are recommended.</li> <li>Monitoring equipment must comply with the Publication NPC-103, "Procedure for Measurement of Sound and Vibration due to Blasting Operations".</li> <li>Avoid performing blasting operations at various locations within the Project site simultaneously. This may increase the negative effects of blasting ground vibration and air overpressure.</li> <li>Prepare Blasting Management Plan prior to the start of construction. The plan shall include opportunities for adaptive management, in which the intensity of the control measures would be increase if site inspections and continuous monitoring indicate that implemented measures are insufficient.</li> </ul>
<p><b>Canadian Department of Fisheries (DFO)</b></p>	<ul style="list-style-type: none"> <li>Before any blasting activity starts near Dixie Creek and Unnamed Watercourse 3 (IS-35), perform onsite low-charge blasts to determine the site-specific parameters governing the propagation of ground vibration and water overpressure to impacted fish habitats. These studies shall consider both open pits and underground blasting. The goal is to update predictions using site-specific parameters and adjust the Blasting Management Plan as required before commencing blasting operations.</li> <li>Mitigate impact to fish habitats by satisfying the procedures and recommendations established in the DFO Guideline [3] and the technical paper by Cott &amp; Hanna [4].</li> <li>Reduce the weight of explosive charge detonated per delay period to avoid impact to the fish habitats. Refer to Table 4-12 listing various setback distances depending on explosive charges.</li> <li>Implement ground vibration and water overpressure monitoring at the nearest active fish habitats from the open pits and underground blast locations.</li> <li>Avoid blasting on LP Central pit, Viggo pit and/or Underground Mine simultaneously. If this is unavoidable, reduce blast charge to minimize impact and/or maintain a monitoring program at the nearest fish habitats.</li> <li>Prepare Blasting Management Plan prior to the start of construction. The plan shall include opportunities for ongoing monitoring and adaptive management, in which the intensity of the control measures would be increased if site inspections and continuous monitoring indicate that implemented measures are insufficient.</li> </ul>

## 6.0 Conclusions

The blasting vibration and overpressure impacts associated with the activities of the Great Bear Project were evaluated using prediction equations in accordance with the guidelines established by the MECP, Health Canada and DFO. For the nominal charge provided by Great Bear Resources, the blasting prediction equations indicate no exceedances of regulatory limits at the nearest PORs with respect to MECP and HC guidelines. To ensure compliance with applicable limits for the Project during blasting operations, a Blasting Management Plan will be prepared before the start of construction activities. This plan will include opportunities for ongoing monitoring and adaptive management, in which the intensity of the control measures would be increased if site inspections and continuous monitoring indicate that implemented measures are insufficient. Potential residual effects to fish and fish habitat will be addressed in the Fish Habitat Compensation and Offsetting Plan.

## 7.0 Closing

This Blasting Vibration and Overpressure Modelling Report was prepared for Great Bear Resources Ltd. by Wood. The quality of information and conclusions contained herein is consistent with the level of effort involved in Wood's services and based on: i) information available at the time of preparation; ii) data supplied by outside sources; and iii) the assumptions, conditions and qualifications set forth in this report.

Yours truly,

**Wood Group Asset Integrity Solutions, Inc.**  
**Vibration, Dynamics and Noise (VDN)**

**Prepared by:**

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## 8.0 References

- [1] Ministry of Environment, Conservation and Parks (MECP), *Noise Pollution Control (NPC) Publication 119 of Model Municipal Noise Control By-law*, Ontario Ministry of the Environment, Conservation and Parks, 1982.
- [2] Health Canada, *Guidance for Evaluating Human Health Impacts in Environmental Assessment: NOISE*, 2017.
- [3] G. Hopky and D. Wright, *Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters*, Ottawa: Department of Fisheries and Oceans, 1998, p. iv + 34p.
- [4] P. A. Cott, "Monitoring Explosive-Based Winter Seismic Exploration in Waterbodies, NWT 2000-2002," in *Proceedings of the Offshore Oil and Gas Environmental Effects Monitoring Workshop: Approaches and Technologies*, Columbus, 2005.
- [5] Ontario Ministry of the Environment, Conservation and Parks (MOECC), *Noise Pollution Control (NPC) Publication 119 of Model Municipal Noise Control By-law*, MOECC, 1982.
- [6] World Health Organization (WHO), "Guidelines for Community Noise," 1999.
- [7] International Society of Explosives Engineers (ISEE), *ISEE Blasters' Handbook, 18th Edition*, 2011.
- [8] D. S. e. al., "Report Investigation 8485 Structure Response and Damage Produced by Airblast," United States Bureau of Mines, 1979.
- [9] D. S. e. al., "Report Investigation 8507 Structure Response and Damage Produced by ground vibration," United States Bureau of Mines, 1980.
- [10] C. F. J. a. W. I. D. Harry R. Nicholls, "Bulletin 656 Blasting Vibrations and Their Effects on Structures," United States Bureau of Mines, 1971.
- [11] A. R. a. A. Moore, "Blast Vibration Course," in *Terrock Consulting Engineers*, Eltham, Melbourne, Australia, 2009.
- [12] J. E. a. A. I. Wiss, "Control of Vibration and Blast noise from Surface Coal Mining, Volume I," United States Bureau of Mines, December 1978.
- [13] J. E. a. A. I. Wiss, "Control of Vibration and Blast noise from Surface Coal Mining, Volume II," United States Bureau of Mines, December 1978.
- [14] J. E. a. A. I. Wiss, "Control of Vibration and Blast noise from Surface Coal Mining, Volume III," United States Bureau of Mines, December 1978.
- [15] Federal Highway Administration, *Construction Noise Handbook*, Washington, DC: U.S. Department of Transportation, 2006.
- [16] Wood VDN, "2022 Sound and Vibration Baseline Report (Leaves-Off Program)," June 2022.
- [17] Wood VDN, "2022 Sound and Vibration Baseline Report (Leaves-On Program)," Dec 2022.
- [18] Wood VDN, "2023 Sound and Vibration Baseline Report (Leaves-Off Program)," December 2023.
- [19] Wood VDN, "2023 Sound and Vibration Baseline Report (Leaves-On Program)," October 2023.
- [20] E. L. J. F. J. A. C. C.L. Jimeno, *Drilling and Blasting of Rocks*, Geology and Mining Institute of Spain: Revised and updated edition in English: A.A. Balkema BB Rotterdam, Netherlands, 1995, 1987, ISBN 90 5410 199 7.
- [21] Kinross Gold Corporation, *Blasting Parameters*, Internal Communication, 2024.
- [22] Kinross Gold Corporation, *GBR\_MASTER\_IS\_RFI Tracker (28Jun2024)*, Unpublished / Internal Document, 2024.

**Appendix A**

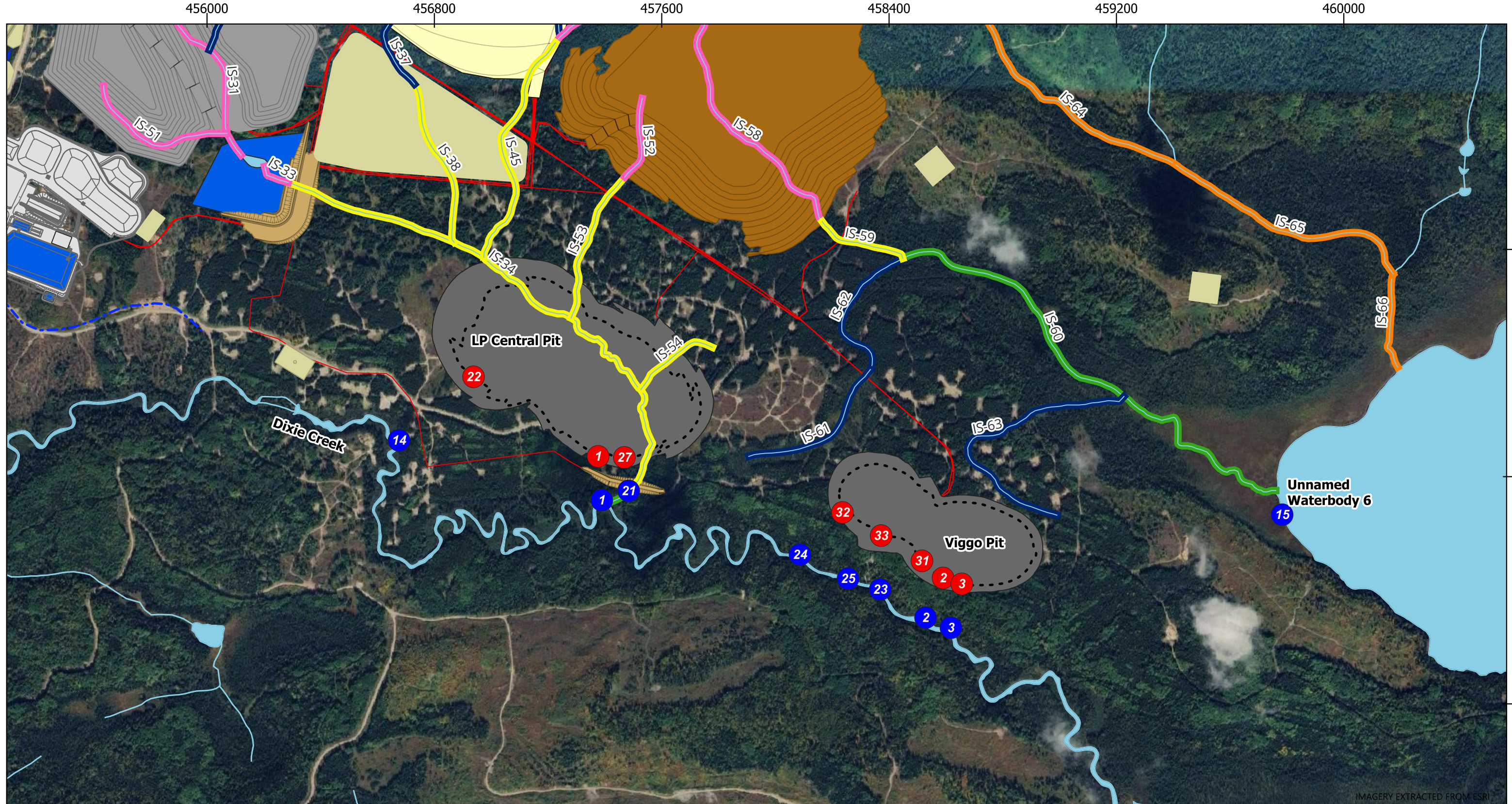
**Results Tables on Ground Vibration and Air  
Overpressure**

Compliance Assessment of Open pits blasting on surface operations predicted results															
Blast General Location	Blast Coordinates		Receptor Coordinates		Charge (kg)	Distance (m)	Location of interest	Predicted Airblast Overpressure dB(L)	HC limit dB(L)	MECP limit dB(L)	Airblast Overpressure MECP & HC Compliant?	Predicted Ground Vibration mm/s	MECP limit mm/s	Ground Vibration MECP compliant ?	Reference
	Latitude	Longitude	Latitude	Longitude											
LP Central Pit	457300	5634000	456965.3	5639222.7	207.6	5233	POR 1 to LP Central Pit	93	120	128	Yes	0.092	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
Viggo Pit	458516	5633451	465624.0	5635180.0	207.6	7315	POR 2 to Viggo Pit	90	120	128	Yes	0.053	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
Viggo Pit	458516	5633451	465611.0	5635303.0	207.6	7332	POR 3 to Viggo Pit	90	120	128	Yes	0.053	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
LP Central Pit	457300	5634000	451915.2	5639044.2	207.6	7378	POR 4 to LP Central Pit	90	120	128	Yes	0.053	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
LP Central Pit	457300	5634000	451670.6	5630890.6	207.6	6431	POR 5 to LP Central Pit	91	120	128	Yes	0.066	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
Viggo Pit	458516	5633451	465139.1	5634938.7	207.6	6788	POR 6 to Viggo Pit	91	120	128	Yes	0.060	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
Viggo Pit	458516	5633451	467084.9	5631026.4	207.6	8905	POR 7 to Viggo Pit	88	120	128	Yes	0.039	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
LP Central Pit	457300	5634000	447866.0	5639124.0	207.6	10736	POR 8 to LP Central Pit	86	120	128	Yes	0.029	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
LP Central Pit	457300	5634000	451051.0	5639187.0	207.6	8121	POR 9 to LP Central Pit	89	120	128	Yes	0.045	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
LP Central Pit	457300	5634000	452236.7	5640215.1	207.6	8016	POR 10 to LP Central Pit	89	120	128	Yes	0.046	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
LP Central Pit	457300	5634000	458555.5	5640149.2	207.6	6276	POR 11 to LP Central Pit	92	120	128	Yes	0.068	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
LP Central Pit	457300	5634000	450762.0	5642634.3	207.6	10830	POR 12 to LP Central Pit	86	120	128	Yes	0.029	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
LP Central Pit	457300	5634000	447707.6	5641952.3	207.6	12460	POR 13 to LP Central Pit	85	120	128	Yes	0.023	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
LP Central Pit	457300	5634000	446384.8	5641885.6	207.6	13466	POR 14 to LP Central Pit	84	120	128	Yes	0.020	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
LP Central Pit	457300	5634000	446675.0	5642960.0	207.6	13899	POR 15 to LP Central Pit	84	120	128	Yes	0.019	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
LP Central Pit	457300	5634000	447897.0	5645762.0	207.6	15059	POR 16 to LP Central Pit	83	120	128	Yes	0.017	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
LP Central Pit	457300	5634000	446101.8	5646374.8	207.6	16689	POR 17 to LP Central Pit	82	120	128	Yes	0.014	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
Viggo Pit	458700	5633350	465476.1	5635383.4	207.6	7223	POR 18 to Viggo Pit	90	120	128	Yes	0.055	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
LP Central Pit	457300	5634000	446876.2	5642540.0	207.6	13475	POR 19 to LP Central Pit	84	120	128	Yes	0.020	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
LP Central Pit	457300	5634000	447444.1	5642108.7	207.6	12763	POR 20 to LP Central Pit	84	120	128	Yes	0.022	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
LP Central Pit	457300	5634000	447961.4	5637216.3	207.6	9877	POR 21 to LP Central Pit	87	120	128	Yes	0.033	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
Viggo Pit	458516	5633451	469646.0	5628897.0	207.6	12025	POR 22 to Viggo Pit	85	120	128	Yes	0.024	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
Viggo Pit	458516	5633451	469091.0	5623932.0	207.6	14228	POR 23 to Viggo Pit	83	120	128	Yes	0.018	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
Viggo Pit	458516	5633451	470572.0	5630691.0	207.6	12368	POR 24 to Viggo Pit	85	120	128	Yes	0.023	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
Viggo Pit	458516	5633451	463047.0	5614594.0	207.6	19394	POR 25 to Viggo Pit	80	120	128	Yes	0.011	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
Viggo Pit	458516	5633451	467430.0	5631399.0	207.6	9147	POR 26 to Viggo Pit	88	120	128	Yes	0.037	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
Viggo Pit	458516	5633451	468788.0	5623627.0	207.6	14213	POR 27 to Viggo Pit	83	120	128	Yes	0.018	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
Viggo Pit	458516	5633451	465478.0	5635052.0	207.6	7143	POR 28 to Viggo Pit	90	120	128	Yes	0.056	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
LP Central Pit	457300	5634000	447525.0	5643902.0	207.6	13914	POR 29 to LP Central Pit	84	120	128	Yes	0.019	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation

Compliance Assessment of Quarries blasting on surface operations predicted results															
Blast General Location	Blast Coordinates		Receptor Coordinates		Charge (kg)	Distance (m)	Location of interest	Predicted Airblast Overpressure dB(L)	HC limit dB(L)	MECP limit dB(L)	Airblast Overpressure MECP & HC Compliant?	Predicted Ground Vibration mm/s	MECP limit mm/s	Ground Vibration MECP compliant ?	Reference
	Latitude	Longitude	Latitude	Longitude											
Quarry 2	452232	5636846	456965.3	5639222.7	41.2	5296	POR 1 to Quarry 2	94	120	128	Yes	0.005	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
Quarry 2	452232	5636846	465624.0	5635180.0	41.2	3155	POR 2 to Quarry 2	84	120	128	Yes	0.001	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
Quarry 2	452232	5636846	465611.0	5635303.0	41.2	2561	POR 3 to Quarry 2	84	120	128	Yes	0.001	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
Quarry 2	452232	5636846	451915.2	5639044.2	41.2	2221	POR 4 to Quarry 2	102	120	128	Yes	0.026	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
Quarry 1	451782	5635982	451670.6	5630890.6	41.2	5093	POR 5 to Quarry 1	94	120	128	Yes	0.006	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
Quarry 2	452232	5636846	465139.1	5634938.7	41.2	13047	POR 6 to Quarry 2	84	120	128	Yes	0.001	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
Quarry 2	452232	5636846	467084.9	5631026.4	41.2	15952	POR 7 to Quarry 2	82	120	128	Yes	0.001	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
Quarry 2	452232	5636846	447866.0	5639124.0	41.2	4925	POR 8 to Quarry 2	96	120	128	Yes	0.006	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
Quarry 2	452232	5636846	451051.0	5639187.0	41.2	2622	POR 9 to Quarry 2	102	120	128	Yes	0.019	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
Quarry 2	452232	5636846	452236.7	5640215.1	41.2	3369	POR 10 to Quarry 2	100	120	128	Yes	0.012	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
Quarry 2	452232	5636846	458555.5	5640149.2	41.2	7134	POR 11 to Quarry 2	90	120	128	Yes	0.003	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
Quarry 2	452232	5636846	450762.0	5642634.3	41.2	5972	POR 12 to Quarry 2	93	120	128	Yes	0.004	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
Quarry 2	452232	5636846	447707.6	5641952.3	41.2	6822	POR 13 to Quarry 2	92	120	128	Yes	0.003	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
Quarry 2	452232	5636846	446384.8	5641885.6	41.2	7719	POR 14 to Quarry 2	90	120	128	Yes	0.003	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
Quarry 2	452232	5636846	446675.0	5642960.0	41.2	8262	POR 15 to Quarry 2	89	120	128	Yes	0.002	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
Quarry 2	452232	5636846	447897.0	5645762.0	41.2	9914	POR 16 to Quarry 2	87	120	128	Yes	0.002	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
Quarry 2	452232	5636846	446101.8	5646374.8	41.2	11330	POR 17 to Quarry 2	85	120	128	Yes	0.001	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
Quarry 2	452232	5636846	465476.1	5635383.4	41.2	13325	POR 18 to Quarry 2	84	120	128	Yes	0.001	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
Quarry 2	452232	5636846	446876.2	5642540.0	41.2	7817	POR 19 to Quarry 2	89	120	128	Yes	0.003	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
Quarry 2	452232	5636846	447444.1	5642108.7	41.2	7115	POR 20 to Quarry 2	91	120	128	Yes	0.003	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
Quarry 1	451782	5635982	447961.4	5637216.3	41.2	4015	POR 21 to Quarry 1	98	120	128	Yes	0.009	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
Quarry 2	452232	5636846	469646.0	5628897.0	41.2	19142	POR 22 to Quarry 2	80	120	128	Yes	0.001	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
Quarry 1	451782	5635982	469091.0	5623932.0	41.2	21090	POR 23 to Quarry 1	79	120	128	Yes	0.000	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
Quarry 2	452232	5636846	470572.0	5630691.0	41.2	19345	POR 24 to Quarry 2	80	120	128	Yes	0.001	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
Quarry 1	451782	5635982	463047.0	5614594.0	41.2	24173	POR 25 to Quarry 1	78	120	128	Yes	0.000	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
Quarry 2	452232	5636846	467430.0	5631399.0	41.2	16145	POR 26 to Quarry 2	82	120	128	Yes	0.001	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
Quarry 1	451782	5635982	468788.0	5623627.0	41.2	21020	POR 27 to Quarry 1	79	120	128	Yes	0.000	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
Quarry 2	452232	5636846	465478.0	5635052.0	41.2	13367	POR 28 to Quarry 2	84	120	128	Yes	0.001	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation
Quarry 2	452232	5636846	447525.0	5643902.0	41.2	4392	POR 29 to Quarry 2	88	120	128	Yes	0.002	12.5	Yes	Cadnaa model for distances; ISEE and USBM documentation

## **Appendix B**

### **Figures on Blasting Effects on Fish Habitats**



IMAGERY EXTRACTED FROM ESRI

<b>LEGEND</b>		Notes: -Site Plan provided by Kinross June 2025 -Fisheries Impacted Watercourses provided by WSP April 2025			
--- Tuzyks Road --- Truck Haul Routes	--- Redirected Watercourses --- Redirected Watercourses --- Flow Reduction Watercourses --- Not Fish Frequented		--- Overburden/Bedrock Interface ● Blasting Location ● Fisheries Receiver Location	<b>Great Bear Mine</b> <b>Blasting Impact Assessment</b> Blasting Locations and Fish Habitat Locations, Construction Phase, Open Pits Area	
0 100 200 300 400 500 600 700 800 900 1,000 m		Datum & Projection: NAD83 / UTM zone 15N		PROJECT NO: CA03912 SCALE: 1:12898	FIGURE B-1 DATE: August 2025

451200

452000

452800

453600

454400

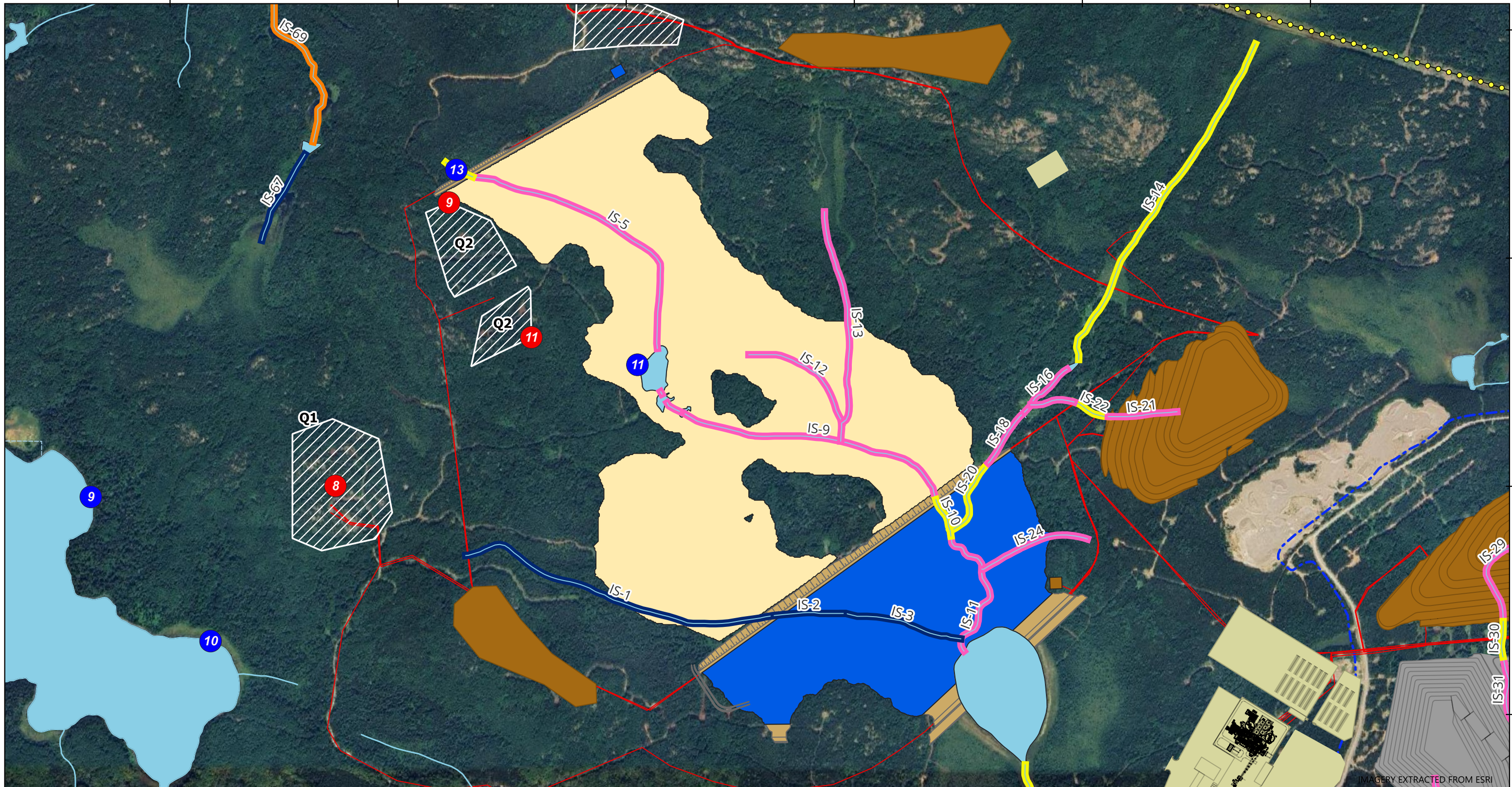
455200

5637600

5636800

5636000

5635200



IMAGERY EXTRACTED FROM ESRI

**LEGEND**

- Powerline 115 kV
- Tuzyks Road
- Truck Haul Routes

- Redirected Watercourses
- Redirected Watercourses
- Flow Increased Watercourse
- Not Fish Frequented

- Blasting Location
- Fisheries Receiver Location

Notes:

-Site Plan provided by Kinross February 2025  
 -Fisheries Impacted Watercourses provided by WSP April 2025

Datum & Projection:  
NAD83 / UTM zone 15N



**Great Bear Mine  
Blasting Impact Assessment**

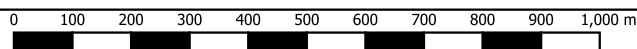
Blasting Locations and Fish Habitat Locations,  
Construction Phase, Quarries

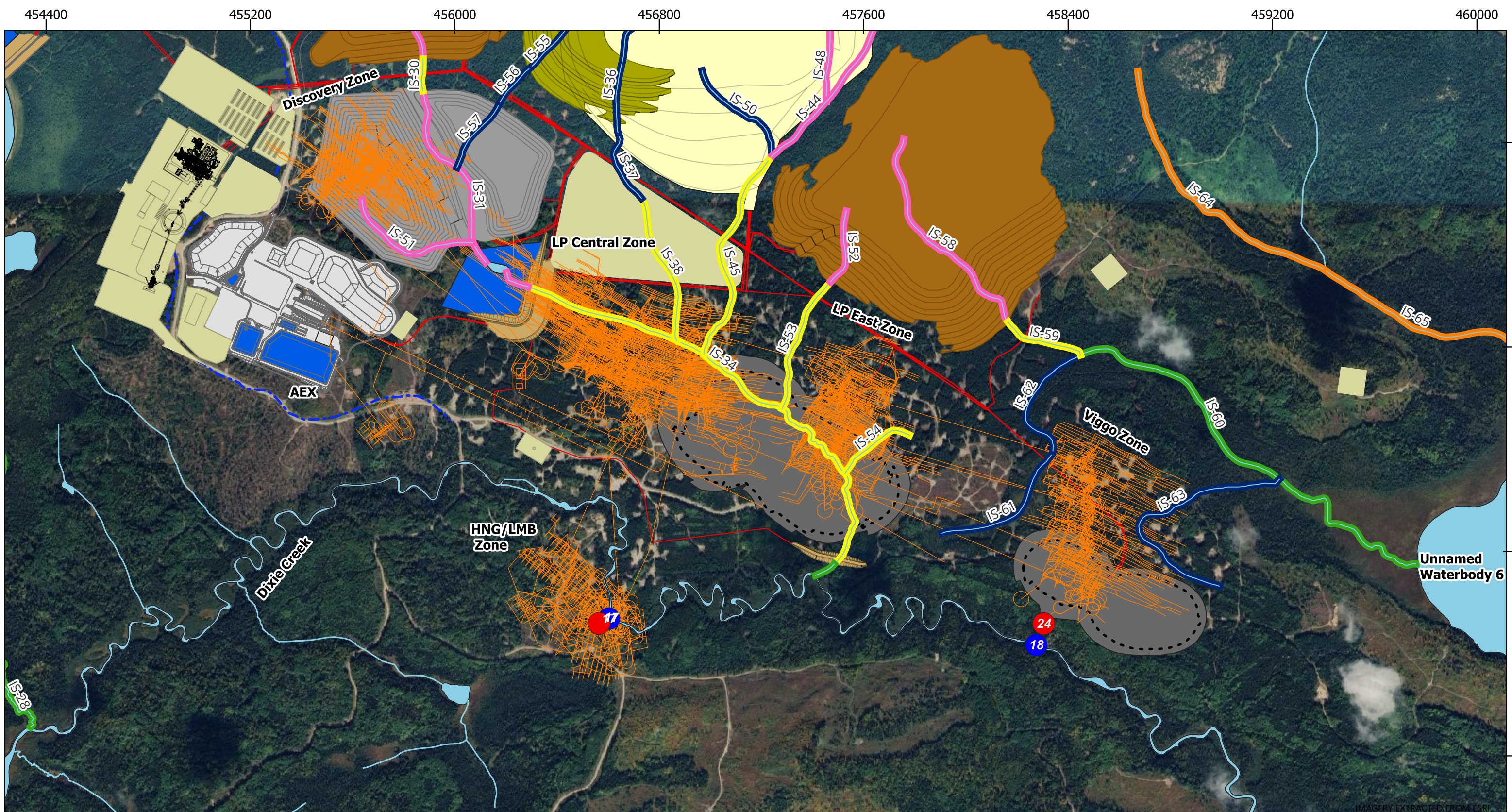
PROJECT NO: CA03912

SCALE: 1:12898

FIGURE B-2

DATE: August 2025





**LEGEND**

- Underground Mine
- - - Tuzyks Road
- Underground Production Phase Haul Route

- Flow Increased Watercourse
- Redirected Watercourses
- Redirected Watercourses
- Flow Reduction Watercourses
- Not Fish Frequented

- Fisheries Receiver Location
- Blasting Location

**Notes:**

-Underground Mine shapefile provided by Kinross May 2025  
 -Site Plan provided by Kinross June 2025  
 -Fisheries Impacted Watercourses provided by WSP April 2025

Datum & Projection:  
 NAD83 / UTM zone 15N



**Great Bear Mine  
 Blasting Impact Assessment**

Blasting Locations and Fish Habitat Locations,  
 Construction Phase, Underground Mine

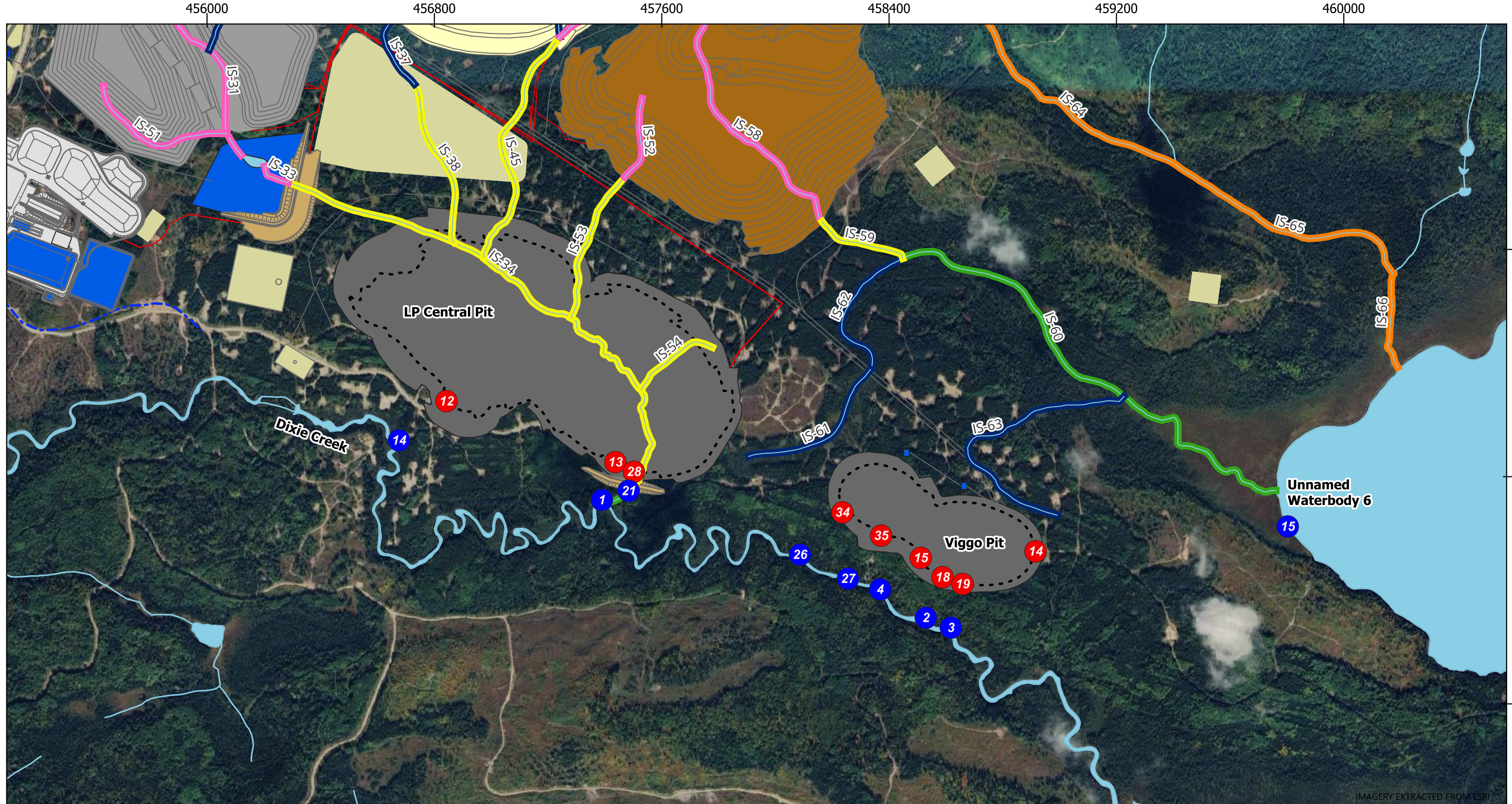
PROJECT NO: CA04440

FIGURE B-3

SCALE: 1:14364

DATE: August 2025

IMAGERY EXTRACTED FROM ESRI




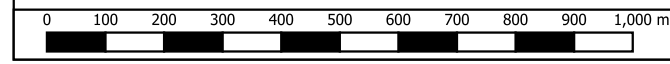
**LEGEND**

- Tuzyks Road
- Truck Haul Routes
- Redirected Watercourses
- Redirected Watercourses
- Flow Reduction Watercourses
- Not Fish Frequented
- Overburden/Bedrock Interface
- Blasting Location
- Fisheries Receiver Location

Notes:  
 -Site Plan provided by Kinross June 2025  
 -Fisheries Impacted Watercourses provided by WSP April 2025

Datum & Projection:  
 NAD83 / UTM zone 15N

	
<p><b>Great Bear Mine</b>  <b>Blasting Impact Assessment</b></p>	
<p>Blasting Locations and Fish Habitat Locations,          Operations Phase, Open Pits Area</p>	
<p>PROJECT NO: CA03912</p>	<p>FIGURE B-4</p>
<p>SCALE: 1:12898</p>	<p>DATE: August 2025</p>



IMAGERY EXTRACTED FROM ESRI

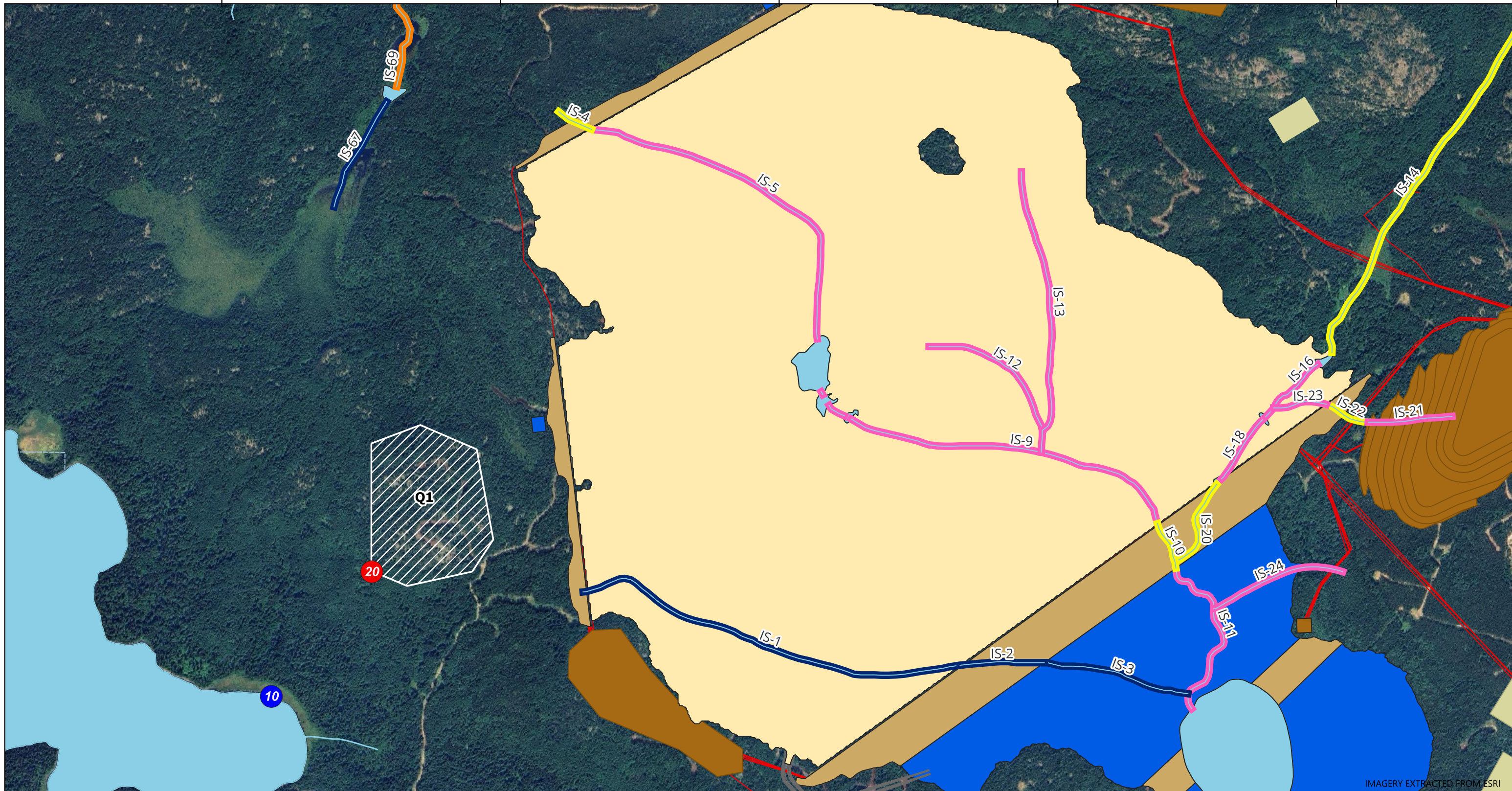
451200

452000

452800

453600

454400



5636800

5636000

5635200

IMAGERY EXTRACTED FROM ESRI

**LEGEND**

- Tuzyks Road
- Truck Haul Routes
- Redirected Watercourses
- Redirected Watercourses
- Flow Increased Watercourse
- Not Fish Frequented
- Blasting Location
- Fisheries Receiver Location

Notes:  
 - Site Plan provided by Kinross February 2025  
 - Fisheries Impacted Watercourses provided by WSP April 2025

Datum & Projection:  
 NAD83 / UTM zone 15N



**Great Bear Mine  
 Blasting Impact Assessment**

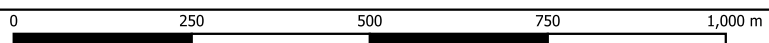
Blasting Locations and Fish Habitat Locations,  
 Operation Phase, Quarries

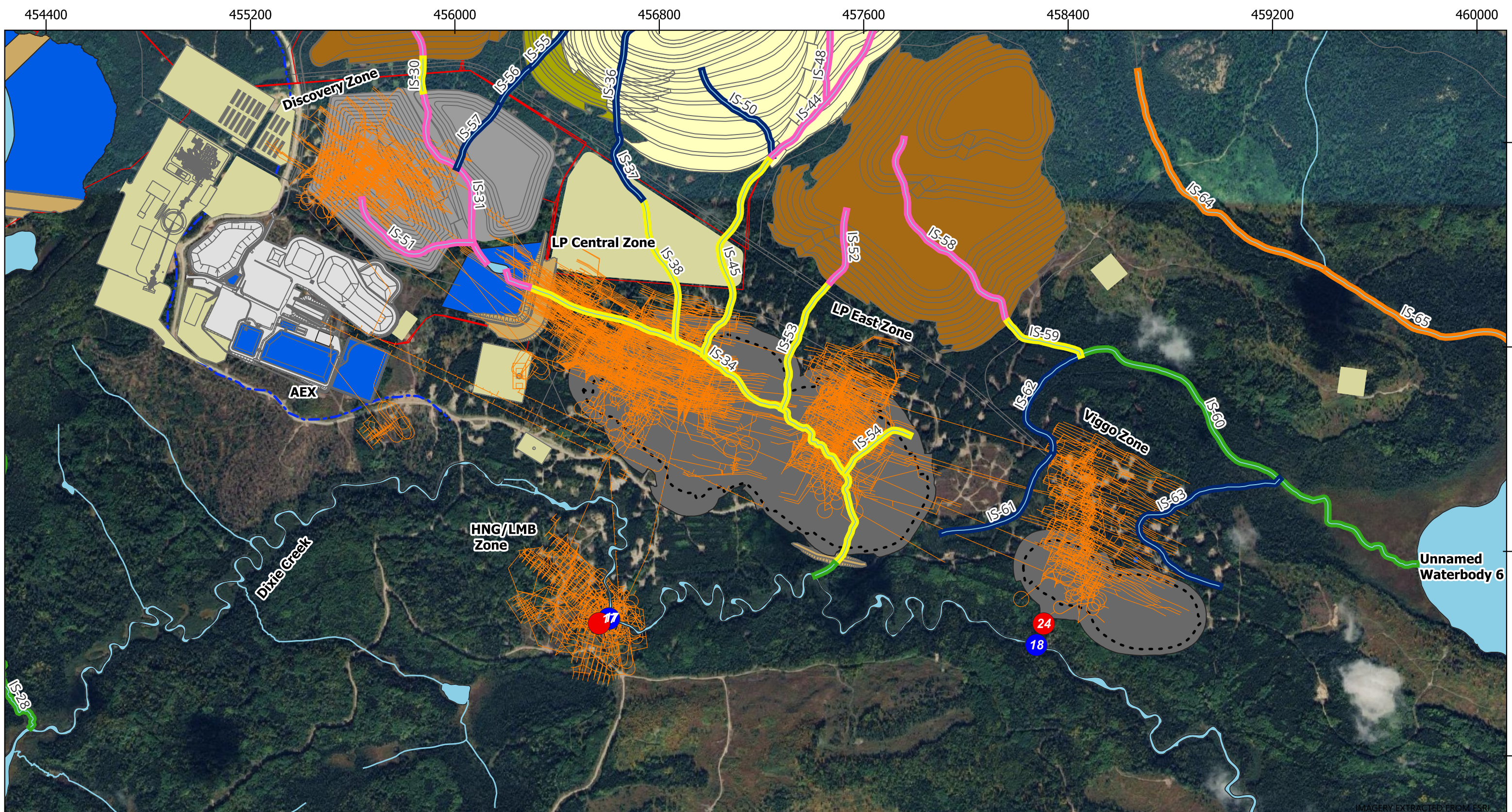
PROJECT NO: CA03912

FIGURE B-5

SCALE: 1:10611

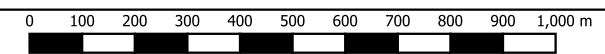
DATE: August 2025





**LEGEND**

- Underground Mine
- - - Tuzyks Road
- Underground Production Phase Haul Route
- Flow Increased Watercourse
- Redirected Watercourses
- Redirected Watercourses
- Flow Reduction Watercourses
- Not Fish Frequented
- Fisheries Receiver Location
- Blasting Location



Notes:  
 -Underground Mine shapefile provided by Kinross May 2025  
 -Site Plan provided by Kinross June 2025  
 -Fisheries Impacted Watercourses provided by WSP April 2025

Datum & Projection:  
 NAD83 / UTM zone 15N



**Great Bear Mine  
 Blasting Impact Assessment**

Blasting Locations and Fish Habitat Locations, Operations Phase, Underground Mine

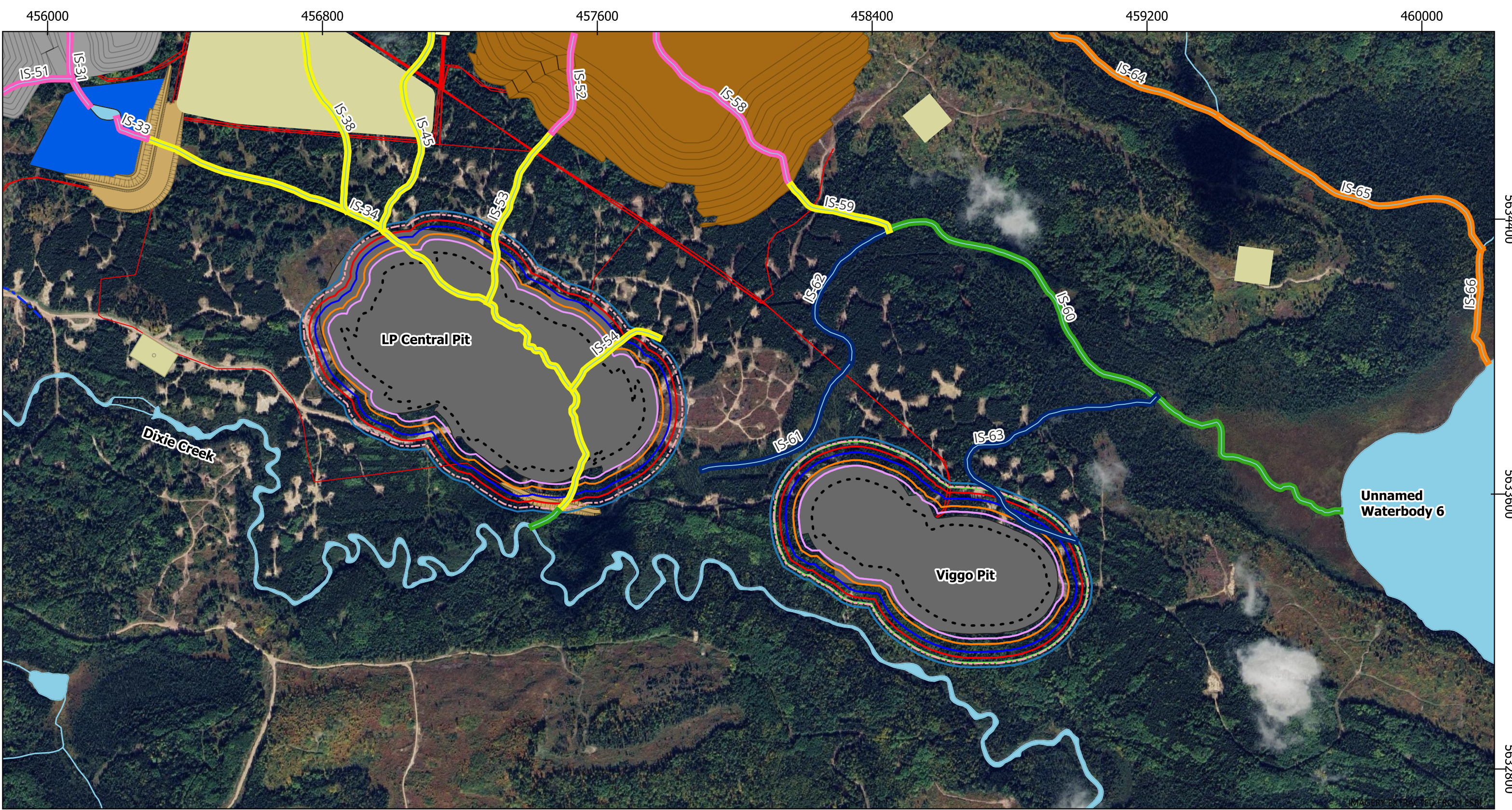
PROJECT NO: CA04440

SCALE: 1:14364

FIGURE B-6

DATE: August 2025

IMAGERY EXTRACTED FROM ESRI



**LEGEND**

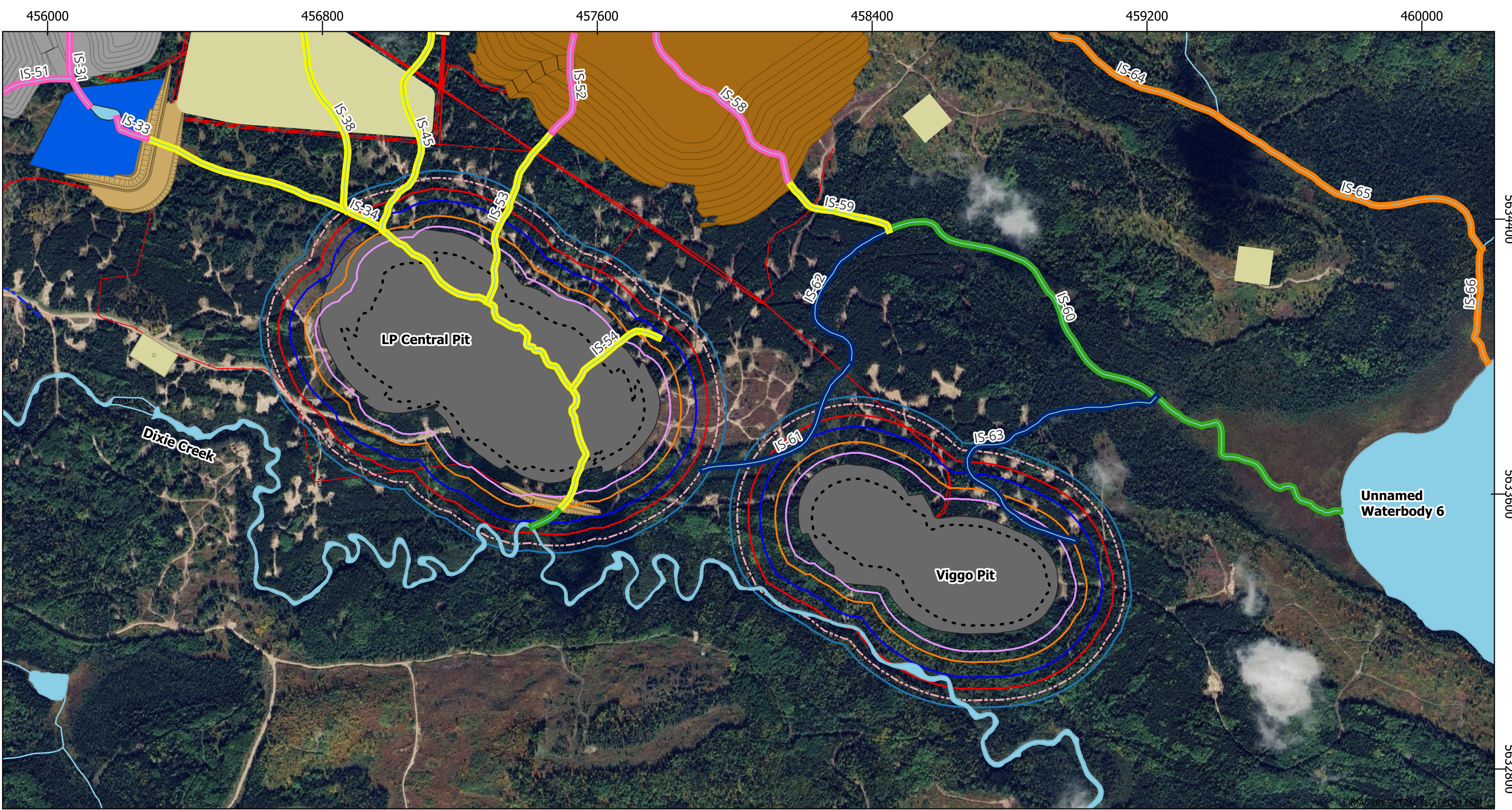
— Truck Haul Routes	— Redirected Watercourses	— Charge = 25kg/delay	— Charge = 207.6kg/delay
--- Tuzyks Road	— Redirected Watercourses	— Charge = 50kg/delay	— Charge = 250kg/delay
- - - Overburden/Bedrock Interface	— Flow Reduction Watercourses	— Charge = 100kg/delay	
	— Flow Increased Watercourse	— Charge = 150kg/delay	
	— Not Fish Frequented		

0 100 200 300 400 500 600 700 800 900 1,000 m

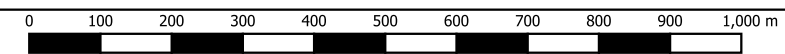
Notes:  
 - Blast Impact Area is calculated using the elevation of the top of Bedrock  
 - Site Plan provided by Kinross June 2025  
 - Fisheries Impacted Watercourses provided by WSP April 2025

Datum & Projection:  
 NAD83 / UTM zone 15N

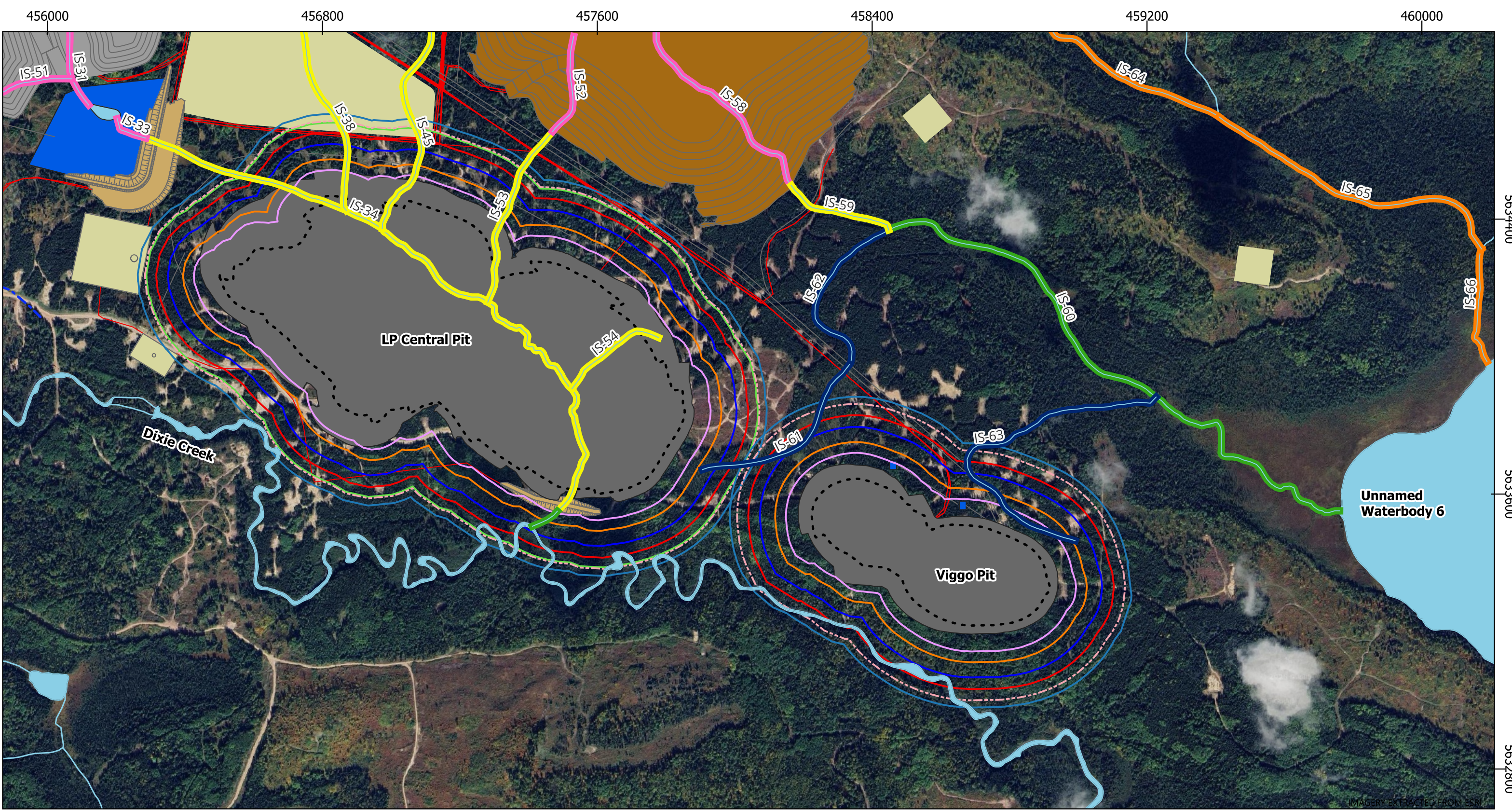
<b>Great Bear Mine          Blasting Impact Assessment</b>	
DFO Setback Distances per Charge Weight - Limit: 50 kPa - Construction Phase	
PROJECT NO: CA03912	FIGURE B-7
SCALE: 1:10611	DATE: August 2025



<b>LEGEND</b> — Truck Haul Routes - - - Tuzyks Road - - - Overburden/Bedrock Interface — Redirected Watercourses (Yellow) — Redirected Watercourses (Pink) — Flow Reduction Watercourses (Green) — Flow Increased Watercourse (Orange) — Not Fish Frequented (Blue)		Charge = 25kg/delay (Purple) Charge = 50kg/delay (Light Orange) Charge = 100kg/delay (Blue) Charge = 150kg/delay (Red)		Charge = 207.6kg/delay (Dashed Red) Charge = 250kg/delay (Light Blue)		Notes: - Blast Impact Area is calculated using the elevation of the top of Bedrock - Site Plan provided by Kinross June 2025 - Fisheries Impacted Watercourses provided by WSP April 2025 Datum & Projection: NAD83 / UTM zone 15N	<b>KINROSS wood.</b>	
<b>Great Bear Mine Blasting Impact Assessment</b> DFO Setback Distances per Charge Weight - Limit: 13 mm/s - Construction Phase							PROJECT NO: CA03912 SCALE: 1:10611	FIGURE B-8 DATE: August 2025



IMAGERY EXTRACTED FROM ESRI



**LEGEND**

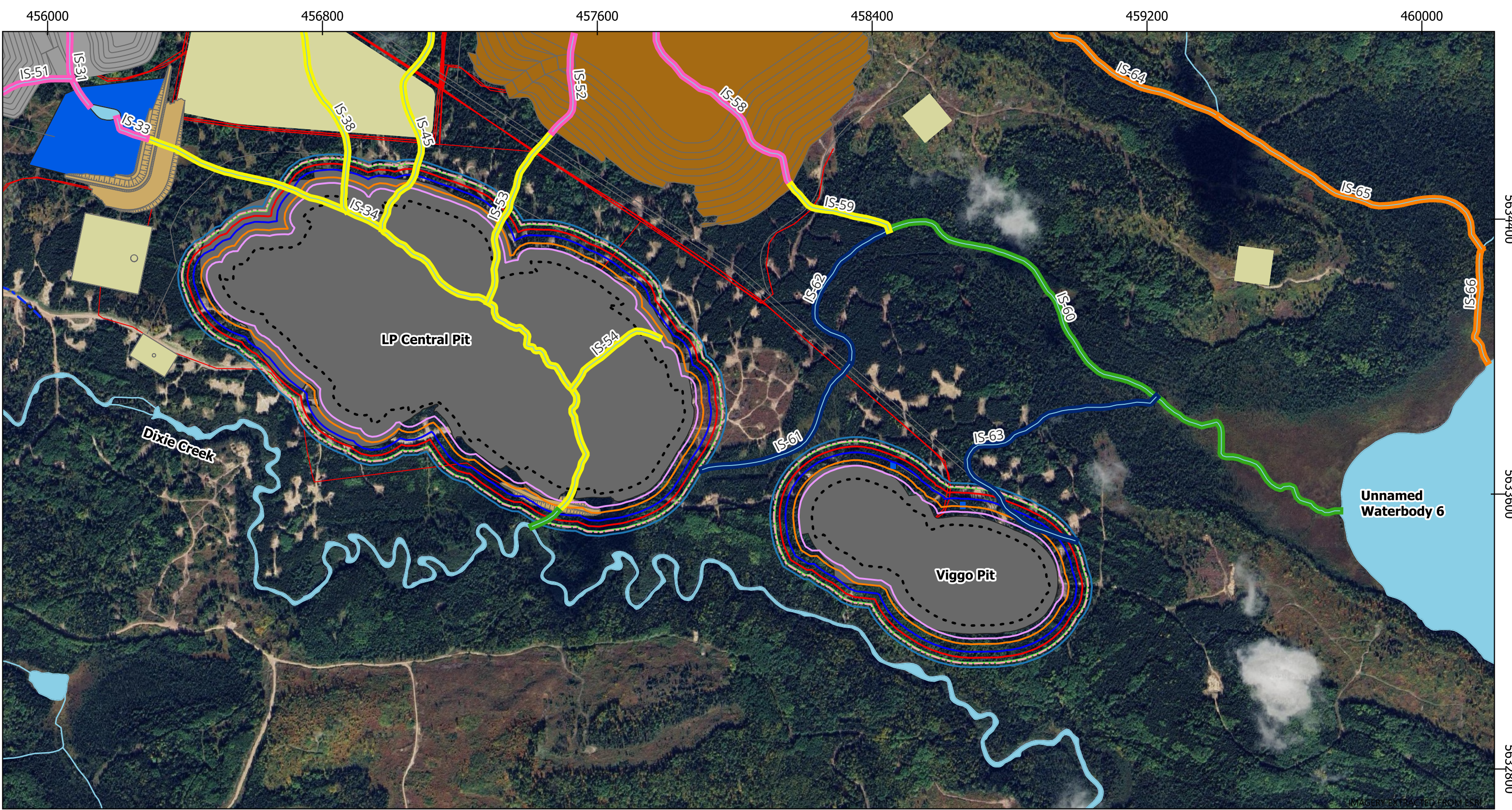
— Truck Haul Routes	— Redirected Watercourses	— Charge = 25kg/delay	— Charge = 207.6kg/delay
- - - Tuzyks Road	— Redirected Watercourses	— Charge = 50kg/delay	— Charge = 250kg/delay
- - - Overburden/Bedrock Interface	— Flow Reduction Watercourses	— Charge = 100kg/delay	
	— Flow Increased Watercourse	— Charge = 150kg/delay	
	— Not Fish Frequented		

0 100 200 300 400 500 600 700 800 900 1,000 m

Notes:  
 - Blast Impact Area is calculated using the elevation of the top of Bedrock  
 - Site Plan provided by Kinross June 2025  
 - Fisheries Impacted Watercourses provided by WSP April 2025

Datum & Projection:  
 NAD83 / UTM zone 15N

<p align="center"><b>Great Bear Mine Blasting Impact Assessment</b></p>	
<p align="center">DFO Setback Distances per Charge Weight - Limit: 13 mm/s - Operations Phase</p>	
PROJECT NO: CA03912	FIGURE B-9
SCALE: 1:10611	DATE: August 2025



**LEGEND**

— Truck Haul Routes	— Redirected Watercourses	□ Charge = 25kg/delay	□ Charge = 207.6kg/delay
--- Tuzyks Road	— Redirected Watercourses	□ Charge = 50kg/delay	□ Charge = 250kg/delay
- - - Overburden/Bedrock Interface	— Flow Reduction Watercourses	□ Charge = 100kg/delay	
	— Flow Increased Watercourse	□ Charge = 150kg/delay	
	— Not Fish Frequented		

0 100 200 300 400 500 600 700 800 900 1,000 m

Notes:  
 - Blast Impact Area is calculated using the elevation of the top of Bedrock  
 - Site Plan provided by Kinross June 2025  
 - Fisheries Impacted Watercourses provided by WSP April 2025

Datum & Projection:  
 NAD83 / UTM zone 15N

<p align="center"><b>Great Bear Mine Blasting Impact Assessment</b></p>	
<p align="center">DFO Setback Distances per Charge Weight - Limit: 50 kPa - Operations Phase</p>	
PROJECT NO: CA03912	FIGURE B-10
SCALE: 1:10611	DATE: August 2025

**Appendix C**

**Technical Terms and Acoustical Descriptors**



# **Appendix C**

## **Technical Terms and Acoustical Descriptors**

## Technical Terms and Acoustical Descriptors

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<i>Frequency</i>	<p>Typically the rate in Hertz (Hz) - previously denoted cycles per second, at which an event is repeated.</p> <p><i>Normal human hearing extends over a range of frequencies from about 15 Hz to about 15 kHz.</i></p>
<i>A-Weighting Network</i>	<p>A frequency-response adjustment of a sound level meter that makes its reading conform to human response. The sensitivity of the human ear is frequency dependent. At low and high frequencies, the ear is not very sensitive, but between 500 Hz and 6 kHz the ear is very sensitive. The A-weighting filter is a broadband filter that covers the interval from 20 Hz to 20 kHz. The shape of the A-weighting curve approximates the frequency sensitivity of the human ear. So the A-weighted value of a noise source is an approximation to how the human ear perceives the noise. Written as dB(A) or dBA</p>
<i>Z-Weighting Network</i>	<p>Z for 'Zero' frequency weighting, which implies no frequency weighting. In reality the range is 10 Hz to 20 kHz <math>\pm</math>1.5 dB.</p> <p>Introduced (IEC 61672 2003) to replace the Flat or Linear Filters. Written as dB(Z) or dBZ</p>
<i>Exponential Averaging</i>	<p>Generates a continuous running average where the most recently sampled levels have more influence on the average than older samples. This provides a convenient form to examine rapidly changing data with the benefit of some averaging to smooth the spectra.</p>
<i>Linear Averaging</i>	<p>The process of adding together a sequence of spectra measurements and then dividing the total by the number of samples. The result is a true arithmetic average on a sample by sample basis. Averaging smooths out random noise components in a spectrum.</p>
<i>Time Constants or Time Weightings</i>	<p>Time constants used for exponential averaging.</p> <p>Three time constants can be used and are defined as:</p> <ul style="list-style-type: none"><li>• Fast "F" time constant corresponds to 125 ms;</li><li>• Slow "S" time constant corresponds to 1s; and</li><li>• Impulse "I" time constant corresponding to 35 ms while the signal level is increasing and 1,500 ms while the signal level is decreasing.</li></ul>
<i>P(t) – "Sound Pressure"</i>	<p>The instantaneous difference between the actual pressure and the average barometric pressure at a given location.</p>
<i>Sound Pressure Level (SPL)</i>	<p>A measurement of instantaneous sound pressure and equal to 20 times the logarithm (base 10) of the ratio of the instantaneous</p>

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sound pressure of a sound divided by the reference sound pressure of 20  $\mu$ Pa (0 dB). Reported and measured in decibels (dB or dBA).

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$L_{x\text{eq}}(T)$  – “Equivalent continuous sound level with a frequency weighting, x”

The equivalent continuous sound level (also called time-average sound level),  $L_{x\text{eq}}(T)$ , is defined as twenty times the logarithm to base ten of the ratio of a root-mean-square sound pressure during a time interval (T) to the reference sound pressure, sound pressure being obtained with a frequency weighting, x.

x can be replaced by:

- A for A-weighted;
  - B for B-weighted;
  - C for C-weighted; or
  - Z for Z-weighted.
- 

$L_{xy\text{max}}(T)$  – “Maximum sound level, with a frequency weighting, x, and with a time-weighting, y”

The maximum time-weighted sound level,  $L_{xy\text{max}}(T)$ , is defined as the greatest time-weighted sound level,  $L_{xy}(t)$ , within a measurement interval (T).

x can be replaced by:

- A for A-weighted;
  - B for B-weighted;
  - C for C-weighted; or
  - Z for Z-weighted.
  - Y can be replaced by:
  - S for slow time weighting, or
  - F for fast time weighting.
- 

$L_{xy\text{min}}(T)$  – “Minimum sound level, with a frequency weighting, x, and with a time-weighting, y”

The minimum time-weighted sound level,  $L_{xy\text{min}}(T)$ , is defined as the smallest time-weighted sound level,  $L_{xy}(t)$ , within a measurement interval (T).

x can be replaced by:

- A for A-weighted,
  - B for B-weighted,
  - C for C-weighted, or
  - Z for Z-weighted.
  - Y can be replaced by:
  - S for slow time weighting, or
  - F for fast time weighting.
-

<p><math>L_{xyN}</math> – “N<sup>th</sup> Exceedance level, with a frequency weighting, x, and with a time-weighting, y”</p>	<p>Is the sound pressure level which is exceeded N percent of the measurement time. The sound pressure being obtained with a frequency weighting, x and a time-weighting, y.</p>
<p>where N is between 0.1 to 99.9</p>	<p>x can be replaced by:</p> <ul style="list-style-type: none"> <li>• A for A-weighted;</li> <li>• B for B-weighted;</li> <li>• C for C-weighted; or</li> <li>• Z for Z-weighted.</li> <li>• Y can be replaced by:</li> <li>• S for slow time weighting, or</li> <li>• F for fast time weighting.</li> </ul>
<p><math>L_{xpeak}(T)</math> – “Peak sound level</p>	<p>The peak sound level, <math>L_{xpeak}(T)</math>, is defined as twenty times the logarithm to base ten of the ratio of the greatest absolute instantaneous sound pressure, <math>p_x(t)</math>, instantaneous sound pressure being obtained with a frequency weighting, x</p> <p>x can be replaced by:</p> <ul style="list-style-type: none"> <li>• A for A-weighted;</li> <li>• B for B-weighted;</li> <li>• C for C-weighted; or</li> <li>• Z for Z-weighted.</li> </ul>
<p>Octave Band</p>	<p>A band of frequencies where the upper limiting frequency (u.l.f.) is twice the lower limiting frequency (l.l.f.). <i>Octave bands are identified by their centre-frequencies. The octave bands standardized for acoustic measurements include those centered at 31.5, 63, 125, 250, 500, 1000, 2000, 4000, &amp; 8000 Hz.</i></p>
<p>Velocity</p>	<p>Rate of change in position, measured in distance per unit of time. When measuring vibration signals, velocity represents the rate of change in displacement.</p> <p>Units: Millimetres per second [mm/s].</p>
<p>Peak Particle Velocity (PPV)</p>	<p>Highest particle velocity which is recorded during a particular vibration event.</p> <p>Unit: Millimetres per second [mm/s].</p>
<p>Root Mean Square (RMS) Velocity</p>	<p>Square root of the average of the squared instantaneous vibration velocity (V) over a specified time interval or integration time (T) reported in millimeters per second (mm/s).</p> <p>For the purposes of vibration monitoring the integration time (T) is one second.</p>

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Unit: Millimetres per second [mm/s].

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*1/N Octave Band*

A band of frequencies integrally divided from an Octave Band. The u.l.f. equals  $2^{1/N}$  times the l.l.f. *The most commonly used frequency band is the 1/3 octave band.*

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*Five-Number Summary*

The five-number summary is a set of descriptive statistics that provide information about a dataset. It consists of the five most important sample percentiles:

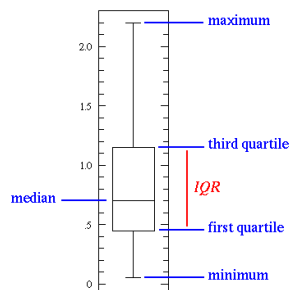
The sample minimum (smallest observation);

The lower quartile or first quartile;

The median (middle value);

The upper quartile or third quartile; and

The sample maximum (largest observation).



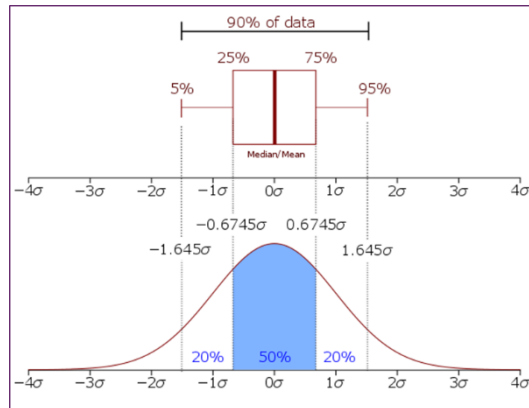
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*Box plot Representation or Box plot Graph*

Box plot (also known as a box-and-whisker plot) is a type of graph that is designed specifically to show the distribution of a set of data based on a five-number summary.

The representation of the box plot and data varies depending on the used. Alternates of the Five-Number Summary are generally used.

Box plots are uniform in their use of the box: the bottom and top of the box are always the first and third quartiles, and the band inside the box is always the median, but the ends of the whiskers can represent several possible alternative values.



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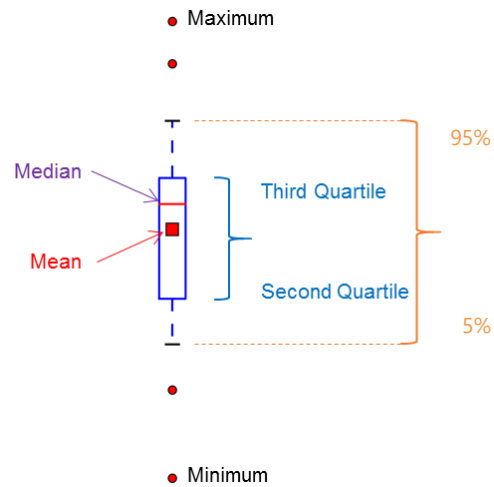
It should be noted that Box plots describe the sample and make no representation or assumptions regarding the population. Box plot data need not be normally distributed as represented in the figure above.

For the purpose of this report the type of representation chosen for the box plots represents a set of summary data that differs from the Five-Number Summary as follows:

The "whiskers" represent the 5 percentile and 95 percentile of the sample;

The red square indicated within the plot is the mean of the sample; and

The red dots represent any data points below or above the 5 and 95 percentiles respectively of the sample (including maximum and minimum of the sample).





**wood.**



## **Limitations**

## Limitations

1. The work performed in the preparation of this report and the conclusions presented are subject to the following:
  - a. The Standard Terms and Conditions which form a part of our Professional Services Contract;
  - b. The Scope of Services;
  - c. Time and Budgetary limitations as described in our Contract; and
  - d. The Limitations stated herein.
2. No other warranties or representations, either expressed or implied, are made as to the professional services provided under the terms of our Contract, or the conclusions presented.
3. The conclusions presented in this report were based, in part, on visual observations of the Site and attendant structures. Our conclusions cannot and are not extended to include those portions of the Site or structures, which are not reasonably available, in Wood's opinion, for direct observation.
4. The environmental conditions at the Site were assessed, within the limitations set out above, having due regard for applicable environmental regulations as of the date of the inspection. A review of compliance by past owners or occupants of the Site with any applicable local, provincial or federal bylaws, orders-in-council, legislative enactments and regulations was not performed.
5. The Site history research included obtaining information from third parties and employees or agents of the owner. No attempt has been made to verify the accuracy of any information provided, unless specifically noted in our report.
6. Where testing was performed, it was carried out in accordance with the terms of our contract providing for testing. Other substances, or different quantities of substances testing for, may be present on-site and may be revealed by different or other testing not provided for in our contract.
7. Because of the limitations referred to above, different environmental conditions from those stated in our report may exist. Should such different conditions be encountered, Wood must be notified in order that it may determine if modifications to the conclusions in the report are necessary.
8. The utilization of Wood's services during the implementation of any remedial measures will allow Wood to observe compliance with the conclusions and recommendations contained in the report. Wood's involvement will also allow for changes to be made as necessary to suit field conditions as they are encountered.
9. This report is for the sole use of the party to whom it is addressed unless expressly stated otherwise in the report or contract. Any use which any third party makes of the report, in whole or the part, or any reliance thereon or decisions made based on any information or conclusions in the report is the sole responsibility of such third party. Wood accepts no responsibility whatsoever for damages or loss of any nature or kind suffered by any such third party as a result of actions taken or not taken or decisions made in reliance on the report, or anything set out therein.
10. This report is not to be given over to any third party for any purpose whatsoever without the written permission of Wood.
11. Provided that the report is still reliable, and less than 12 months old, Wood will issue a third-party reliance letter to parties that the client identifies in writing, upon payment of the then current fee for such letters. All third parties relying on Wood's report, by such reliance agree to be bound by our proposal and Wood's standard reliance letter. Wood's standard reliance letter indicates that in no event shall Wood be liable for any damages, howsoever arising, relating to third-party reliance on Wood's report. No reliance by any party is permitted without such agreement.