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Department

Environment, Health and Safety

Site

Tara Mines

RFI Response IEL P0516-05

Subtitle

Recipients

First name Last name

Organization/department

First name Last name

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Introduction

This document has been prepared in response to the Agency's request for further information in respect to the license review.

Point 9

Update the Attachment 7-4-1 Emissions to Atmosphere to accurately reflect the emissions to air at the installation.

Response

An updated Attachment 7-4-1 Emissions to Atmosphere has been attached below to this document to reflect main emissions to atmosphere for the installation.

Point 10

Provide the control monitoring in place on all emissions to atmosphere.

Response

All monitoring of emissions to atmosphere at the installation are carried out in accordance with IEL P0516-04 Schedule C requirements as agreed with the Agency.

Point 11

Submit a revised air dispersion model report, which complies with the EPAs Air Dispersion modelling from Industrial Installations Guidance Note (AG4).

Response

An updated air dispersion model report has been completed to address all items raised in Point 11 of the RFI and is attached to this document.

Point 15

The cumulative impact of any other plans or projects that may, in combination with the plan or project under consideration, adversely affect the integrity of a European Site.

Response

A NIS has been prepared to take into consideration the potential cumulative impacts of any other plans and projects that could potentially affect the integrity of a European Site. The NIS has concluded that the proposed projects will not cumulatively affect the integrity of any European Site.

Please see Section 4 of attached updated NIS for further details.

Point 16

All potential impacts on water or air quality, including any impacts from nitrogen

Response

The NIS has taken into consideration the potential cumulative impacts on air and water quality and has determined that there will be no adverse impacts.

Proposed and existing mitigation measures are detailed within Section 3.6 of attached updated NIS.

Point 17

All potential impacts on water or air quality, including any impacts from nitrogen

Response

The NIS has taken into consideration the potential cumulative impacts on air and water quality and has determined that there will be no adverse impacts.

All potential impacts on water and air quality are detailed in Section 3.7 of attached updated NIS.

Conclusion

In addition to the above, an updated non-technical summary and reason for license review to reflect changes required following the request for further information has been attached to this document.

Updated Attachment 7.63 and 9.2.3 have also been attached to this document to reflect most recent reports carried out on site.

Point 9 – Attachment 7-4-1

EPA Application Form

7.4.1 - Emissions to Atmosphere - Main and Fugitive Emissions - Attachment

Organisation Name: *

Boliden Tara Mines Designated Activity Company

Application I.D.: *

LA007059

Authorisation Application Form

Amendments to this Application Form Attachment

Version No.	Date	Amendment since previous version	Reason
V.1.0	July 2017	N/A	Online application form attachment
As above	Mar 2017	Identification of required fields	Assist correct completion of attachment

Authorisation Application Form

EMISSIONS TO ATMOSPHERE

Emissions to air/atmosphere include the following:

Main Emissions

Main emissions include all emissions of environmental significance. Where a **mass emission threshold** is specified in a BAT document (BAT Conclusions, National BAT note or BREF), emissions which exceed this threshold prior to abatement are regarded as significant, i.e., 'main emissions'. (In some cases emissions below the threshold can still be significant and qualify as Main Emissions).

Minor Emissions

Emissions below the mass emission threshold may be considered minor emissions and therefore do not generally need to be specifically controlled by the conditions or schedules of the licence (i.e., setting of ELVs, abatement control measures, or monitoring requirements). Emissions may also be deemed minor by virtue of their source/nature (e.g., laboratory fume hoods, workspace extractions, passive vents from storage tanks, HVAC exhausts), or composition (e.g., water vapour emissions).

For combustion plant such as boilers, these can be considered minor where the rated thermal input is < 1MW where natural gas is the main fuel, and for liquid and solid fuels where its < 250kW.

In completing the separate '*Emissions to Atmosphere - Minor and Potential*' attachment for minor emissions, the applicant should supply sufficient information to justify the determination of the emission as minor. Notwithstanding this guidance, the Agency may consider any emission to be significant (i.e., a main emission) on the basis of environmental impact.

Fugitive Emissions

Fugitive emissions include emissions from non-point sources and diffuse sources.

Potential Emissions

These are emissions which only operate under abnormal process conditions. Typical examples include bursting discs, pressure relief valves, and emergency generators. Bypasses and flares may also fall within this category, depending on how they are operated or designed to operate. Although the Agency does not normally set controls in licences for potential emissions, it may do so for the purposes of environmental protection.

This attachment collects information on main and fugitive emissions to atmosphere. Waste gas means the final gaseous emission from a stack or abatement equipment.

For minor and potential emissions to atmosphere, complete the separate '*Emissions to Atmosphere - Minor and Potential*' attachment.

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Main Emissions to Atmosphere - Waste Gas Emission Point Details - one row per emission point *

Complete the following table with summary details for all main emission points to atmosphere.

(Guidance on completing the table is included in **Note i** at the end of this attachment)

The applicant should address in particular any emissions which may contain the principal polluting substances listed in the First Schedule of Environmental Protection Agency (Integrated Pollution Control) (Licensing) Regulations 2013/ (Industrial Emissions)(Licensing) Regulations 2013.

Please note that the determination of any emission limit values and monitoring requirements in a proposed licence if granted will be based on the information supplied hereunder.

Emission Point Code	Emission Point Grid Ref.		Typical Days Usage/ Year	Measures to reduce /minimise / prevent emissions (list techniques) ¹ <i>Where EQS considerations require measures stricter than BAT, highlight these measures in bold</i>	Source of Waste Gases ²	Minimum Discharge Height Above Ground (m)	Reference Conditions			
	Easting ³	Northing ⁴					Pressure ⁵	Temp. ⁶	% Oxygen ⁷	Moisture ⁸
A2-4	285115	267941	260	Usage 'on demand' Wet scrubber	General extraction from building	22.1	101.325k Pa	273.15K	No correction.	Dry
A2 – 5	284892	268265	0	Currently not operational	Other : General extraction from mine	1	101.325k Pa	273.15K	No correction.	Dry

¹ Detailed descriptions and schematics of all abatement systems should be included in the Operational Report (Tab 4.8 – 'Reports').

² **Options:** Boiler, Gas Turbine, Incineration, Co-Incineration, CHP, Kiln, Engine, Indirect drying activity (e.g. milk drying), Other Combustion activity (e.g., oven), Distillation/Chemical reaction, Solvent based coating activity, Other coating activity (provide description), Composting Tunnels, General extraction from buildings or Other (provide a description if 'Other' is selected).

³ **Six Digit GPS Irish National Grid Reference.**

⁴ **Six Digit GPS Irish National Grid Reference.**

⁵ **Options:** 101.325kPa or No correction.

⁶ **Options:** 273.15K or No correction.

⁷ **Options:** 3%, 6%, 10%, 11%, 15%, 18% or No correction.

⁸ **Options:** Wet or Dry.

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Emission Point Code	Emission Point Grid Ref.		Typical Days Usage/ Year	Measures to reduce /minimise / prevent emissions (list techniques) ¹ <i>Where EQS considerations require measures stricter than BAT, highlight these measures in bold</i>	Source of Waste Gases ²	Minimum Discharge Height Above Ground (m)	Reference Conditions			
	Easting ³	Northing ⁴					Pressure ⁵	Temp. ⁶	% Oxygen ⁷	Moisture ⁸
A2 – 6	285343	268163	365	Usage 'on demand'	Other : General extraction from mine	1	101.325k Pa	273.15K	No correction.	Dry
A2 – 7	284929	268647	365	Usage 'on demand'	Other : General extraction from mine	1	101.325k Pa	273.15K	No correction.	Dry
A2 – 8	284626	268671	365	Usage 'on demand'	Other : General extraction from mine	1	101.325k Pa	273.15K	No correction.	Dry
A2 - 9	283950	268230	365	Usage 'on demand'	Other : General extraction from mine	1	101.325k Pa	273.15K	No correction.	Dry
A2-10	283314	266800	365	Usage 'on demand'	Other : General extraction from mine	1	101.325k Pa	273.15K	No correction.	Dry
A2-11	283304	266884	365	Usage 'on demand'	Other : General extraction from mine	1	101.325k Pa	273.15K	No correction.	Dry
A2-12	284414	264848	365	Usage 'on demand'	Other : General extraction from mine	1	101.325k Pa	273.15K	No correction.	Dry

*add rows to the table as necessary



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Emission Points from Combustion, Incineration or Co-incineration Sources Only

Complete the table below for each emission point to atmosphere from a combustion source, waste incineration or co-incineration plant

Emission Point Code	Primary Fuel Type ⁹ (where applicable)	Secondary Fuel Type ¹⁰ (where applicable)	LCP Plant Reference (where applicable)	Waste incineration or co-incineration plant reference (where applicable)
n/a				

*add rows to the table as necessary

⁹ Options: Coal, Lignite, Heavy Fuel Oil, Other Fuel Oil, Peat, Natural Gas, Biogas, Solid Biomass, Waste, Gas Oil, Other or None

¹⁰ Options: Coal, Lignite, Heavy Fuel Oil, Other Fuel Oil, Peat, Natural Gas, Biogas, Solid Biomass, Waste, Gas Oil, Other or None

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Emission Points with Solvent Emissions Only

Complete the table below for each emission point associated with a solvent activity

Emission Point Code	Are specific Hazardous Substances ¹¹ Emitted?	Mass Flow of Emitted Hazardous Substances (g/hour)	Halogenated VOCs ¹² Emitted?	Mass Flow of Emitted Halogenated VOCs (g/hour)
n/a				

*add rows to the table as necessary

¹¹ Emissions of volatile organic compounds referred to in Article 58 (Substances or mixtures which, because of their content of volatile organic compounds classified as carcinogens, mutagens, or toxic to reproduction under Regulation (EC) No. 1272/2008, are assigned or need to carry the hazard statements H340, H350,H350i, H360D or H360F) of the Industrial Emissions Directive.

¹² Halogenated volatile organic compounds which are assigned or need to carry the hazard statements H341 or H351.

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Waste Gas Emission Monitoring Points

Complete the table below for each emission point, by entering the Emission Point Code, the associated Monitoring Point Code and the grid reference of the Monitoring Point. *

Emission Point Code	Monitoring Point Code ¹³	Monitoring Point Grid Reference	
		Easting ¹⁴	Northing ¹⁵
A2-4	A2-4	285117	267952
A2 – 5	A2 – 5	284892	268265
A2 – 6	A2 – 6	285343	268163
A2 – 7	A2 – 7	284929	268625
A2 – 8	A2 – 8	284628	268650
A2 - 9	A2 - 9	283969	268239
A2-10	A2-10	283314	266800
A2-11	A2-11	283279	266873
A2-12	A2-12	284414	264848

*add rows to the table as necessary

¹³ To include monitoring and sampling points

¹⁴ Six Digit GPS Irish National Grid Reference

¹⁵ Six Digit GPS Irish National Grid Reference



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Waste Gas - Abatement /Treatment Control

Complete the table below for each emission point with an abatement/treatment system (one table per emission point)

Emission Point Code: A2-4

Control ¹⁶ parameter	Monitoring to be carried out ¹⁷	Additional notes (where relevant)
Scrubber Solution Flow	Continuous	
Electric current to scrubber unit	Continuous	

*add rows to the table as necessary

¹⁶ List the operating parameters of the treatment/abatement system which control its function.

¹⁷ List the monitoring of the control parameter to be carried out.



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Waste Gas Emissions

Complete the table below for all main emission points to atmosphere (include one row for each identified parameter) *

Emission Point Code	Parameter	Monitoring Point Code	Proposed Emission Limits ¹⁸					BAT Associated Emission Range (if applicable)	Sampling / Monitoring EPA Guidance for Monitoring - AG2 Index of Preferred Methods		
			Max. Hourly ¹⁹	Max. Daily ²⁰	Average Month ²¹	Average Annual ²²	How was the Proposed Emission Limit Derived?		Proposed Monitoring Frequency	Proposed Monitoring and Analysis Method ²³	Compliant with BAT Monitoring Requirement?
A2-4	Volume	A2-4	15,000 m ³	360,000 m ³			Existing ELV		Monthly	EN16911:2013	Yes
	Particulates	A2-4		10 mg/m ³			Existing ELV		Monthly	EN13284-1:2017	Yes
	Zinc	A2-4		0.5 mg/m ³			Existing ELV		Monthly	EN14385:2004	Yes
	Lead	A2-4		0.5 mg/m ³			Existing ELV		Monthly	EN14385:2004	Yes
	Cadmium	A2-4		0.05 mg/m ³			Existing ELV		Monthly	EN14385:2004	Yes
	Arsenic	A2-4		0.05 mg/m ³			Existing ELV		Monthly	EN14385:2004	Yes
A2-5 (Currently not)	Volume	A2-5	775,000 m ³	18,600,000 m ³			Existing ELV		Quarterly	EN16911:2013	Yes
	Particulates			5 mg/m ³			Existing ELV		Quarterly	EN13284-1:2017	Yes

¹⁸ For emissions outside the BAT Conclusion, BREF or BAT guidance limit, a full evaluation of the existing abatement/treatment system must be provided. **A planned programme of improvement towards meeting upgraded standards is required.** This should highlight specific goals and a time scale, together with options for modification, upgrading or replacement as required to bring emissions within the limits set out in the BAT Conclusion(s), BREF(s) or BAT guidance note(s). These notes can be found on the EPA website at www.epa.ie.

¹⁹ Specify the proposed limit **and** the units.

²⁰ Specify the proposed limit **and** the units.

²¹ Specify the proposed limit **and** the units.

²² Specify the proposed limit **and** the units.

²³ For continuous monitoring 'EN15267 approved CEMS' is the standard method. For periodic monitoring please refer to the EPA guidance document '[AG2 Index of Preferred Methods](#)'.

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Emission Point Code	Parameter	Monitoring Point Code	Proposed Emission Limits ¹⁸					BAT Associated Emission Range (if applicable)	Sampling / Monitoring EPA Guidance for Monitoring - AG2 Index of Preferred Methods		
			Max. Hourly ¹⁹	Max. Daily ²⁰	Average Month ²¹	Average Annual ²²	How was the Proposed Emission Limit Derived?		Proposed Monitoring Frequency	Proposed Monitoring and Analysis Method ²³	Compliant with BAT Monitoring Requirement?
operational)	Hydrogen sulphide			0.01 mg/m ³			Existing ELV		Quarterly	EN13649:2014	Yes
	Nitrogen oxides (as NO ₂)			20 mg/m ³			Existing ELV		Quarterly	EN14792:2017	Yes
	Ammonia								Quarterly	EN14791:2017	Yes
A2-6	Volume	A2-6	775,000 m ³	18,600,000 m ³			Existing ELV		Quarterly	EN16911:2013	Yes
	Particulates			5 mg/m ³			Existing ELV		Quarterly	EN13284-1:2017	Yes
	Hydrogen sulphide			0.01 mg/m ³			Existing ELV		Quarterly	EN13649:2014	Yes
	Nitrogen oxides (as NO ₂)			20 mg/m ³			Existing ELV		Quarterly	EN14792:2017	Yes
	Ammonia								Quarterly	EN14791:2017	Yes
A2-7	Volume	A2-7	580,000 m ³	13,900,000 m ³			Existing ELV		Quarterly	EN16911:2013	Yes
	Particulates			5 mg/m ³			Existing ELV		Quarterly	EN13284-1:2017	Yes
	Hydrogen sulphide			0.01 mg/m ³			Existing ELV		Quarterly	EN13649:2014	Yes

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Emission Point Code	Parameter	Monitoring Point Code	Proposed Emission Limits ¹⁸					BAT Associated Emission Range (if applicable)	Sampling / Monitoring EPA Guidance for Monitoring - AG2 Index of Preferred Methods		
			Max. Hourly ¹⁹	Max. Daily ²⁰	Average Month ²¹	Average Annual ²²	How was the Proposed Emission Limit Derived?		Proposed Monitoring Frequency	Proposed Monitoring and Analysis Method ²³	Compliant with BAT Monitoring Requirement?
	Nitrogen oxides (as NO ₂)			20 mg/m ³			Existing ELV		Quarterly	EN14792:2017	Yes
	Ammonia							Quarterly	EN14791:2017	Yes	
A2-8	Volume	A2-8	580,000 m ³	13,900,000 m ³			Existing ELV		Quarterly	EN16911:2013	Yes
	Particulates			5 mg/m ³			Existing ELV		Quarterly	EN13284-1:2017	Yes
	Hydrogen sulphide			0.01 mg/m ³			Existing ELV		Quarterly	EN13649:2014	Yes
	Nitrogen oxides (as NO ₂)			20 mg/m ³			Existing ELV		Quarterly	EN14792:2017	Yes
	Ammonia								Quarterly	EN14791:2017	Yes
A2-9	Volume	A2-9	775,000 m ³	18,600,000 m ³			Existing ELV		Quarterly	EN16911:2013	Yes
	Particulates			5 mg/m ³			Existing ELV		Quarterly	EN13284-1:2017	Yes
	Hydrogen sulphide			0.01 mg/m ³			Existing ELV		Quarterly	EN13649:2014	Yes
	Nitrogen oxides (as NO ₂)			20 mg/m ³			Existing ELV		Quarterly	EN14792:2017	Yes

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Emission Point Code	Parameter	Monitoring Point Code	Proposed Emission Limits ¹⁸					BAT Associated Emission Range (if applicable)	Sampling / Monitoring EPA Guidance for Monitoring - AG2 Index of Preferred Methods		
			Max. Hourly ¹⁹	Max. Daily ²⁰	Average Month ²¹	Average Annual ²²	How was the Proposed Emission Limit Derived?		Proposed Monitoring Frequency	Proposed Monitoring and Analysis Method ²³	Compliant with BAT Monitoring Requirement?
	Ammonia								Quarterly	EN14791:2017	Yes
A2-10	Volume	A2-10	1,333,334 m ³	32,000,000 m ³			Existing ELV		Quarterly	EN16911:2013	Yes
	Particulates			5 mg/m ³			Existing ELV		Quarterly	EN13284-1:2017	Yes
	Hydrogen sulphide			0.01 mg/m ³			Existing ELV		Quarterly	EN13649:2014	Yes
	Nitrogen oxides (as NO ₂)			20 mg/m ³			Existing ELV		Quarterly	EN14792:2017	Yes
	Ammonia								Quarterly	EN14791:2017	Yes
A2-11	Volume	A2-11	1,333,334 m ³	32,000,000 m ³			Existing ELV		Quarterly	EN16911:2013	Yes
	Particulates			5 mg/m ³			Existing ELV		Quarterly	EN13284-1:2017	Yes
	Hydrogen sulphide			0.01 mg/m ³			Existing ELV		Quarterly	EN13649:2014	Yes
	Nitrogen oxides (as NO ₂)			20 mg/m ³			Existing ELV		Quarterly	EN14792:2017	Yes
	Ammonia								Quarterly	EN14791:2017	Yes

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Emission Point Code	Parameter	Monitoring Point Code	Proposed Emission Limits ¹⁸					BAT Associated Emission Range (if applicable)	Sampling / Monitoring EPA Guidance for Monitoring - AG2 Index of Preferred Methods		
			Max. Hourly ¹⁹	Max. Daily ²⁰	Average Month ²¹	Average Annual ²²	How was the Proposed Emission Limit Derived?		Proposed Monitoring Frequency	Proposed Monitoring and Analysis Method ²³	Compliant with BAT Monitoring Requirement?
A2-12 (new)	Volume	A2-12	1,333,334 m ³	32,000,000 m ³			Dispersion Modelling		Quarterly	EN16911:2013	Yes
	Particulates			5 mg/m ³			Existing ELV		Quarterly	EN13284-1:2017	Yes
	Hydrogen sulphide			0.01 mg/m ³			Existing ELV		Quarterly	EN13649:2014	Yes
	Nitrogen oxides (as NO ₂)			20 mg/m ³			Existing ELV		Quarterly	EN14792:2017	Yes
	Ammonia								Quarterly	EN14791:2017	Yes

* For continuous monitoring 'EN15267 approved CEMS' is the standard method. For periodic monitoring please refer to the EPA guidance document 'AG2 Index of Preferred Methods' linked above

*add rows to the table as necessary



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Minor and/or Potential Emissions to Atmosphere²⁴

Are there any minor or potential emission point(s) to atmosphere at the installation/facility?
(Yes/No) *

Yes

If 'Yes' complete and upload the **Emissions to Atmosphere – Minor and Potential Emissions** template with details of minor and potential emissions (select Document Type: '**Minor - Potential Emissions**' in the application form)

Emissions to Atmosphere - Minor - Potential Emissions file name:

Attachment 7-4-2 – Emission to Air Minor Potential

²⁴ Refer to page 3 for guidance on what constitutes a minor or potential emission.

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Fugitive Emission to Atmosphere

Fugitive emissions must be controlled by way of appropriate controls and techniques to minimise emissions.

(Additional information on fugitive emission is included in **Note ii** at the end of this attachment)

Are there any sources of fugitive emissions at the installation/facility?²⁵ **(Yes/No) ***

If 'Yes' provide summary details of the fugitive emissions in the table below:

Type of Fugitive Emission	Emission Type Applicable? (Yes/No)	Description of fugitive emissions source(s)	Maximum Level	Units	Descriptor/Location
Dust	Yes	General particulate (non-hazardous).	350	mg/m ² /day	Dust deposition
VOC ²⁶				%	of solvent input
Ammonia				ug/m ³	at the nearest European Site
Nitrogen				kgN/ha/yr	at the nearest European Site
Odour				Odour Units	at boundary of installation

²⁵ For waste activities, dust and odour emissions should be considered and described in the table below where applicable.

²⁶ In relation to activities listed in Chapter V (for installations using Organic Solvents) of the Industrial Emissions Directive (2010/75/EU):

- specify how the requirements in relation to fugitive emissions will be met.

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Provide details of the techniques to be used to reduce / minimise / prevent fugitive emissions in text box below

- Filled areas of the TSF are rehabilitated back to grasslands on a phased basis which eliminates dust blow from the surface
- Water bowsers used at the Tailings Management Facility (TSF) during dry weather periods to mist the surface of the tailings and reduce dust blow.
- Wheelwash facility at the TSF
- Wheelwash facility at the mine site
- Roadsweeper available at the TSF and mine site to clean roads in the event that dust migrates onto the road surface

Note i Complete the table for each emission point having regard to the guidance hereunder.

The following convention should be observed when labelling emission points:

Boiler Emissions A1-1, A1-2, A1-3,...etc.

Main Emissions A2-1, A2-2, A2-3,...etc.

Minor Emissions A3-1, A3-2, A3-3,...etc. (NOTE: Minor emission points are to be included in the '*Emissions to Atmosphere - Minor and Potential*' attachment)

Potential Emissions A4-1, A4-2, A4-3,...etc. (NOTE: Potential emission points are to be included in the '*Emissions to Atmosphere - Minor and Potential*' attachment)

A National Grid Reference (12 digit, 6E, 6N) must be provided for each emission point.

Measures are usually required to reduce, minimise or prevent emissions from occurring. They may involve the application of a single technique or a combination of techniques including process integrated, recovery, abatement and treatment techniques. List all techniques proposed/employed. Technique(s) employed must comply with BAT. Highlight additional measures required for the purposes of protecting the environment i.e. AQS considerations. The measures or techniques to be taken must be capable of complying with the proposed/known emission level(s).

The measures required shall be informed by the following:

1. BAT techniques with BAT-AEL
2. BAT techniques without BAT-AEL
3. Stricter measures/techniques than BAT (due to AQS)
4. BAT determined by competent authority in consultation with the applicant
5. Measures to minimise pollution over long distances or in the territory of other states.
6. Emerging techniques
7. Less strict measures than BAT (due to derogation)
8. Other measures

Select from the drop down list the source of the emission as it helps explain the nature of the emission.

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Particular attention should be paid to ensuring that emissions data (volumetric flow and pollutant concentrations) are presented at the required reference conditions for oxygen, temperature, pressure and moisture.

Note ii Fugitive emissions include the following:

- Dust from area sources such as a quarry.
- Odour from volume sources such as a pig unit, waste water treatment plant, waste handling etc.
- VOCs from processes using solvent not captured in waste gases.
- Ammonia and nitrogen from pig and poultry units.

Processes that can give rise to fugitive emissions include:

- o Leaks from valve seals, pump seals and flanges;
- o Breathing and working losses from liquid storage facilities;
- o Dust emissions from solids stored in the open;
- o Loading and unloading operations;
- o Cleaning operations; and,
- o Emissions from waste water treatment (e.g. volatile organics).

The measures taken to reduce/ prevent fugitive emissions to atmosphere must be addressed, and the facilities and operations required to control emissions must be detailed.

Reason For Licence Review

Attachment 1.1 – Reasons for Licence Review

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1 EPA Guidance Consulted

Prior to commencing the review application for Industrial Emissions (IE) Register Number P0516-04 EPA Guidance titled “Guidance on Requests for Alterations to a Licensed Industrial or Waste Activity”, June 2019, was consulted.

2 Proposed Changes

The purpose of this review of IE licence Register No. P0516-04 is as follows:

2.1 New Air Emission Points

Boliden Tara Mines (BTM) are currently developing an exploration tunnel from the closest point in the existing mine to a potential mineral resource (a distance in excess of 1.5 km) in order that exploration drilling from underground may take place. At the distance involved, ventilation shafts are required to manage air supply to this tunnel and support exploration drilling activities.

Ventilation will be achieved by the development of two ventilation shafts in the townland of Hanlonstown, Navan, Co. Meath. The development works will consist of raise-bore drilling two vertical 4.5-meter diameter shafts reamed from a depth below ground of c. 1,000 meters to surface. The proposed shafts will connect to an underground fan station that will draw air from the existing exploration tunnel and exhaust it to surface. It is proposed to commission one ventilation shaft as a Return Air Raise (RAR), (RAR 6) and to utilise the second ventilation shaft as a Fresh Air Raise (FAR) until a time operational demands require an additional RAR. The commissioning of an additional RAR will only be done so in agreement with the Agency.

The RAR represent one new emission points to air (emission point reference No’s A2-12). The development has also received planning permission from Meath County Council (Planning Register Number: NA/201153) and required the completion of a Natura Impact Statement (NIS). A full Environmental Report was completed and submitted to Meath County Council to support the planning application, an updated air dispersion model was completed following a request for further information from the Agency and is attached to this document.

2.2 Amend Trigger Values and Compliance Points for Groundwater Monitoring Locations set out in Schedule C.7

BTM propose to amend Compliance Points and Trigger levels in Schedule C.7 of IE licence P0516-04.

2.2.1 Current Licence Trigger Values and Compliance Points

Schedule C.7 of IE licence P0516-04 currently reads as follows:

Table 1: Current Trigger Levels at compliance points OB4-P2, OB13 and BR4

Parameter	Trigger Level (mg/l)	Monitoring Frequency	Analysis
Magnesium	50	Monthly	Standard Method
Sulphate	1000	Monthly	Standard Method

The trigger levels outlined in Table 1 were set as part of the Risk Screening and Technical Assessment Report (2015) for the Tailings Storage Facility (TSF) (report included as Appendix A to Attachment 7.6.3 – Emissions to Ground Controls).

Trigger levels for OB4-P2 related to overburden (superficial deposits) and surface water (Yellow River) receptors, trigger levels at OB13 related to overburden (superficial deposits) and surface water (River Blackwater) receptors and trigger levels at BR4 related to a bedrock receptor.

2.2.2 Proposed Trigger Levels and Compliance Points

In accordance with Condition 6.20.1 of the IE licence a Remediation Action Plan (RAP) at the TSF was undertaken by AECOM in 2021. As part of this plan compliance points, Intervention Values and trigger values were reviewed and revised. The compliance points are set at OB13, OB20, BR14 and T8 for the River Blackwater receptor, and at BR14 for the bedrock aquifer receptor. Compliance points OB14 and OB20 were deemed more appropriate than BR4 and hence this compliance point was replaced.

The justification for the selection of compliance points and trigger values is outlined in Section 3.2 of the Remediation Action Plan for the TSF (2021) which is included in Attachment 7-6-3 Emission to Ground Controls.

Table 2: Revised Compliance, Intervention and Trigger Values for Groundwater

Water quality Parameter	Receptor	Compliance Point	Intervention Value (mg/l)	Trigger Value (mg/l)
Sulphate (mg/l)	River Blackwater	OB13, OB20, BR14, T8	None set for groundwater. 250 at T8	None set for groundwater. 187.5 at T8

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	Bedrock aquifer	BR14	2,000	1,600
Magnesium (mg/l)	River Blackwater	OB13, OB20, BR14, T8	None set	None set
	Bedrock aquifer	BR14	230	185

BTM update the model of the sulphate plume and report to the EPA (via EDEN) on a monthly basis.

This includes contouring and presenting of monthly sulphate concentrations in all superficial deposits and bedrock monitoring boreholes (for a 5-year period).

BTM will continue to examine the trends across all the monitoring locations within the superficial deposits, the bedrock and surface water and compare sulphate concentrations to the trigger and intervention values. In addition, sulphate concentrations are compared to monthly sulphate concentrations to a 12-month rolling average.

2.3 Amend Condition 6.13.1 of emissions to water

BTM propose to amend discharge limits in Condition 6.13.1 of IEL P0516-04.

2.3.1 Current Licence Condition 6.13.1

The current Condition 6.13.1 limits discharge at SW1 to dilution factor of 100:1 according to the flow in the Boyne River.

“Unless otherwise agreed by the Agency, the dilution factor in the Boyne River when discharge is taking place at SW1 shall not be less than 100:1.”

2.3.2 Proposed

It is proposed to reduce the dilution factor from 100:1 to not less than or equal to 75:1 (as required) during the drier periods of April to September where reduced flow of the River Boyne restricts discharge, leading to surplus water to be stored within the TSF.

Attachment 7-2-1 Emissions to Water demonstrates that assimilation capacity of the River Boyne for the proposed change in dilution factor.

Non – Technical Summary

Attachment 1.2 – Non-Technical Summary

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1 Introduction

Boliden Tara Mine Dac (Tara Mines), the largest operating zinc-lead mine in Europe, is located at Knockumber, 2 km from west of Navan in County Meath and 50 km northwest of Dublin.

The mine exploits the Zn-Pb deposit, which was discovered in 1970 by the Tara Exploration and Development Company Limited (a Company formed in Canada in 1953 by four Irishmen). Development of the orebody commenced in 1973 and production of concentrate commenced in 1977.

The original ore reserves (calculated in 1971) in the entire orebody amounted to 69.9 million tonnes grading 10.09% Zn, 2.63% Pb. Mining continues today at a rate of between 2.3 and 2.6 million tonnes of ore each year, resulting in 400,000 tonnes of zinc and lead concentrate.

The approximate National Grid Reference of the Knockumber mine site is 284877E, 267985N and of the Randalstown Tailings Storage Facility (TSF) is 285160E, 271557N. Location Maps of the IE licence boundary application at the mine site and the TSF is presented in Appendix 3.3 – Site Plan(s).

The facility is currently regulated under Industrial Emissions Licence P0516-04 and is operational 24-hours per day for approximately 365 days per year. Planning permission was granted for the development of two Return Air Raises (RARs) under planning ref NA171232, it is proposed to commission one ventilation shaft as an RAR and utilise the second ventilation shaft as a Fresh Air Raise (FAR) until a time operational demands require an additional RAR, which will be done so following agreement with the Agency.

It is proposed to amend Condition 6.13.1 of IEL P0516-04,

“Unless otherwise agreed by the Agency, the dilution factor in the Boyne River when discharge is taking place at SW1 shall not be less than 100:1”

It is proposed to reduce the dilution factor from 100:1 to greater than or equal to 75:1 (as required) during the drier periods of April to September where reduced flow of the River Boyne restricts discharge, leading to surplus water to be stored within the TSF.

2 Classes of Activity

The Company was granted an IPC licence from the EPA on 29th May 2001, Reference No 516. The relevant activities in the First Schedule of the EPA Act 1992, as amended, to which the activity relates are as follows:

- 1.3 (a) *The extraction and processing (including size reduction, grading and heating) of minerals within the meaning of the Minerals*

Development Acts 1940 to 1999, where the facility involves a metalliferous operation.

- 1.3 (b) *The extraction and processing (including size reduction, grading and heating) of minerals within the meaning of the Minerals Development Acts 1940 to 1999, where the facility involves any other operation where either the level of extracted or processed minerals is greater than 200,000 tonnes per annum or the total operational yield is greater than 1,000,000 tonnes, and storage of related mineral waste.*
- 11.1 *The recovery or disposal of waste in a facility, within the meaning of the Act of 1996, which facility is connected or associated with another activity specified in this schedule in respect of which a licence or revised licence under Part IV is in force or in respect of which a licence under the said Part is or will be required*
- 11.5 *Landfills, within the meaning of section 5 (amended by Regulation 11(1) of the Waste Management (Certification of Historic Unlicensed Waste Disposal and Recovery Activity) Regulations 2008 (S.I. No. 524 of 2008)) of the Act of 1996, receiving more than 10 tonnes of waste per day or with a total capacity exceeding 25,000 tonnes, other than landfills of inert waste.*

3 EIAR/EIS and Planning Documents

The proposed development of Two Return Air raises (RARs), (One Shaft will be commissions as an RAR within this application, the remaining ventilation shaft will be utilised as a Fresh Air Raise (FAR), until a time operational demands require a second RAR, which will only be commissioned following agreement with the Agency) is not listed in Annex 1 (EIA Directive) or Schedule 5 (Part 1) of the Planning and Development Regulations and therefore does not require mandatory Environmental Impact Assessment (EIA).

Planning applications relevant to the installation to which the activity relates are included in Attachment 6.1 – Stakeholder Engagement.

4 Relevant BAT and BAT Conclusion Decisions

Relevant BAT/BREF and BAT Conclusions, as applicable to the activity, are as follows:

- Reference Document on Best Available Techniques for Energy Efficiency, 2009

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- Best Available Techniques (BAT) Reference Document for Waste Treatment, 2018
- BREF on Emissions from Storage, 2006
- Best Available Techniques (BAT) Reference Document for the Management of Waste from Extractive Industries in accordance with Directive 2006/21/EC, 2018

5 COMAH Regulations

A consultation process with Euromines (advisors to the mining industry) on the application of the COMAH Regulations to the mining operations at BTM was completed. The outcome of this consultation process was that the COMAH Regulations apply to the lead concentrate produced at BTM.

BTM made a formal notification to the Health and Safety Authority (HSA) as an Upper Tier Establishment and submitted a full Safety Report which was approved by the HSA.

6 Derogation under Section 86A (6)

A derogation under Section 86A (6) is not being sought.

7 Description of the Installation

BTM, the largest operating zinc mine in Europe, is located at Knockumber, 2 km west of Navan in County Meath. The mine exploits a Zn-Pb orebody which lies between 50 and 1000 metres below the surface and extends over an area of 6.5 kilometres by 1.5 kilometres. Development of the orebody commenced in 1973 and mining and processing have been in operation since 1977. Due to the large geographical area and varying depths of the orebody a mining method that utilises mobile equipment for ore haulage, rock drilling and explosives charging is required. The mining methods employed are principally long hole open stoping with backfill. Room and pillar methods are applied where the ore is thinner.

Ore production encompasses the drilling, blasting and removal of the ore from underground deposits. Broken ore is delivered to one of five underground primary crushers and reduced in size to less than 150 mm before being hoisted to the surface. Ore is then fed to an autogenous grinding mill which grinds the ore to a fine powder which is then pumped as aqueous slurry to metallurgic flotation cells.

Within the flotation cells, galena (Lead sulphide) and sphalerite (Zinc sulphide) are differentially separated, while undesirable minerals such as pyrite are depressed. Differential flotation and selective depression of minerals are enhanced by chemical additives to the flotation chamber feed.

Once the target minerals have been extracted the tailings stream is cycloned to separate the coarse sand fraction from the finer slimes fraction. The coarse fraction of tailings is pumped to the underground mined out areas and used to backfill mined out stopes. The tailings used for backfilling is stabilised, chemically and physically, by mixing with Portland cement.

The remaining fines fraction tailings is pumped as an aqueous slime to the TSF located some 2.5 km north of the processing plant in the townland of Randalstown. On an annual basis approximately 1.2 million tonnes of tailings are deposited for permanent storage in the TSF.

7.1 Mine Development

Mine development involves the drilling and blasting of new tunnels or drifts to extend the mine and/or to access the orebody to prepare for the production cycle. Exploration and mine development are generally in waste rock or low-grade ore and allow initial access to mining blocks. Stope development is within the mineable ore boundary and gives access to the drilling, blasting and ore recovery from stopes and pillars. Exploration and mine development extends to about 4500 metres per year and stope development is generally 6500 metres per year. Ore generated from development is approximately 400,000 tonnes per year.

7.2 Mine Production

Mine production encompasses the drilling, blasting and removal of the ore from stopes. Broken ore from both production and development is delivered to one of five underground crushers and reduced in size to less than 150 millimetres before being carried by conveyor to a 3600-tonne capacity storage bin at the base of the production shaft. Skip loading and hoisting are automatic, supplying ore to the 30,000-tonne surface coarse ore storage building.

7.3 Processing

Ore is in the form of zinc and lead sulphides while the host rock is limestone, containing both calcite and dolomite. The objective of ore processing is to separate and recover the zinc and lead minerals into two separate saleable grade concentrates.

7.3.1 Grinding

Mineral particles must be physically liberated from the host rock in order to selectively recover the lead and zinc metal. Initially, the ore passes through an underground crusher reducing the particle size to less than 150 millimeters and is then hoisted to the surface. The ore then passes to the Autogenous grinding circuit and is mixed with water. The Autogenous grinding circuit reduces the ore particle size to less than 120 microns, a size range where the mineral particles and the host rock can be separated. Autogenous Mills use large particles of ore instead of steel balls for grinding media. The finely ground ore slurry is then pumped to the floatation stage of the process where the lead and zinc minerals are recovered respectively.

7.3.2 Flotation

The flotation circuit consists of a series of cells. Each cell is equipped with a rotating agitator, which disperses the air and maintains the mineral particles in suspension. Various chemicals are added to the lead and zinc flotation circuits. The valuable minerals are 'collected' and carried by air bubbles, which form a froth phase on the top of each cell.

7.3.3 Dewatering

The final products are pumped to separate dewatering circuits. Concentrates are dewatered separately using thickening and filtration in pressure filters. The Mesto pressure filters drying system has a very positive impact on the environment as it has eliminated the use of thermal drying, which resulted in emissions to the atmosphere, and the use of nitric acid as a cleaning agent for the old filter plates.

Lead concentrate contains approximately 67% lead metal and the zinc concentrate contains 56% zinc metal.

7.3.4 Concentrate Transportation

Concentrates are transported by rail to a storage and ship loading facility at Dublin Port from where it is shipped to smelters in Finland, Norway, Spain, Italy and Germany.

7.3.5 Tailings and Backfill

When the valuable minerals have been recovered in the flotation process, the remaining material is known as tailings. Slimes and fine particles are removed using cyclones and are pumped to the tailings pond, which is located 2.5 kilometres from the mine site. The suspended solids settle out and clean water is recycled to the mine site for re-use in various processes.

The remaining coarser sandy tailings particles from flotation are stored in sand tanks. When backfill is required underground, water and cement are added to the sand, which is then pumped through boreholes into open stopes. Each year in excess of one million tonnes of tailings sand are pumped into the mine as backfill.

7.4 Measures to Avoid, Reduce, Offset Major Environmental Effects

Measures to Avoid, Reduce, Offset Major Environmental Effects include:

- As an Upper Tier Establishment under the COMAH Regulations BTM has submitted and received approval for a comprehensive Safety Report. BTM continues to implement all measures outlined in the Safety Report.

- BTM has a comprehensive environmental monitoring programme in place in accordance with the requirements of IE Licence Reg. No. P0516-04. This includes monitoring of air, surface waters, groundwater, emissions to water, waste, sediment, animal health, vibration, noise, dust and the TSF environment.
- An experienced environmental team is in place with a combined experience of 60+ years.
- All proposed projects are assessed in terms of potential impact.
- Good practice, training, environmental awareness is promoted and communicated to all employees.
- BTM is accredited to ISO 14001 and has established environmental policies and procedures in place for a range of site activities.
- A costed Environmental Liabilities Risk Assessment (ELRA) has been prepared and approved by the Agency.

8 Raw and Auxiliary Materials

The purpose of the facility is to produce zinc and lead concentrates, which are transported by rail to Dublin port and shipped overseas to various smelters in Europe for further processing into the pure zinc and lead metals. These are the only materials produced at BTM.

The main resource used in the process is energy for the operation of the underground mine and the above-ground processing facility (referred to as The Mill). Diesel fuel (Ultra Low Sulphur Diesel and Road Diesel) is used to power both light and heavy vehicles that are used in the mine. Chemicals are used in the processing of ore that aid the separation of lead and zinc from the host rock (flotation agents, flocculants, coagulants, thickeners, and binders). Explosives are used in the blasting process (primarily ammonium nitrate). Smaller quantities of raw materials utilised on site include laboratory chemicals, maintenance oils, greases, lubricants, transmission fluid, gear oils and kerosene (heating).

A full list of raw materials and auxiliary materials are included in Attachment 4.6.2 Raw Materials.

9 Emissions

9.1 Sources of Emissions

9.1.1 Emissions to Air

Direct emissions to air are from two sources:

1. Return Ventilation Shaft Exhausts: RAR1, RAR2, RAR3N, RAR3S, RAR4, RAR5, RAR5-2 (Emission Point References A2-5, A2-6, A2-7, A2-8, A2-

9, A2-10, A2-11). Note: A2-5 has not been in operation since 2006. Two new emissions points are proposed as part of this Licence Review.

2. Concentrate Load-Out Stack: Emission Point Reference A2-4

BTM uses an INAB accredited contractor, Air Scientific, to carry out compliance monitoring at air Emission Points which meets with ISO 17025 requirements.

In addition to the main air emission points listed, minor and fugitive emissions also exist. Minor emissions include those from on-site boilers, extract fans and heaters. Potential fugitive emissions include fugitive dust from both the mine site and the TSF. Attachment 7.4.1 – Emissions to Air Main and Attachment 7.4.2 – Emissions to Air Minor Potential include further details on all emissions to air.

One new emission points to air is proposed in this IE Licence Review (emissions from Return Air Raises (RARs) No. 6).

Odour Monitoring Ireland Ltd was commissioned by BTM to perform an examination of the potential air quality impact associated with the operation of the two proposed ventilation shafts in Hanlonstown, Navan, Co. Meath. Emission rates of pollutants were calculated and utilised within an air dispersion model in accordance with EPA Guidance AG4. Baseline air quality was assessment utilising EPA reported values for pollutants located in a Zone D air quality zone.

An updated air quality model was completed upon request from the Agency. The modelling completed indicated that the emissions from the combined ventilation shafts will not result in any significant impact on worst case sensitive receptors in the surrounding area with all ground level concentrations of pollutants within their respective ground level concentration limit values for the protection of human health. A copy of the updated Dispersion Modelling Assessment is included in Attachment 7.1.3.2 – Emissions Impact Assessment.

Mass emissions (kg) from the six operational RARs in 2024 is as follows; NH3 5,732 kg, NO2 26,734 kg, H2S 14 kg, Particulates 7,596 kg.

The EPA carry out independent air reconnaissance visits annually which include the inspection and sampling of licensed air emission points.

9.1.2 Emissions to Surface Water:

There are two point source emissions to surface water, Emission Point Reference SW1 of treated process wastewater to the River Boyne and Emission Point Reference SW2 of clean groundwater to the River Blackwater.

Emissions of treated wastewater to the River Boyne at Emission Point Reference SW1 are from three sources:

1. Minewater (water which enters the mine and is pumped out to maintain a dry working environment)
2. Surface run-off from aboveground mine site areas which is captured and collected in the site water management system
3. Wastewater from the Processing Plant

Wastewater from the process plant is pumped to the TSF and subsequently returned to the reclaim pond on site. Minewater and surface run-off, representing a low risk effluent, are treated in the onsite water treatment system prior to discharge at SW1.

The emission to the River Blackwater at Emission Point Reference SW2 is from one source – clean groundwater derived from the Nevinstown mine area which has minimal or no contact with the orebody. This groundwater is collected in a dedicated reservoir and pumped directly to surface for discharge to the River Blackwater. Discharge is recorded and controlled from the Processing Departments (Mill) automated ABB system.

Within this application it is proposed to amend condition 6.13.1 of IEL P0516-04, which limits discharge from SW1 to a dilution ratio of 100:1 or greater. During dry periods of low rain (April to September), water levels within the River Boyne are reduced, leading to surplus water to be stored within the TSF. It is proposed during drier months (1st April through September 30th) the dilution factor may be reduced to not less than or equal to 75:1, as required (Please see Attachment 7-2-1 Emissions to Water).

Further information on emissions to surface water and compliance data for 2020 and 2021 is included in Attachment 7.1.3.1 – Emissions Compliance Report.

In 2024, 6,386,934 m³ was discharged at SW1 and 731,372 m³ was discharged at SW2.

9.1.3 Noise Emissions

Noise emissions from general site activities are minimised through proper design and operating procedures. Noise emissions are monitored at two permanent monitoring stations on the periphery of the mine site and at one fixed station as a control measure during construction works at the Tailings Storage Facility.

Noise emissions from the mine site plant are continuous and are the same for daytime and night-time due to its continuous operation. Many individual noise

sources are ‘tonal’ in character, however when these sources operate together inside a building the resultant emission outside the building can be described as ‘broadband’. Where significant single noise sources are tonal, abatement measures are immediately taken.

The TSF is located in a rural setting and existing noise levels are typical of such an environment. Normal operation of the facility does not generate any discernible noise. The main noise sources historically have been associated with construction activity.

Further information on noise emissions and compliance data is included in Attachment 7.1.3.1 – Emissions Compliance Report.

9.2 Effects on the Environment

Emission Impact Assessments have been completed for all the above emissions.

Further detailed information can be found in Attachment 7.1.3.2 – Emissions Impact Assessment.

9.3 Measures Planned to Monitor Emissions into the Environment

The new proposed emission to air will be monitored by an INAB accredited contractor, Air Scientific, in accordance with the frequency specified in the reviewed IE licence.

Environmental monitoring for emissions to surface waters will continue to be monitored as required under IE licence Register No. P0516-04.

All other emissions will continue to be monitored as required under IE licence Register No. P0516-04.

10 Environmental Condition of the Site

All control and monitoring is undertaken in accordance with IE Licence Condition 6 and Schedule C: Control and Monitoring. A comprehensive monitoring programme is in place which allows BTM to monitor all environmental emissions and assess the condition of the licensed site and the surrounding local area.

An annual independent review of hydrogeological, hydrological and water quality monitoring at the TSF is undertaken. Data collected during 2024 is presented in the AECOM report title “Annual Environmental Monitoring Report for the TSF site at Tara Mines, 2024” which is provided in Attachment 7.6.3. The report reviews 2024 data and compares with historic monitoring data to identify changes and trends in hydrogeological and water quality conditions. The EC Environmental Objectives (Groundwater) Regulations S.I.

No 9 of 2010 Threshold values are used as a guide for comparison with measured concentrations in groundwater.

A Baseline Assessment of the mine site was completed by AECOM Ireland Limited between March – May 2022. This involved an assessment of Relevant Hazardous Substances and a site investigation to determine current soil and groundwater conditions. The Baseline Report concluded that there is no significant impact from Relevant Hazardous Substances to soil or groundwater on the BTM site.

The full Baseline Report is included in Attachment 4.8.3 – Complete Baseline Report.

11 Quantity and Nature of Wastes

Waste management at BTM operates in a manner to prevent any unnecessary waste and maximise the reuse and recycling on site before transfer off-site for recovery / disposal to licensed facilities.

In accordance with the Waste Hierarchy, improvements in environmental performance is promoted as part of the EMS associated by setting objectives and targets associated with reducing resource material use (e.g. water, energy, paper) and waste production generally. Procedures are also in place for the prevention and recovery of hazardous and non-hazardous waste.

A summary of average wastes generated at BTM during 2021 to 2024 is provide below:

Non hazardous wastes:

- End of life waste tyres: 138 tonnes
- Scrap iron and steel: 748 tonnes
- Paper and Cardboard: 15 tonnes
- Glass: 0.012 tonnes
- Biodegradable canteen waste: 4.9 tonnes
- Wood packaging: 234 tonnes
- Mixed waste 520 tonnes
- Tailings to underground mine as backfill: 640,667 tonnes
- Tailings to the TSF: 1,278,334 tonnes
- Mine Rock: 226,347 tonnes (this was used as a construction material in the construction of Stage 6 at the TSF)

Hazardous Wastes:

- Packaging: 18.6 tonnes
- Paint: 0.27 tonnes

- Filter cloths: 5.2 tonnes
- Solid oily waste: 11.3 tonnes
- Oil filters: 3.5 tonnes
- Engine oil: 96.5 tonnes
- Solid waste grease: 7 tonnes
- Aerosol cans: 0.4 tonnes
- Laboratory waste: 0.38 tonnes
- Fluorescent tubes: 0.4 tonnes
- Lead batteries: 10.2 tonnes
- Waste Electrical and Electronic Equipment (WEEE): 0.26 tonnes

Greenfield soil and stone (LoW 17 05 04) and mine rock (LoW 01 01 01) is accepted at the TSF. In 2021, 15,555 tonnes of greenfield soil and stone was accepted at the TSF and 226,347 tonnes of mine rock. BTM have approval from the Environmental Protection Agency (EPA) to accept these materials at the TSF.

12 Measures to be Taken During Abnormal Operating Conditions

Potential abnormal operating conditions identified include uncontrolled releases to water, leak on tailings or reclaim pipeline, train loading/unloading without the wet scrubber system running and not maintaining the necessary freeboard in the TSF.

12.1 Discharges to Waters

Discharges to waters at emission points SW1 and SW2 are tightly controlled and there is a low risk of uncontrolled releases at these points due to the control measures in place. Control measures include automatic shutdown in the event of deviation from licence ELVs (for suspended solids, pH, DO, temperature and flow at SW1 and for suspended solids, pH, DO and temperature at SW2). Emissions to SW1 and SW2 are controlled by an automated computer system and in the event of any suspected incident or contamination of discharge waters the emission can be shut off immediately.

12.2 Leak on Tailings/Reclaim Pipelines

Flow meters and pressure transmitters are in place along the route of the pipelines. A computer controlled (ABB) system constantly monitors these instruments thus enabling instantaneous detection of any drops in flow/pressure that would indicate the occurrence of a failure. In the event of a significant relative pressure difference between these transmitters an audible alarm sounds in the Mill Control Room and automatic shutdown of the feed pumps occurs after a set period of time. The Mill Control Room is manned 24/7, 365 days a year.

The tailings and reclaim pipelines are currently being replaced along the route from the north bank of the River Blackwater to the TSF.

12.3 Train Loading/Unloading

A wet scrubber is located in the train loading facility. The purpose of this unit is to remove particulate matter from the atmosphere in the loading area. The start-up and shutdown of the scrubber unit is fully controlled by an automated computer control system.

The running of the unit is interlocked with the train loading process. It is not possible to start the automated train loading system, unless the scrubber unit is running first.

The operation of the scrubber is continuously monitored using the automated computer control system. If any part of the scrubber system goes into fault while running, this issue will be identified to the operator in the central control room with an alarm.

12.4 TSF Freeboard

A freeboard of 1m is maintained at all times during operation. An alarmed process control system (ABB) is in place which monitors the height of the freeboard.

An External Emergency Plan is in place for the TSF and incorporates external bodies including Meath County Council, An Garda Siochana and the Health Service Executive (HSE).

13 Measures to be Taken Following Permanent Cessation of Activities

A Closure, Remediation and Aftercare Management Plan (CRAMP) has been prepared (2024) which covers the closure and remediation of both the TSF and the mine site. The full plan is included in Attachment 9.2.3 – Site Closure.

14 Measures for Minimising Pollution Over Long Distances

BTM undertakes an extensive environmental monitoring programme to assess the impact of its activities on the local environment. The programme includes:

- Surface water monitoring
- Sediment sampling
- Groundwater monitoring
- Ambient air monitoring
- Soil monitoring

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- Dust monitoring
- Animal health monitoring
- Vegetation monitoring
- Waste monitoring
- Noise monitoring
- Ground Vibration Monitoring
- Fish population surveys

The focus of the programme is to determine the potential acute and chronic effects of the operation's impacts on the local environment. The programme is designed to identify, at the earliest stage, potential negative impacts while also trending monitoring data over a very long period c. 40 years.

It is the Company's contention that by controlling the potential impact at a local level it is by design controlling the impact over longer distance.

Attachment 7-6-3

Annual Environmental Monitoring Report for the TSF site at Tara Mines, 2024

Final

Boliden, Tara Mines

March 2025

Quality information

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1. Introduction

- 1.1 This report has been prepared to provide a review of the hydrogeological, hydrological and water quality monitoring data collected during 2024 at the tailings storage facility (TSF) at Tara Mines, Navan. The 2024 hydro-environmental data have been reviewed and compared with data collected since 2020 (5 years' worth of data), to identify changes and trends in the hydrogeological and water quality conditions.
- 1.2 The extraction and processing operations at the Tara Mines site and Randalstown TSF are subject to Industrial Emissions Licence (IEL) No. P0516-04. This report has been prepared to address Condition 6.21 of the licence, as follows:

“The licensee shall review and assess all hydrogeological monitoring and water quality monitoring results and report annually on compliance with the European Communities Environmental Objectives (Surface Water) Regulations 2009 as amended and European Communities Environmental Objectives (Groundwater) Regulations 2010 as amended. The report shall include trend assessments.”

Background

- 1.3 The Tara zinc-lead mine is situated 2 km west of Navan, County Meath, Ireland. Since 1977, part of the residue produced from processing the ore (known as tailings) has been pumped to the Randalstown TSF, some 2.8 km north of the mine site. Since 2019, Stage 6 of the TSF is being operated.
- 1.4 This report is the most recent in a series of review reports based on hydro-environmental monitoring data collected and supplied by Boliden Tara Mines DAC. The reports outlined below have provided background on the geology, hydrology, and hydrogeology of the TSF site, along with geological maps and graphs of the spatial variation of sulphate concentrations:
 - Randalstown Tailings Facility - Stage IV: Hydro-environmental Monitoring Report (Knight Piésold, 1996).
 - Randalstown Tailings Management Facility Stage V Raise to Embankment Environmental Impact Statement (EIS) (Tara Mines, 2009).
 - Risk Screening and Technical Assessment Report for Randalstown Tailings Management Facility at Tara Mines (AECOM, 2015).
 - TSF Stage 6 Extension – Hydrology & Hydrogeology Environmental Impact Assessment (AECOM, 2016).
 - Remediation Action Plan for Randalstown Tailings Management Facility at Tara Mines (AECOM, 2021).
 - Corrective Action Feasibility & Design Report for Tara Mines TSF (AECOM, 2022).
 - Annual Environmental Monitoring Report for the TSF site at Tara Mines, 2023 (AECOM, 2024).
 - Tailings Facility Embankment Buttress – EIAR Chapter 7: Hydrology and Hydrogeology (AECOM 2024).

2. Hydro-Environmental Monitoring

Mine water abstraction

- 2.1 The mine water abstraction data is presented in Charts 1 and 2 below and includes details of the annual rate and volume of water abstracted at the Main Mine / SWEX mine area (No 1 pumping station), abstraction point (APR02826) and the Nevinstown/ Liscarton/ Rathaldron mine area (1390L pumping station), abstraction point (APRAPR02827), as well as the annual rainfall.
- 2.2 In 2024, the abstraction volumes and rates in Nevinstown/ Liscarton/ Rathaldron mine area showed a decrease of approximately 25% from 2023, while the abstraction volumes and rates in the Main Mine / SWEX mine area showed a decrease of approximately 36% from 2023, representing the lowest abstraction volumes and rates compared to the previous years between 2015 to 2023.
- 2.3 These 2024 reductions groundwater abstractions were due to recent period from late 2023 through 2024 when Tara Mine was placed under Care and Maintenance, and pumping stations 7 and 8 in the Main Mine / SWEX areas were shut down and abstractions from the 1390L pumping station were reduced. BTM is currently preparing an application for an abstraction license for each of this abstraction points, in line with Water Environment Act 2022 and Licensing Regulations 2024.

Chart 1: Annual volume of groundwater abstraction at the Tara Mine

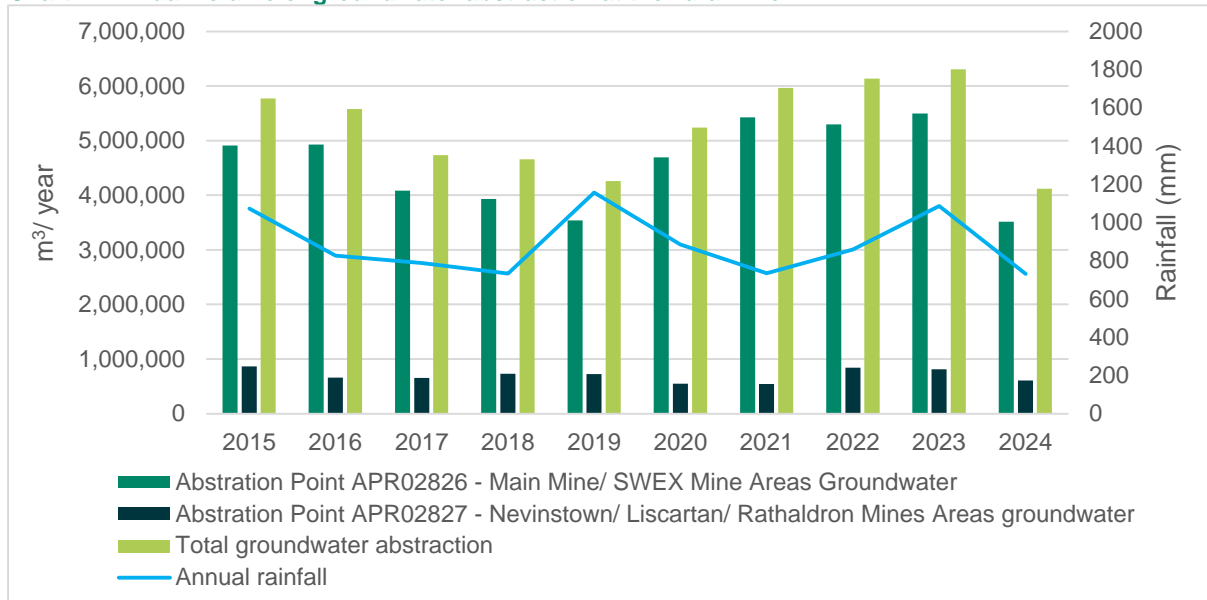


Chart 2: Annual rate of groundwater abstraction at the Tara Mine



Development of the monitoring system

- 2.4 The TSF monitoring system has been operating since 1996 to collect relevant water quality data at strategic locations in the immediate area. The system aims to act as an advance warning system for any potential pollution incidents to local landowners or water users and to ensure compliance with the IEL and the Water Framework Directive (WFD).
- 2.5 The potential for localised contamination of groundwater in the vicinity of the TSF has been consistently monitored through the collection and analysis of spot samples from an extensive network of sampling points, in accordance with IEL P0516-04. Sulphate is the main water quality parameter associated with contamination from the TSF and is used as the key parameter for evaluating water quality trends. Therefore, emphasis is placed in this report on the observed concentrations of sulphate.

Location of sampling points

- 2.6 The locations of groundwater and surface water monitoring points currently in use are presented in Figure 2.1 and Figure 2.2, respectively. The original monitoring network evolved and expanded as works took place in the area, with additional sampling points introduced to ensure a comprehensive understanding of all potential pollution locations.
- 2.7 A summary of monitoring points and abbreviations used in this report are listed in Table 2-1 below.

Table 2-1. Summary of monitoring points and abbreviations

Abbreviation	Description	No. of monitoring points
ICP	Interceptor channel monitoring points:	12
	Water quality monitoring point (ICP1.E, ICP1.W, ICP6, S6_IC1)	4
	Water level monitoring point VNW1, VNW2, VNW3, VNW4, VNW5, VNW6, VNW7, VNW8.	8
OB	Overburden monitoring points:	
	Piezometer at level 2 – in overburden deposits (OB1-P2, OB2 (dry since July 2024), OB3, OB4-P2, OB5 (dry since September 2024), OB6, OB7, OB10, OB11 (dry since July 2024), OB12, OB13, OB20, OB21, OB22, OB24 (inaccessible since July 2024 due to crop in the field), OB25, OB26, OB27)	18
BR	Piezometer at level 1 – in bedrock (OB4-P1)	
	Bedrock monitoring point (OB1-P1 (blocked 2023 – not monitored in 2024), BR1 (water too deep since September 2024 to sample), BR2, BR3, BR4, BR5, BR6, BR9, BR10, BR14, BR15 (blocked – not monitored in 2024), BR16, BR23, BR24 (inaccessible since July 2024 due to crop in the field), BR25, BR26, BR27)	18
R	Domestic well monitoring point (9R (dry – not monitored in 2024), 10R, 12R, 17R, 18R, 22R, 23R, 28R, 29R, 30R, 32R, 35R)	12
GR	Bedrock monitoring points (GR1 and GR2)	2
T	Surface water monitoring points:	
	Yellow River (T8, T13)	
	Simonstown Stream (T12, T14, T15 (Blake's stream diverted and now enters Simonstown))	
	River Blackwater (T4, T7, T11)	13
	Duog Stream (T10 (dry since August 2024))	
	River Boyne (T5, T0A – downstream of Tara Mines effluent discharge point, T0B, T6 – upstream of Tara Mines effluent discharge point)	

Groundwater monitoring

- 2.8 Groundwater chemistry has been determined from the collection and analysis of samples taken from domestic wells and piezometers at up to 45 locations. The groundwater encountered is characterised as

generally being of "bicarbonate type", with calcium and bicarbonate as the major ions, and is typical of water in a limestone bedrock aquifer (Figure 2.1).

2.9 The existing groundwater monitoring system in the TSF area involves:

- Monthly sampling of groundwater from overburden (OB) and bedrock monitoring boreholes (BR and GR), totalling 34 piezometers (landowners have refused access at two sites).
- Quarterly sampling of groundwater from up to 12 domestic wells, depending on accessibility.

Surface water monitoring

2.10 Surface water chemistry is determined from the collection and analysis of samples taken from rivers, streams, and water from the interceptor channel at up to 17 locations (Figure 2.2).

2.11 The existing surface water monitoring system in the TSF area involves:

- Monthly sampling of surface water from rivers and streams at up to 13 locations. These locations are on the River Boyne, River Blackwater, Yellow River and Simonstown and Duog Streams (the River Blackwater is the only watercourse in the immediate area used for abstraction of potable water supplies).
- Monthly sampling of water from the interceptor channel (ICP) at up to 4 locations. The interceptor channel is part of the TSF dam and collects water from the internal drainage system within the embankment of the TSF, horizontal seepage from the TSF, local runoff and groundwater.

Sampling analysis and frequency

2.12 The sampling frequency of groundwater and surface water for physical and chemical parameters (including metals), as required by IEL P0516-04 is summarised in Table 2-2 below. The schedule of parameters includes all chemicals of potential concern, and no new chemicals of concern have been identified to date.

Table 2-2. Summary of analysed parameter and frequency

Parameter	Units	Overburden boreholes**	Bedrock boreholes**	Domestic wells	Interceptor channel	River & streams
pH	pH units	Monthly	Monthly	Quarterly	Monthly	Monthly
Temperature	°C	Monthly	Monthly	Quarterly	Monthly	Monthly
Electrical Conductivity	(µS/cm)	Monthly	Monthly	Quarterly	Monthly	Monthly
Total Hardness as CaCO ₃	mg/l	-	-	-	-	Monthly
Alkalinity as CaCO ₃	mg/l	-	-	-	-	Monthly
Suspended Solids	mg/l	-	-	-	Monthly	Monthly
Dissolved Oxygen	mg/l	Monthly	Monthly	Quarterly	-	Monthly
Ammonia (NH ₄ -N)	mg/l	Quarterly	Quarterly	Quarterly	-	Monthly
Chloride as Cl	mg/l	Quarterly	Quarterly	Quarterly	-	Quarterly
Nitrate as NO ₃	mg/l	Quarterly	Quarterly	Quarterly	-	Monthly
Nitrite as N	mg/l	Quarterly	Quarterly	Quarterly	-	-
Phosphate as P	mg/l	Quarterly	Quarterly	Quarterly	-	Quarterly
Aluminium	mg/l	Monthly	Monthly	Quarterly	Quarterly	Quarterly
Antimony	mg/l	-	-	-	-	Quarterly
Arsenic	mg/l	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly
Cadmium	mg/l	-	-	-	Quarterly	Quarterly

Parameter	Units	Overburden boreholes**	Bedrock boreholes**	Domestic wells	Interceptor channel	River & streams
Chromium	mg/l	-	-	-	-	Quarterly
Copper	mg/l	-	-	-	Quarterly	Quarterly
Cobalt	mg/l	-	-	-	Quarterly	Quarterly
Cyanide	mg/l	-	-	-	Quarterly	Quarterly
Iron	mg/l	Monthly	Monthly	Quarterly	Quarterly	Quarterly
Lead	mg/l	Monthly	Monthly	Quarterly	Quarterly	Monthly
Manganese	mg/l	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly
Magnesium*	mg/l	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly
Mercury	mg/l	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly
Nickel	mg/l	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly
Potassium	mg/l	Quarterly	Quarterly	Quarterly	-	-
Sodium	mg/l	Quarterly	Quarterly	Quarterly	-	Quarterly
Sulphate*	mg/l	Monthly	Monthly	Quarterly	Monthly	Monthly
Zinc	mg/l	Monthly	Monthly	Quarterly	Quarterly	Monthly

* Schedule C.7 Groundwater Monitoring of IEL P0516-04 requires that samples from OB4-P2, OB13 and BR4 be analysed for magnesium and sulphate monthly. This requirement follows on from the setting out of compliance points, trigger values and intervention values for the Chemicals of Potential Concern (COPCs) at the TSF, sulphate and magnesium, in AECOM's Risk Screening and Technical Assessment report (2015). This assessment of compliance points has now been reviewed to include OB20, BR14 and T8 (on the Yellow River), as set out in the Remediation Action Plan for Tailings Management Facility at Tara Mines (AECOM, 2021); IEL P0516-04 is currently under review to reflect this.

** The frequency of monitoring at the following boreholes is proposed to be reduced from monthly to quarterly, as sulphate concentrations at these locations have remained stable and below the threshold value since monitoring began – OB10, OB22, OB24, OB25, BR10, BR16, BR23, BR24 and BR25. This request was submitted to the Environmental Protection Agency (EPA) in the Memo - EPA Audit Response, dated 19th December 2024 (LR089592).

Screening criteria

2.13 Water quality is evaluated in the context of current legislative requirements for Ireland, in particular the European Water Framework Directive (2000/60/EC) (WFD). As part of the WFD implementation process, EU Member States are required to set or review their national water quality standards, considering groundwater-surface water interaction and potential ecological impacts. The Competent Authority responsible for reviewing water quality standards in Ireland is the Environmental Protection Agency (EPA).

2.14 The following regulations give effect to the Water Framework Directive in Ireland:

- EC Environmental Objectives (Groundwater) (Amendment) Regulations S.I. No. 366 of 2016, which came into force on 15th July 2016 to amend EC Environmental Objectives (Groundwater) Amendment Regulations S.I. No. 389 of 2011 and S.I. No. 9 of 2010.
- EC Environmental Objectives (Surface Waters) Regulations S.I. No. 272 of 2009, which came into operation on 30 July 2009 to give effect to the Water Framework Directive including the environmental quality standards of Directive 2008/105/EC and further effect to the Dangerous Substances Directive (2006/11/EC).
- EU Environmental Objectives (Surface Waters) Regulations S.I. No. 386 of 2015, which came into force on 15th September 2015.

- EU Environmental Objectives (Surface Waters) (Amendment) Regulations S.I. No. 77 of 2019, which came into force on 12th March 2019 to amend EC Environmental Objectives (Surface Waters) Amendment Regulations S.I. No. 327 of 2012 and S.I. No. 272 of 2009.
- EC Environmental Objectives (Surface Waters) (Amendment) Regulations S.I. No. 659 of 2021, which came into force on 7th December 2021 to amend EC Environmental Objectives (Surface Waters) Amendment Regulations S.I. No. 272 of 2009.
- EC Environmental Objectives (Surface Waters) (Amendment) Regulations S.I. No. 288 of 2022, which came into force on 17th June 2022 to amend EC Environmental Objectives (Surface Waters) Amendment Regulations S.I. No. 272 of 2009.
- European Union (Drinking Water) Regulations S.I. No. 99 of 2023, which came into force on 10th March 2023.

2.15 The groundwater threshold values set by the EC Environmental Objectives (Groundwater) Regulations are the most stringent guideline values and therefore these values were included in the assessment of the monitoring data for 2010 onwards. Although these guideline values were established for the protection of groundwater, they are considered appropriate for the protection of surface waters influenced by groundwater, such as at the TSF.

2.16 Where there is no threshold value, the most stringent alternative is used as summarised in the Table 2-3 below. The most stringent alternatives for all monitored parameters are Interim Guideline Values (IGVs), which were set to assist in the characterisation of groundwater bodies. However, there is no groundwater threshold value or IGV for antimony; therefore, the EU (Drinking Water) Regulations 2023 (S.I. No. 99 of 2023) value has been used. The applicable groundwater threshold values, the IGVs or drinking water standards, are henceforth referred to as “guideline values” or “GTV” on the figures.

Table 2-3. Guideline values for groundwater and surface water

Parameter	Threshold value*	IGV**	Drinking Water Regulations***
Aluminium (mg/l)	0.15	-	0.2
Ammoniacal Nitrogen (NH ₄ -N) (mg/l)	0.065	-	0.38
Antimony (mg/l)	-	-	0.01
Arsenic (mg/l)	0.0075	-	0.01
Cadmium (mg/l)	-	0.005	0.005
Calcium (mg/l)	-	200	-
Chromium (mg/l)	0.0375	-	0.025
Cobalt (mg/l)	-	-	-
Copper (mg/l)	-	0.03	2
Chloride (mg/l)	24	-	250
Cyanide (mg/l)	-	0.01	0.05
Electrical Conductivity (µS/cm)	800	1,000	2,500
Iron (mg/l)	-	0.2	0.2
Lead (mg/l)	0.0075	-	0.005
Magnesium (mg/l)	-	50	-
Manganese (µg/l)	-	50	50
Mercury (mg/l)	0.00075	-	0.001
Nickel (mg/l)	-	0.02	0.02
Nitrate as NO ₃ (mg/l)	37.5	-	50
Nitrite as NO ₂ (mg/l)	0.375	-	0.5

Parameter	Threshold value*	IGV**	Drinking Water Regulations***
Orthophosphate (mg/l)	-	0.03	-
pH (pH units)	-	≥6.5 to ≤9.5	-
Phosphorus (MRP-P) (mg/l)	0.035	-	-
Potassium (mg/l)	-	5	-
Sodium (mg/l)	-	150	200
Sulphate (mg/l)	187.5	-	250
Sulphide (mg/l)	-	-	-
Temperature (°C)	-	25	-
Total hardness (CaCO ₃)	-	200	-
Uranium (mg/l)	-	0.009	0.03
Zinc (µg/l)	75	-	-

* *Threshold Value: EC Environmental Objectives (Groundwater) (Amendment) Regulations Threshold Value, 2016 (S.I. No. 366 of 2016)*

** *Interim Guideline Values: Towards Setting Guideline Values for the Protection of Groundwater in Ireland*

*** *EU (Drinking Water) Regulations 2023 (S.I. No. 99 of 2023)*

Note: All values are for hardness >100 mg/l

3. Data presentation

Sulphate

3.1 Sulphate is used as the key parameter for assessing seepage from the TSF. The 2024 monitoring data is presented in graphical format, along with data collected since 2020 (5 years' worth of data), as follows:

- Figure 4.1 - Groundwater sulphate concentrations in the overburden.
- Figure 4.2 – Average groundwater sulphate concentrations in the overburden and 5-year trend.
- Figure 4.3 - Groundwater sulphate concentrations in bedrock.
- Figure 4.4 – Average groundwater sulphate concentrations in bedrock and 5-year trend.
- Figure 4.5 - Annual average sulphate concentrations in overburden at each monitoring location and 5-year trend.
- Figure 4.6 - Annual average sulphate concentrations in bedrock at each monitoring location and 5-year trend.
- Figure 4.7 - Number of exceedances of the trigger value for sulphate in the last 5 years.
- Figure 4.8 - Sulphate concentration contours in overburden.
- Figure 4.9 – Sulphate concentration contour in bedrock.
- Figure 4.10 - Sulphate concentrations in domestic wells.
- Figure 4.11 - Average sulphate concentrations in domestic wells and 5-year trend.
- Figure 4.12 - Sulphate concentrations in surface water.
- Figure 4.13 - Average sulphate concentrations in surface water and 5-year trend.
- Figure 4.14 – Sulphate concentrations in the interceptor channel.
- Figure 4.15 – Average sulphate concentrations in the interceptor channel and 5-year trend.

3.2 Sulphate concentrations are discussed in Section 4.

Other substances

- 3.3 All water quality monitoring data has been reviewed and any notably high values in excess of background levels or environmental guidelines are discussed in the following sections. In previous years elevated concentrations of manganese, potassium, ammonia, and magnesium have been detected at various times in various locations; however, concentrations of nickel and aluminium continue to remain below the guideline value and have been excluded from the Appendices in this report.
- 3.4 Appendices A-E contain graphs for these substances as summarised in Table 3-1 below.

Table 3-1. Summary of graphs in Appendices A-E

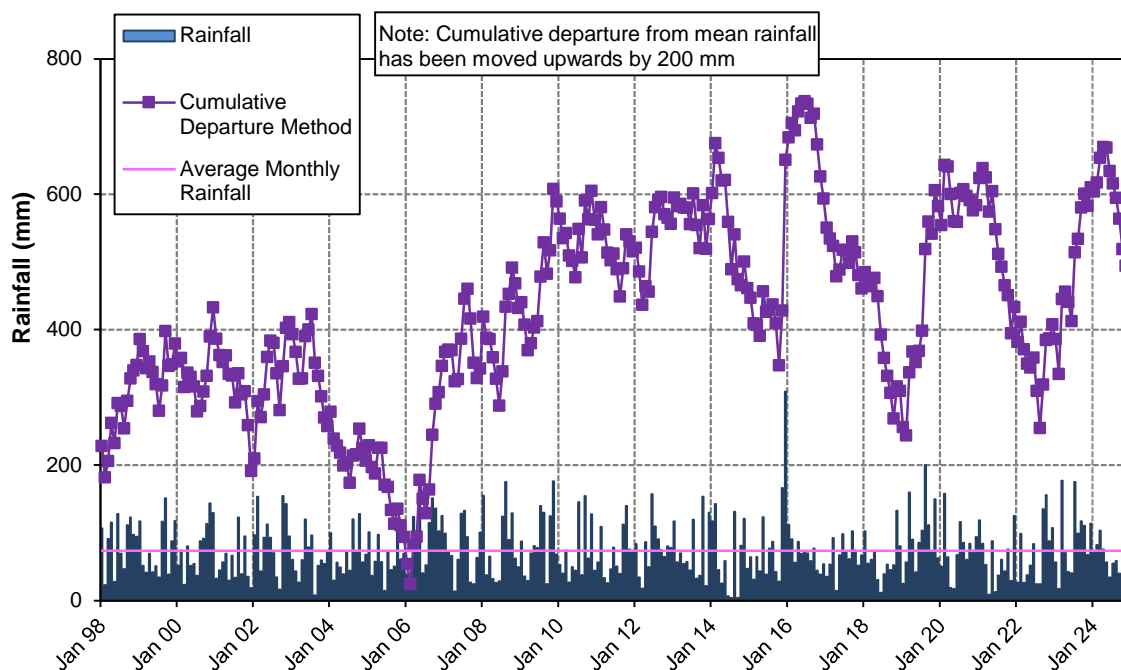
Data included	Manganese	Ammoniacal Nitrogen (NH ₄ -N)	Magnesium	Zinc	Potassium
Interceptor channel	A1	B1	C1	D1	-
Overburden	A2	B2	C2	D2	E1
Bedrock	A3	B3	C3	D3	E2
Domestic Wells	A4	B4	C4	D4	E3
Surface Water	A5	B5	C5	D5	-

4. Hydro-Environmental Monitoring Results

Rainfall

- 4.1 A long-term record of rainfall from the rain gauge at Tara Mines has been used which includes daily rainfall data from 1987 to 2024. The location of the rain gauge station is shown in Figure 2.2. As of 1st October 2013, rainfall data has been sourced from an automatic meteorological station located at Randalstown which records from midnight to midnight.
- 4.2 The annual rainfall for 2024 was 731 mm. The average annual rainfall recorded between 1987 and 2024 is 882 mm. The cumulative departure from average rainfall method shows that monthly rainfall in 2024 increased and decreased monthly with no clear pattern emerging (see Chart 3 below).

Chart 3. Rainfall data for Tara Mines (1997 to 2024)



Groundwater monitoring data

Sulphate concentrations

4.3 Sulphate concentrations in the overburden and bedrock boreholes for 2019-2024 are shown graphically in Figures 4.1 and 4.3. Figures 4.2 and 4.4 present the average sulphate concentrations and the trends in the data for overburden and bedrock monitoring boreholes respectively. Table 4-1 below summarises the average sulphate concentrations measured in boreholes and piezometers at 34 sampling locations for 2024 and the historic average sulphate concentrations. The red text indicates where sulphate concentrations have exceeded the GTV.

Table 4-1. Average sulphate concentrations in observation boreholes

Sampling point	Sulphate concentrations (mg/l)					Start of record
	Average 2020	Average 2021	Average 2022	Average 2023	Average 2024	
Bedrock						
OB1-P1	734	428	-	-	-	1996
OB4-P1	598	875	791	632	703	1996
BR1	350	279	399	344	294	1996
BR2	107	114	114	124	90	1996
BR3	52	38	41	47	32	1996
BR4	94	96	90	105	68	1999
BR5	37	15	21	18	15	1999
BR6	43	28	50	25	24	1999
BR9	39	31	39	20	26	1999
BR10	28	26	25	19	19	1999
BR14	1,554	1,507	1,627	1,507	1,401	2014
BR15	131	100	145	99	-	2014

Sampling point	Sulphate concentrations (mg/l)					Start of record
	Average 2020	Average 2021	Average 2022	Average 2023	Average 2024	
BR16	35	34	44	18	5	2014
BR23	31	43	39	40	39	2016
BR24	33	27	26	25	14	2016
BR25	32	31	41	30	28	2016
BR26	140	95	90	71	63	2018
BR27	1,407	1,323	1,346	1,358	1,309	2018
GR1	52	51	53	26	36	1996
GR2	174	191	142	85	63	2018
Overburden						
OB1-P2	379	492	-	479	-	1996
OB2	601	427	487	317	240	1996
OB3	622	771	1,194	322	130	1996
OB4-P2	1,013	1,168	1,123	829	928	1996
OB5	117	125	276	135	56	1996
OB6	162	210	225	46	57	1999
OB7	27	19	57	22	14	1999
OB10	48	41	39	30	23	2014
OB11	108	124	114	90	61	1999
OB12	175	124	175	183	108	1999
OB13	45	48	138	56	27	1999
OB20	1,355	1,413	1,402	1,168	1,286	2014
OB21	177	196	196	-	-	2014
OB22	27	28	28	23	28	2014
OB24	37	30	31	28	16	2016
OB25	43	34	49	46	38	2016
OB26	123	152	160	186	88	2018
OB27	672	718	850	630	749	2018

4.4 Figures 4.5 and 4.6 present the annual average sulphate concentrations for each monitoring boreholes in the overburden and in bedrock for the last 5 years, and associated trends for those locations where annual average sulphate concentrations exceed the GTV. All the datasets show a reducing or stable trend in annual average sulphate concentrations over the last 5 years, with the exception of at OB27 where annual average concentrations fluctuate but monthly concentrations show a reducing trend.

4.5 Figure 4.7 presents the number of exceedances of the trigger value for sulphate in the overburden and bedrock per year for the last 5 years. There have been no exceedances of the trigger value in 2024.

4.6 The following are the key points relating to the average sulphate concentrations in groundwater surrounding the TSF in 2024:

- In general, average sulphate concentrations continue to be higher in the overburden than in the bedrock sampling locations. Also, average sulphate concentrations continue to be highest in the overburden to the west and southwest of the TSF, as evidenced by concentrations at OB3, OB4-P2, OB20 and OB27. In 2024, while the average values at locations to the south of the TSF have decreased since 2023, the average values have increased at locations to the west. The reduction in mine water abstraction, particularly from the Main Mine / SWEX areas (No1 Pumping station) and

consequent reduction in tailing water discharge at the TSF in late 2023 and 2024, is likely to have contributed to this reduction in sulphate concentrations to the south of the TSF.

- Of those overburden monitoring points with data for 2024, most points show a decrease in average sulphate concentrations compared to 2023. Maximum concentrations at OB20, the overburden compliance point, and at OB4-P2 remain below the trigger level of 1,600mg/l. There is no apparent spatial pattern of increase or decrease in average sulphate concentrations relative to the TSF.
- Of those bedrock monitoring points with data for 2024, most points show a decrease in average sulphate concentrations compared to 2023, including at BR14, the bedrock compliance point. Maximum concentrations at BR14 remain below the trigger level of 1,600mg/l. Again, there is no apparent spatial pattern of increase or decrease in average sulphate concentrations relative to the TSF.
- The average sulphate concentrations show a steady overall decreasing trend in the 5 years' worth of data in both overburden and bedrock boreholes (see Figures 4.2 and 4.4).

Comparison with natural background sulphate concentrations

4.7 The following are the key points relating to the average sulphate concentrations in groundwater surrounding the TSF over time:

- Sulphate concentrations in OB7 and OB24, and BR10 and BR24 are likely to represent natural background concentrations in the overburden and bedrock respectively. With exception of OB7, these boreholes are located up hydraulic gradient of the TSF. The range of annual average sulphate concentrations measured between 1996 and 2024 at OB7 and OB24 is 10 to 68 mg/l and at BR10 and BR24 is 10 to 72 mg/l, which remain below the guideline value. The range in bedrock corresponds well with the median Natural Background Level (NBL) reported for sulphate of 11 mg/l (EPA, 2008).
- Sulphate concentrations in the overburden are elevated above natural background conditions to the south of the TSF as far east as OB12 and as far west as OB20 and at least as far south as OB11 (the most southerly monitoring point). Sulphate concentrations in bedrock are elevated above natural background concentrations to the south of the TSF at least as far as the most westerly monitoring point BR14 and as far the most southerly monitoring point BR4. This area corresponds approximately with the extent of the Meath Formation or 'Pale Beds' bedrock geology in the direction of regional groundwater flow.
- Elevated sulphate concentrations to the south of the TSF are thought to be exacerbated by mine dewatering, where bedrock groundwater levels are drawdown below overburden groundwater levels and a downward vertical hydraulic gradient is established, permitting elevated sulphate concentrations in the overburden to move downwards into the bedrock aquifer. Elevated sulphate concentrations are thought to be spatially limited by the heterogeneous nature of the overburden and by bedrock lithology and faulting. Groundwater levels are further discussed in the sections below.
- Figure 4.8 shows the average sulphate concentrations recorded in overburden boreholes in 2024 and an approximate contour of where these average sulphate concentrations met the guideline value for sulphate of 187.5 mg/l. The contours suggest that conditions have remained relatively stable since late 2022, when the area over which sulphate concentrations exceed the GTV is modelled to have decreased from previous years.
- This pattern is most likely influenced by the fragmented bedrock geology here and the presence of faults. However, at the request of the EPA, this additional plot of average sulphate concentrations in bedrock and contour lines has been prepared and included in Figure 4.9. The contour lines suggest that conditions have remained stable since late 2020, when the area over which sulphate concentrations exceed the GTV is modelled to have decreased from previous years.
- The borehole log for BR1 shows Argillaceous Limestones and Calcareous Sandstones associated with the Meath Formation or 'Pale Beds', whilst the borehole log for BR3 shows shales, sandstones and conglomerates associated with the Carboniferous Old Red Sandstone or 'Red Beds' at the base of the Navan Group. This suggests that the variation in bedrock geology influences average sulphate concentrations, and that bedrock concentrations here are not dominated by the downward vertical movement of overburden groundwater, but rather background bedrock concentrations within this bedrock unit.

Metals and other major ions

- 4.8 All water quality data for groundwater monitoring boreholes in 2024 has been reviewed in line with relevant water quality standards, as discussed in Section 2. In previous years, the assessment has focused on manganese, ammonia, magnesium, zinc, and potassium, as there were known instances of guidelines being exceeded for these parameters. This format has been maintained in this report and Appendices A-E show the concentrations over time for each of these parameters, including the latest data from 2024.
- **Manganese** concentrations in groundwater in 2024 generally exceeded the guideline value of 50 µg/l (Appendix A.2 and A.3). Concentrations increased slightly in terms of the annual average concentration in 2024 compared to 2023. Annual manganese concentrations in groundwater averaged 862 µg/l in 2020 followed by 869 µg/l in 2021, 880 µg/l in 2022, 778 µg/l in 2023, and 818 µg/l in 2024. There is evidence from historical data that manganese occurs naturally in groundwater within the catchment.
 - **Ammoniacal Nitrogen** concentrations in groundwater in 2024 generally remained below the limit of detection of 0.06 mg/l, but where detected, concentrations exceeded the guideline value of 0.065 mg/l (Appendix B.2 and B.3). Concentrations increased slightly in terms of the annual average concentration in 2024. Annual ammoniacal nitrogen concentrations in groundwater averaged 0.46 mg/l in 2020 followed by 0.36 mg/l in 2021, 0.65 mg/l in 2022, 0.36 mg/l in 2023 and 0.43 mg/l in 2024. Concentrations recorded at BR06 in November 2024 are the highest on record.
 - **Magnesium** concentrations in groundwater in 2024 generally remained below the guideline value of 50 mg/l, except for concentrations at OB20, OB27, OB04P2, BR14, OB04P1 and BR27 on at least one occasion (Appendix C.2 and C.3). A concentration of 113 mg/l of magnesium was recorded in September at point BR27, the highest concentration ever recorded for this point. Concentrations decreased slightly in terms of the annual average concentration in 2024. In 2020, annual magnesium concentrations in groundwater averaged 37.4 mg/l, 39.7 mg/l in 2021, 39.5 mg/l in 2022, 37.0 mg/l in 2023 and 35.1 mg/l in 2024.
 - **Zinc** concentrations in groundwater in 2024 generally remained below the guideline value of 75 µg/l, except for concentrations at OB2, OB20, BR2, BR6, BR14 and BR23 on at least one sampling occasion (Appendix D.2 and D.3). Overall, zinc concentrations decreased slightly in terms of the annual average in 2024. In 2020, annual zinc concentrations in groundwater averaged 48 µg/l, 38.1 µg/l in 2021, 47 µg/l in 2022, 39.6 µg/l in 2023 and 31.2 µg/l in 2024.
 - **Potassium** concentrations in groundwater in 2024 remained below the guideline value of 5 mg/l, except for concentrations at OB20, OB22, OB26, OB4P1, BR6, BR14, BR16 and BR26 (Appendix E.1 and E.2). Concentrations have decreased in terms of the annual average concentration in 2024. In 2020, annual potassium concentrations in groundwater averaged 8.4 mg/l, 8.7 mg/l in 2021, 7.4 mg/l in 2022, 6.9 mg/l in 2023 and 5.3 mg/l in 2024. The spatial distribution of potassium means that the source is unlikely to be the TSF and may be from agricultural activity.
 - **Electrical conductivity** readings in groundwater exceeded the guideline value of 800 µS/cm at most of the groundwater sampling locations at some point in 2024. However, unlike 2023, almost half of the sampling points had an annual average below the guideline value.
 - **Nitrate** concentrations in groundwater generally remain below the guideline value of 37.5 mg/l except for BR25, GR2, OB13 and OB25 on at least one sampling occasion. According to the EPA's Pollution Impact Potential Nitrate (PIP-N) mapping, there are some high-ranking areas (Rank 1-3) to the south, southwest and northeast of the TSF, where these boreholes are located. These are areas where there is a source of nitrate from agricultural areas and the land is susceptible to losses.
- 4.9 The following additional parameters demonstrated minor exceedances of guideline values on some occasions in groundwater during 2024: arsenic, chloride, iron, nickel, nitrite, and orthophosphate. All other parameters tested for in groundwater met the relevant guideline values in the 2024 data.

Domestic well monitoring data

- 4.10 Historically, 18 domestic wells have been monitored, with 4 of these wells, 8R, 31R, 33R and 34R, being decommissioned in 2003, 2022, 2012 and 2004, respectively. Only 3 of the 15 domestic wells are currently in use: 10R, 18R and 29R, with only 10R used for potable purposes (Figure 2.1). In 2024, only 11 domestic wells were monitored (9R dry, no access to 27R and 12R).

Sulphate concentrations

- 4.11 Sulphate concentrations in the monitored domestic wells for 2020-2024 are shown in Figure 4.10. There were no exceedances of the guideline value in 2024.
- 4.12 Figure 4.11 presents the average sulphate concentrations and the trend in the data. The average sulphate concentrations met the guideline value of 187.5 mg/l at all sampling locations and there is a downward trend in the dataset (2020-2024)

Metals and other major ions

- 4.13 Results of the other parameters analysed are presented below. Appendices A-E shows the concentrations over time for each of these parameters and include the latest data from 2024.
- **Manganese** concentrations in the domestic wells in 2024 generally remained below the threshold value of 50 µg/l, except for concentrations at 28R and 32R on one sampling occasion (Appendix A.4). The 2024 annual average for domestic wells cannot be compared with previous years because most of the measurements were below the detection threshold. In 2020, annual manganese concentrations averaged 118 µg/l, followed by 119 µg/l in 2021, 63 µg/l in 2022, 45µg/l in 2023 and 15 µg/l in 2024. The elevated annual average concentration in 2020 and 2021 was driven up by anomalously high results at 35R in December 2020 and 17R in July 2021. There is evidence from historical data that manganese occurs naturally in groundwater in the area. There is no elevated concentration at 35R in 2024.
 - **Ammoniacal Nitrogen** concentrations in domestic wells in 2024 generally remained below the limit of detection of 0.41 mg/l, which is above the guideline value of 0.065 mg/l (Appendix B.4).
 - **Magnesium** concentrations in the domestic wells in 2024 remained below the guideline value of 50 mg/l (Appendix C.4).
 - **Zinc** concentrations in the domestic wells in 2024 remained below the guideline value of 75 µg/l(Appendix D.4).
 - **Potassium** concentrations in the domestic wells in 2024 generally exceeded the guideline value of 5 mg/l (Appendix E.3) and have decreased slightly in terms of the annual average. In 2020, annual potassium concentrations averaged 8.3 mg/l, followed by 8.6 mg/l in 2021, 7.8 mg/l in 2022, 8.4 mg/l in 2023 and 8.2 mg/l in 2024. The spatial distribution of potassium means that the source is unlikely to be the TSF and may be from agricultural activity.
 - **Nitrate** concentrations generally remain below the guideline value of 37.5 mg/l in 2023 except for 12R and 22R on one and two occasions respectively.
- 4.14 The following additional parameters demonstrated minor exceedances of guideline values in domestic wells during 2024: chloride and orthophosphate. No other parameters exhibited elevated concentrations or indicated cause for concern.

Surface water monitoring data

Sulphate concentrations

4.15 Sulphate concentrations in the monitored surface water locations for 2020-2024 are shown in Figure 4.12. There were no exceedances of the guideline value of 187.5 mg/l in any of the collected samples in 2024. Figure 4.13 presents the average sulphate concentrations and the trend in the data. There is a downward trend in the dataset (2020-2024).

Metals and other major ions

4.16 Results of the other parameters analysed are presented below. Potassium monitoring is no longer required as part of the IEL conditions. Appendices A-D show the concentrations over time for manganese, ammonia/ammoniacal nitrogen, magnesium, and zinc, and include the latest data from 2024.

- **Manganese** concentrations in surface water in 2023 generally remained below the guideline of 50 µg/l, except for concentrations at T0A, T0B, T10 and T6 in January and T13 in July (Appendix A.5). Concentrations showed a slight increase in terms of the annual average concentrations in 2024 compared with 2023. In 2020, annual manganese concentrations in surface water averaged 19 µg/l, followed by 27 µg/l in 2021, 25 µg/l in 2022, 24 µg/l in 2023 and 29 µg/l in 2024. There is evidence from historical data that manganese occurs naturally in surface water in the area.
- **Ammoniacal Nitrogen** concentrations in surface water in 2024 generally remained below the limit of detection of 0.06-0.08 mg/l, but where detected, concentrations exceeded the guideline value of 0.065 mg/l. Exceedances occurred at T4, T8, T11, T13, T14 and T14 on one occasion and T7 on two sampling occasions only (Appendix B.5).
- **Magnesium** concentrations in surface water in 2024 remained below the guideline value of 50 mg/l (Appendix C.5).
- **Zinc** concentrations in surface water in 2024 remained below the guideline value of 75 µg/l (Appendix D.5).
- **Total Hardness** concentrations in surface water in 2024 exceeded the guideline value of 200 mg/l at all of the monitoring locations on at least one occasion, with an annual average of 259 mg/l. Readings in surface water were notably lower than those taken at the interceptor channel.
- **Nitrate** concentrations in surface water in 2024 generally remained below the guideline value of 37.5 mg/l at all of the monitoring locations, with the exception of T6 and T15 on one sampling occasion.

4.17 The following additional parameters demonstrated minor exceedances of guideline values on some occasions in surface water during 2024: chloride, electrical conductivity, mercury (at T11 on one occasion only), pH (at T11 on one occasion only) and phosphate. All other parameters analysed in surface waters met the relevant guideline values for 2024 data. There are no relevant guideline values for cobalt and silver.

Interceptor channel monitoring data

4.18 The interceptor channel is part of the TSF dam and collects water from the internal drainage system within the embankment of the TSF, horizontal seepage from the TSF, local runoff and groundwater. The results of monitoring here reflect water quality in the TSF, and the water is pumped back into the active stage of the tailings dam. Re-grading and piping of the perimeter interceptor channel to the west and south of Stage 3, adjacent to the Yellow River, took place in 2023.

Sulphate concentrations

4.19 Monthly sulphate concentrations for all 4 monitoring points in the interceptor channel for 2020-2024 are presented in Figure 4.14. Concentrations in the channel generally have not met the guideline value (187.5 mg/l), which is as expected, given the nature of the intercepted waters. Figure 4.15 presents the average sulphate concentrations and the trend in the data. There is a downward trend in the dataset (2020-2024).

4.20 Table 4-2 summarises the average annual sulphate concentrations at the sampling points for 2020-2024, together with the maximum concentrations measured in 2024. Average sulphate concentrations at most

sampling points have increased in 2024 compared to 2023 but remain below values observed in and prior to 2021.

Table 4-2. Average sulphate concentrations in interceptor channel

Sampling point	Average sulphate concentrations (mg/l)					Maximum sulphate concentration (mg/l)
	2020	2021	2022	2023	2024	2024
ICP1.E	529	607	428	431	506	692
ICP1.W	737	827	602	772	808	1,055
ICP3	682	733	617	676	-	-
ICP6	485	543	428	394	498	779
S6_IC1	610	568	-	347	412	585
All samples	609	660	518	501	545	1,055

Metals and other major ions

4.21 All the water quality data for the interceptor channel in 2024 has been reviewed and compared with the relevant guidelines, as discussed in Section 2. Appendices A-D show the concentrations over time for manganese, total ammonia/ ammoniacal nitrogen, magnesium and zinc and include the latest data from 2024.

- **Manganese** concentrations in the interceptor channel in 2024 generally exceeded the guideline value of 50 µg/l. Concentrations increased in terms of the annual average concentrations in 2024 compared to 2023, from 298 to 373 µg/l (Appendix A.1).
- **Ammoniacal Nitrogen** concentrations in the interceptor channel, where detected, exceeded the guideline value of 0.065 mg/l. Concentrations in 2024 are slightly higher than in 2023 but remain below those in and prior to 2020 (Appendix B.1).
- **Magnesium** concentrations in the interceptor channel in 2024 exceeded the guideline value of 50 mg/l at least at one sampling occasion for each monitoring point. Concentrations have decreased in terms of the annual average in 2024 compared to 2024, from 53.7 to 50.5 mg/l (Appendix C.1).
- **Zinc** concentrations in the interceptor channel in 2024 exceeded the guideline value of 75 µg/l for ICP1E and ICP6. However, concentrations increased slightly in terms of the annual average concentration in 2024 compared to 2023, from 121 to 125 µg/l (Appendix D.1).
- **Electrical Conductivity** readings within the interceptor channel in 2024 exceeded the guideline value of 800 µS/cm on all of the sampling occasions, with an annual average of 1,494 µS/cm. Readings in the interceptor channel were notably higher than other surface water courses included in the monitoring programme.
- **Total Hardness** concentrations in the interceptor channel in 2024 exceeded the guideline value of 200 mg/l in all samples, with an annual average of 596 mg/l. Readings in the interceptor channel were notably higher than other surface water courses included in the monitoring programme.
- **Antimony** concentrations remained below the Drinking Water Regulations of 0.01 mg/l at all the interceptor channel monitoring locations, except for S6_IC1 on most sampling occasion.
- **Chloride** concentrations exceeded the guideline value of 24 mg/l in all the interceptor channel monitoring locations on most sampling occasion.
- **Calcium** concentrations exceeded the IGV of 200 mg/l in all the interceptor channel monitoring locations on at least one monitoring occasion.

4.22 Given the nature of the intercepted water, it would be expected that elevated concentrations are detected at times. In addition to the above exceedances, nitrate (at S6_IC1 on one occasion) demonstrated a minor exceedance of guideline values in the interceptor channel during 2024. All other parameters analysed in surface waters met the relevant guideline values for 2024 data. There are no relevant guideline values for cobalt and silver.

Trigger and intervention levels

- 4.23 As part of the *Risk Screening and Technical Assessment Report for Randalstown Tailings Management Facility at Tara Mines* (AECOM, 2015), compliance points and intervention and trigger values were set. The compliance points were set at OB4-P2 for overburden and the Yellow River; OB13 for overburden and the River Blackwater; and BR4 for bedrock.
- 4.24 As part of the *Remediation Action Plan for Randalstown Tailings Management Facility at Tara Mines* (AECOM, 2021), these points and values were reviewed and revised. The compliance points are set at OB13, OB20, BR14 and T8 for the River Blackwater receptor, and at BR14 for the bedrock aquifer receptor. The revised trigger and intervention values are set out for BR14 and T8 in Table 4-3 below.
- 4.25 Sulphate concentrations at T8 did not exceed the trigger or intervention values in 2024. Sulphate concentrations at BR14 did not exceed the trigger or intervention values in 2024, but remains close to the trigger value of 1,600 mg/l, with the highest concentration reaching 1,401 mg/l.
- 4.26 Magnesium concentrations at BR14 remained below the trigger value of 185 mg/l on all four sampling occasions in 2024. The average concentration at BR14 for 2024 is 175 mg/l, with the highest concentrations reaching a concentration of 184 mg/l.

Table 4-3. Trigger and intervention values

Water quality parameter	Receptor	Compliance point	Guideline value (mg/l)	Intervention value (mg/l)	Trigger value (mg/l)
Sulphate (mg/l)	River Blackwater	OB13, OB20, BR14, T8	187.5*	None set for groundwater 250 (at T8)	None set for groundwater 187.5 (at T8)
	Bedrock aquifer	BR14	187.5*	2,000	1,600
Magnesium (mg/l)	River Blackwater	OB13, OB20, BR14, T8	50	None set	None set
	Bedrock aquifer	BR14	50	230	185

* For comparison with annual average concentration

Water levels

Groundwater levels

- 4.27 There are a total of 17 bedrock boreholes and 17 overburden boreholes within the TSF monitoring network where groundwater levels are currently monitored monthly. Groundwater levels have been monitored around the TSF since 1997. The groundwater hydrographs for overburden and bedrock are plotted in Figures 4.16 and 4.17 to illustrate trends in groundwater levels over the last 5 years. In addition, a groundwater contour map has been prepared, which shows overburden and bedrock groundwater levels contoured and the overburden and bedrock geology. The maps are included in Figures 4.18 and 4.19. The contours are plotted using groundwater level data taken in November 2024.
- 4.28 The following are the key points relating to these groundwater levels:
- Groundwater levels in the overburden and bedrock are generally between 0.25 m and 18.65 m below ground level (at BR1).
 - The dominant flow direction in the overburden is towards the southwest, where the seepage collection system may be influencing groundwater levels. The dominant flow direction in bedrock is towards the south, where abstraction for mine dewatering appears to be influencing groundwater levels, within the 'Pale Beds' or Meath Formation (see Figure 4.19). The influence of dewatering on groundwater levels has reduced significantly during and since the Care and Maintenance shut down, between mid-2023 and end of 2024.
 - Groundwater hydrographs show seasonal fluctuations in groundwater levels around the TSF in response to rainfall events. The magnitude of groundwater level fluctuation generally varies between 0.5 m and 3.5 m depending on the geology and location. The overburden monitoring point showing the highest fluctuation in 2024 was OB12, located to the southern boundary of the TSF, and showing a

fluctuation across the year of approximately 3.9 m. The bedrock monitoring point showing the highest fluctuation in 2024 was BR01, located to the south of the TSF, and showing a fluctuation across the year of approximately 10.3 m, followed closely by BR04 and BR05. These boreholes are located within the mapped Meath Formation or Pale Beds.

- 4.29 Overall, groundwater levels have remained relatively stable since 2015. In 2019, groundwater levels in boreholes located to the south of the TSF started to show an overall rising trend. The location of these boreholes corresponds approximately with the extent of the Meath Formation or Pale Beds in the direction of regional groundwater flow. The Pale Beds host the bulk of the Navan Orebody and are subject to dewatering. The rising trend observed in these boreholes is most likely as a result of the recent plugging/ decommissioning of exploration holes in the Nevinstown area.

Comparison between groundwater levels in overburden and in bedrock

- 4.30 Where groundwater levels show a continued declining trend, groundwater hydrographs for coupled boreholes (or pairs of boreholes) around the TSF are plotted (Figure 4.20) to compare overburden and bedrock groundwater levels. The following are the key points relating to the comparison of water levels in the overburden and in bedrock:
- Water levels within the bedrock at BR5 are up to 3 m higher than in the overburden at OB12 throughout 2024. Where water levels in the bedrock are higher than in overburden, there is an upward head gradient and little potential for vertical seepage downwards from the interceptor channel into the overburden.
 - Water levels within the overburden at OB2 are up to 6.5 m higher than in the bedrock at BR1 throughout 2024 and previous years. Where water levels in the overburden are higher than in bedrock, there is a downward head gradient allowing the potential for vertical seepage downwards.
 - Water levels within the overburden and bedrock at OB5 and BR2 are similar, with the head gradient fluctuating throughout 2024.
- 4.31 Groundwater levels in November 2024 are shown in groundwater contour plots in Figures 4.18 and 4.19. The groundwater levels show influence of lower rainfall in 2024 (82% of the LTA rainfall) in overburden and bedrock, and possible influence of dewatering at the Tara Mines (albeit reduced in 2024 at 65% of 2023 abstraction volumes) in bedrock, at BR1, BR2, BR4 and BR5.

Water levels in interceptor channel

- 4.32 The TSF consists of an impoundment (the tailings pond) contained by earth-built embankment walls (the tailings dam). The walls and foundations are constructed from the Quaternary glacial till which underlies the site to reduce the potential amount of seepage from the overburden material (tailings) into groundwater and adjacent surface watercourses.
- 4.33 An interceptor channel close to the base of the dam captures runoff and underdrainage from the dam. Tailings water collected in the interceptor channel is then pumped back up to the TSF (tailings pond) from one pump with automated level controls, at the south of the interceptor channel/ dam. By returning tailings water back to the TSF, a closed water cycle system operates which helps to protect the local water environment.
- 4.34 However, the occurrence of elevated sulphate concentrations in groundwater in the immediate vicinity of the TSF suggests that there is a small amount of seepage occurring from the tailings into groundwater. The interceptor channel may be an intermittent source of seepage when adjacent groundwater levels drop below the base of the interceptor channel. Therefore, maintaining water levels in the interceptor channel below adjacent groundwater levels is key to limiting the occurrence of seepage into the groundwater environment.
- 4.35 Re-grading and piping of the perimeter interceptor channel to the west and south of Stage 3, adjacent to the Yellow River has taken place in 2023. This is where previous attempts at re-grading the channel was thwarted by bedrock close to the surface and a high-water table. To overcome these issues, this area of the channel was piped and backfilled with drainage stone. The re-grading and piping of the perimeter interceptor channel is considered to have the potential to reduce the occurrence of seepage into the

groundwater environment. In 2024, the average sulphate concentrations in the interceptor channel have increased slightly compared to 2023 but remain below values observed in and prior to 2021.

- 4.36 All options have been examined for controlling water levels within the interceptor channel, with the outcome provided in AECOM's *Corrective Action Feasibility & Design Report* for the Environmental Protection Agency.
- 4.37 During the re-grading and piping works, the historic monitoring locations on the interceptor channel – VNW 108, VNW 800, VNW 1600, VNW 3025, VNW 3610 and VNW 4045 – were decommissioned in December 2022, and eight (no. 8) new monitoring locations commissioned in July 2023 - VNW1, VNW2, VNW3, VNW4, VNW5, VNW6, VNW7 and VNW8 – where weekly water levels are collected. These are presented in Figure 2.2.
- 4.38 The water levels in the interceptor channel are controlled by pumping from the channel and remain constant apart from some response to rainfall events. The water level in the interceptor channel remained between 1566.3 and 1577.6 m above mine datum (AMD), consistent with previous years (Figure 4.21).

Comparison between groundwater levels in overburden and water levels in interceptor channel

- 4.39 The water level records are plotted in Figure 4.21 to compare water levels in the interceptor channel and overburden and thus understand the effectiveness of the interceptor channel in collecting the seepage from TSF. The following are the key points relating to the comparison of water levels in the overburden and in the interceptor channel:
- Figure 4.21 shows that water levels at interceptor channel monitoring points VNW1 and VNW8 remain above groundwater levels in the overburden at nearby boreholes OB25 and OB27 respectively. These water levels suggest that there is a downward hydraulic gradient at these locations and the potential for vertical seepage downwards from the interceptor channel into the overburden.
 - Water levels at interceptor monitoring points VNW2, VNW3, VNW5, VNW6, VNW7 remain below groundwater levels in the overburden at adjacent boreholes OB24, OB10 and OB22, OB2 and OB27 respectively (see colour coded 'pairs' in Figure 4.21). These water levels suggest that there is an upward hydraulic gradient at these locations and little potential for vertical seepage downwards from the interceptor channel into the overburden. Water levels at VNW4 are similar to groundwater levels in OB5 in the first half of the year. Then, groundwater levels in OB5 have decreased from May and water levels VNW4 remained stable for the rest of the year.

5. Conclusions and recommendations

Conclusions

- 5.1 The on-going monitoring of the hydrogeological and hydrological environment at the Randalstown TSF is providing sufficient data to assess the effects of seepage from the TSF into the local environment. Based on the on-going monitoring, the following comments/ conclusions can be made:
- The EU (Drinking Water Supply) Regulations, EC Environmental Objectives (Groundwater) Regulations, EC Environmental Objectives (Surface Water) Regulations and interim guideline values for groundwater were used as guideline values for comparison with measured concentrations in groundwater and in surface water.
 - Sulphate continues to be used as the key indicator parameter for monitoring seepage from the TSF and concentrations in groundwater continue to be generally higher in the overburden than in the bedrock.
 - Historic water level monitoring in the interceptor channel suggested that there is a downward head gradient out of the interceptor channel and potential for vertical seepage downwards into the overburden at some locations, which may be the source of contamination in groundwater in the overburden and subsequently in bedrock.
 - In 2024:

- Overall, sulphate concentrations in the interceptor channel have increased by approximately 8%, compared to 2023, but remain below values observed in and prior to 2021.
- Sulphate concentrations in groundwater have continued to remain highest in the overburden and to the south and southwest of the TSF close to and along the channel of the Yellow River.
- Average sulphate concentrations have remained below the guideline value in most overburden and bedrock boreholes. The majority of overburden and bedrock boreholes show a decrease in average sulphate concentrations in 2024, compared to 2023.
- The trigger and intervention value for sulphate was not exceeded at compliance points T8 and BR14 and the trigger value for magnesium was not exceeded at compliance point BR14.
- Sulphate concentrations in domestic wells and surface water in the area have remained below the guideline value.
- Contouring of the available average sulphate concentrations recorded at overburden and bedrock boreholes in 2024 shows that conditions have remained relatively stable since 2022 and 2020 respectively. The area over which sulphate concentrations exceed the GTV is modelled to have decreased compared with previous years.
- In groundwater, concentrations of other parameters such as ammoniacal nitrogen, magnesium, manganese, nitrate, potassium and zinc, have exceeded the guideline values, and on occasions, arsenic, chloride, iron, nickel, nitrite, and orthophosphate.
- In surface water, concentrations of other parameters such as ammoniacal nitrogen, manganese and total hardness have exceeded the guideline values, and on occasions chloride, electrical conductivity, mercury (at T11 only), pH (at T11 only) and phosphate.
- In addition to sulphate, the interceptor channel is characterised by elevated concentrations of ammoniacal nitrogen, calcium, chloride, electrical conductivity, hardness, magnesium, manganese, and zinc, and on occasions, antimony (at S6_IC1 only) and nitrate (at S6_IC1 only).
- Groundwater levels to the south and southeast of the TSF appear to show some local influence of the seepage capture pumping system in the overburden, and possible influence of abstraction for mine dewatering at Tara Mines in the bedrock. In 2024, groundwater levels in OB12 were up to 3 m lower than in corresponding bedrock borehole BR5, resulting in little potential for vertical seepage downwards here, while groundwater levels in OB2 were up to 6.5 m higher than in the corresponding bedrock borehole BR1, resulting in the potential for vertical seepage downwards here.
- As a result of the Care and Maintenance shut down in 2024 and reduction in mine dewatering in the Main Mine / SWEX areas, the mine water abstraction volume and rates were much lower than in previous years.

Recommendations

5.2 The interceptor channel provides an effective means of limiting the release of sulphate rich water into the local environment, as demonstrated by the generally higher sulphate content of samples taken from the channel compared with the lower values in the groundwater. After mid-2007, the situation started to change as a result of change in hydraulic conditions around the TSF due to mine dewatering, and groundwater sulphate concentrations started to increase slightly to the south of the TSF.

- It is recommended that the future mine dewatering strategy is reviewed and that groundwater levels are predicted so that the historical and potential future of effects of dewatering on groundwater levels and contaminant migration at the TMF may be evaluated.
- It is recommended that the monitoring strategy is continued, and comparisons are made with monitoring results from the previous 5 years' worth of data, as well as with relevant guideline values, so that trends can be observed, and comparison made against trigger and intervention values.
- It is recommended that concentrations recorded at OB4-P1, OB4-P2 and BR14 (where sulphate concentrations are highest) to the southwest and at BR14 and T8 (compliance points) should continue to be observed for future, potential increases and exceedance of trigger or intervention values.
- It is recommended that regular clearance of vegetation in the interceptor channel is carried out. A high level of maintenance of this channel will ensure its effectiveness, keep water levels low and closer to

adjacent groundwater levels, and reduce the risk of seepage, channel blockage, local infilling, or pump malfunction.

- It is recommended that new monitoring boreholes be installed in the overburden and bedrock in nearfield to the north and northwest of the TSF to delineate the limit of potential sulphate migration in these areas.

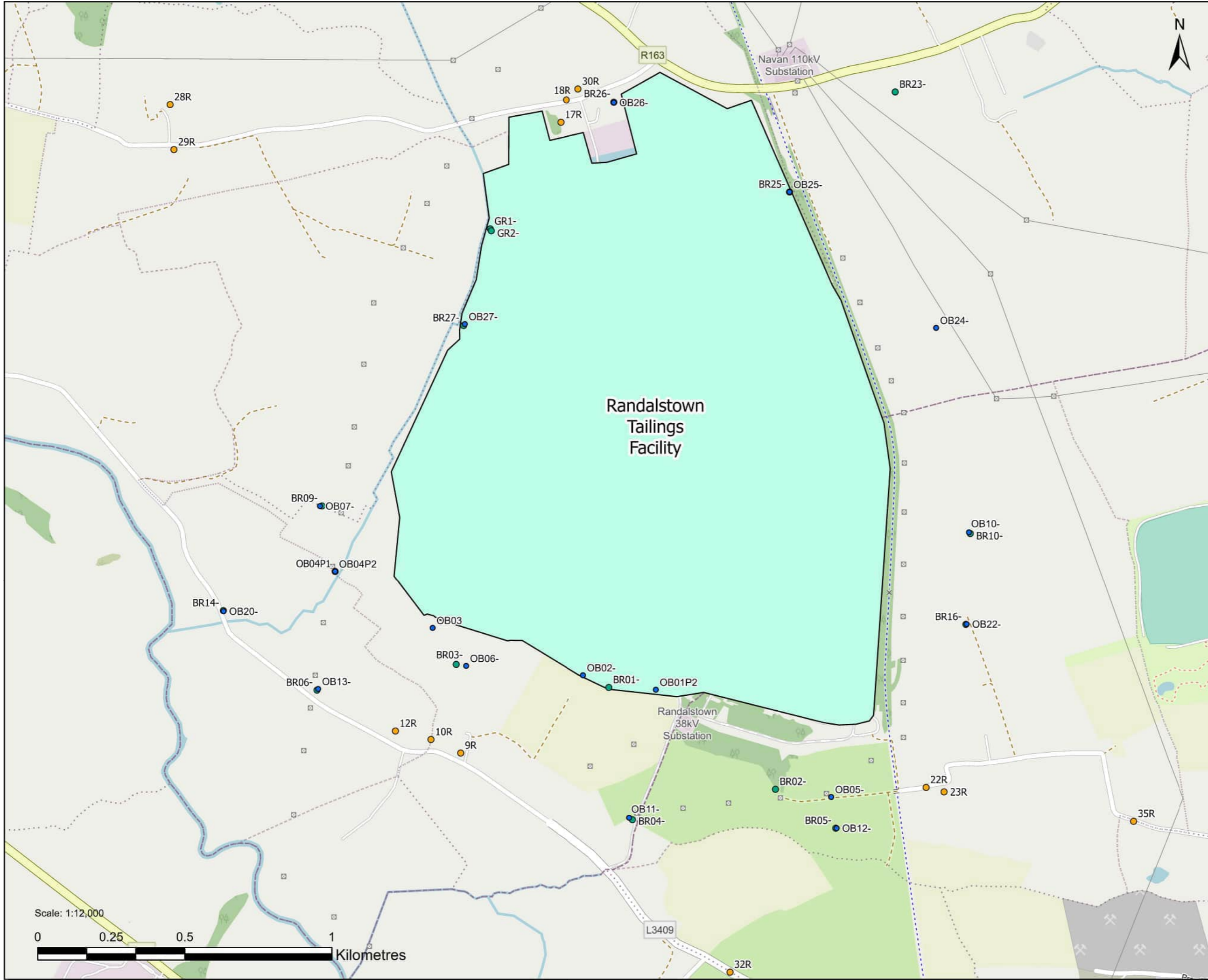
5.3 The following table summarises the recommendations provided in the *Annual Environmental Monitoring Report 2021* and the implementation plan.

Table 5-1. Recommendations and implementation plan

No.	Recommendation	Implementation plan
1	It is recommended that the mine dewatering strategy is reviewed and that groundwater levels are predicted so that the historical and potential future of effects of dewatering can be evaluated.	The mine dewatering strategy will be reviewed as part of the AECOM's <i>Corrective Action Feasibility & Design Report</i> for the Environmental Protection Agency. In addition, a review of groundwater levels corresponding with the highest sulphate concentrations will be undertaken. If appropriate and required, trigger and intervention groundwater levels could be set at compliance points to the south of the TSF.
2	It is recommended that the monitoring strategy is continued, and comparisons are made with monitoring results from the previous 5 years' worth of data, as well as with relevant guideline values, so that trends can be observed, and comparison made against trigger and intervention values.	The licensee will continue to comply with the requirements of IEL P516-04 with regards to the monitoring strategy. Annual reporting will include the results from the previous 5 years' worth of data, comparison with relevant guideline values and trigger and intervention values, and observation of trends.
3	It is recommended that concentrations recorded at T8 and at BR14 to the southwest should continue to be observed for future increases and exceedance of trigger or intervention values.	The licensee will continue to comply with the requirements of IEL P516-04 with regards to monitoring of the compliance points. Annual reporting on concentrations recorded at BR14 and T8 will include the results from the previous 5 years' worth of data, comparison with relevant guideline values and trigger and intervention values, and observation of trends.
4	It is recommended that regular clearance of vegetation in the interceptor channel is carried out. A high level of maintenance of this channel will ensure its effectiveness and reduce the risk of channel blockage, local infilling, or pump malfunction.	The licensee has established a regular maintenance programme for the interceptor channel. This plan consists of: <ul style="list-style-type: none"> • Weekly visual inspections; and • Regular vegetation cutting and clearance.
5.	It is recommended that new monitoring boreholes be installed in the overburden to the north and northwest of the TSF to delineate the limit of sulphate exceedances. (no access to lands in this area-not Tara owned).	The licensee will install new monitoring boreholes.

6. References

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- e. EPA, 2011, Towards Setting Guideline Values for the Protection of Groundwater in Ireland, Interim Report.
- f. AECOM, 2021. Remediation Action Plan for Randalstown Tailings Management Facility at Tara Mines. Final.
- g. AECOM, 2022. Corrective Action Feasibility & Design Report for Tara Mines TSF.



- LEGEND**
- Rain Gauge
 - Surface Water Locations
 - Current VNW Locations
 - Overburden Monitoring Borehole
 - Old VNW Locations
 - ICP Locations
 - Tara Mines
 - Pump
 - Flow Direction

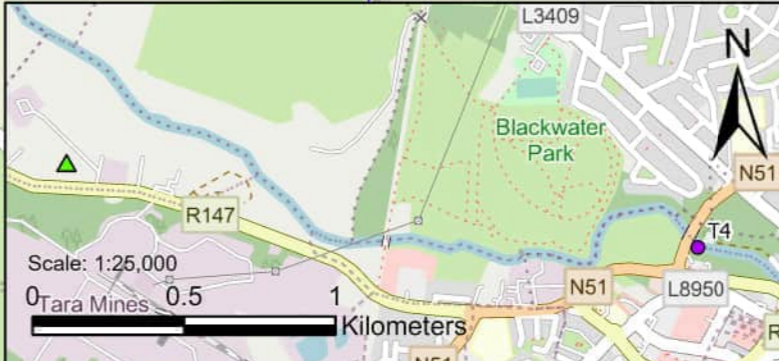
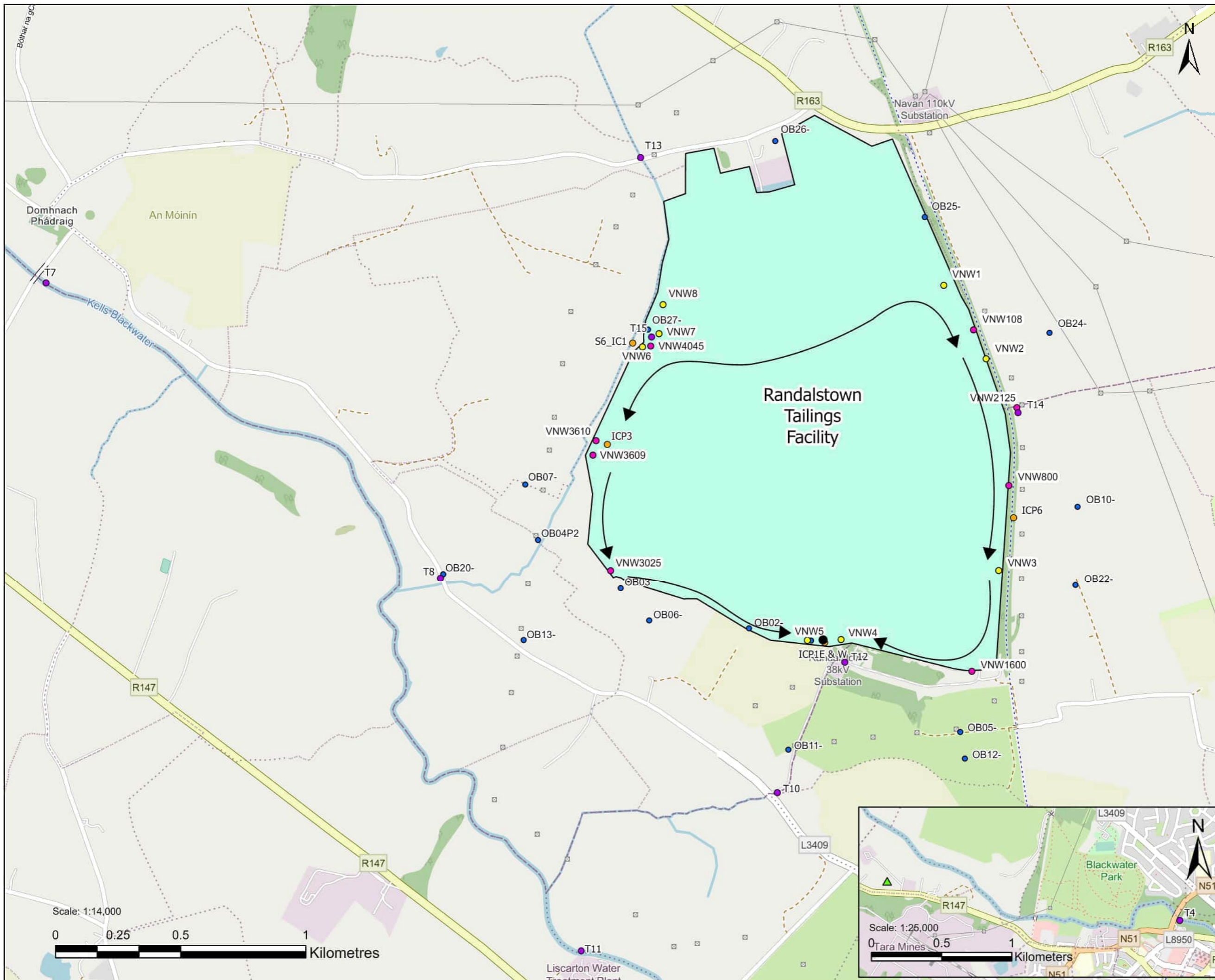
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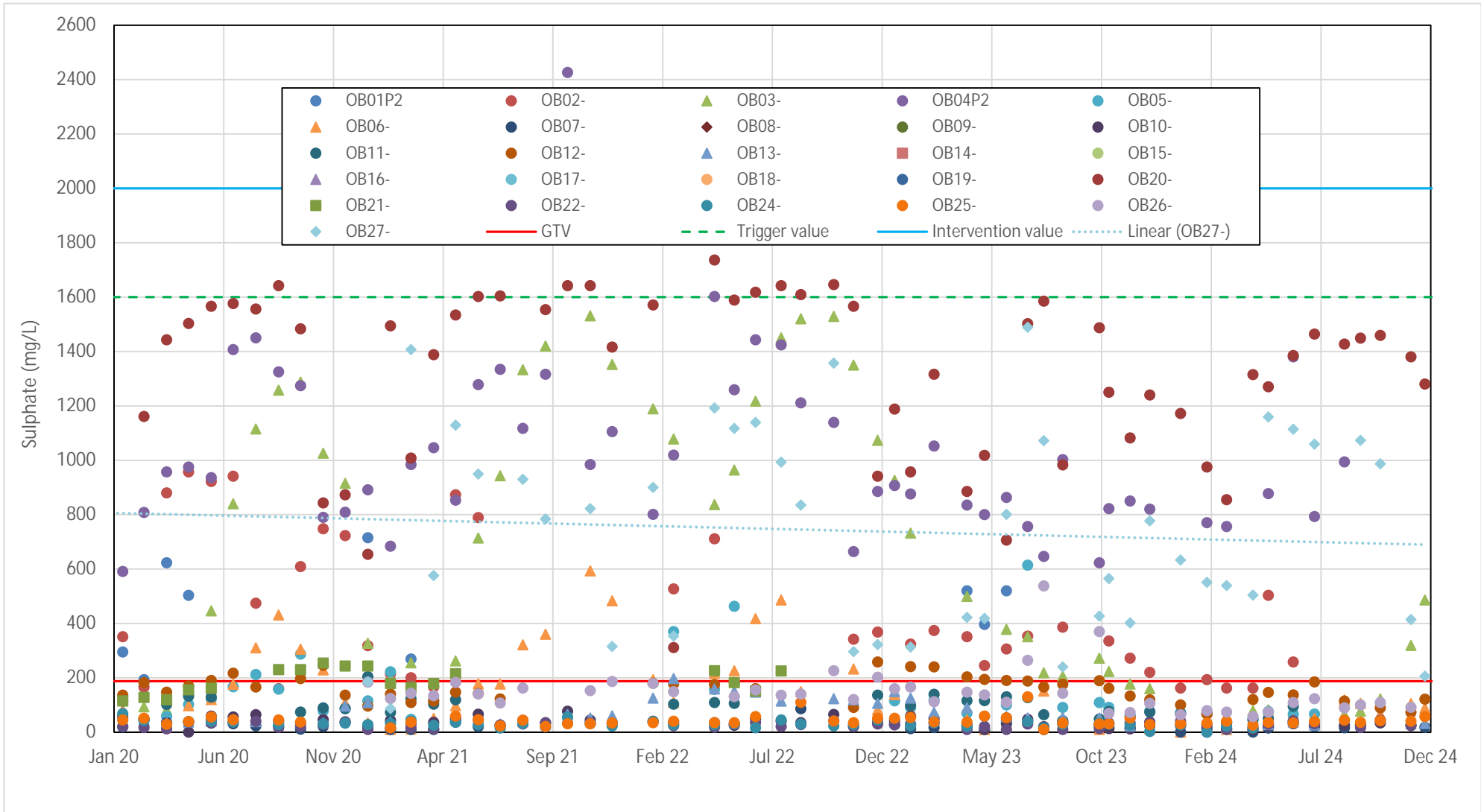
ISSUE PURPOSE
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60628825

FIGURE TITLE
Surface water monitoring locations

FIGURE NUMBER
Figure 2.2





Client: Boliden_TaraMines_DAC

Site: Tara Mines

Figure 4.1 Groundwater sulphate concentrations in the overburden

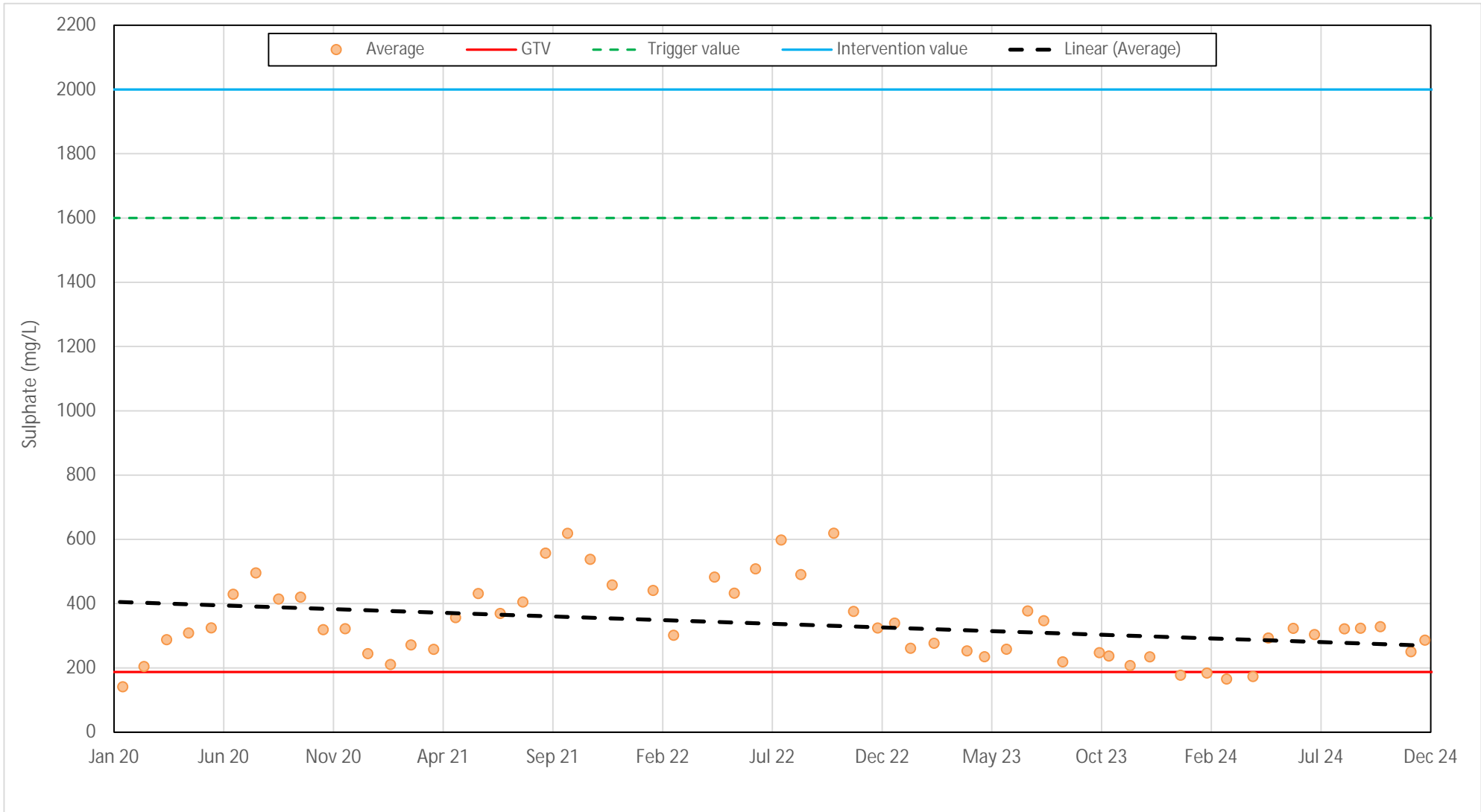


Figure 4.2 Average groundwater sulphate concentrations in the overburden and 5-year trend

Client: Boliden_TaraMines_DAC

Site: Tara Mines

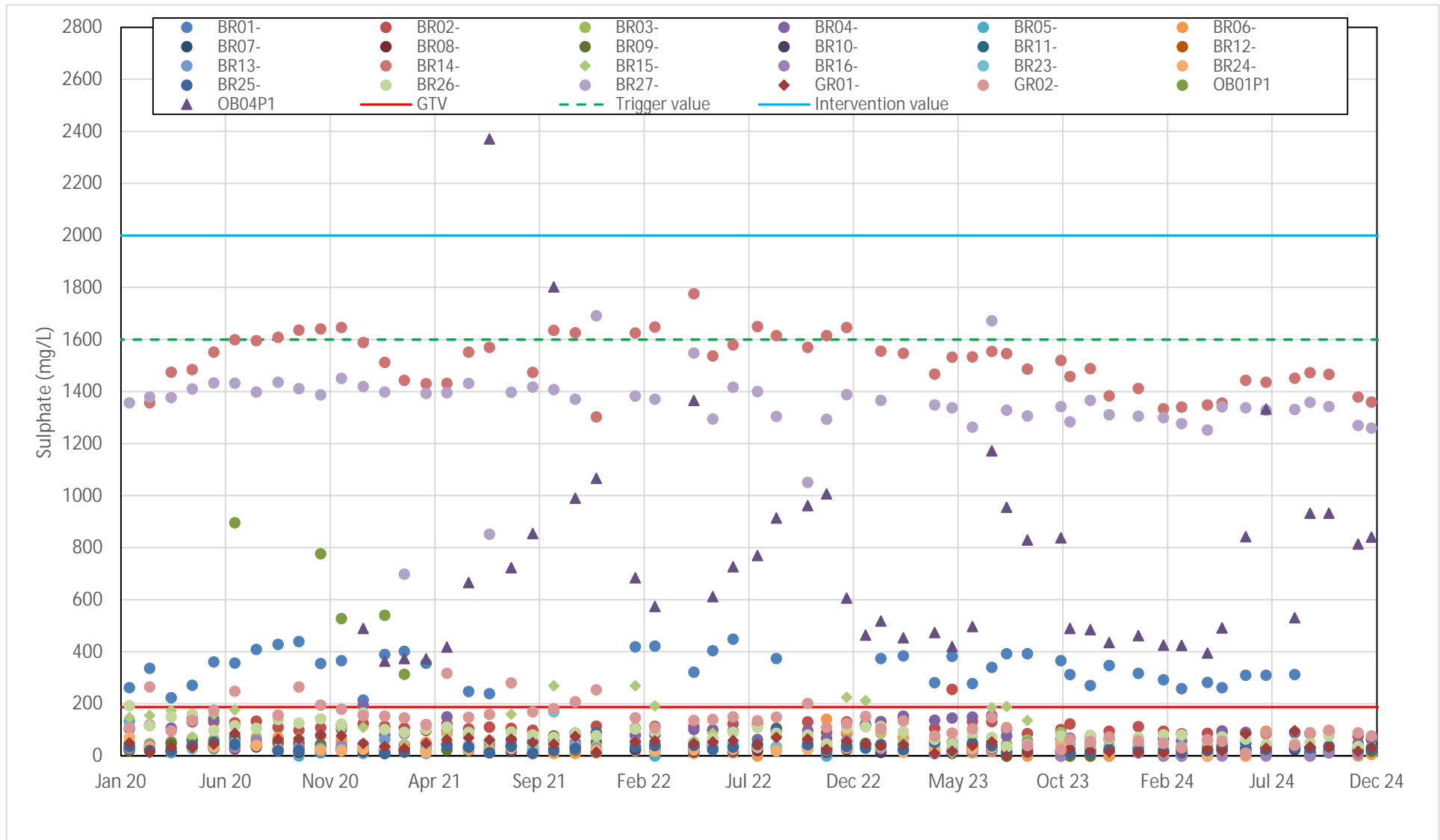
AECOM

60628825

Date: 12/03/2025

Rev: 0

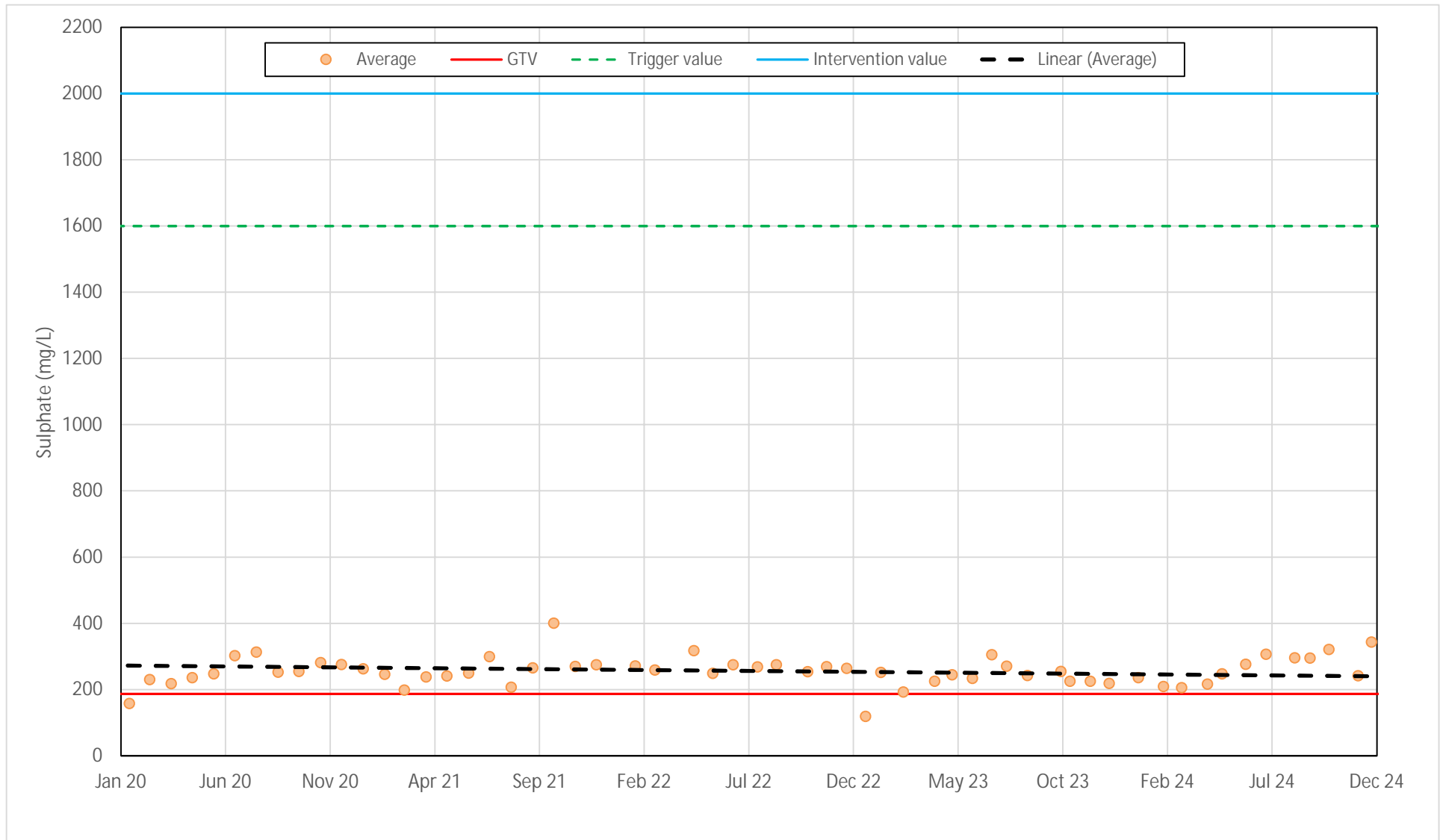
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Client: Boliden_TaraMines_DAC

Site: Tara Mines

Figure 4.3 Groundwater sulphate concentrations in bedrock



Client: Boliden_TaraMines_DAC

Site: Tara Mines

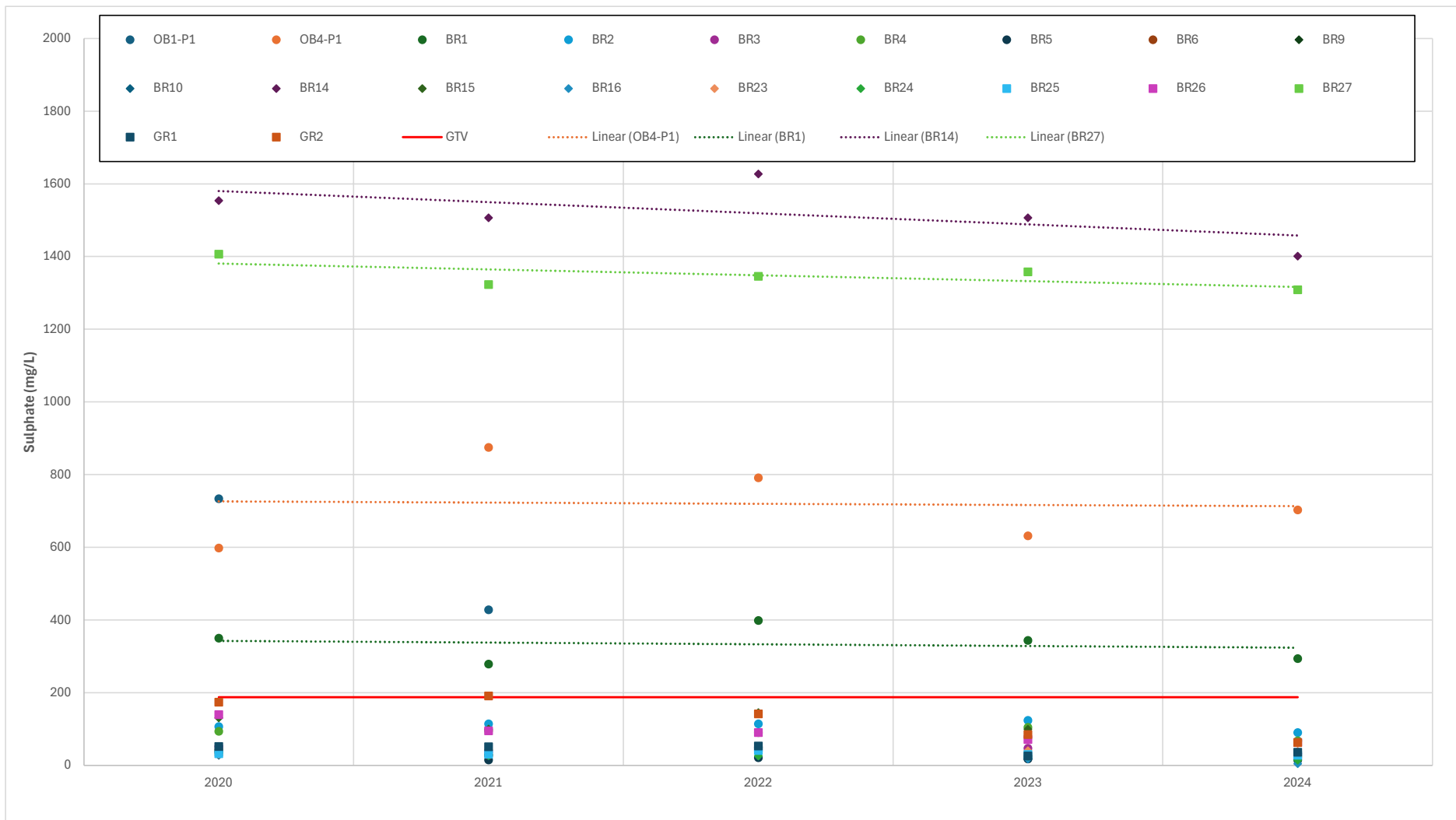
Figure 4.4 Average groundwater sulphate concentrations in bedrock and 5-year trend



Client: Boliden_TaraMines_DAC

Site: Tara Mines

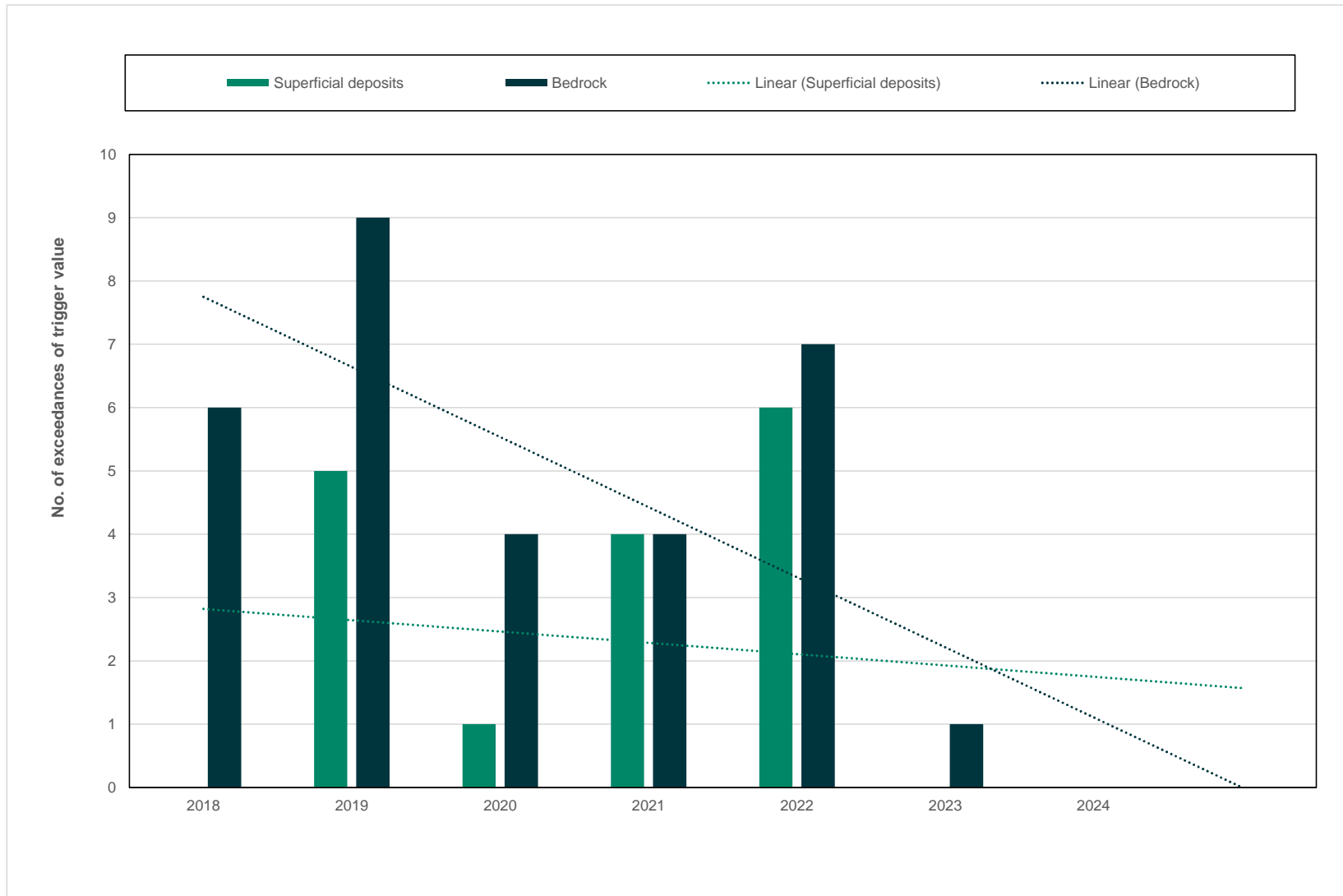
Figure 4.5 Annual average sulphate concentrations in overburden at each monitoring location and 5-year trend



Client: Boliden_TaraMines_DAC

Site: Tara Mines

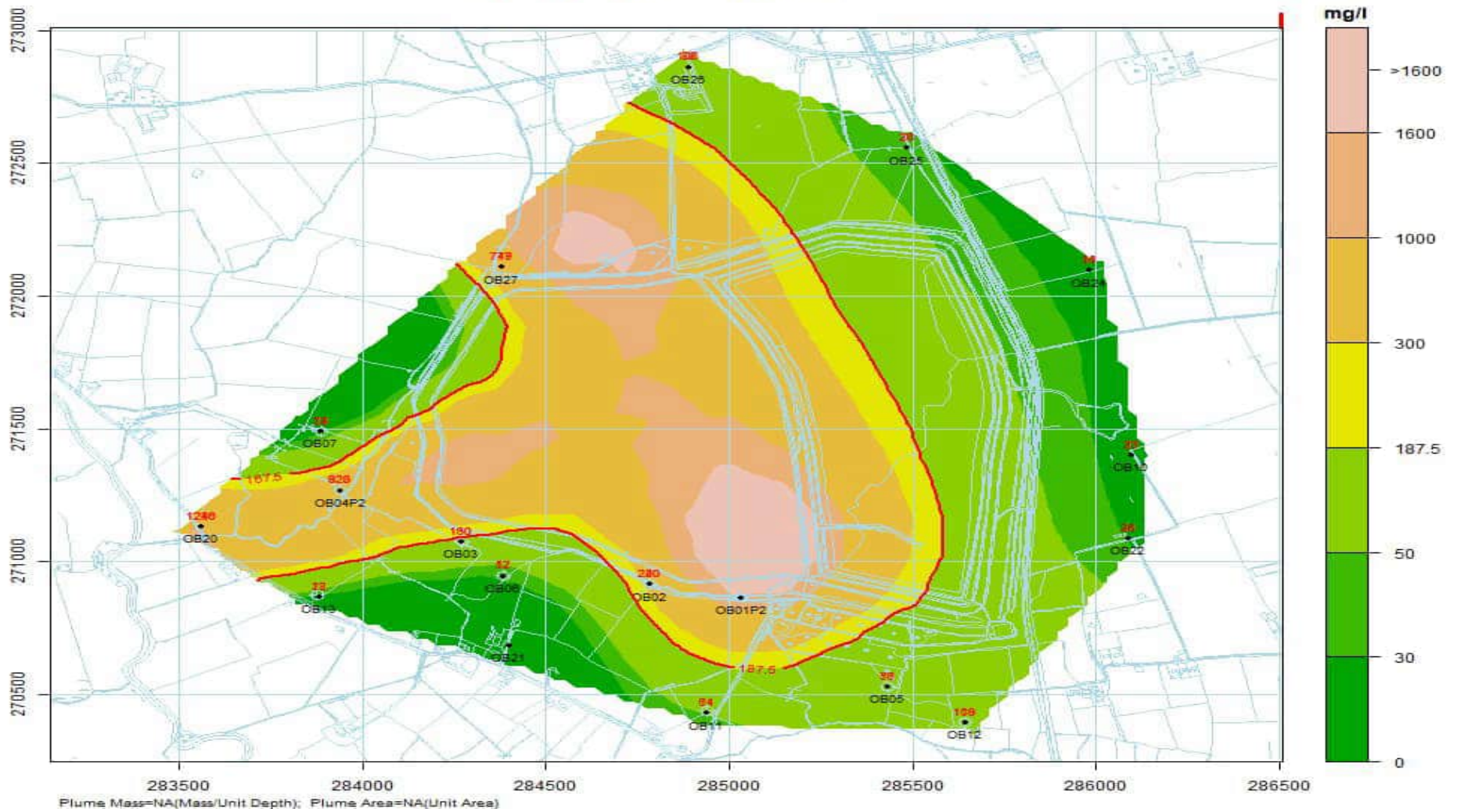
Figure 4.6 Annual average sulphate concentrations in bedrock at each monitoring location and 5-year trend



Client: Boliden_TaraMines_DAC

Site: Tara Mines

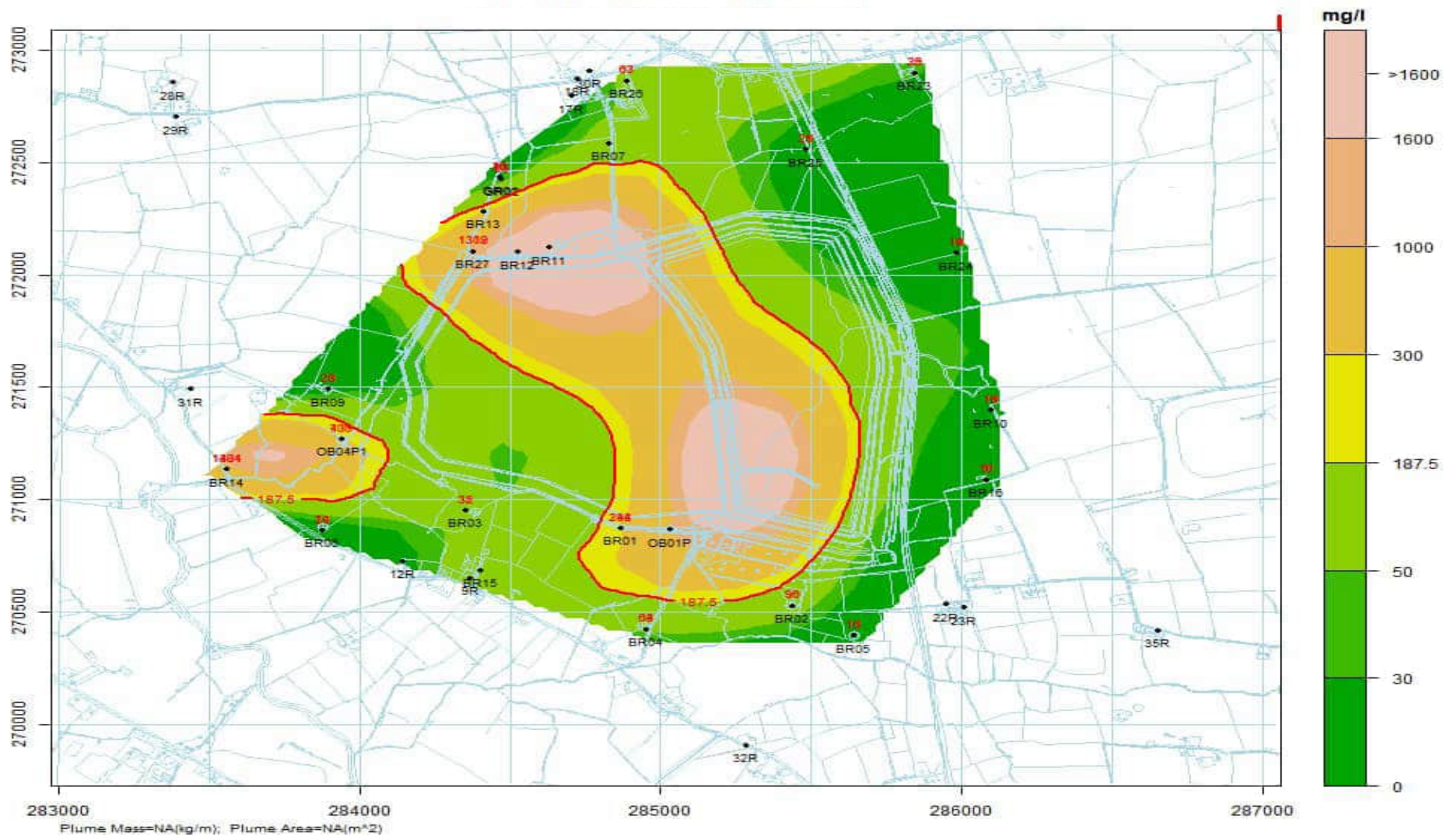
Figure 4.7 No. of exceedances of the trigger value for sulphate in the last 7 years



Client: Boliden_TaraMines_DAC

Site: Tara Mines

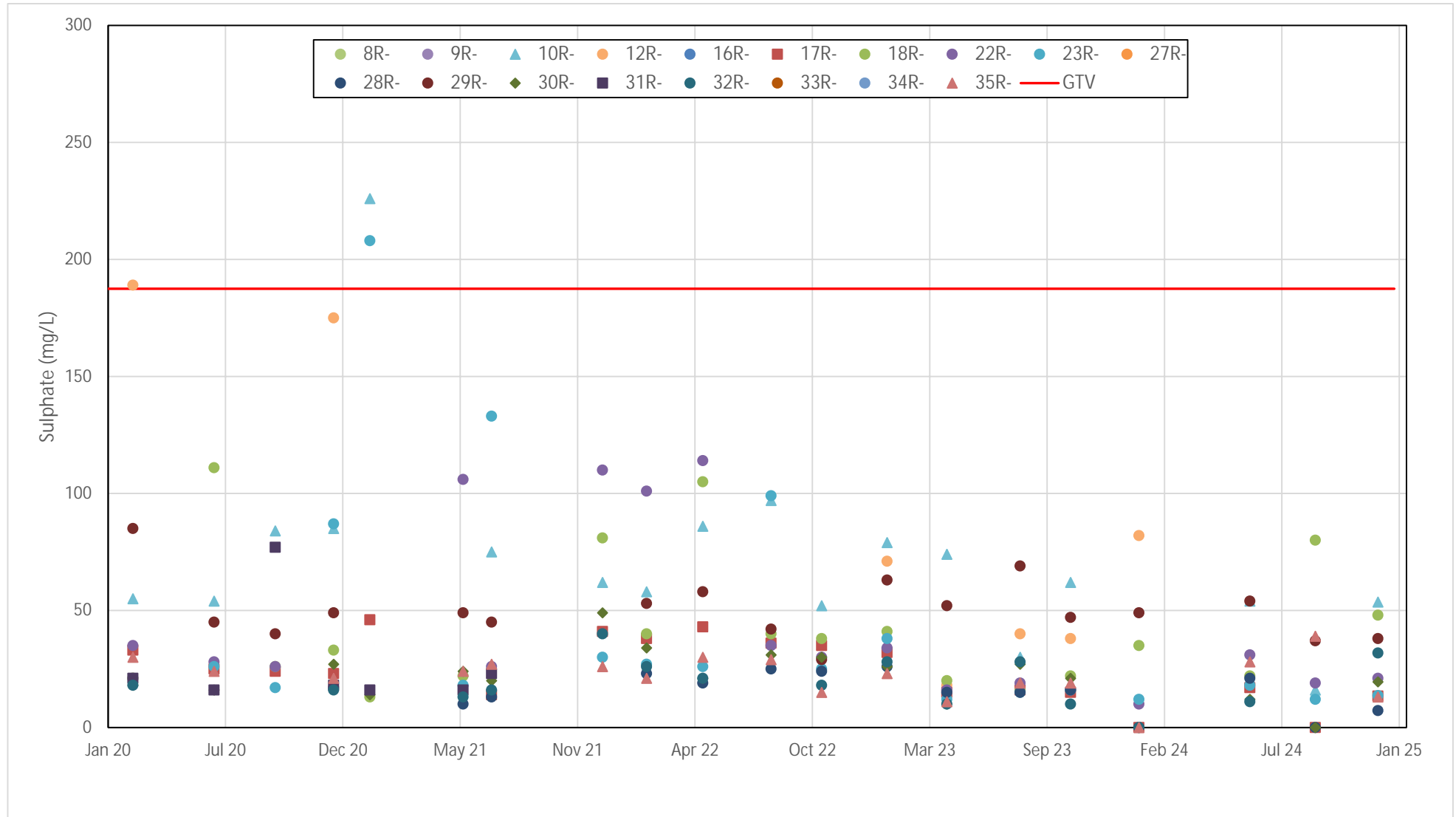
Figure 4.8 Average sulphate concentrations in overburden boreholes in 2024



Client: Boliden_TaraMines_DAC

Site: Tara Mines

Figure 4.9 Average sulphate concentrations in bedrock boreholes in 2024



Client: Boliden_TaraMines_DAC

Site: Tara Mines

Figure 4.10 Sulphate concentrations in domestic wells

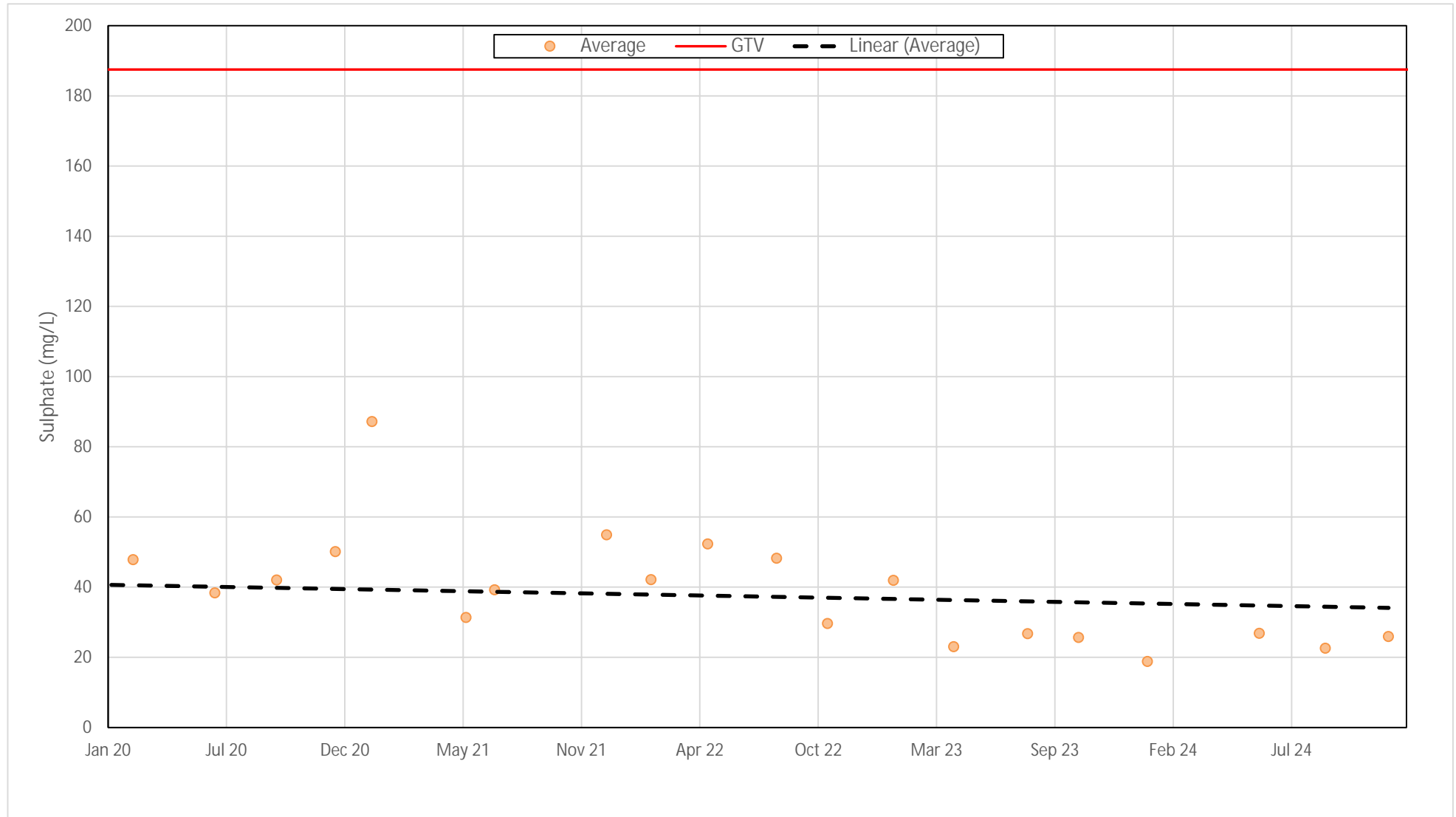
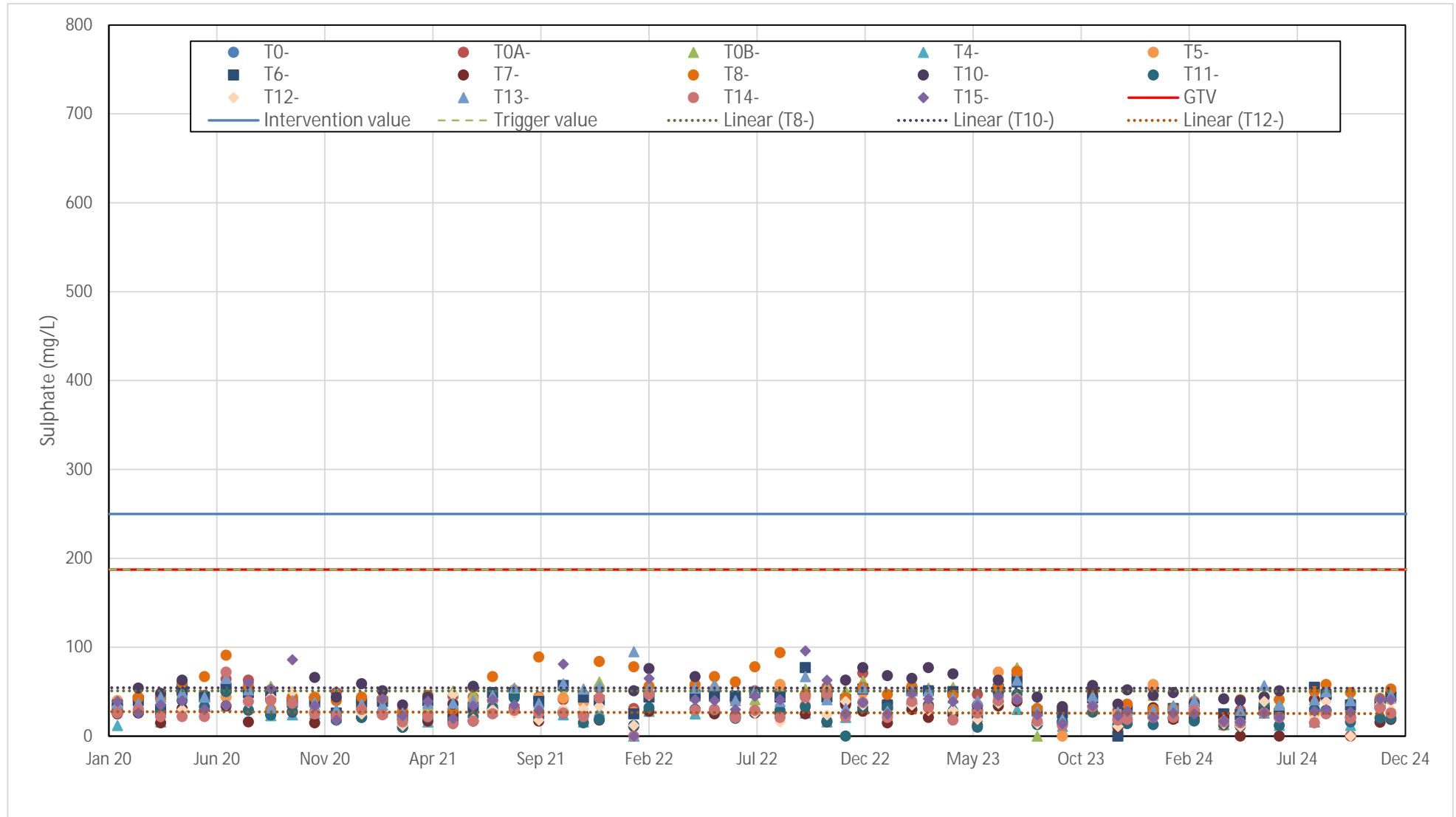


Figure 4.11 Average sulphate concentrations in domestic wells and 5-year trend

Client: Boliden_TaraMines_DAC

Site: Tara Mines



Client: Boliden_TaraMines_DAC

Site: Tara Mines

Figure 4.12 Sulphate concentrations in surface water

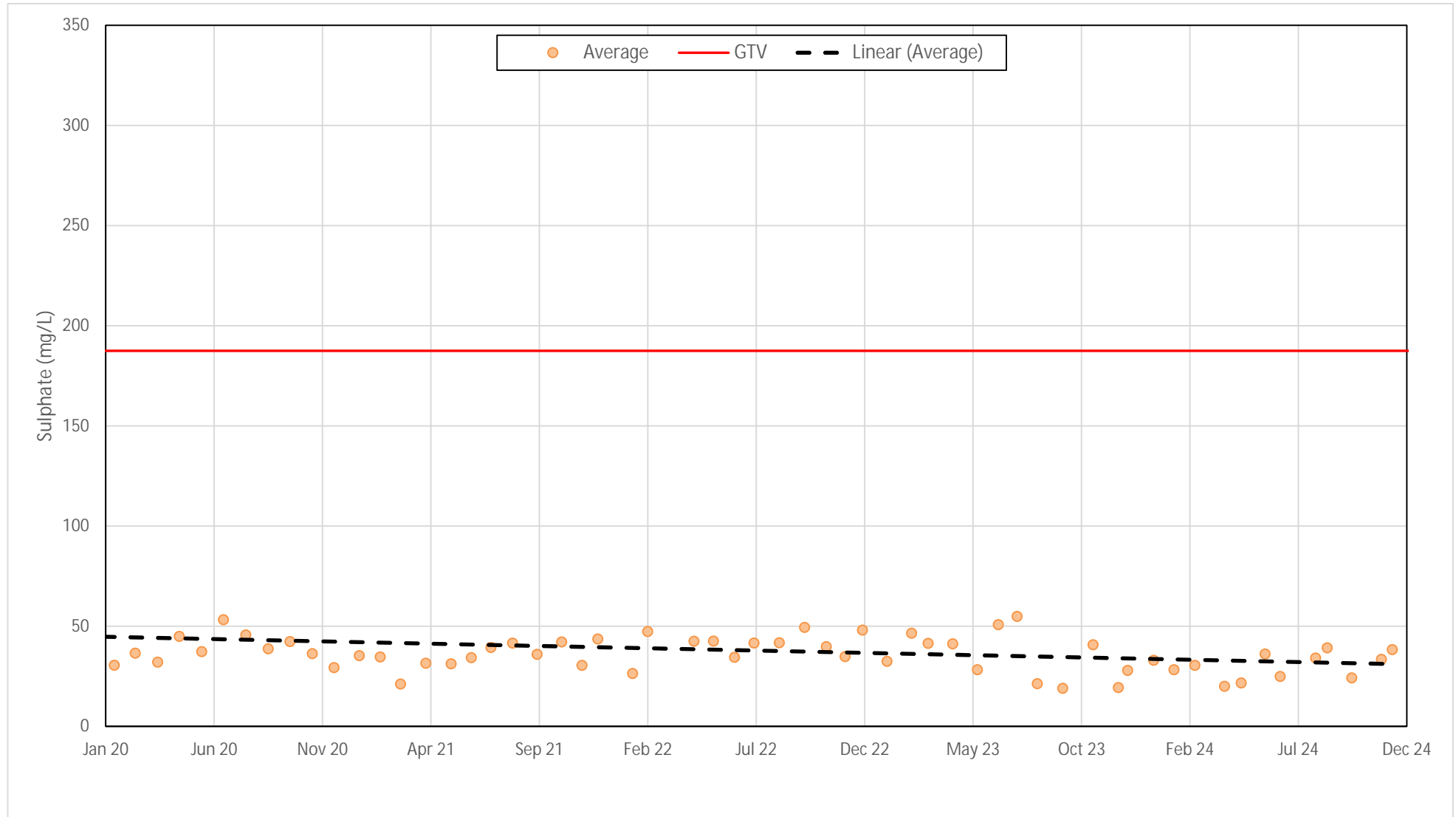
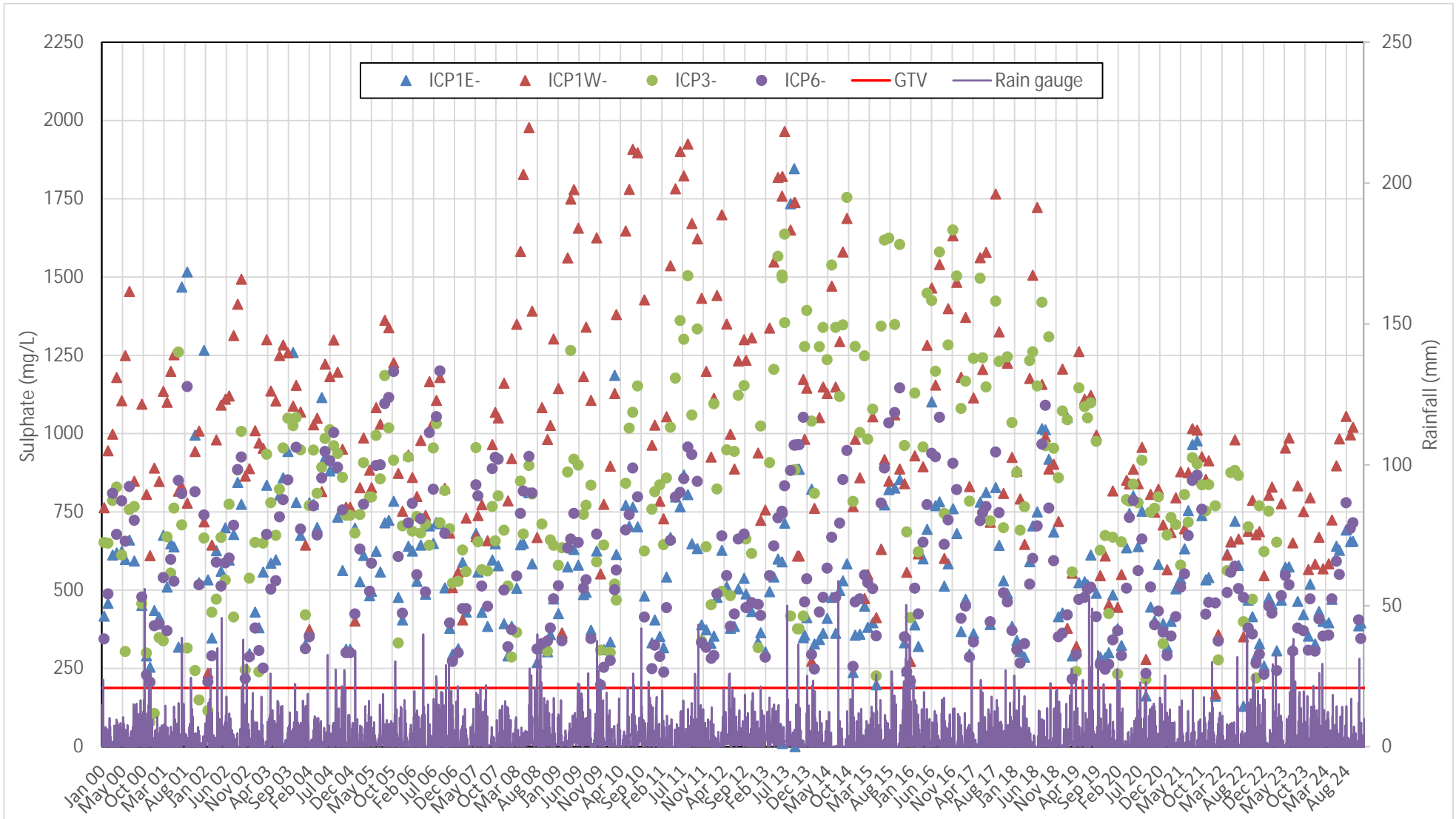


Figure 4.13 Average sulphate concentrations in surface water and 5-year trend

Client: Boliden_TaraMines_DAC

Site: Tara Mines



Client: Boliden_TaraMines_DAC

Site: Tara Mines

Figure 4.14 Sulphate concentrations in the interceptor channel

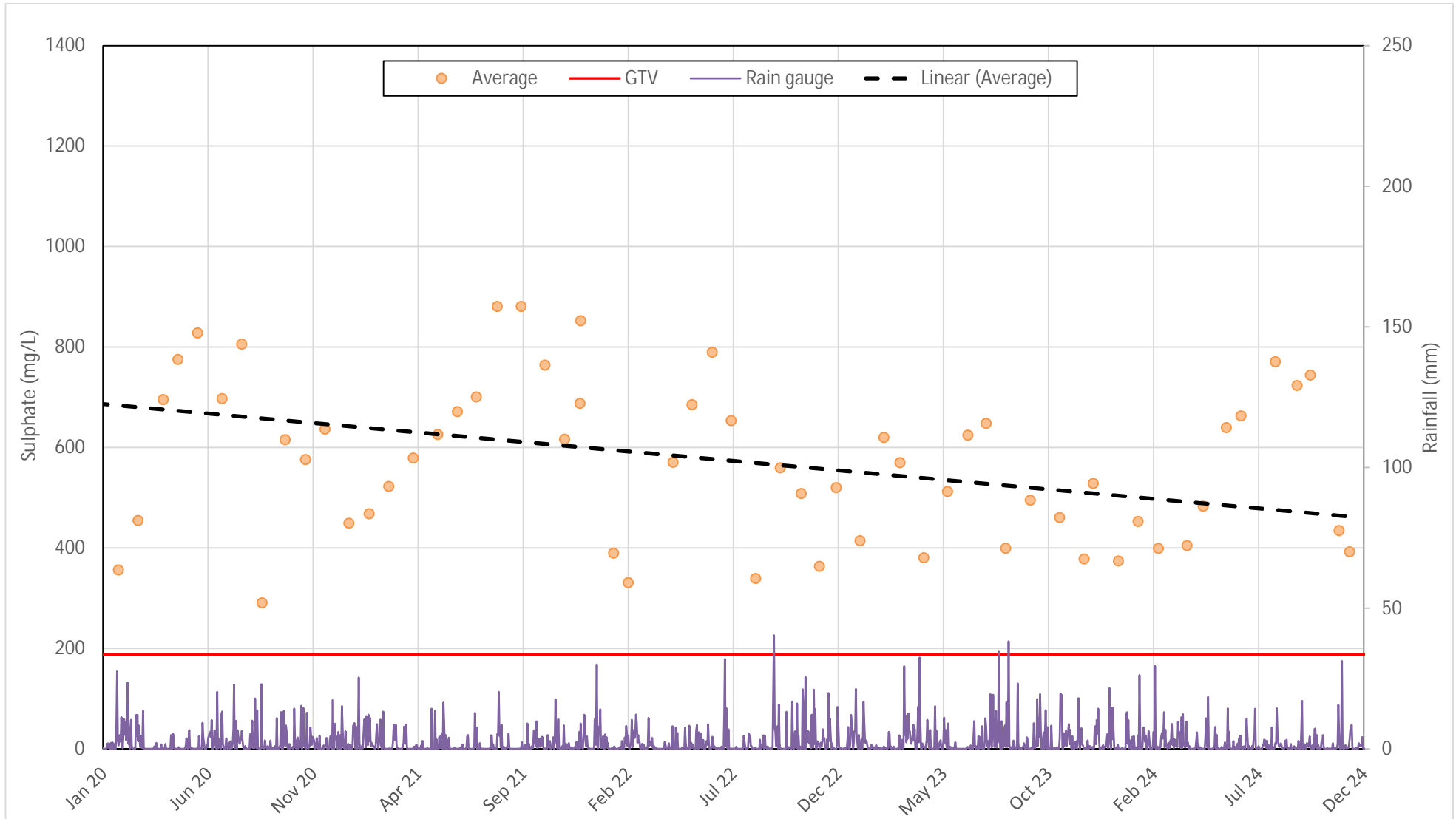
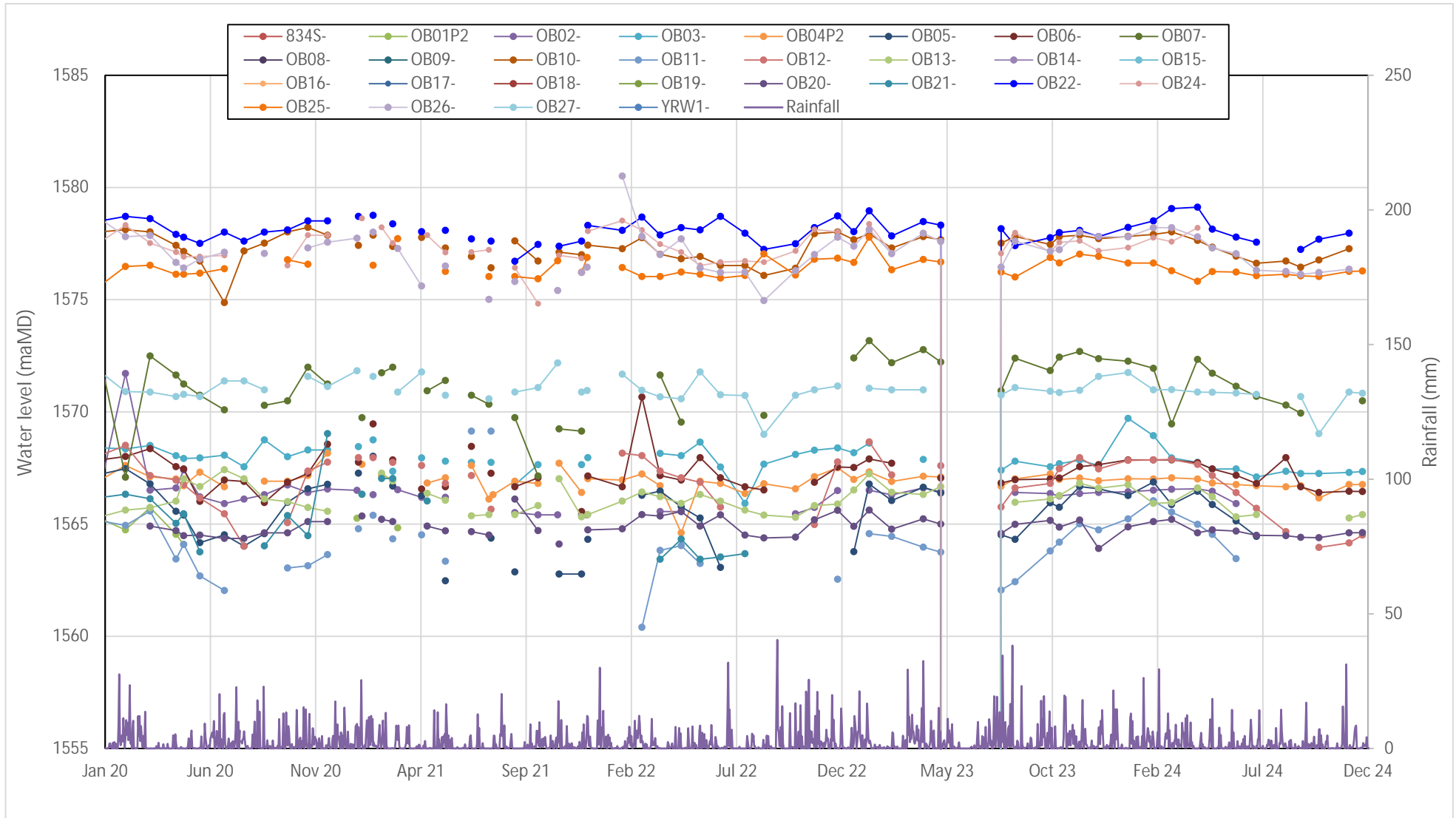


Figure 4.15 Average sulphate concentrations in the interceptor channel and 5-year trend

Client: Boliden_TaraMines_DAC

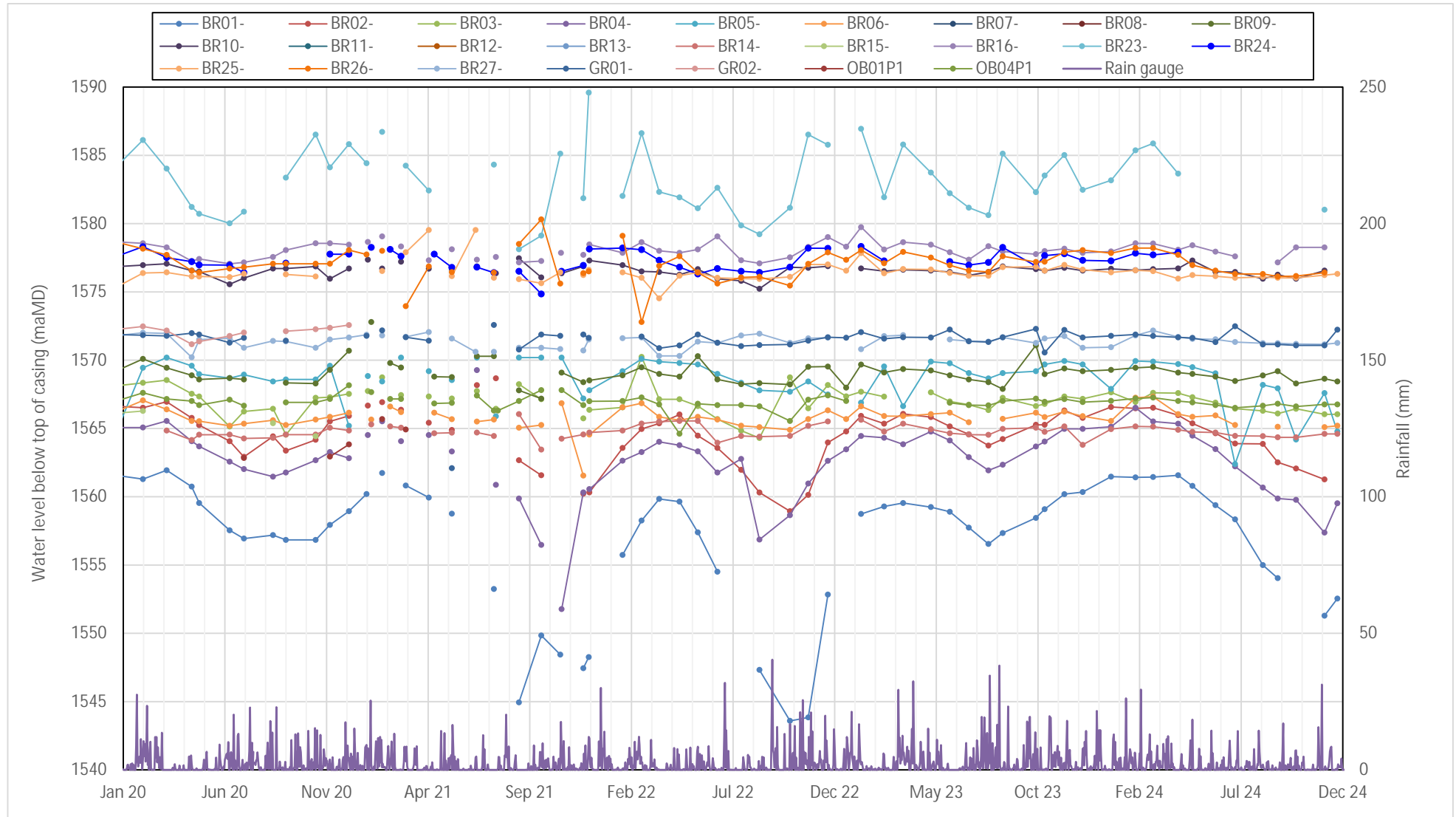
Site: Tara Mines



Client: Boliden_TaraMines_DAC

Site: Tara Mines

Figure 4.16 Groundwater level hydrograph for overburden boreholes



Client: Boliden_TaraMines_DAC

Site: Tara Mines

Figure 4.17 Groundwater level hydrograph for bedrock boreholes

LEGEND

Legend

- Superficial Deposits Monitoring Borehole
- Tara Mines
- 2024-11 OB GWL
- Alluvium
- Cut over raised peat
- Gravels derived from Lower Palaeozoic sandstones and shales
- Gravels derived from Limestones
- Kartsified bedrock outcrop or subcrop
- Lacustrine sediments
- Bedrock outcrop or subcrop
- Till derived from Lower Palaeozoic sandstones and shales
- Till derived from limestones

CREDITS

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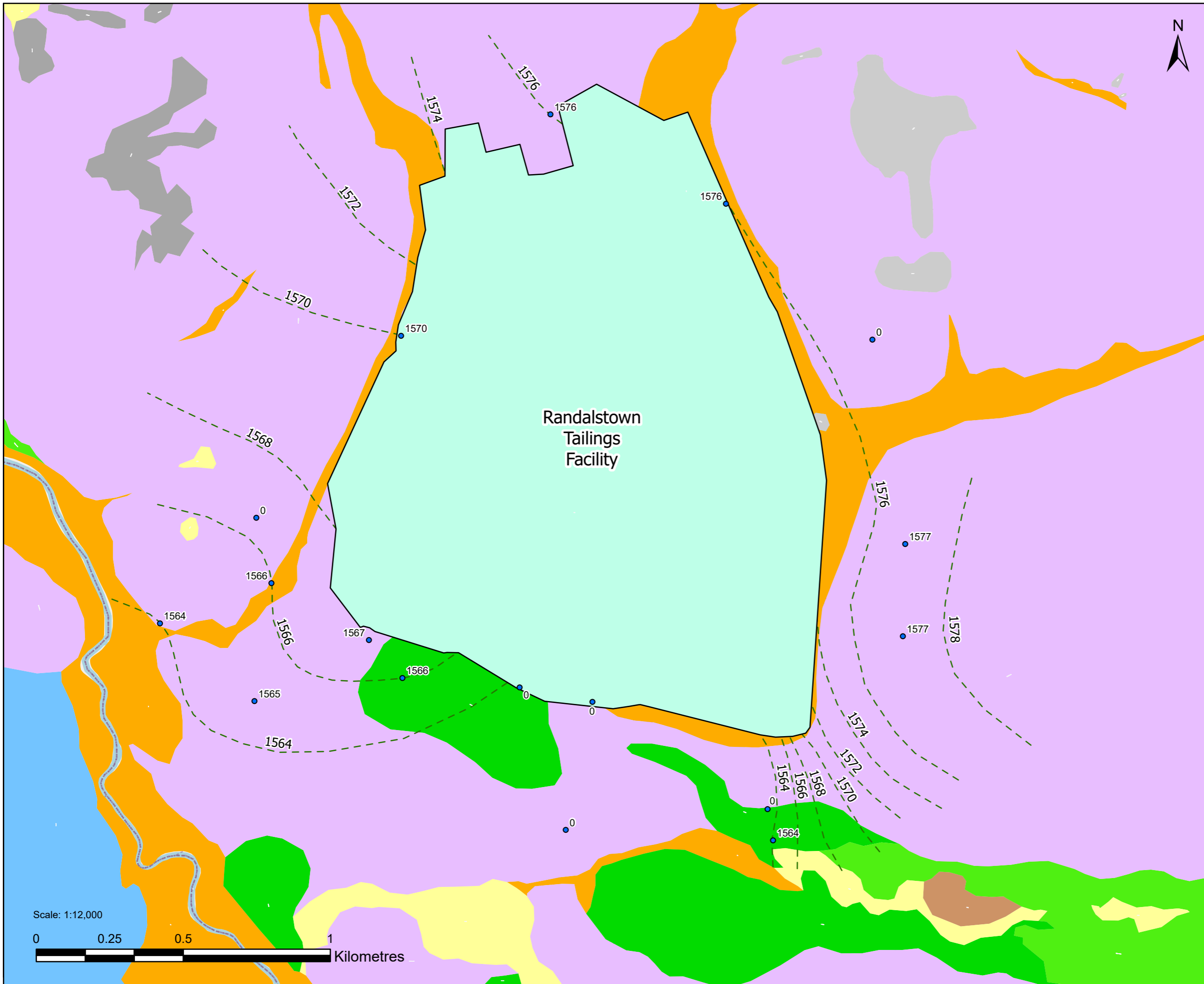
60628825

FIGURE TITLE

Overburden groundwater level contours (November 2024)

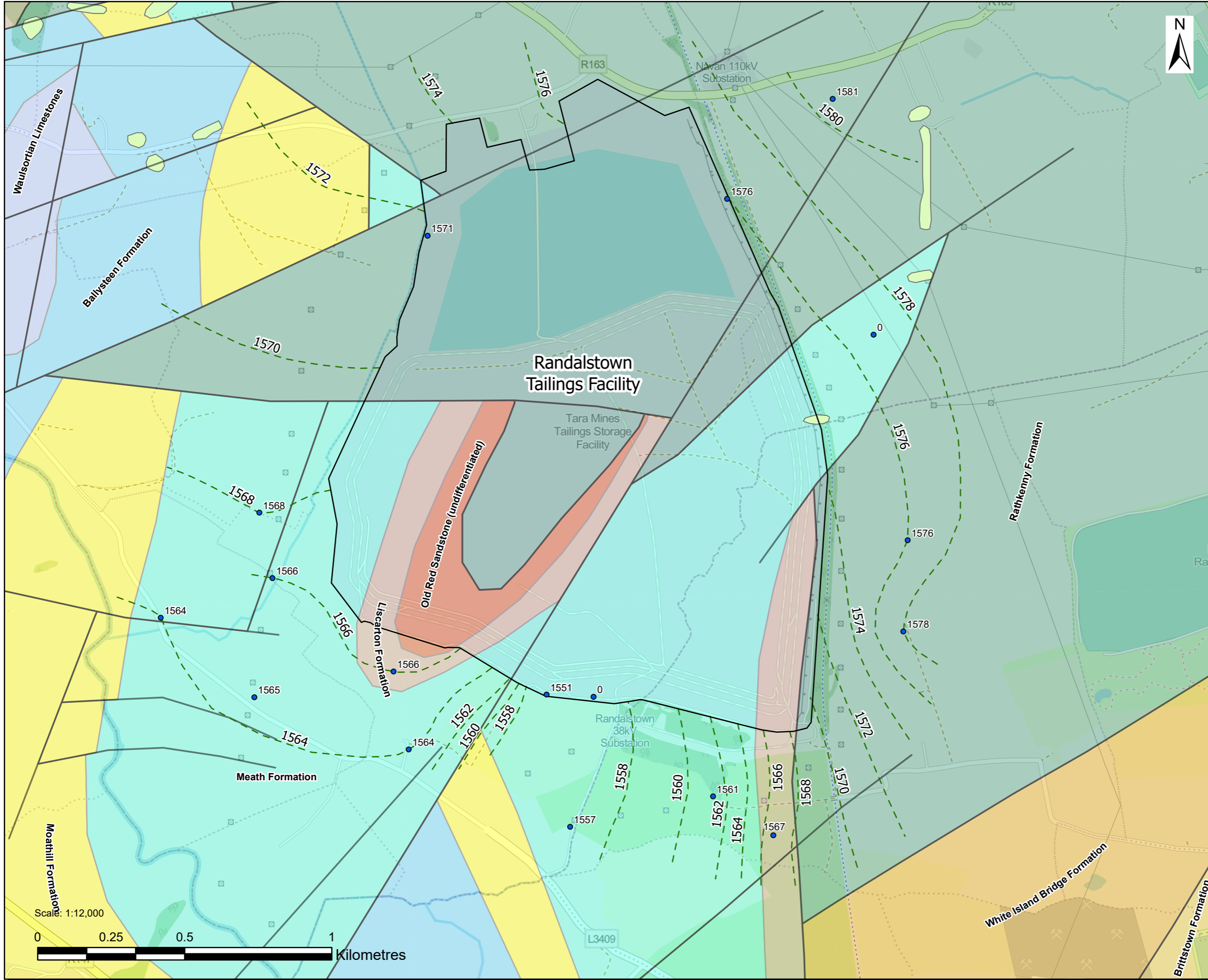
FIGURE NUMBER

Figure 4.18



Scale: 1:12,000

0 0.25 0.5 1 Kilometres



LEGEND

- Legend**
- Bedrock Monitoring Borehole
 - Tara Mines
 - 2024-11 BR GWL

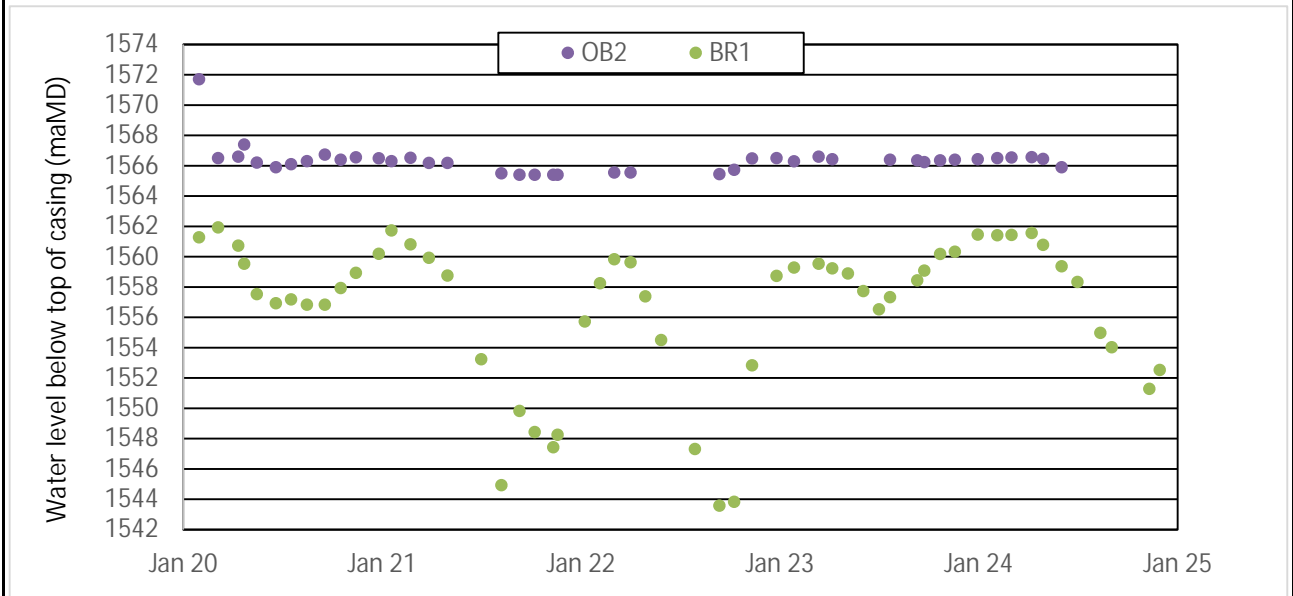
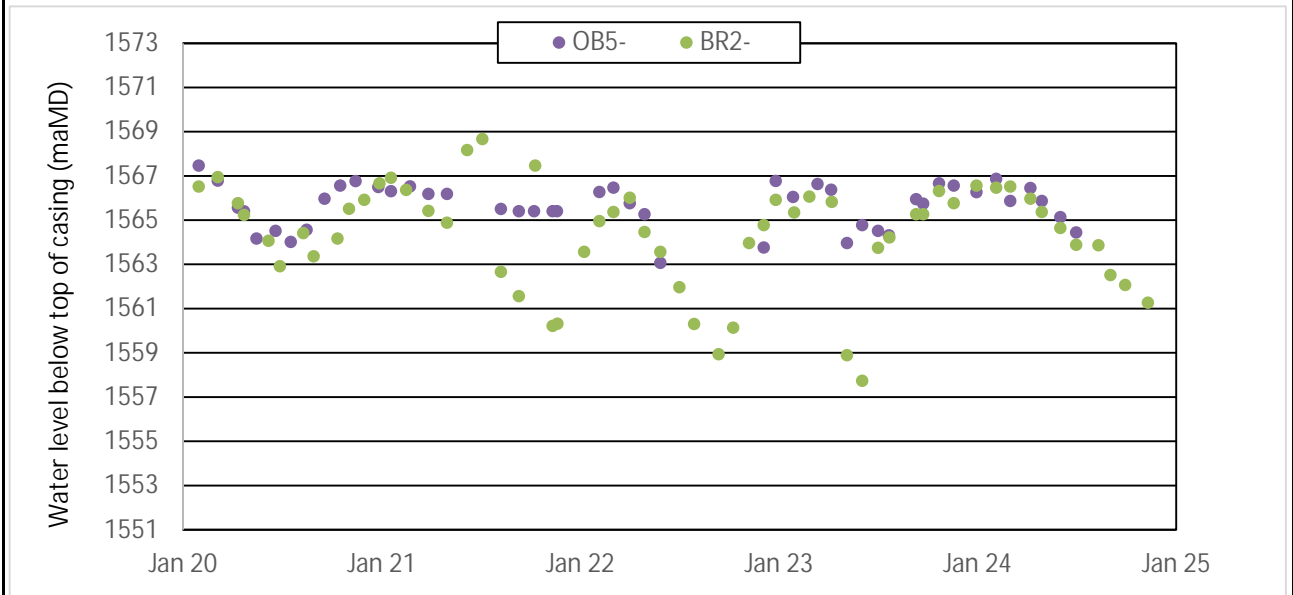
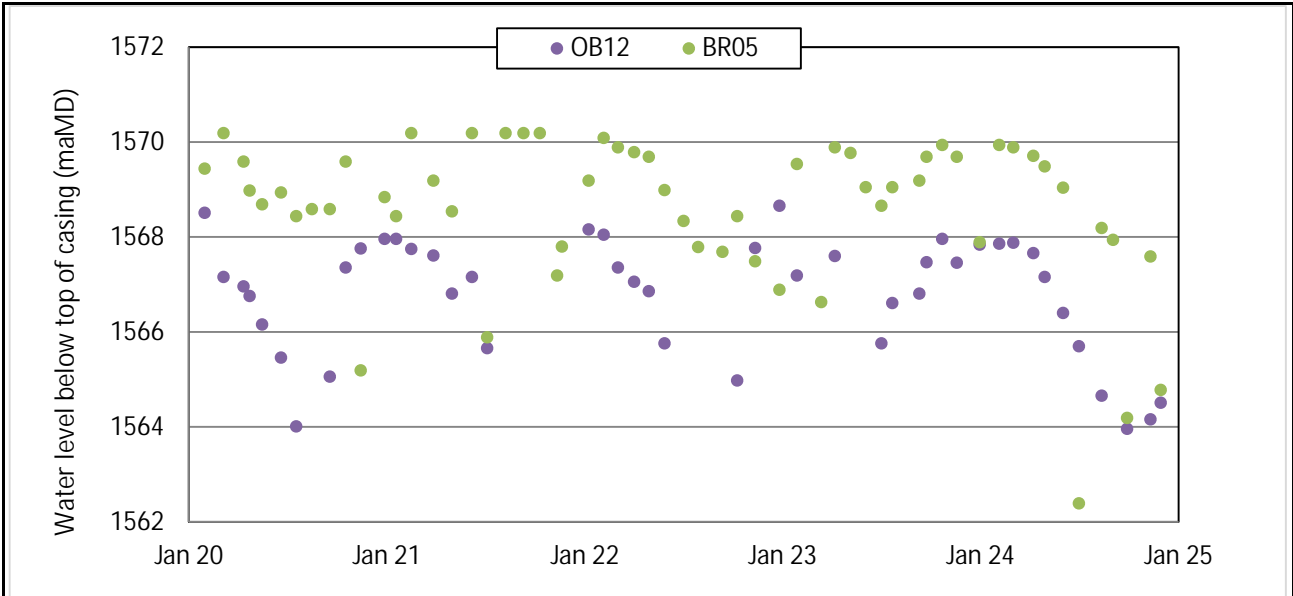
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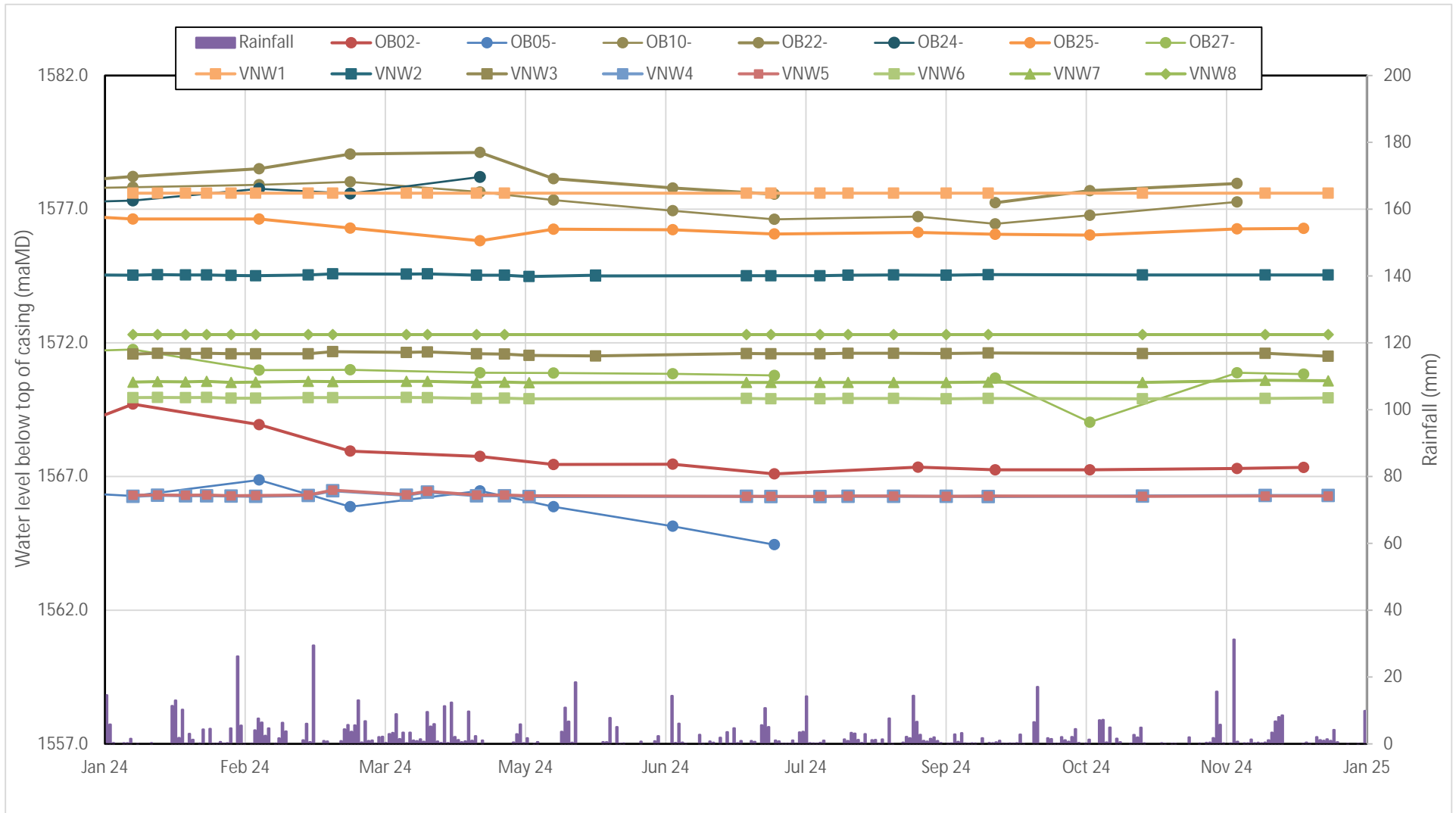
ISSUE PURPOSE
ANNUAL MONITORING REPORT

PROJECT NUMBER
60628825

FIGURE TITLE
Bedrock groundwater level contours (November 2024)

FIGURE NUMBER
Figure 4.19



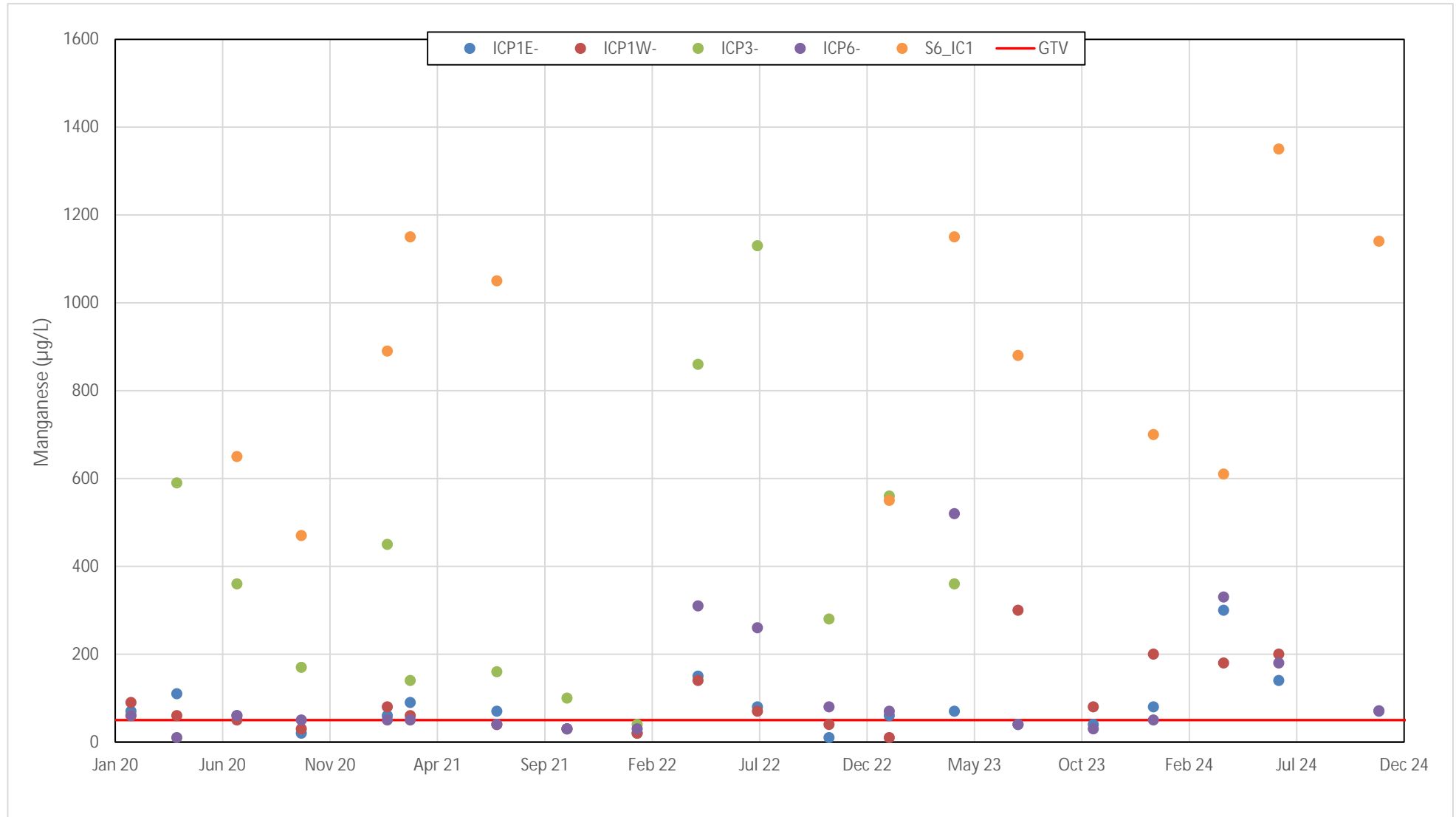


Client: Boliden_TaraMines_DAC

Site: Tara Mines

Figure 4.21 Comparison of interceptor channel and overburden water levels

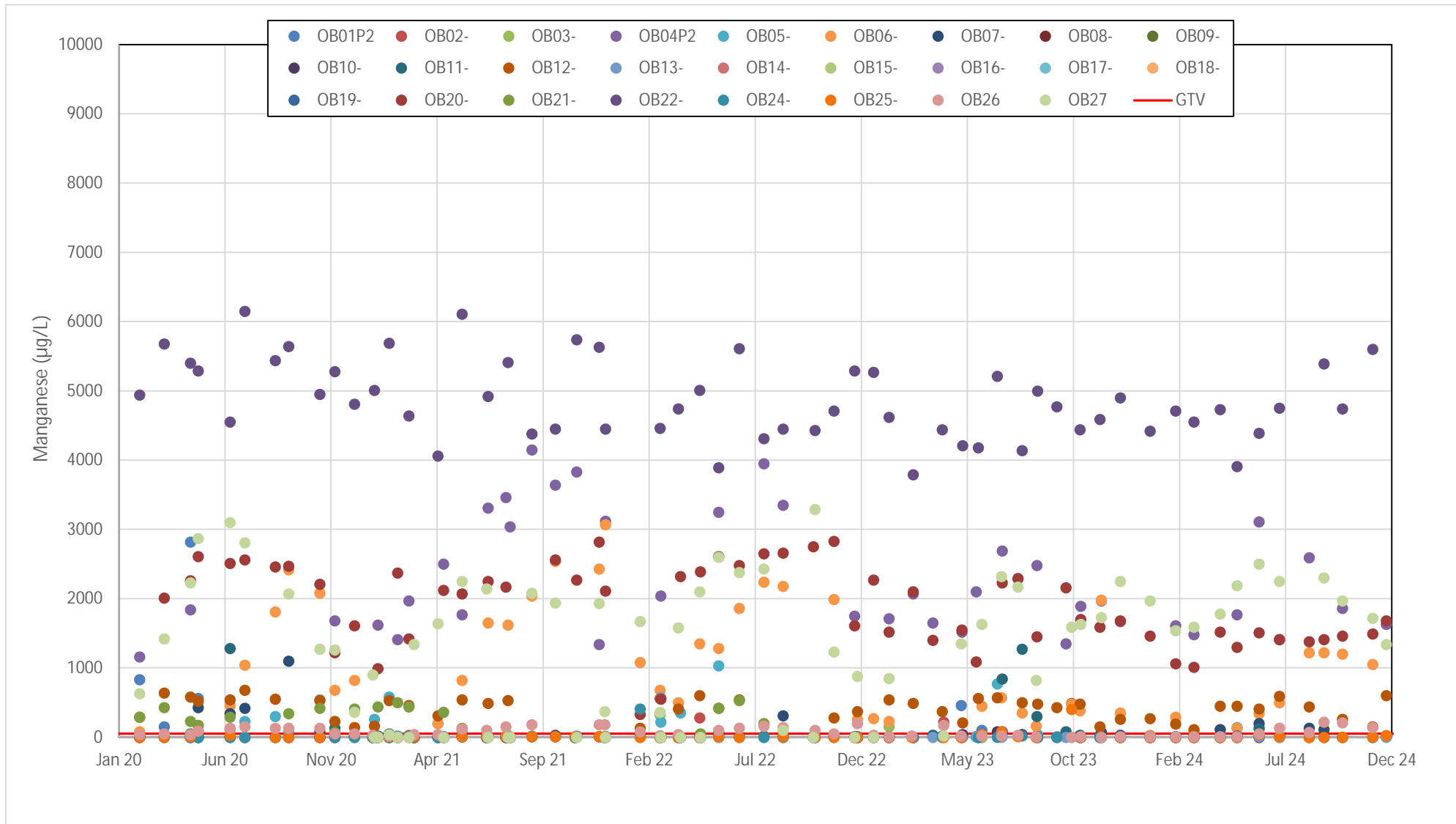
Appendix A Manganese



Client: Boliden_TaraMines_DAC

Site: Tara Mines

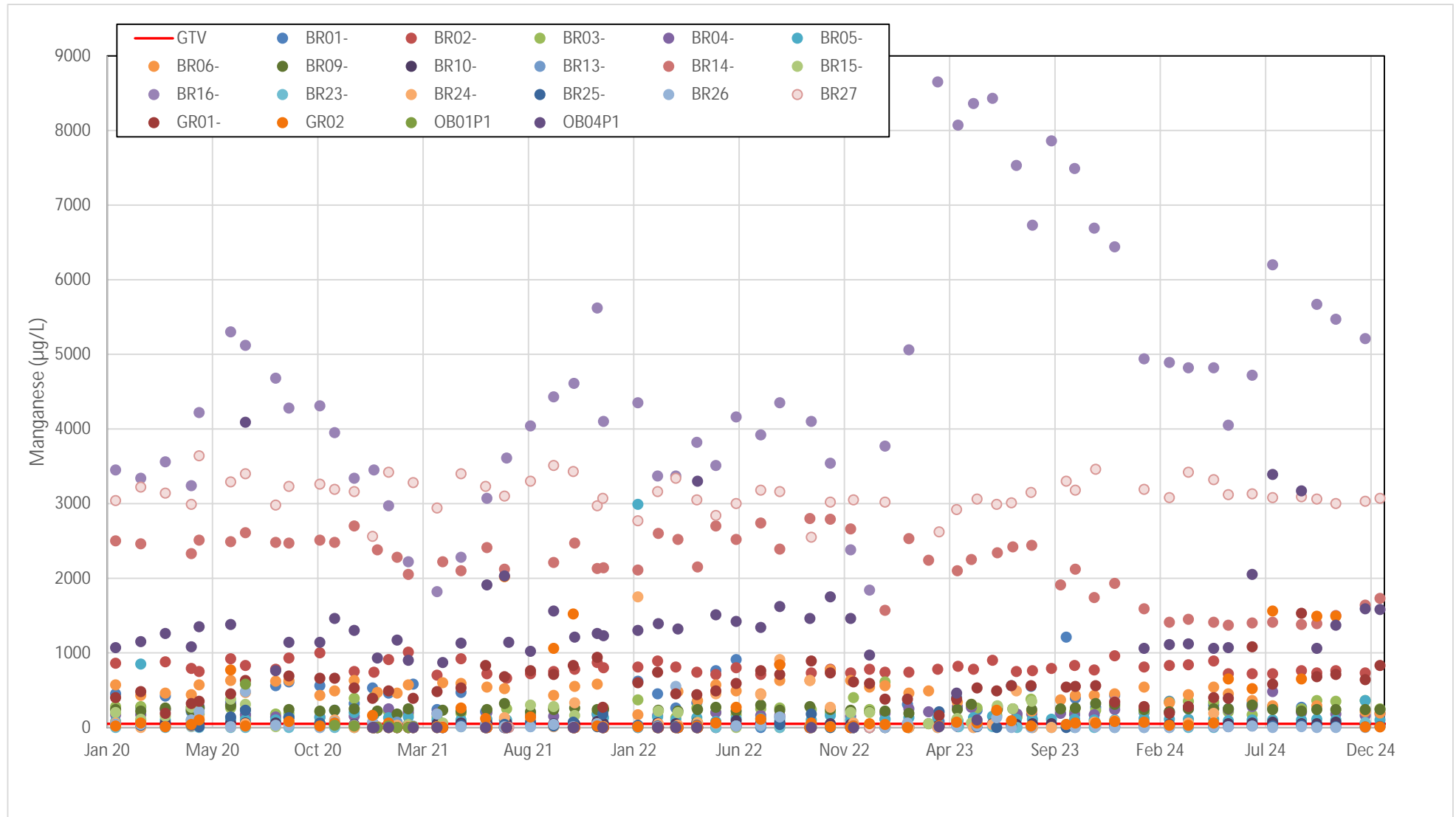
Appendix A.1 Manganese concentrations in the interceptor channel



Client: Boliden_TaraMines_DAC

Site: Tara Mines

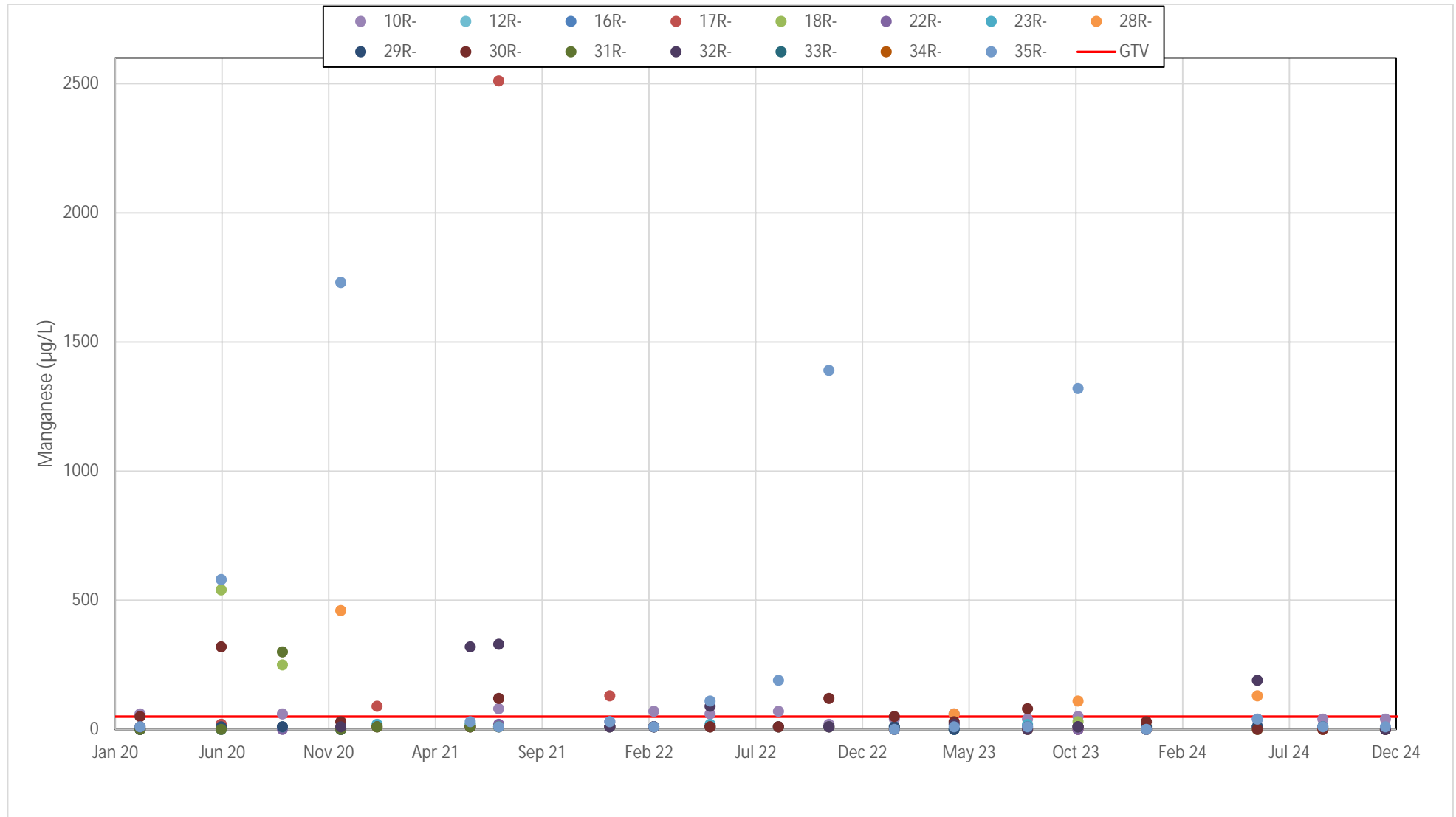
Appendix A.2 Manganese concentrations
in overburden boreholes



Client: Boliden_TaraMines_DAC

Site: Tara Mines

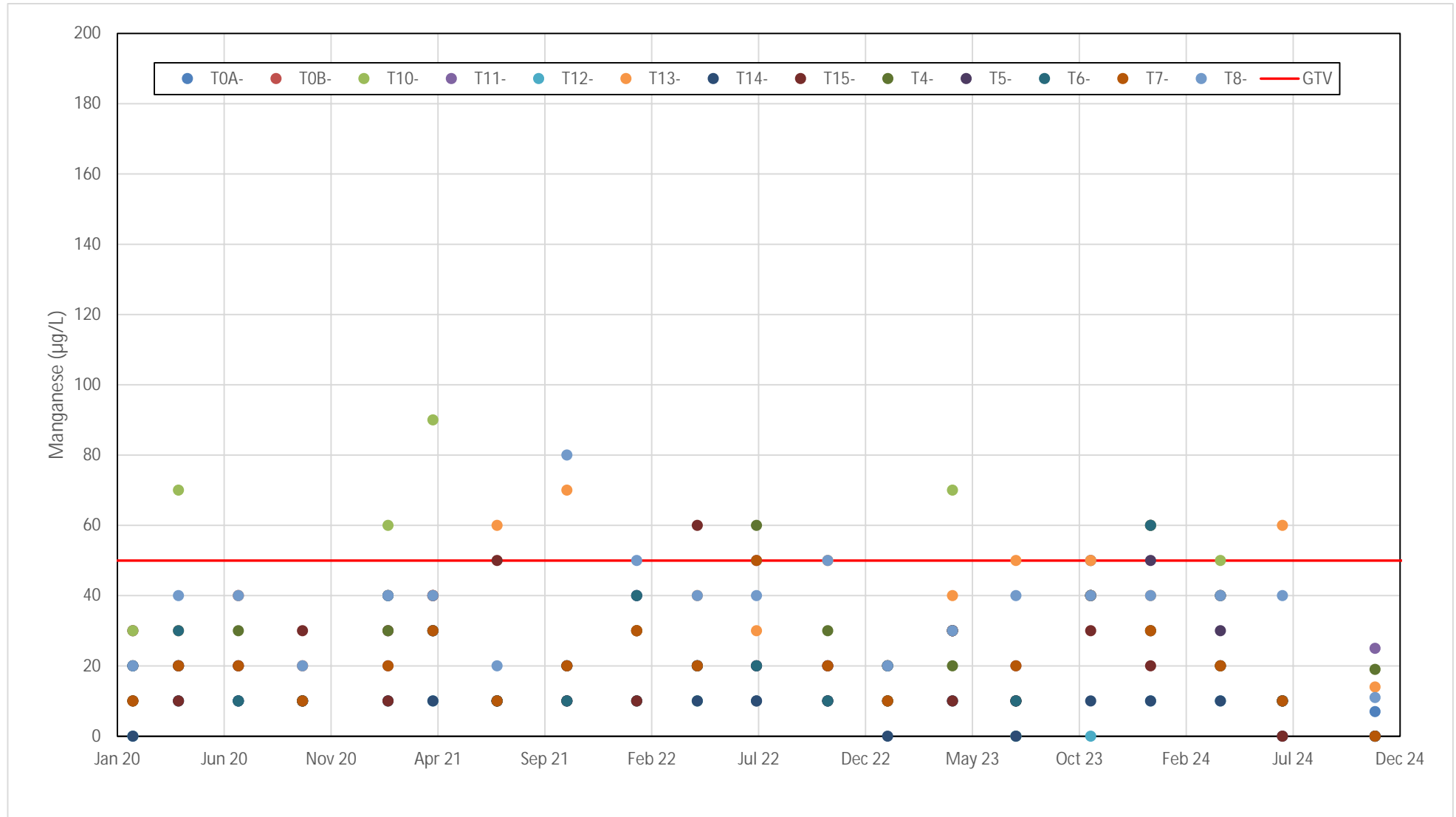
Appendix A.3 Manganese concentrations in bedrock boreholes



Client: Boliden_TaraMines_DAC

Site: Tara Mines

Appendix A.4 Manganese concentrations in domestic wells

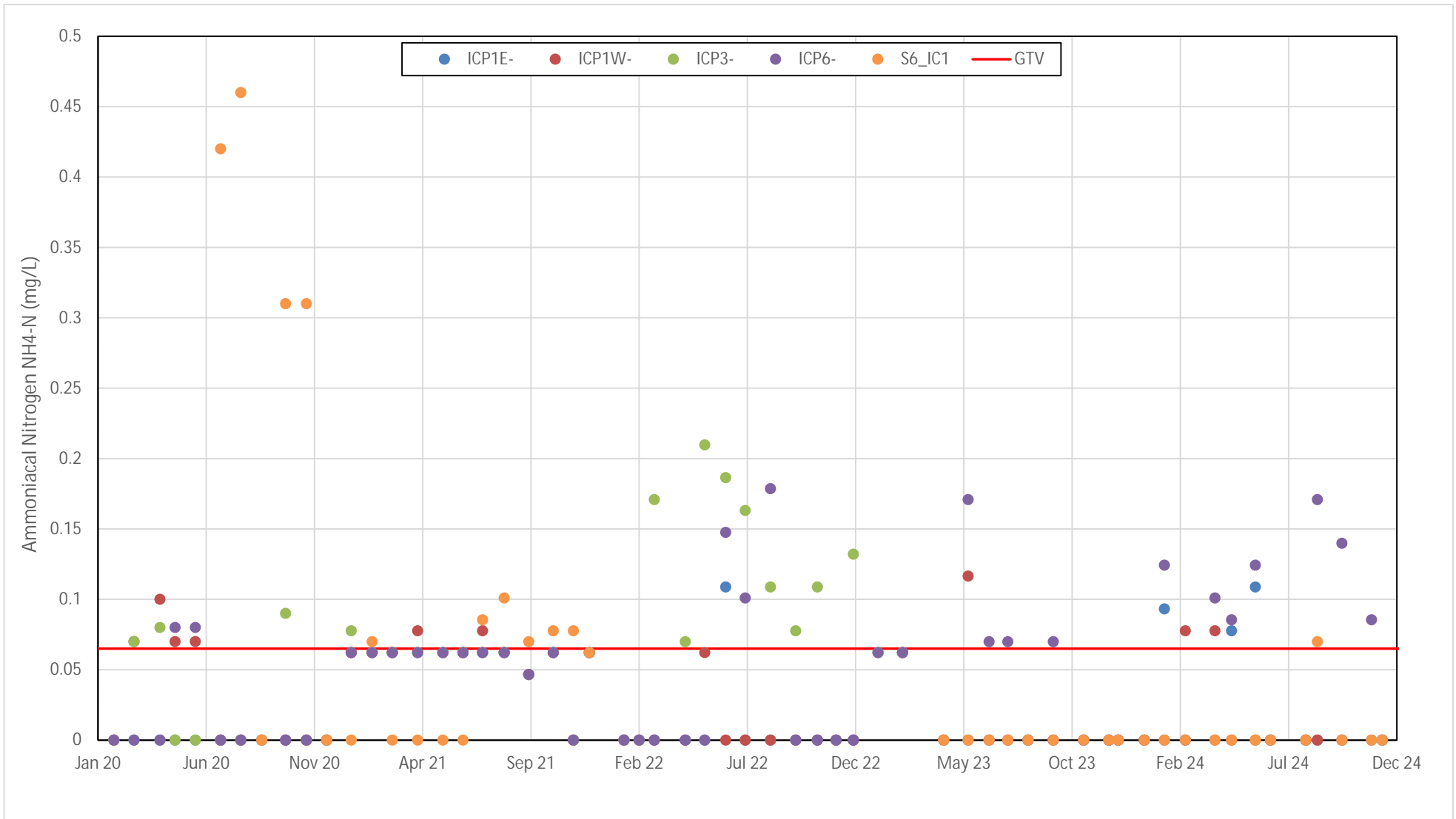


Client: Boliden_TaraMines_DAC

Site: Tara Mines

Appendix A.5 Manganese concentrations in surface water

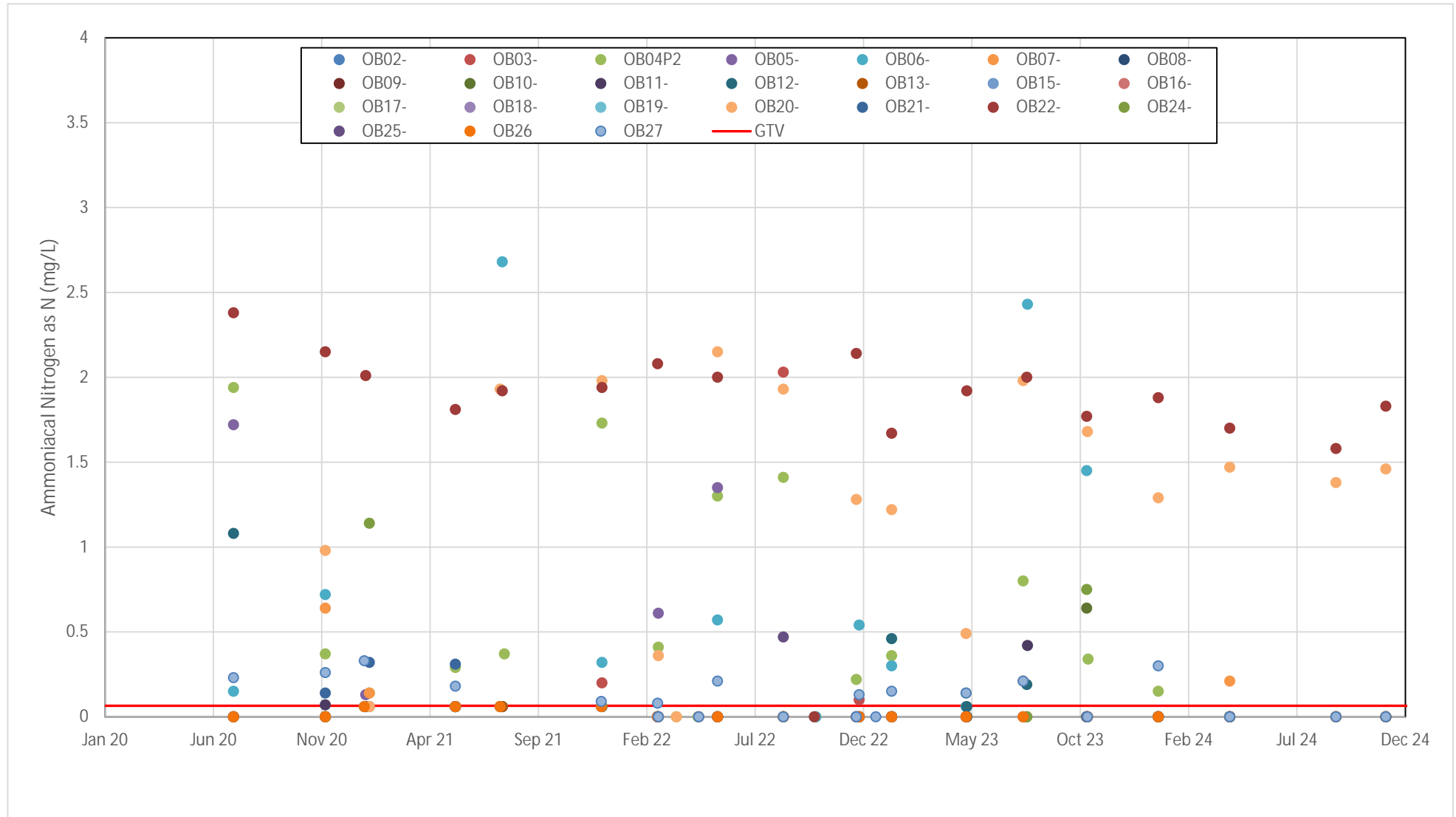
Appendix B Ammoniacal Nitrogen NH_4 as N



Client: Boliden_TaraMines_DAC

Site: Tara Mines

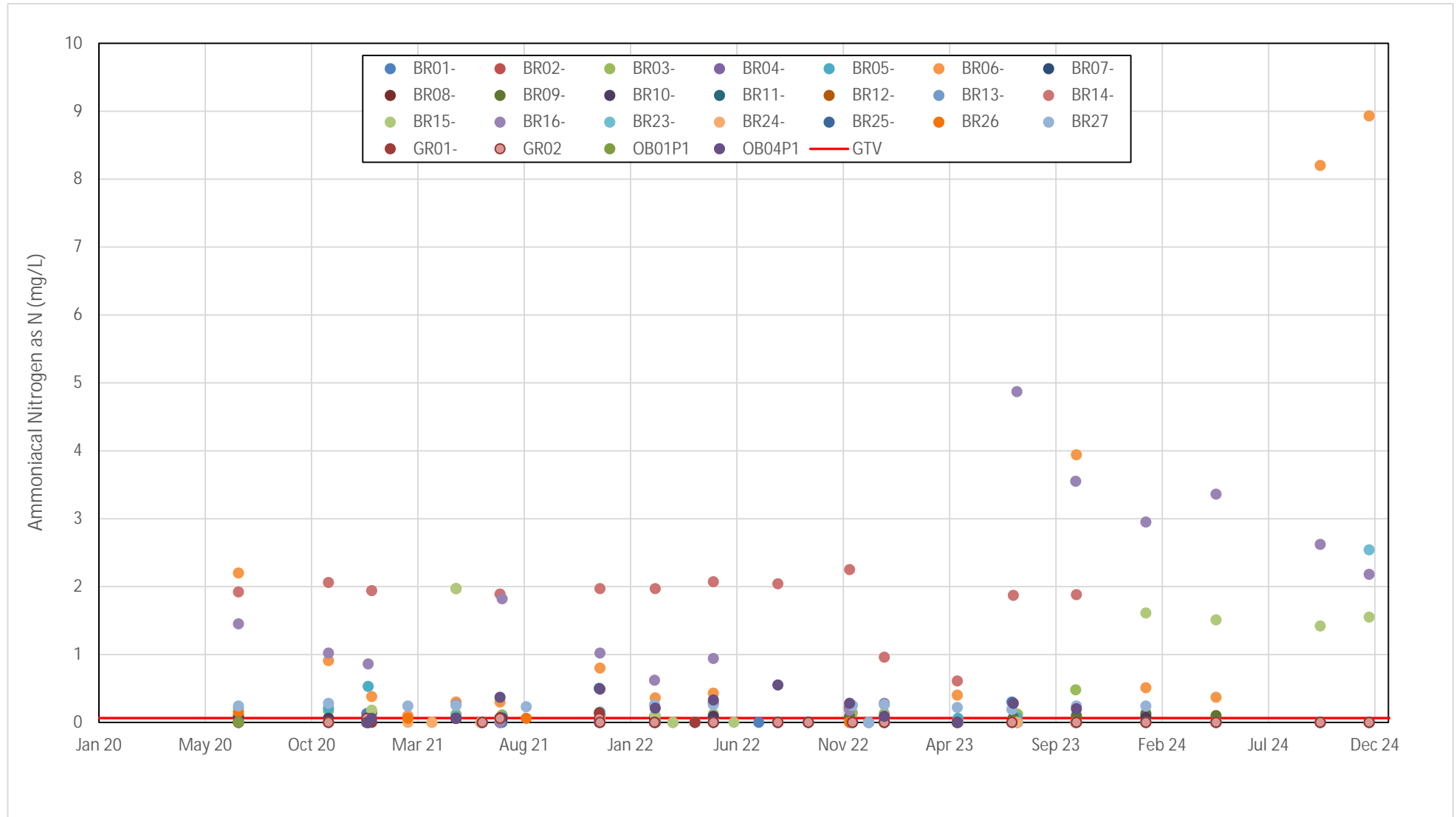
Appendix B.1 Ammoniacal Nitrogen concentrations in the interceptor channel



Client: Boliden_TaraMines_DAC

Site: Tara Mines

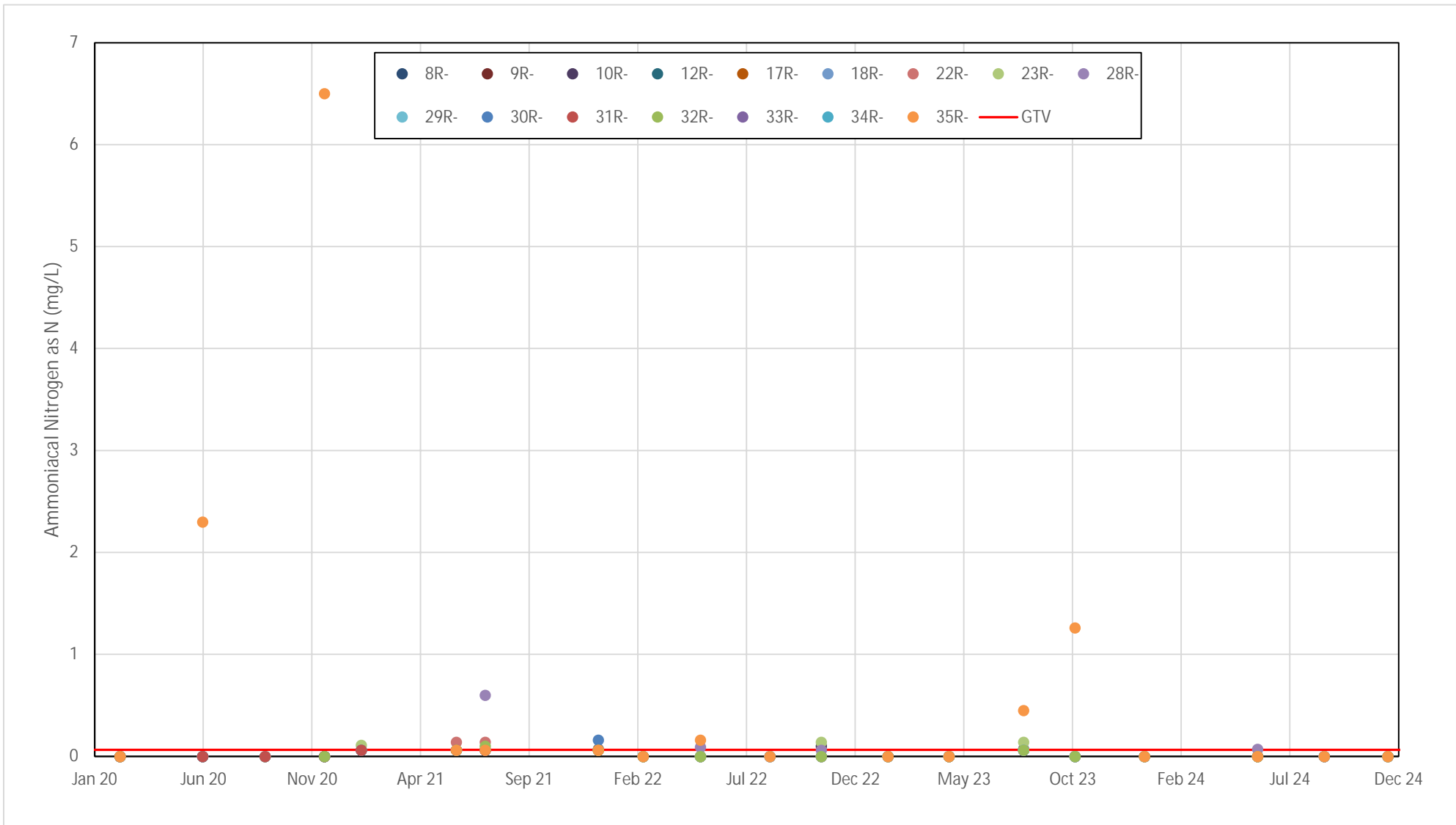
Appendix B.2 Ammoniacal Nitrogen in overburden boreholes



Client: Boliden_TaraMines_DAC

Site: Tara Mines

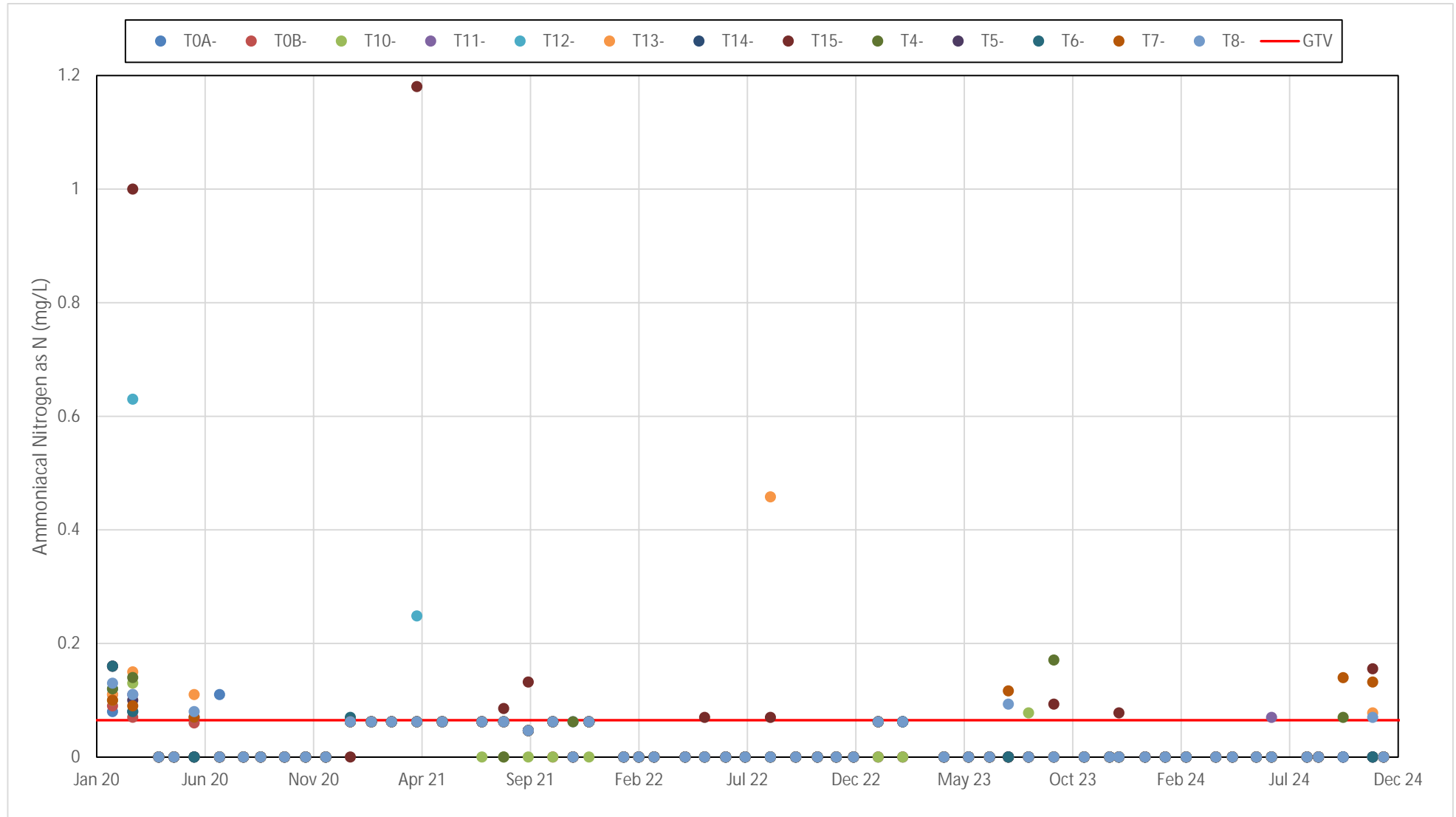
Appendix B.3 Ammoniacal Nitrogen in bedrock boreholes



Client: Boliden_TaraMines_DAC

Site: Tara Mines

Appendix B.4 Ammoniacal Nitrogen in domestic wells

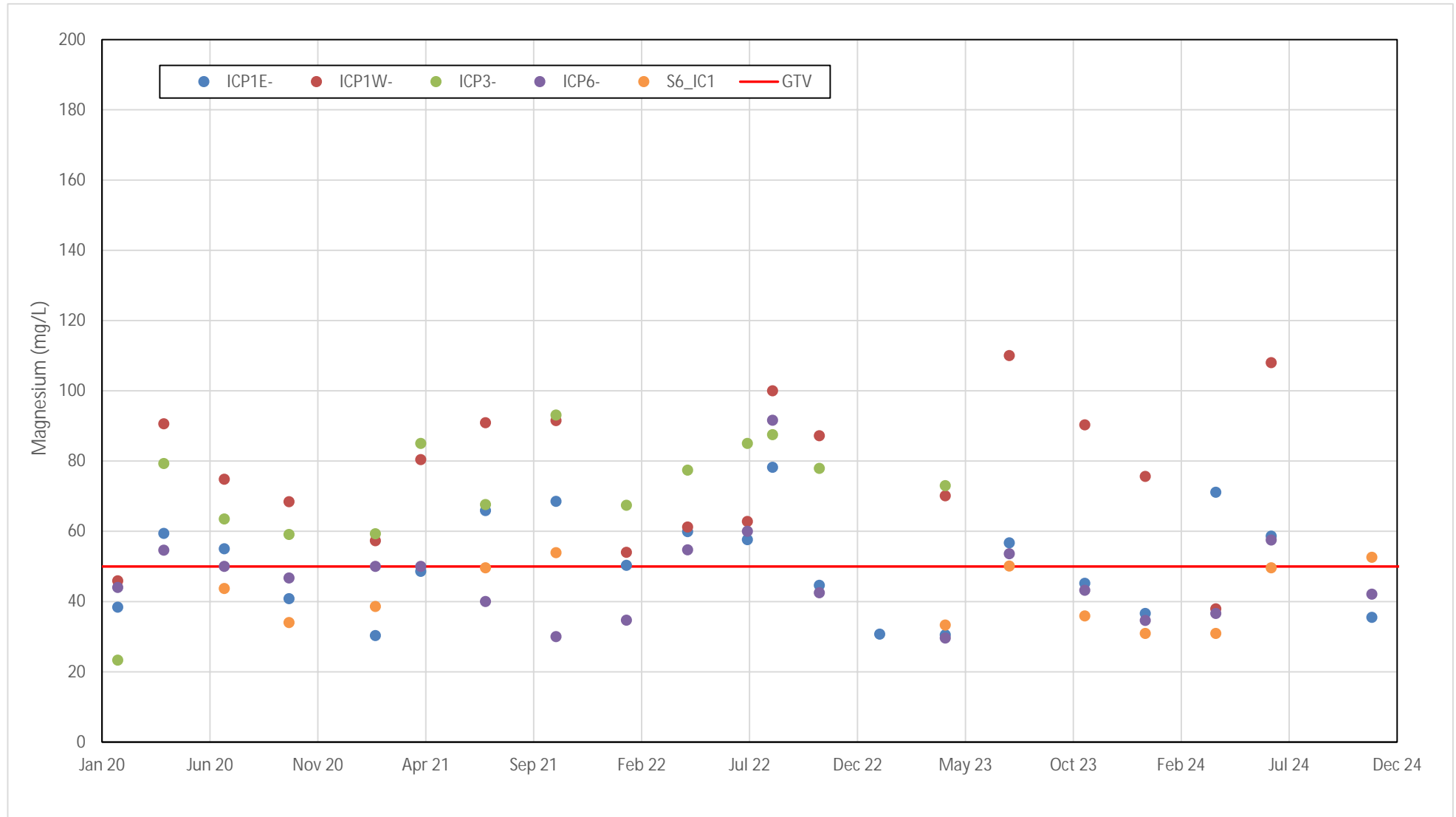


Client: Boliden_TaraMines_DAC

Site: Tara Mines

Appendix B.5 Ammoniacal Nitrogen in surface water

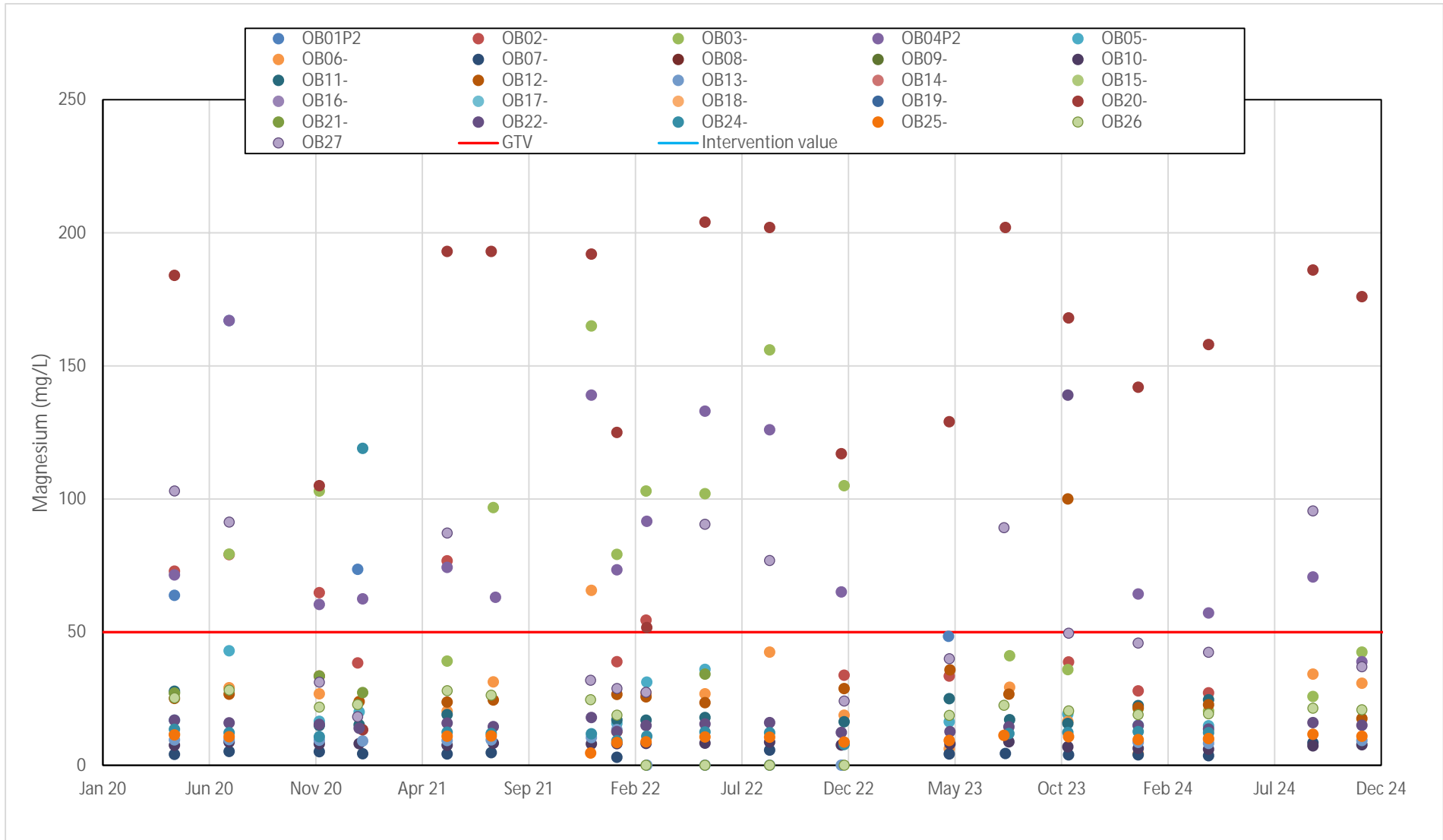
Appendix C Magnesium



Client: Boliden_TaraMines_DAC

Site: Tara Mines

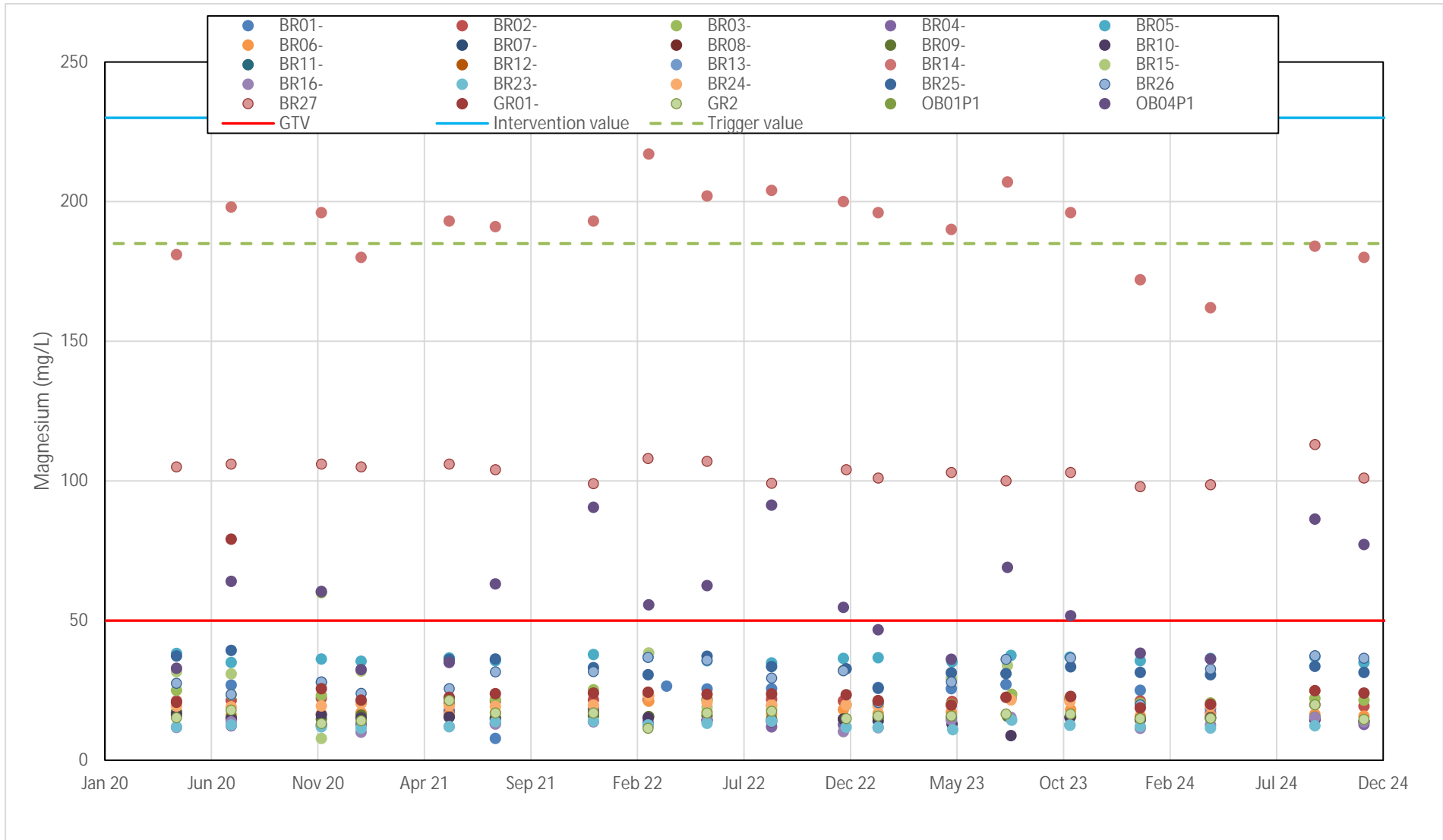
Appendix C.1 Magnesium concentrations in the interceptor channel



Client: Boliden_TaraMines_DAC

Site: Tara Mines

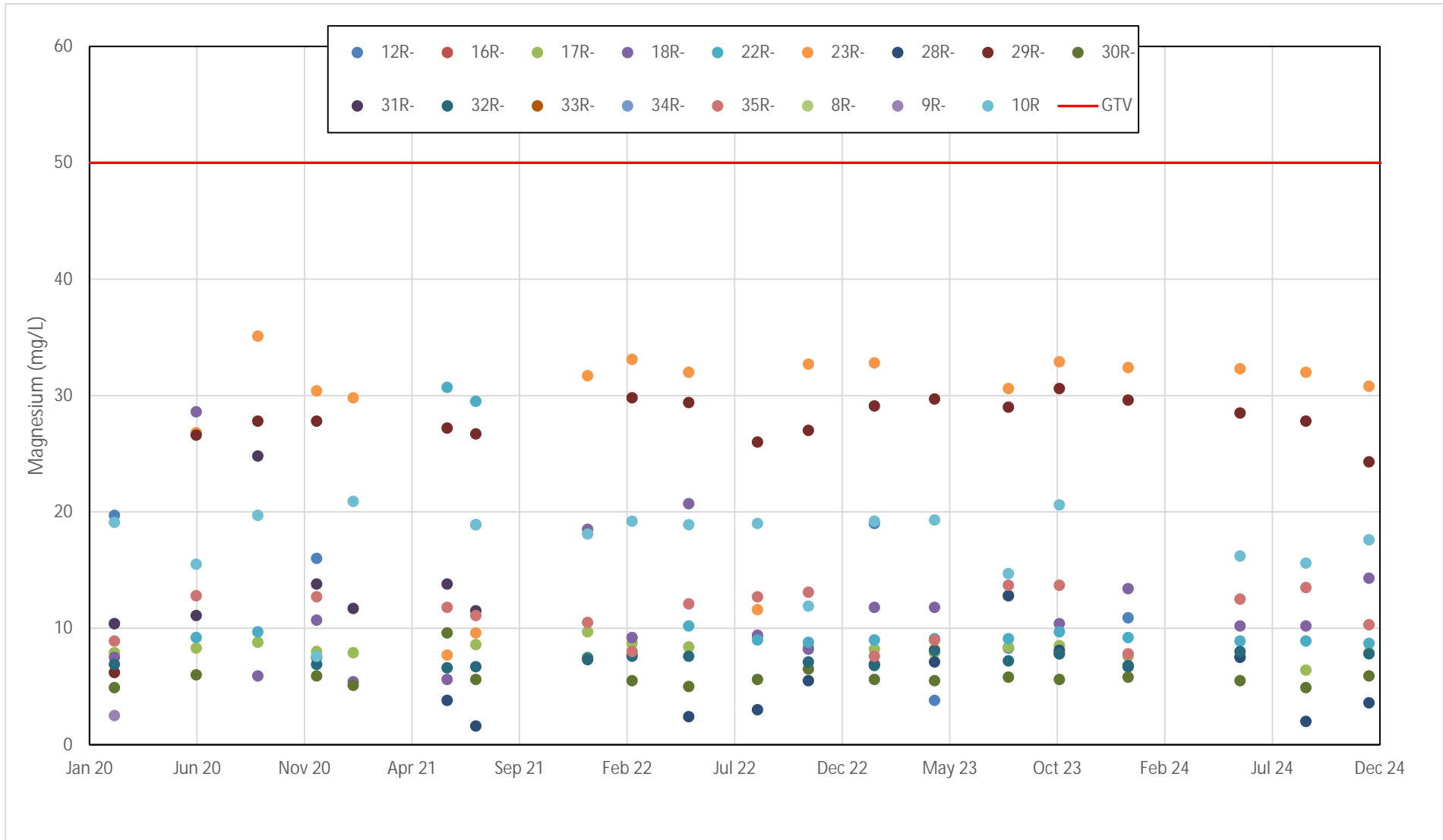
Appendix C.2 Magnesium concentrations in overburden boreholes



Client: Boliden_TaraMines_DAC

Site: Tara Mines

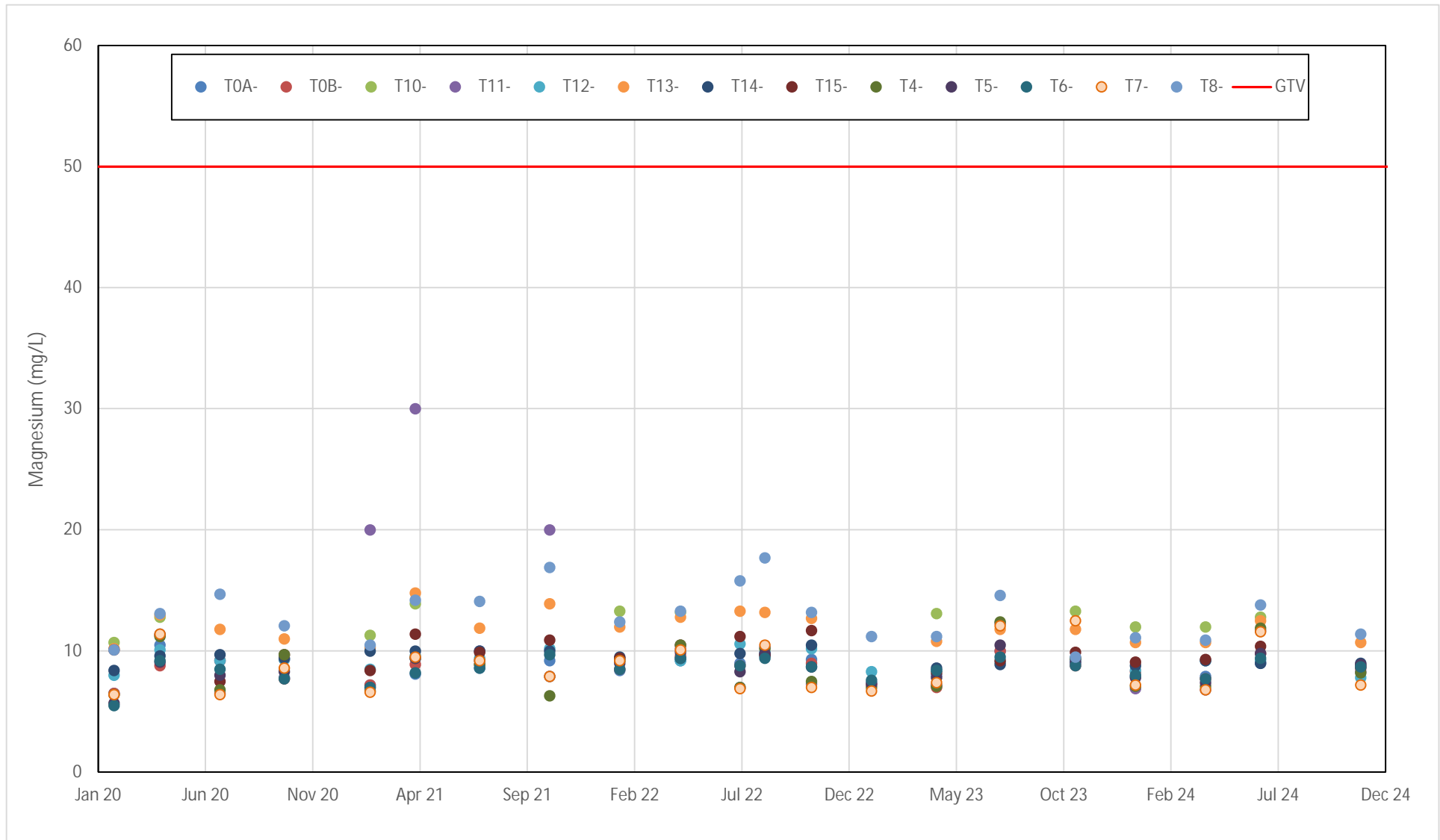
Appendix C.3 Magnesium concentrations in bedrock boreholes



Client: Boliden_TaraMines_DAC

Site: Tara Mines

Appendix C.4 Magnesium concentrations in domestic wells

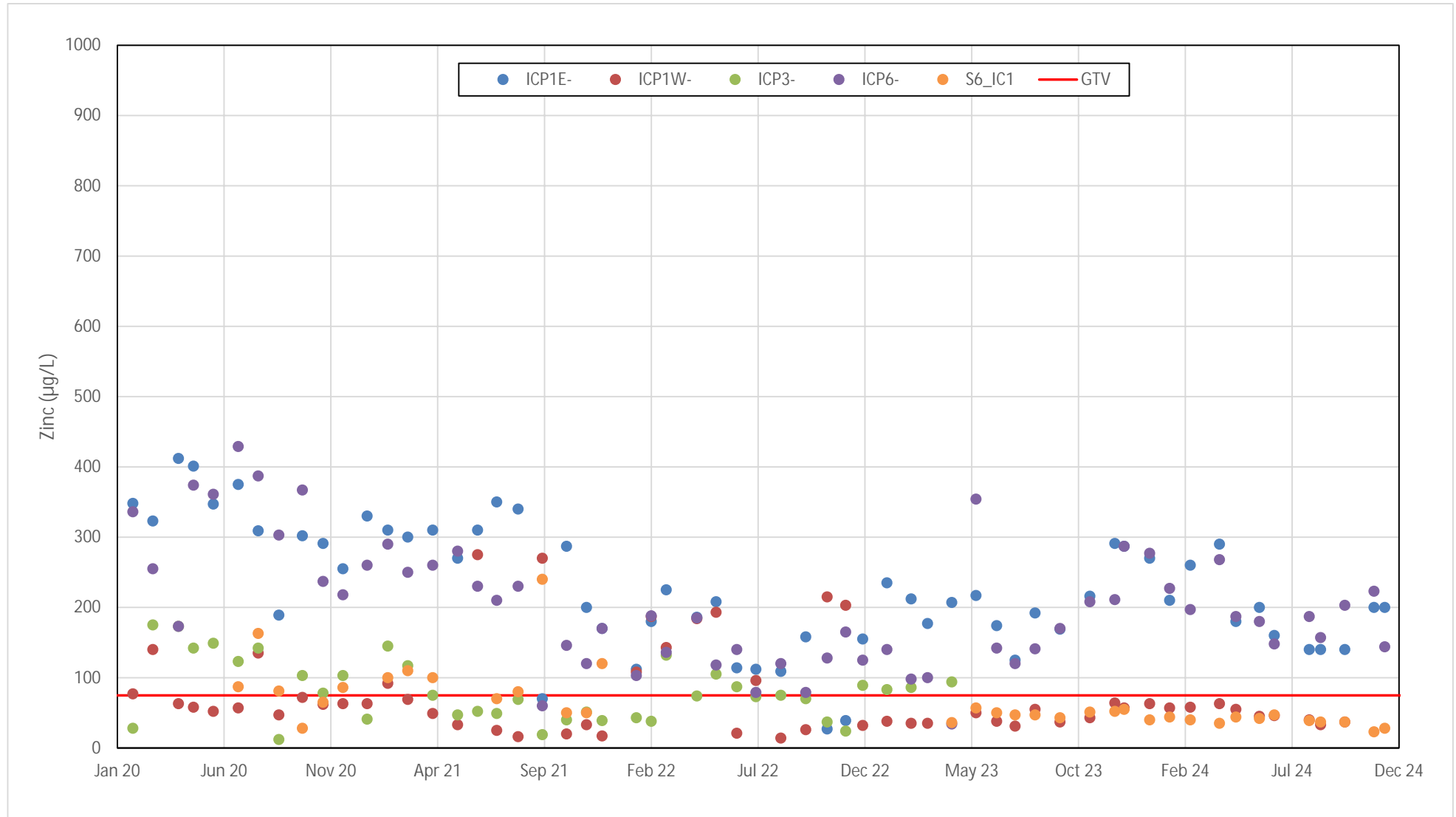


Client: Boliden_TaraMines_DAC

Site: Tara Mines

Appendix C.5 Magnesium concentrations in surface water

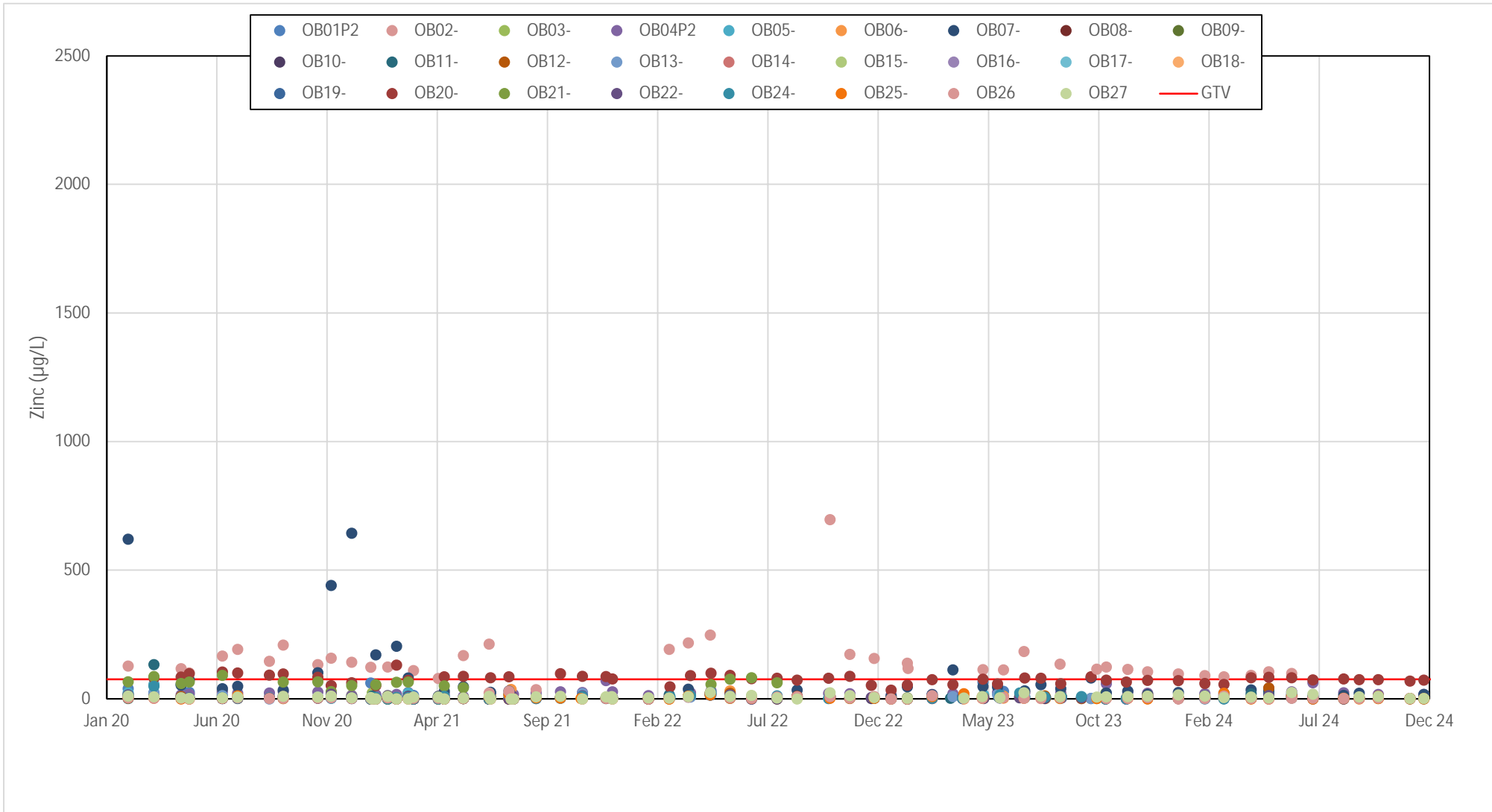
Appendix D Zinc



Client: Boliden_TaraMines_DAC

Site: Tara Mines

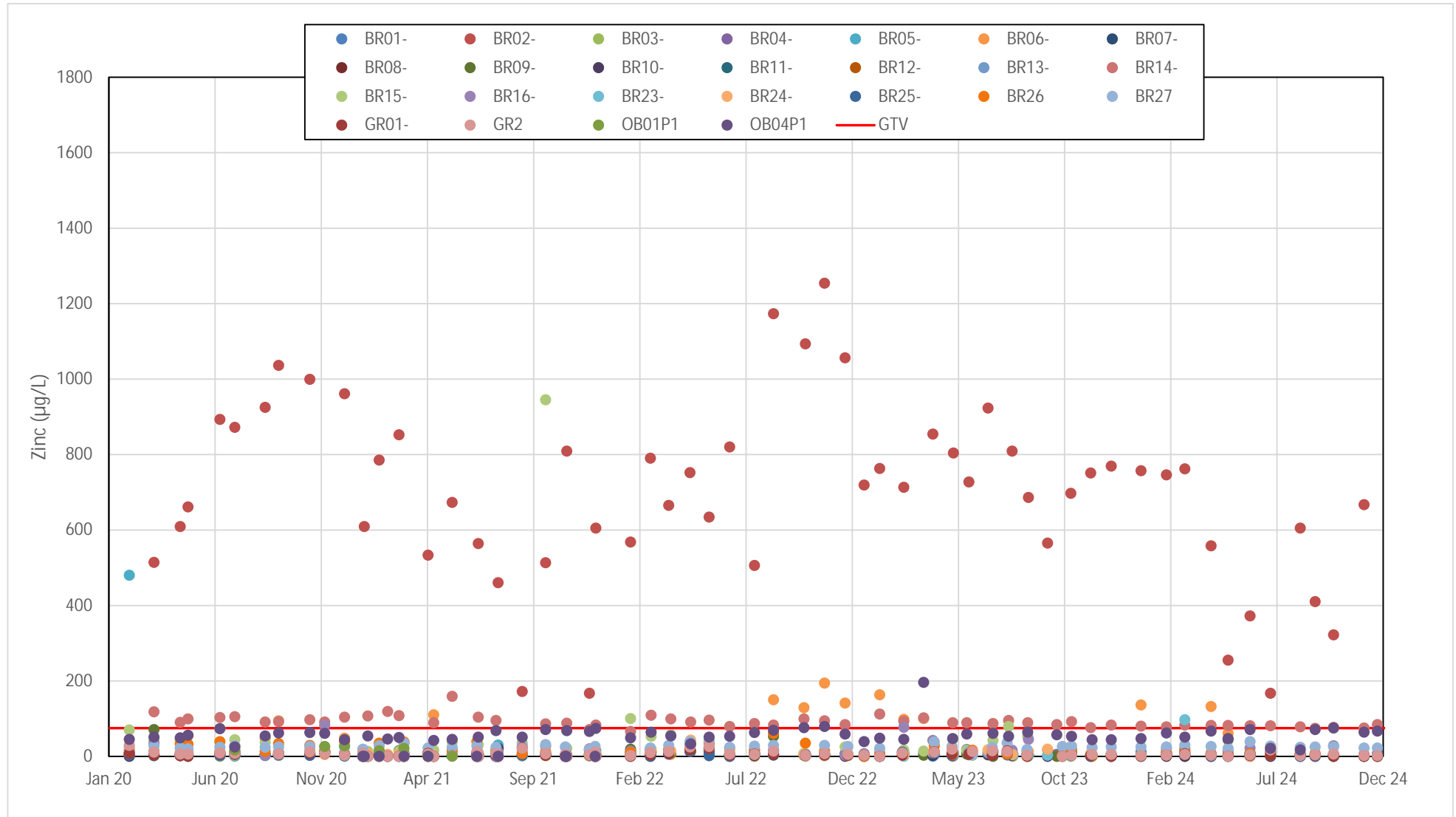
Appendix D.1 Zinc concentrations in the interceptor channel



Client: Boliden_TaraMines_DAC

Site: Tara Mines

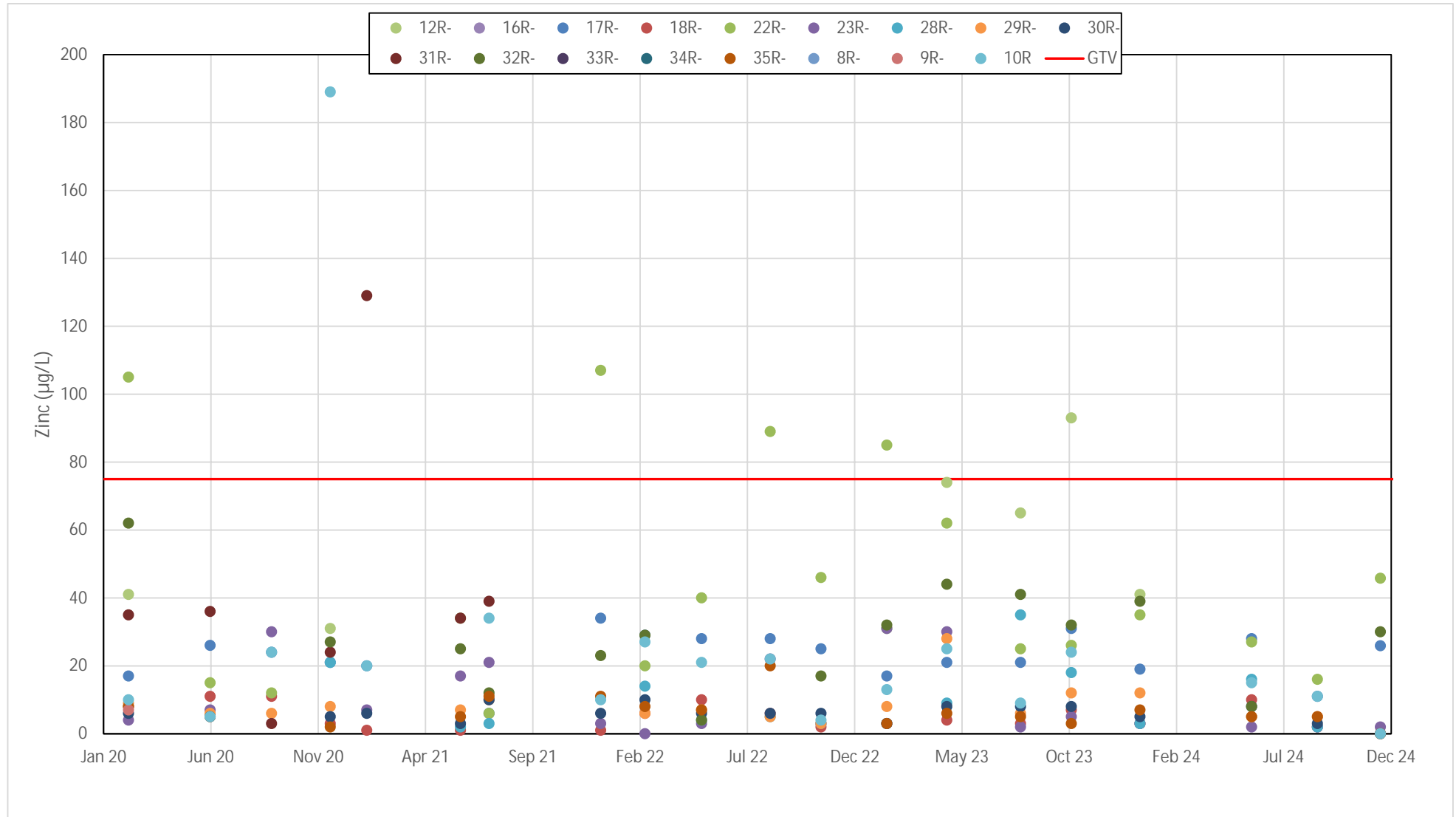
Appendix D.2 Zinc concentrations in overburden boreholes



Client: Boliden_TaraMines_DAC

Site: Tara Mines

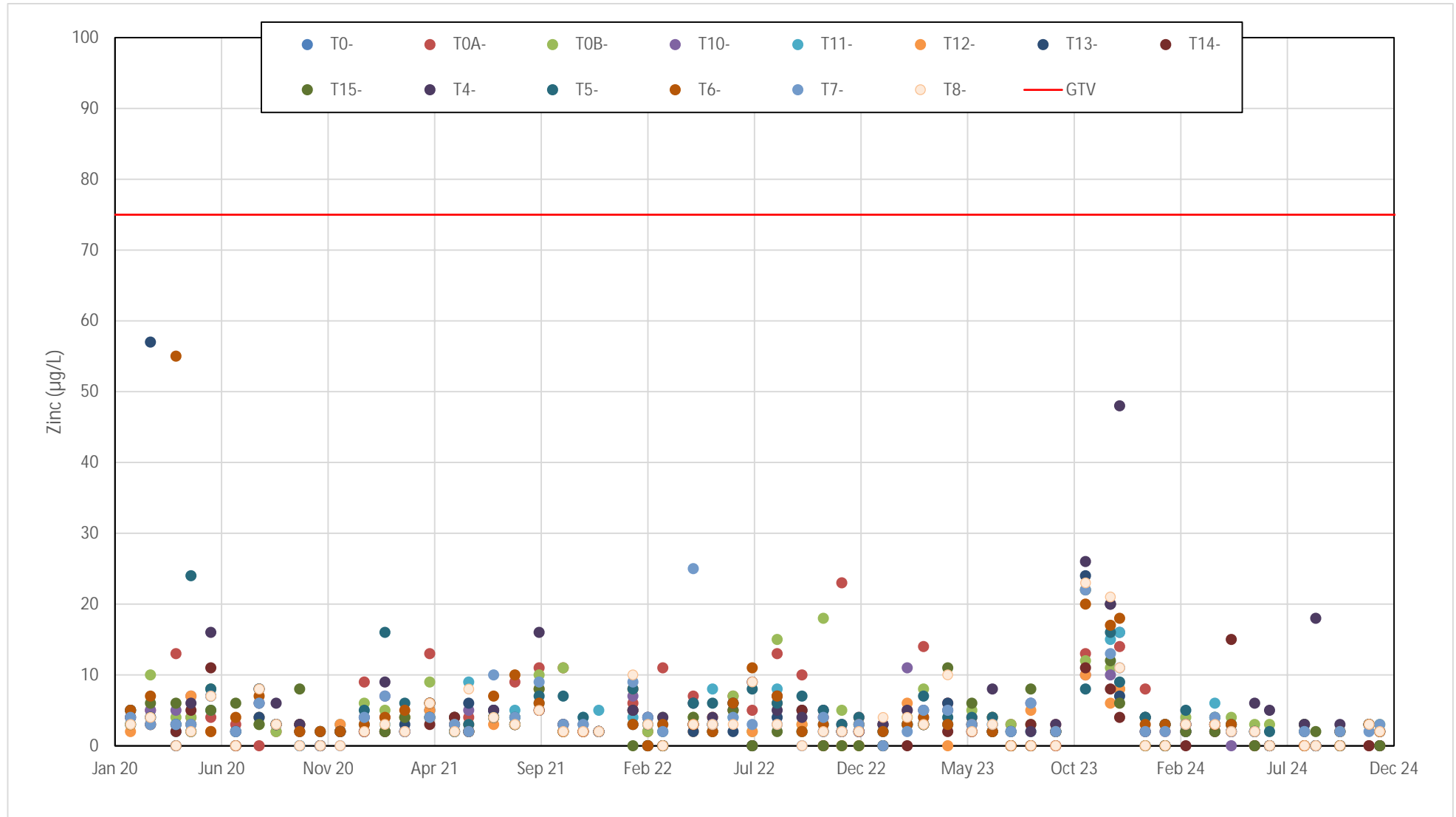
Appendix D.3 Zinc concentrations in bedrock boreholes



Client: Boliden_TaraMines_DAC

Site: Tara Mines

Appendix D.4 Zinc concentrations in domestic wells

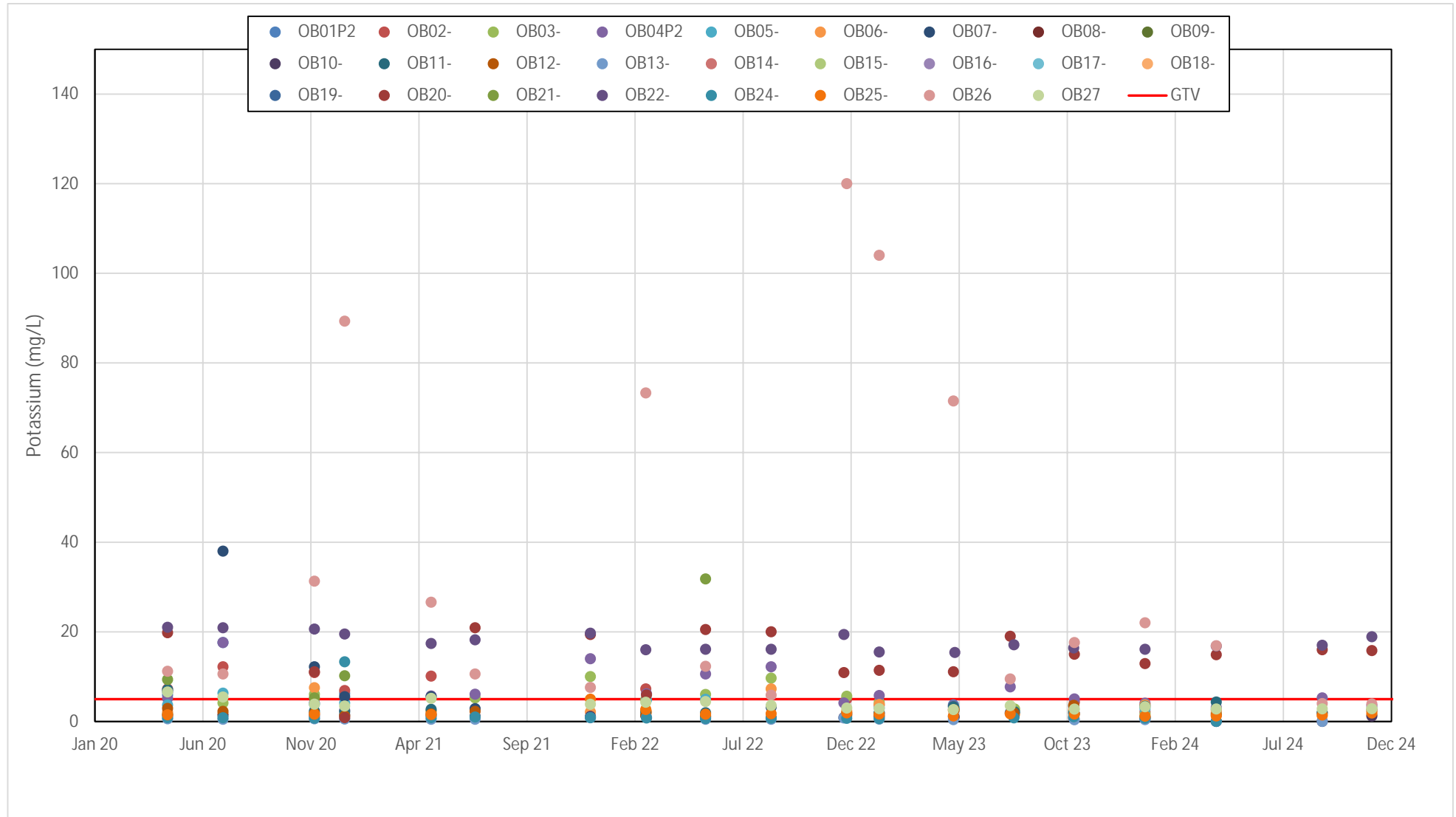


Client: Boliden_TaraMines_DAC

Site: Tara Mines

Appendix D.5 Zinc concentrations in surface water

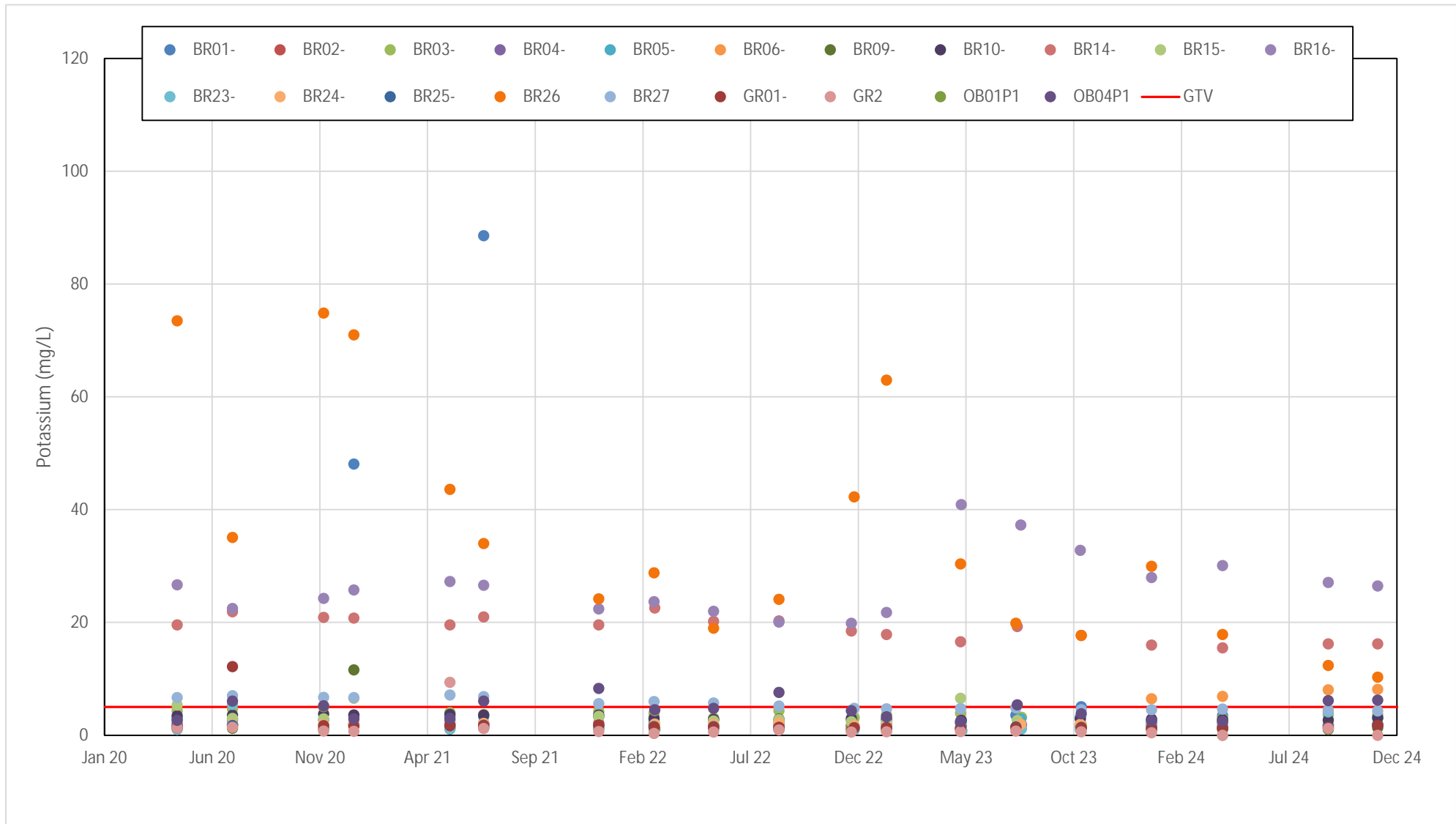
Appendix E Potassium



Client: Boliden_TaraMines_DAC

Site: Tara Mines

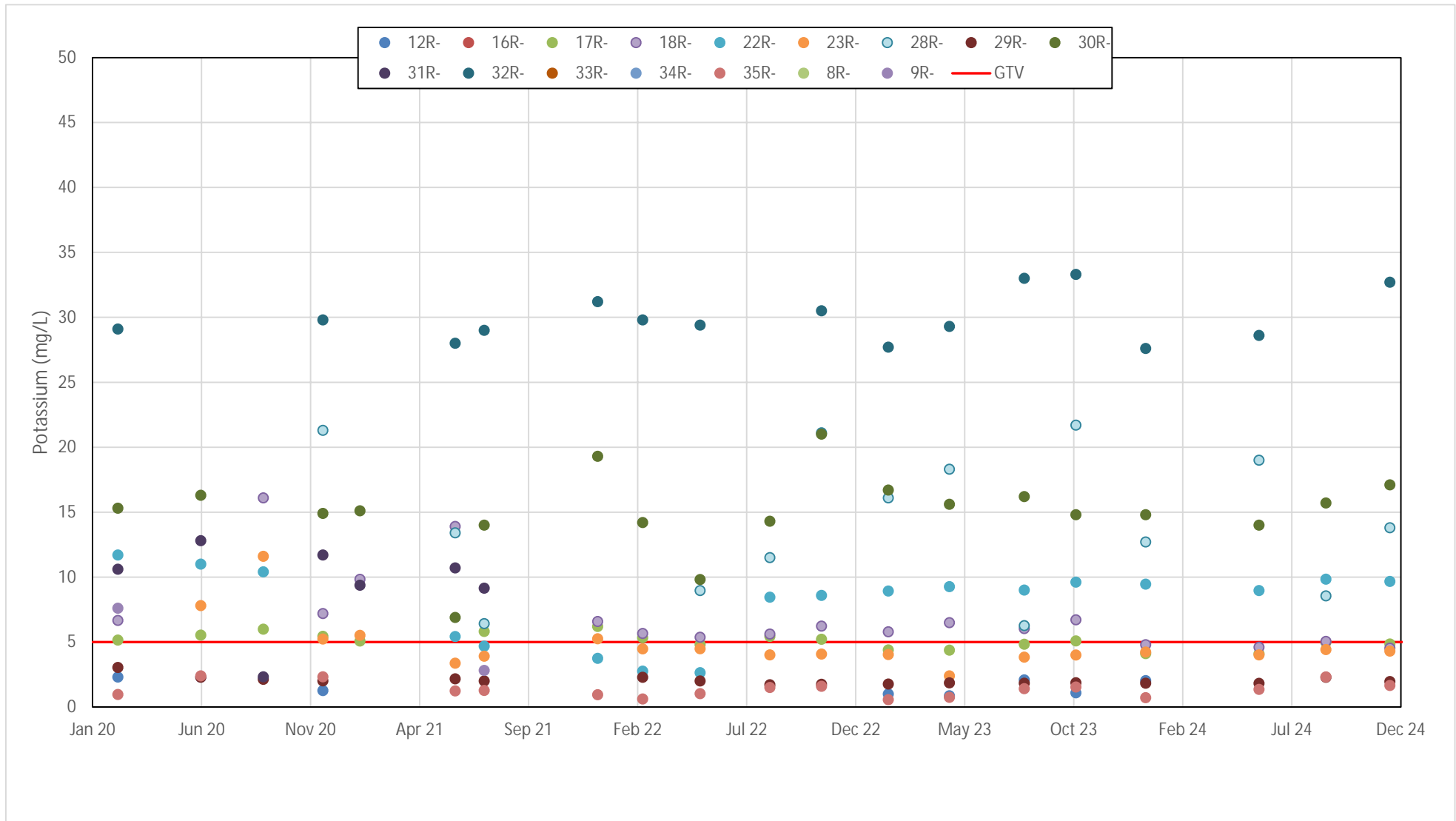
Appendix E.1 Potassium concentrations in overburden boreholes



Client: Boliden_TaraMines_DAC

Site: Tara Mines

Appendix E.2 Potassium concentrations in bedrock boreholes



Client: Boliden_TaraMines_DAC

Site: Tara Mines

Appendix E.3 Potassium concentrations in domestic wells

aecom.com

Attachment 9-2-3

CLOSURE RESTORATION AND AFTERCARE MANAGEMENT PLAN



FEBRUARY, 2025
BOLIDEN TARA MINES

Quality Information

Prepared by

Ailish Mc Cabe	Environmental Engineer
Oliver Fitzsimons	Environmental Engineer

Approved by

Paschal Walsh	Sustainability Manager
---------------	------------------------

Revision	Revision Date	Prepared by	Details	Approved by	Position
1	01/05/2015	OF & A.McC		PW	EHS Manager
2	24/4/2016	OF & A.McC		PW	EHS Manager
3	20/11/2016	OF & A.McC		PW	EHS Manager
4	15/12/2016	OF & A.McC		PW	EHS Manager
5	18/10/2018	OF		PW	EHS Manager
6	30/04/2020	OF		PW	EHS Manager
7	29/07/2023	AMcC		PW	EHS Manager
8	28/02/2025	AMcC	2024 Review Summary	PW	Sustainability Manager

CRAMP 2024 REVIEW

SUMMARY OF 2024 REVIEW AND UPDATE

In 2024 a major update to CRAMP was undertaken.

The update includes information requested by the three key statutory authorities (EPA, MCC and DECC) following their review of the 2023 CRAMP. These information requests were responded to via EDEN .

All information requested has also been included in the 2024 CRAMP document.

The review and subsequent update comprises:

- A restructure of the CRAMP Technical Document to include a series of separate chapters, each describing specific aspects of the closure process;
- This review reflects existing conditions at the minesite and Tailings Storage Facility;
- Assessment of changes to surface mine site facilities since the 2016 CRAMP. Any new buildings/ infrastructure, changes to internal building layouts, etc were quantified and included to provide a current assessment of surface facilities;
- General review of previous CRAMP and update current 2024 CRAMP with notable items that may not have been accounted for (eg. Rehabilitation of Simonstown borrow area);
- Review assumptions made in previous CRAMP to determine if these assessments are still valid, reasonable and relevant;
- Update of all relevant statutory authorisations, permits, licenses and planning permissions and other commitments/obligations requirements for CRAMP;
- Provided Success Criteria Indicators for closure activities;
- Provided update on independent mine site investigations undertaken (20 targeted and non-targeted soil investigations and ground and surface water investigations);
- Update of Geotechnical component to address gaps in Geotechnical Review Report conducted by *ITASCA Consultants AB*, and associated costs included in CRAMP;
- Update of Hydrogeology current and post-closure conditions to include detail on permanent residual downward hydraulic gradient, potential for fault reactivation, crown pillar stability and potential for differential settlement;
- Provision for three Safety Evaluation of Existing Dam (SEED) Audits at the TSF to be undertaken in aftercare management;

- Provided details on proposed Integrated Constructed Wetland (ICW) Passive Treatment system for drainage water at the TSF and planned inspection and maintenance requirements in aftercare and associated costs;
- Applied 2024 market industry rates (obtained from a third party contractor/quantity surveyor) to all costings associated with closure and aftercare activities of the mine site and TSF.
- All assets (mobile fleet, fixed plant and infrastructure) are set at neutral;
- Compared 2024 costings with previous CRAMP costings (submitted via EDEN);
- Confirmed costings associated with placement of additional soil required to increase the depth of the restoration soil cap at the TSF from 350mm to 500mm is applied;
- Contingency levels (requested agreed by statutory agencies in November 2016) are applied:
 - 10% to the closure decommissioning and reclamation of the mine and mine site infrastructure;
 - 33% to the closure decommissioning and reclamation including provision of the passive treatment system (PTS) of the tailings management facility (TMF); and
 - 10% contingency added to the Aftercare, Monitoring and Maintenance

LIFE OF MINE PLAN (LOMP)

The current Life of Mine plan is 2024.

FINANCIAL PROVISION

The financial provision for 2024 CRAMP (to include agreed contingency) is €23,305,557.11 (Table 1 to 5 Refers).

An established and appropriate FP sufficient to underwrite the current CRAMP is in place. The existing financial instrument is by means of a cash deposit (held by MCC with a current value €14.8 million) and a Bank Guaranteed Bond (Danske Bank).

It is proposed that a Bond approved instrument be put in place that will cover the FP of the updated CRAMP in agreement with the three statutory Agencies (EPA, MCC and DECC) prior to its implementation

Table 1 Site Decommissioning Programme Summary Costs

Item	Total 2024 Costs (€)
Site preparation {Decommissioning site infrastructure}	€3,024,880.30
Demolition/decommissioning of site infrastructure	€2,794,350.20
Site Remediation	€1,267,770.00
TOTAL DECOMMISSIONING COSTS	€7,086,980.50
Cost € Including EPA requested Contingency	€7,795,678.55

Table 2 Closure and Remediation of the Tailings Storage Facility

Item	Total 2024 Cost (€)
Engineering Cost for Capping and Ancillary works Stage 5	€ 3,408,040.00
Engineering Cost for Capping and Ancillary works Stage 6	€ 1,555,901.00
Revegetation Cost Estimate for Stage 5 TMF Closure	€ 336,090.00
Revegetation Cost Estimate for Stage 6 TMF Closure	€240,286.00
ICW Passive Treatment System Coat Estimates	€ 1,720,038.43
Total Costs associated with Closure of TSF	€7,260,355.43
Cost € Including EPA requested Contingency	€9,656,272.72

Table 3 Summary of Closure and Aftercare Costs for Knockumber Minesite

Closure and Aftercare Monitoring and Maintenance	Total 2024 Costs (€)	Cost € including EPA requested Contingency
Minesite Closure (0-2 years)	€86,010.72	€94,611.79
Minesite Aftercare (5 years)	€129,416.80	€142,358.48
CRAMP Project Team	€1,470,000.00	€1,617,000.00
Soil and Groundwater Report	€30,000.00	€33,000.00
Electricity (water pumping, ventilation, miscellaneous)	€1,000,000.00	€1,100,000.00
Governance Reporting	€126,000.00	€138,600.00
Mine shafts and ventilation raises	€511,776.00	€562,953.60
TOTAL	€3,353,203.52	€3,688,523.87
Total Cost € including EPA requested Contingency		€3,688,523.87

Table 4 Summary of TSF Closure and Aftercare Costs

Closure and Aftercare Monitoring and Maintenance	Total 2024 Costs (€)	Cost € including EPA requested Contingency
TMF Closure (0-2 years)	€73,543.44	€80,897.78
TMF Active Aftercare (5 years)	€163,495.70	€179,845.27
TMF Passive Aftercare (10 years)	€139,614.60	€153,576.06
TMF Stable Aftercare (15 years)	€81,257.60	€89,383.36
Governance Reporting	€450,000.00	€495,000.00
ICW Passive Treatment System Maintenance	€355,000.00	€390,500.00
Rehabilitation Simonstown borrow area	€355,345.00	€390,879.50
EPA Enforcement Costs	€200,000.00	€220,000.00
Public Liability Insurance	€150,000.00	€165,000.00
Total Cost € including EPA requested Contingency	€1,968,256.34	€2,165,081.97

Table 5 Overview of Total Closure and Aftercare Costs

Closure, Decommissioning, Rehabilitation and Aftercare	Total 2024 Cost (€)	Cost € including EPA requested Contingency
Knockumber site Decommissioning Programme	€7,086,980.50	€7,795,678.55
Rehabilitation of the TSF	€7,260,355.43	€9,656,272.72
Minesite Closure and Aftercare costs	€3,353,203.52	€3,688,523.87
TSF Closure and Aftercare costs	€1,968,256.34	€2,165,081.97
TOTAL CRAMP COST	€19,668,795.79	€23,305,557.11

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CHAPTER 1 INTRODUCTION

1.1 INTRODUCTION

This document details Boliden Tara Mines DAC (BTM) fully costed Closure Restoration and Aftercare Management Plan (CRAMP) for 'licensed activities' at their Mine Site Facility located at Knockumber and Tailings Storage Facility (TSF) located at Randalstown and Sillogue.

This document entitled Site '*Closure, Restoration and Aftercare Management Plan*' (CRAMP) has been prepared to meet EPA Industrial Emissions Licence (IEL) P0516-04 Conditions 10.2.1 (closure plan) and 12.3.1 (financial provision); ensure compliance with requirements of Regulations 14 and 21 of 2009 Waste Management (Management of Waste from the Extractive Industries) Regulations and accord with EPA Guidance on *Assessing and Costing Environmental Liabilities* (2015) for known liabilities at closure.

1.1.1 Aim of CRAMP

The overall purpose of CRAMP is to outline the necessary measures to avoid environmental pollution under a 'closure' scenario and, where pollution has been caused, to return the site to a satisfactory state

The CRAMP outlines the measures necessary to decommission, render safe or remove for disposal/recovery any soil, subsoil, buildings, plant or equipment, or any waste, materials or substances or other matter that may result in environmental pollution. It provides criteria against which successful closure of facilities can be measured and specifies a monitoring programme designed to demonstrate there will be no outstanding environmental issues.

This CRAMP is underwritten with an established and appropriate Financial Provision (FP) with financial measures, funds and drawdown mechanisms provided.

The CRAMP will be considered 'complete' once facilities has been successfully decommissioned, rendered safe and a closure validation report produced and submitted to the statutory authorities.

Future land zoning objectives will have an impact on the Facilities future use. BTM will engage with key stakeholders in relation to post-closure land use that benefits the environment and local communities.

BTM will be responsible for 'aftercare' until the EPA accepts surrender of the IEL as specified under Section 48 of the Waste Management Act, 1996 as amended.

1.2 COMPANY OVERVIEW

1.2.1 Background

Boliden Tara Mines DAC (Tara Mines), the largest operating zinc mine in Europe, is located at Knockumber, 2 km northwest of the town of Navan in County Meath and 50 km northwest of Dublin (Figure 1-1 refers). The mine exploits a zinc-lead orebody that lies between 50 and 1000 metres below the surface and extends over an area of 6.5 kilometres by 1.5 kilometres. Discovered in 1970 by the Tara Exploration and Development Company Limited (a Company formed in Canada in 1953 by four Irishmen) development of the orebody commenced in 1973, and production of zinc and lead concentrate in 1977. The original ore reserves (calculated in 1971) amounted to 69.9 million tonnes grading 10.09% Zn, 2.63% Pb. Mining continues today at a rate of between 2.1 and 2.6 million tonnes of ore each year, resulting in approximately 400,000 tonnes of zinc and lead concentrate. Facilities consists of the underground mine, an aboveground ore processing facility on a footprint of approx. 72 hectares, and an aboveground tailing storage facility on a footprint of 250 hectares, all of which is the subject of this CRAMP.

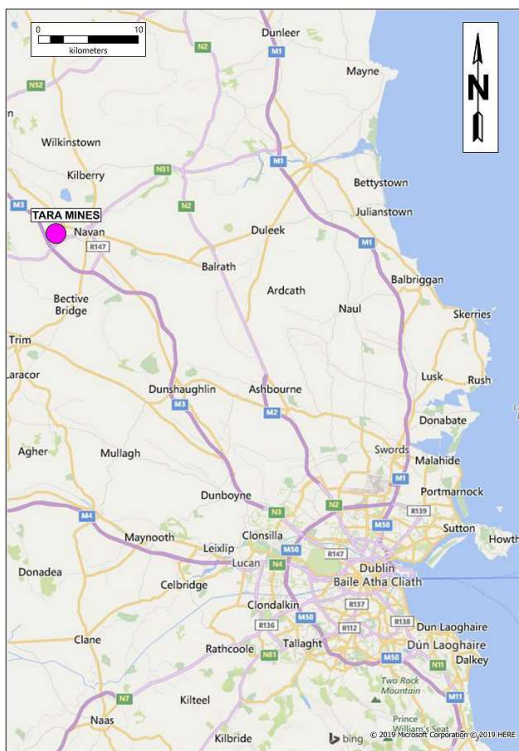


Figure 1-1 Map of Eastern Ireland showing Navan, the Mine Site and Dublin

A satellite deposit, termed ‘Tara Deep’ was discovered in 2012, at depths of 1.1 km to >2 km below surface and approximately 2km for the existing Tara mine. This deposit in addition to near mine exploration is the focus of the exploration programme.

1.2.2 Company Overview

BTM is a wholly owned subsidiary of Boliden Mineral AB part of the Boliden Group, Sweden (acquired in 2004). The Boliden Group is a leading supplier of critical metals for climate transition infrastructure projects. Zinc is a key metal in enabling green technologies such as solar and wind power. The organisation implements a range of policies and commitments to ensure responsible production methods and is accredited to international environmental, health and safety and energy standards such as ISO14001, ISO50001 and ISO 45001¹.

1.2.3 Management Structure

The current management structure at the facility is presented in Figure 1-2 with each position having defined responsibilities in relation to CRAMP (reference Table 3-2, Chapter 3).



Figure 1-2 Management Organisational Chart

¹ <https://www.boliden.com/operations/about-boliden/our-policies-and-commitments/>

1.3 DESCRIPTION OF COMPANY ACTIVITIES

BTMs main activities include exploration, mining, processing, shipping of concentrates and the storage of related tailings waste. Facility Information Summary is presented in Table 1-1 with location of the mine site facility and the Tailings Storage Facility (TSF) in Figure 1-3.

Table 1-1 Facility Information Summary

EPA Licence Registration No.	IEL P0516-04
Operator Name	Boliden Tara Mines (BTM)
Operator Address	Knockumber, Navan, Co. Meath, Ireland C15 NH63
National Grid Reference	Knockumber Mine Site: 284,877 E, 267,985 N Tailings Storage Facility: 285,100 E, 271,545 N
NACE Code	0729
Main Economic Activity	Mining of non-ferrous metal ore
Class of Activity	Schedule 1 Class 1.3 (a)(b) and Class 11.5
RBME Risk Category	A3

Ore production encompasses the drilling, blasting and removal of the ore from underground deposits. The mining methods employed are principally long hole open stoping with backfill. Broken ore is delivered to one of five underground primary crushers and reduced in size to <150 millimetres before being hoisted to the surface. Ore is then fed to an Autogenous grinding mill, which grinds the ore to a fine powder. From there it is pumped to metallurgic flotation cells as aqueous slurry in the main processing plant. Chemical additives are introduced to aid in differential flotation of target minerals and selective depression of waste minerals.

Once the target minerals have been extracted, the waste (i.e. 'tailings') stream is cycloned to separate coarse sand from finer slimes. Concrete is added to the coarse materials and pumped to the worked out underground mine areas as backfill. The remaining fine materials are pumped as an aqueous slime to the TSF, approximately 2.8 km north of the mine, which acts as a large sedimentation/aeration pond where solids settle for permanent storage and clear water at the surface is drawn off for recirculation to the processing plant.

Excess water is discharged under conditions of IEL P0516-04 at Emission Reference Point SW1 to the River Boyne.

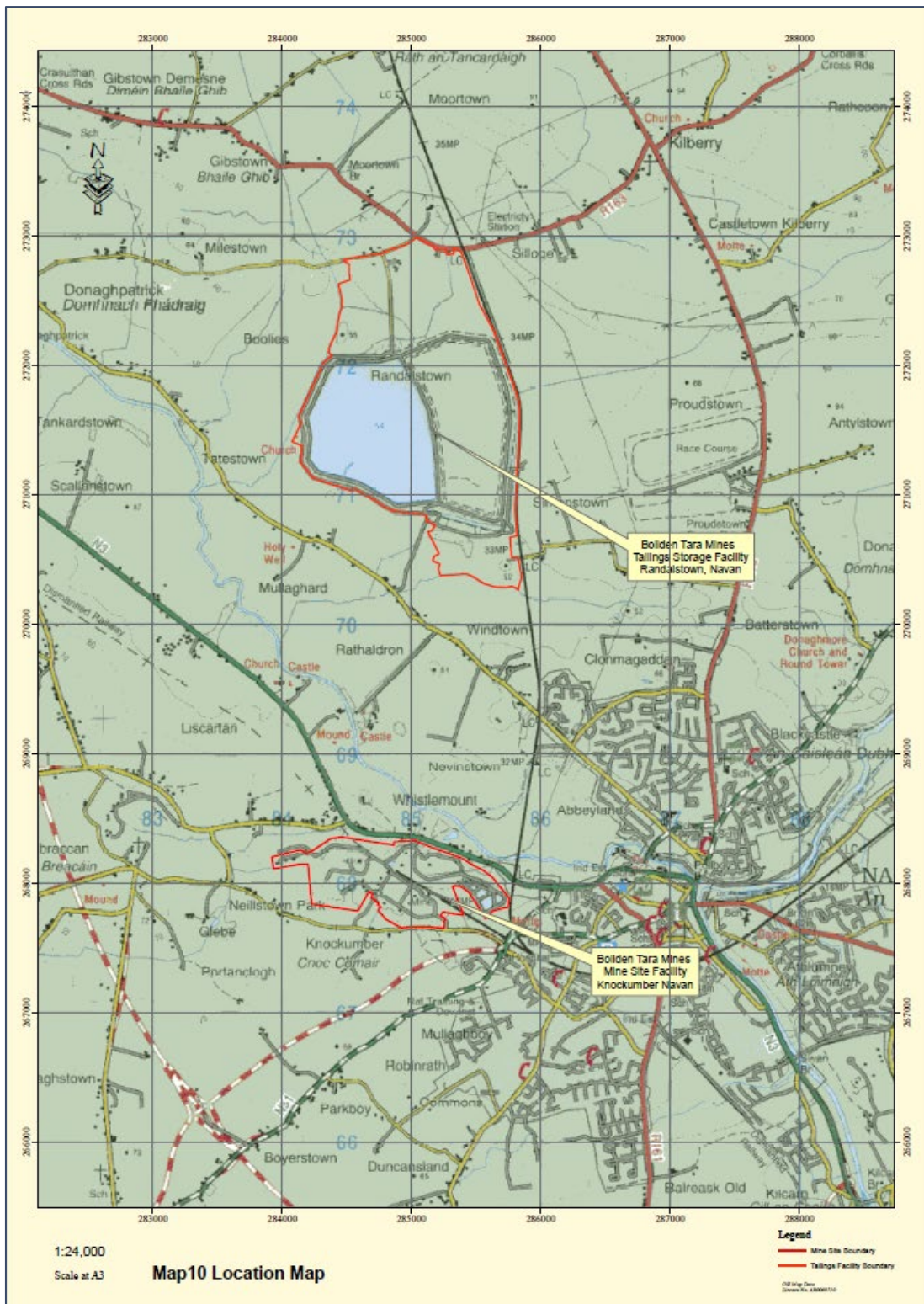


Figure 1-3 Location of Mine Site Facility and Tailings Storage Facility

1.4 SITE CONTEXT

1.4.1 Mine Site

The mine site is located at Knockumber, 2 km northwest of the town of Navan in County Meath and 50km Northwest of Dublin. The area comprises gently rolling farmland with a mild Atlantic climate. The minesite is served by the M3 motorway and rail links to Dublin where concentrate is transported for shipment to smelters in Europe. The site is largely situated within a rural area although with the expansion of Navan town residential developments have extended out towards the minesite. The site comprises an area of 72 hectares and is anthropogenic, owing to its industrial nature. There are a number of raised earth mounds across the site, which act as visual and/or noise attenuation bunds. The topography of the site is generally level at an elevation of 50m above Ordnance Datum (OD).

Land use in the vicinity of the site is mixed residential, commercial and agricultural, as summarised below:

- To the north are the Kells (R147) and Liscartan roads beyond which is largely agricultural land with some residential and light commercial properties. Further North (300m) is the River Blackwater. Land use beyond the River Blackwater is primarily agricultural.
- The town of Navan lies to the east consisting of a mixture of commercial and residential buildings. The Athboy Road (N51) road runs north-east south-west along the eastern site boundary.
- To the south are the Knockumber Road L7418 (Townspark Road) with Navan Retail Park located 100m to the south-east and agricultural land to the south-west. The N51 is situated approximately 500m to the south.
- Agricultural land with a number of one-off residential dwellings is located to the west of the site. Permission has been granted (August 2024) for a solar PV farm to generate renewable electricity (18 megawatts (MW)) for use within the mine site. The M3 motorway is approximately 1.7km further west.

1.4.2 Tailings Storage Facility

The Randalstown TSF, is approximately 2.5 km²/250Ha in size and is located approximately 2 km northwest of Navan, and c. 2 km southwest of the small village of Kilberry. It is of an

industrial character associated with the wider minesite complex. The area surrounding the TSF is predominantly rural comprising of farmland, farm dwellings and residential dwellings and composed of gently undulating lands between 40m and 90m OD. It is bounded by the Yellow River to the west, the Blakes stream to the northeast and the Simonstown Stream to the east and southeast. The new Boyne Valley to Lakelands (BVL) Greenway is located along redundant railway line running 100 m to the east of the TSF forming part of a 30km walking and cycling amenity from Navan to Kingscourt.

The primary access to the TSF site is via an access road that connects with the Donaghpatrick Local Road, L74141, via the R163 Kilberry Road (Kells to Slane Road). There is a good strategic road network in the immediate area, with the R163, R147 and R162 all surrounding the site, providing onward connection with a number of national routes, including the N51 and N52, and on to the M1 and M3 motorways.

1.5 ENVIRONMENTAL CONDITIONS

Three Natura 2000 sites are located within 15km of the mine site and TSF facilities; two areas designated as a special area of conservation (SAC) and one area designated as a Special Protection Area (SPA). Table 1-2 refers.

Table 1-2 Natura 200 sites within 15km

SITE CODE	DESIGNATION	SITE NAME
002203	SAC	GIRLEY (DREWSTOWN) BOG SAC
002299	SAC	RIVER BOYNE AND RIVER BLACKWATER SAC
004232	SPA	RIVER BOYNE AND RIVER BLACKWATER SPA

The River Boyne and River Blackwater SPA is a long, linear site that comprises stretches of the River Boyne and several of its tributaries, and is designated for the Kingfisher *Alcedo atthis* (NPWS, 2010). The River Boyne and River Blackwater SPA is of high ornithological importance as it supports a nationally important population of Kingfisher, a species that is listed on Annex I of the E.U. Birds Directive.

The River Boyne and River Blackwater SAC is an extensive freshwater site, comprising portions of the River Boyne and River Blackwater, draining areas of Meath, Westmeath, Cavan and Louth. The site is designated for two habitats, one being the priority habitat Alluvial Forests, and the other being Alkaline Fens. The site is also designated for three faunal species: River lamprey, Atlantic Salmon and Otter

There is one Natural Heritage Area (NHA) and no proposed Natural Heritage Area (pNHA's) within 5km of the Knockumer site: Jamestown Bog NHA (Site code: 001324) located c.5km southwest of the site designated for peatland habitat. There is one pNHA within 5km of the TSF: Boyne Woods (Site code: 001592).

1.5.1 Environmental Impact Management

Assessment of the potential for significant effects on European nature conservation (Natura 2000) sites designated under the EU Habitats Directive (92/43/EEC) and Birds Directive (2009/147/EC) is undertaken through the preparation of an Appropriate Assessment (AA) Screening Report for any new development.

The most recent appropriate assessment and Natura Impact Statement (NIS) (February 2025) for all site activities has been conducted as part of review process of IEL P0516-04.

1.6 COMAH UPPER TIER SITE

The COMAH Regulations (as defined by EU Directive 2012/18/EU on the control of major-accident hazards involving dangerous substances) are applicable to the minesite. A formal notification as an Upper Tier Establishment based on a 5000-tonne maximum lead concentrate storage has been made to the Health and Safety Authority (HAS) and an approved full Safety Report is in place.

The TSF does not fall outside the COMAG Regulations. An independent assessment to determine concluded that tailings deposited at the TSF are not considered 'Dangerous Substances' as defined in Annex 1 of EU Directive 2012/EU and primarily consist of limestone with limited quantities of residual lead and zinc sulphide concentrations

A detailed waste classification conducted in 2015, to include analysis by x-ray diffraction and chemometric identification of substrates and element distribution, concluded that more than

99% of tailings were comprised of naturally-occurring species derived from limestone and contained less than 0.5% lead and zinc ore. This Waste Acceptance Criteria (WAC) classification assigned the fine tailings stored at the TSF a European Waste Catalogue Code of 01 03 06 (tailings other than those above (non-hazardous)).

1.7 LIFE OF MINE (LOM) PLAN

A Life of Mine Plan (LOMP) is a long-term planning strategy that outlines the anticipated mining operations over the lifespan of a mine. It serves as a roadmap for how resources will be extracted and processed and evaluates the quantity and quality of 'mineral resource' available using both geological data and modelling.

A *mineral resource* is a deposit that has prospects for economic extraction but whose economic viability has not yet been proven. Mineral resource has 3 subdivisions (inferred; indicated and measured) with an increasing level of geological knowledge, evidence and confidence in relation to location, grade and quantity as resource classification moves from inferred to indicated to measured.

The LOMP at Tara is based on 'proven' ore/mineral reserves. *Mineral reserves* are the current economic mineable portion of the mineral resources. A mineral resource becomes a 'reserve' when it is determined that it can be mined at a profit. The proving up of what portion of the resource constitutes a reserve is achieved through exploration drilling.

The LOMP is reviewed and updated annually as part of the mine planning cycle. BTM publish exploration results, mineral resources and/or mineral reserves annually (using the PERC² standard) to inform the public of the mineral assets in the Tara Mine.

The current LOM plan is 2034.

The 'Tara Deep' deposit located approximately 1 km southeast of the main mine is a major focus for exploration and development with exploration campaigns targeted to increase the Inferred mineral resources in this deposit.

² Pan-European Reserves and Resources Reporting Committee (PERC)

1.8 CRAMP STRUCTURE

The CRAMP document comprises a series of separate components each described and presented in separate chapters. The CRAMP is subdivided into ten chapters each covering a specific aspect of the mine closure process.

The structure supports a flexible approach for delivery of the plan to enable periodic review and revision of specific CRAMP elements.

Chapter 1: Introduction:

This chapter provides background information on the Company, facility activities and describes the site context and environmental conditions. This chapter also describes the content and layout of the CRAMP document and details specialist contributions.

Chapter 2: Closure Planning: Obligations and Requirements

This chapter sets out the legal framework under which the CRAMP is written. It addresses all relevant statutory authorisations, permits, licenses and planning permissions issued to the Company. It aims to demonstrate that compliance with statutory and non-statutory obligations/commitments are an important requirement for a successful delivery of CRAMP.

Chapter 3: CRAMP Implementation

This chapter describes the scheduled manner in which the Closure Execution Plan (CEP) will be implemented to ensure a structured and effective mine closure process. It outlines closure activities and success criteria indicators which include closure objectives and performance goals that will provide a framework for validation of the closure and restoration performance.

Chapter 4: Mine Site Decommissioning and Restoration Programme

This chapter describes the surface decommissioning programme at the Knockumber minesite. This involves site works (levelling and backfilling), decommissioning, decontamination and removal of site buildings and infrastructure and site remediation. A detailed breakdown of these closure elements and associated costings are presented here. Water Management during closure is also discussed here.

Chapter 5: Underground Decommissioning

This chapter describes the decommissioning programme of the underground mine. It includes decommissioning of underground plant, equipment, services, and all associated elements, backfilling of the mine workings, decommissioning of the mine ventilation shafts, geotechnical and structural stability assessment and the plan for re-watering the underground workings.

Chapter 6: TMF Rehabilitation and Restoration

This chapter describes the rehabilitation and restoration strategy for the TSF. The objective is to reintegrate disturbed areas into the surrounding landscape such that post reclamation quality and capability will accommodate long term, sustainable after use. It involves placing a 500m restoration soil cap on the tailings surface and vegetation and post-closure drainage and run-off management.

Chapter 7: Passive Treatment System

This chapter describes an Integrated Constructed Wetland (ICW) passive treatment system to treat runoff from the capped and closed tailings surface and mine influenced water (MIW) prior to eventual discharge to the River Blackwater to meet regulatory water quality standards.

Chapter 8: Aftercare Management

This chapter describes the aftercare management plan to include the 'closure' period, to enable a stable, long-term sustainable closure at the minesite and tailings storage facilities. The aftercare plan will comprise a comprehensive monitoring programme to track environmental, stability and social success criteria indicators to include regular and transparent reporting to statutory authorities and key stakeholders on the progress and outcomes of closure and restoration activities.

Chapter 9: Financial Provision

This chapter describes the financial provision (FP) measures, funds and mechanisms that underwrites the CRAMP.

Chapter 10: Costings

This chapter presents costs of distinct closure and restoration activities associated with the implementation of this CRAMP.

1.8.1 Specialist Contributions

BTM engage several key consulting firms that have experience in design and development of mine closure plans, identified in Table 1-3. BTM will continue to work with these specialists to further develop and refine specific closure elements.

These consultants will be retained throughout the closure process.

Table 1-3 Competencies of CRAMP Contributors

Consultant	CRAMP Components
Piteau Associates UK	Hydrogeological assessment and conceptual modelling of underground mine: Plan for Mine re-watering Backfilling mine shafts
AECOM UK	Water: Hydrology and Hydrogeology at TSF
AECOM Ireland	Baseline soil and Groundwater Report
Golder / WSP	TSF Capping Design
Klohn Crippen Berger (KCB)	TSF Capping Design; TSF Spillway Design; TSF Geotechnical Stability and Performance Review
Itasca Consultants AB	Geotechnical issues relating to mine stability and surface subsidence
VESI	Passive Water Treatment System at TSF
PM Group	Surface Decommissioning Programme
Boliden Group Technical Department Closure Engineer Team	All components of CRAMP
Priority Construction Limited (PCL)	Capping of the TSF surface

1.9 UPDATE AND REVIEW OF CRAMP

The CRAMP will be updated following the annual review process in line with IEL conditions or if there is a significant change in the operational process, permitted activities, major emission points, new development or extension or the introduction of new techniques or technologies.

As the mine approaches the Life of Mine the closure execution plan will be refined, and detailed closure activities, schedules and programmes will be established

A framework will be provided for directing these activities towards successful closure and achieving closure validation.

CHAPTER 2 CLOSURE PLANNING

2.1 INTRODUCTION

This chapter sets out the legal framework under which this CRAMP is written. It addresses all relevant statutory authorisations, permits, licenses and planning permissions issued to the Company and other commitments/obligations the Company aligns with.

Compliance with statutory and non-statutory obligations are an important requirement for the successful delivery of this CRAMP.

The CRAMP considers two primary closure scenarios described below:

- Unexpected / unplanned temporary Closure
- Final Closure upon Termination of Operations

2.1.1 Unexpected Temporary Closure

While this CRAMP document has been prepared to cover planned closure upon termination of operations it also considers the event of an unplanned / unexpected / closure scenario. It is envisaged that such an event may occur as a result of one or several of the following:

- Low commodity prices;
- Increased external production costs;
- Increased energy costs;
- Market factors outside on Company's control; and
- Industrial relation issues

This type of unplanned / unexpected / closure scenario is short term or temporary in nature (period up to 12 month). During temporary cessation of works (as in 2001/2002 and more recently in 2023/2024) the mine will operate on a "full care and maintenance" basis, whereby the mine continues to operate, however it does not undertake ore extraction or produce ore concentrate. Emissions, control and environmental monitoring will continue as specified in conditions and schedules of most recent Industrial Emissions License. The Environmental Office will remain open to the public during normal working hours with Environmental Department personnel available.

If the mine is placed in temporary closure the facilities will not be decommissioned. The statutory authorities will be informed that the cessation of works is not permanent, and execution of the CRAMP will not be implemented. In such an event, the financial burden of short-term disuse/closure will be met from the normal cash-flow of the Company, without any drawdown from the Financial Provision dedicated for CRAMP delivery. This will ensure that the Financial Provision for planned closure is always available.

2.2 APPROACH AND PRINCIPLES OF CRAMP

The approach and principles of closure and remediation adopted are crucial for ensuring that all phases of BTM's activities and operations have minimal long-term impacts and will not pose a threat of environmental pollution.

In addition to the regulatory adherence BTM's approach to closure incorporates Key stakeholder engagement, ecological restoration, risk management and sustainable practices to ensure closure and remediation efforts are effective, sustainable, and beneficial to the environment and local communities.

2.2.1 Closure Objectives

The overall objective of this plan is to reintegrate land that has been disturbed by construction, operational and decommissioning activities into the surrounding landscape such that the post reclamation quality and capability of the disturbed areas will, where possible, resemble conditions prior to disturbance.

Key objectives include:

- Long term stability;
- Environmental and human health and safety;
- Surface and groundwater hydrology and quality;
- Reinstatement of ecological and agricultural resources;
- Restoration of appropriate reclaimed land use capability;
- Post closure monitoring and reporting;
- Closure cost management.

2.2.2 Closure Success Criteria

The closure strategy will be underpinned by a set of success criteria which be used as a framework for validation of the closure and restoration performance. The achievement of these success criteria indicators will be verified through a monitoring / measurement process with approval from the Regulatory Authorities prior to commencement of closure activities.

Assessing progress and demonstrating specific success criteria have been met will involve utilising the following quality control measurement tools:

- regular environmental and stability monitoring,
- data collection and reporting;
- ensuring regulatory compliance,
- conducting independent audits and assessments; and
- long-term post-closure monitoring.

Key success criteria are presented in Table 3-1, Chapter 3. Specific success criteria indicators to evaluate closure and remediation success will be established closer to the LOM plan to restore facilities to comply with current and future Planning Conditions and future land zoning.

An adaptive management approach to refine and adjust closure activities based on monitoring data results and stakeholder feedback will be applied throughout the process.

BTM will be responsible for 'aftercare' until the EPA accepts surrender of the IEL as specified under section 48 of the Waste Management Act, 1996 as amended.

2.3 TERMS OF REFERENCE

The following regulatory and commitments/ obligations have controlled the development of this CRAMP:

- Regulatory – All relevant Government laws and Regulations, Industrial Emissions License, Planning Conditions, State Mining Leases;
- Best practice – Guidance an Reference documents;
- Commitments - ICMM / GISTM
- Environmental and Social Governance (ESG) – key stakeholders (Table 2-2 refers)

2.4 REGULATORY REQUIREMENTS

The closure and planned cessation of mining has specific obligations under various regulatory permissions and licenses issued by the following competent authorities:

- Environmental Protection Agency (EPA);
- Meath County Council (MCC);
- The Department of the Environmental Climate and Communications (DECC);
Geoscience Regulation office (GSRO);
- Department of Justice and Equality

Compliance with these statutory obligations are an important requirement for the successful delivery of CRAMP.

2.4.1 industrial Emissions Licence (IEL)

Industrial Emissions License (IEL) Register Number PO516-04 (Revision 4) and amendments issued on the 7th of September 2018 supersedes all prior IPPC and IPC licenses.

IEL P0516-04 Conditions 10 and 12 (Decommissioning and Residuals Management and Financial Charges and Provisions respectfully) specifically relate to closure and restoration / aftercare of the BTM industrial site at Knockumber and the Tailings Storage Facility (TSF) at Randallstown and Sillogue.

2.4.2 Planning Permissions

All Planning Permissions granted are administered by Meath County Council and include conditions that are specific to closure and aftercare management.

Original Planning Permission

The original notification of grant of planning permission to construct mine facilities and Stages III Tailings Management Facilities was issued by Meath County Council in 1973 with this decision upheld by An Bord Pleanála in 1974 (planning register reference P73/125).

Condition 21 (a) specifically refers to closure or disuse of the mine Insofar as it shall not conflict with the obligations of the Developers under any State mining lease:-

(a) If and when the mine becomes disused, and has in the opinion of the planning authority permanently ceased to function as a mine, the Developers shall, to the extent required by the planning authority, take down and remove all or specified plant, equipment, installations, buildings and stored material and shall reinstate the site above and below ground visually and hydrologically (so as to ensure a natural self-regulating terrain) to a condition fit for agricultural use or for such other use or uses for which planning permission may be granted.

Subsequent planning permissions granted include extensions to the TSF; extensions of mining operations (SWEX, Nevinstown, Liscartan and Rathaldron); development of mine ventilation shafts among other permissions. A non-exhaustive list of permissions granted over the intervening years are presented in Table 2-1.

Table 2-1 Planning Permissions Granted

Planning Reference	Development Details
P 96/919	Stage 4 vertical extension to Tailings Storage Facility and operation of 2 Borrow areas
NA901452	Stage 5 vertical extension (4-meter) to Tailings Storage Facility
ABP 17.247707	Stage 6 lateral extension to Tailings Storage Facility
NA4005	Southwest extension (SWEX) of underground mining operations and provision of a fresh and return air raise
PL 17.204034	Extension to the existing underground mining operations solely by underground means into Nevinstown
NA 101054	Mining of the current uninterrupted orebody into Liscartan and Rathaldron
NA 120917	Develop Mine fresh air intake shaft, FAR5
NA 111149	Develop Mine Return Air Raise RAR 5N
NA 201153	Develop Mine Return Air Raise 6 and 7
NA 140328	Excavation of material in Simonstown Borrow Area
NA 140328	Solar PV Development to generate renewable energy to be used on Knockumber Site
ABP-315173-22	Reinforcement Buttress to sections of the extant embankment walls of the TSF
ABP-317390-23	Construction of Water Treatment Plant

Meath County Development Plan (2023-2027)

In the current version of the Navan Development Plan (2021-2027) an area to the south of the Knockumber mine site is zoned *E2 General Enterprise and Employment*. It is believed that in time the remainder of the Knockumber site will be rezoned to accommodate light industrial or commercial end uses. The focus of the existing CRAMP is to reclaim the site to an agricultural end use in accordance with original planning permission for the facility.

2.4.3 Stare Mining facilities

State Mine Leases (SML)

BTM operate in accordance with the following State Mine Leases (SML) and Prospecting Licenses (PL) issued by the DECC, Geoscience Regulation Office (GSRO):

- State Mine Licence 2; State Mine Licence 3; State Mine Licence 4; State Mine Licence 5; State Mine Licence 12; State Mine Lease 146; State Mine Lease 147; and Nevinstown State Mine Lease 144

Prospecting Licenses

BTM operate in accordance with the following Prospecting Licenses (PL) issued by the GSRO:

- Prospecting Licence 4991 issued on 19.04.2002
- Prospecting Licence 1496 issued on 15.08.1971
- Prospecting Licence 4502 issued on 26.10.1970
- Prospecting Licence 1440R issued on 23.10.1972

Explosive Storage Licenses

The underground magazine storage licence is (Licence Reference Number 65/57/17/164/A) issued by the Department of Justice and Equality.

2.5 RELEVANT GOVERNMENT LAWS AND REGULATIONS

There are a number of statutory provisions relevant to specific aspects of the closure process. Closure considerations are included within a series of legal and policy frameworks and guidance notes.

The CRAMP has been planned and prepared to comply with relevant Government laws and regulations such as environmental protection, regulation of waste and the protection of biodiversity:

- Waste Management (Management of Waste from the Extractive Industries) Regulations 2009 (S.I. No. 566 of 2009).
The Mine Waste Directive (2006/21/EC) became EU law on 1st May 2006 and plays a crucial role in ensuring the proper closure and rehabilitation of mining sites. The directive requires mine operators to develop and implement such plans to minimize the long-term environmental and human health risks associated with mining activities.
- European Communities (Birds and Natural Habitats) Regulations, 2011 (S.I. No. 477 of 2011)
- European Communities Environmental Objectives (Groundwater) Regulations, 2010 (S.I. No. 9 of 2010)
- WFD and Groundwater Directive (2006/118/EC)
- European Communities Environmental Objectives (Surface Water) Regulations, 2009 (S.I. No. 272 of 2009).
- Control of Major Accident Hazards Involving Dangerous Substances) Regulations 2015 (S.I. 209 of 2015)

2.5.1 Guidance and Reference Documents

The CRAMP has been prepared to accord with the following guidance documents:

- EPA Guidance on *Assessing and Costing Environmental Liabilities* (2015)
- Guidance on *Environmental Impairment Liability* (2017)
- EPA Approach to Environmental Liabilities and Financial Provision (2019)
- AA 'Code of Conduct', the International Council on Mining and Metals' (ICMM) principles and commitments as well as the Good Practice Guidance for Integrated Mine Closure;
- BAT Reference Document *Management of Tailings and Waste Rock in Mining Activities*
- BAT conclusions for waste treatment, under Directive 2010/75/EU of the European Parliament and of the Council.

2.6 OTHER COMMITMENTS

2.6.1 Global Industry Standard on Tailings Management (GISTM)

BTM became a member of the International Council for Mining and Metals (ICMM) in 2019. A requirement is the adoption of the Global Industry Standard on Tailings Management (GISTM)¹ issued in 2022, which has specific requirements related to closure.

Requirement 5.6:

Design the closure phase in a manner that meets all the Requirements of the Standard with sufficient detail to demonstrate the feasibility of the closure scenario and to allow implementation of elements of the design during construction and operation as appropriate. The design should include progressive closure and reclamation during operations.

Requirement 10.7:

The amount of estimated costs for planned closure, early closure, reclamation, and post-closure of the tailings facility and its appurtenant structures shall be reviewed periodically to confirm that adequate financial capacity (including insurance, to the extent commercially reasonable) is available for such purposes throughout the tailings facility lifecycle, and the conclusions of the review shall be publicly disclosed annually. Disclosure may be made in audited financial statements or in public regulatory findings.

2.6.2 Environmental, Social and Governance (ESG) Considerations

The CRAMP considers ESG priorities in line with Group expectations and applicable requirements such as:

- Current and future legislation
- Stakeholder expectations
- ISO 14001; 50001 and 45001 Management Standards
- International Council on Mining and Metals (ICMM) principles
- Corporate Sustainability Reporting Regulations 2024
- BTM Code of Conduct

¹ The Global Tailings Review convened by the United Nations Environment Programme (UNEP), the Principles for Responsible Investment (PRI) and the International Council on Mining and Metals (ICMM) launched the **Global Industry Standard on Tailings Management**.

- UN Global Compact
- UN Sustainable Development Goals (SDGs)

2.7 EMERGENCY PLANNING

BTM will continue to consult with the Principal Response Agencies (Meath County Council Fire Service Division, Health Service Executive and An Garda Síochána) in relation to emergency planning during closure and aftercare management.

An External Emergency Plan is in place that details the arrangements, and the inter-agency coordinated response for dealing with major accidents at the facilities.

2.8 COMMUNICATION OF CLOSURE PLAN

All aspects of the Closure plan will be communicated to relevant statutory authorities and key stakeholders in a timely and transparent manner. Agreement / approval shall be reached with all relevant statutory agencies prior to the commencement of closure activities.

2.8.1 Stakeholder Engagement

Consistent and transparent engagement involving key stakeholders is fundamental to effective closure and ensure stakeholder input is relevant and representative throughout the process. Stakeholders will be made aware of their objectives and role in the process.

BTM have an efficient communication and feedback mechanism for engagement with the local communities allowing the Company to provide regular updates regarding activities and projects and where community concerns and issues can be directly raised and addressed.

BTM will continue with active community and stakeholder engagement throughout the closure and aftercare management periods. This will ensure:

- Their input into the process/plan is relevant and representative
- Expectations are understood and managed effectively;
- Made aware of any residual impacts that may arise from decommissioning and post closure

The 'open-door' policy with regard to public access at the Environmental Department office during business hours will continue throughout the closure process.

This forum along with regular scheduled meetings will provide a means to share regular and transparent information and details of the closure plan, progress and outcomes of closure activities and reviews against success criteria indicators.

A list of key stakeholders and potential concerns is provided in Table 2-2.

Table 2-2 Key Stakeholders

Stakeholders	Key Concerns
Government and Regulatory Bodies	Compliance with statutory obligations and all applicable environmental requirements and industry standards. Closure performance.
Local community groups / Landowners	Closure be undertaken in a scheduled manner, which eliminates or minimises potential adverse impacts on the environment. Public health and safety. Environmental performance. Long term stability Restoration of ecological and agricultural resources
Employees / contractors	Safety, Health and Environmental preparation for Closure. Clear communication of closure requirements and implementation
Consultants	Closure planning and design to minimise environmental risk
Boliden Group (owners)	Overall responsibility to ensure successful mine closure implementation. Compliance with relevant statutory and corporate closure, environmental and sustainable goals and standards.

Stakeholders	Key Concerns
Emergency Services	Emergency Response Planning.
Legal Advisors	Ensure all legal and regulatory requirements are met
Insurance Companies	Ensure adequate insurance is in place: ELRA and Environmental Impairment Liability Insurance

CHAPTER 3 CRAMP IMPLEMENTATION

3.1 INTRODUCTION

Where the site is deemed to have fully terminated operations the closure plan will be implemented. Closure will be undertaken in accordance with best practice in a cost effective and scheduled manner, which eliminates or minimises potential adverse environmental and social impacts considering public health and safety, physical ground stability and emissions. BTM will seek to draw down on the financial provision established.

Implementation will be undertaken in consultation with the three key statutory authorities: EPA, Meath County Council, Department of Environment, Climate and Communications (DECC) and other identified key stakeholders (Table 1-3 refers).

As the mine approaches the Life of Mine a detailed Closure Execution Plan (CEP) will be prepared to ensure a structured and effective mine closure process.

The CEP will outline closure activities and tasks, resources required with schedules outlining the sequence and duration of each closure activity. A framework will be provided for directing these activities towards successful closure and defined success criteria indicators will be established with key milestones and deadlines to track progress.

Evaluation of progress on achieving success will be assessed and clearly documented through the following steps: description of closure activity; objective; target date for completion; quarterly progress % rate; monitoring undertaken; specific success criteria indicators to evaluate success; and quality control measurement Tools (Validation/compliance). Progress reports will be shared with key stakeholders.

Independent audits/assessments will be conducted to verify that the success criteria have been met.

The CEP will be dynamic and adjusted, if necessary, to incorporate new or emerging information and technologies and best practice to improve closure outcomes or to address any emerging issues.

BTM are committed to implementing progressive rehabilitation activities throughout the mine's operational life to reduce the final closure burden.

3.2 RESPONSIBILITY

The overall responsibility and management of the CRAMP in the event of closure will be undertaken by the **Boliden Group**. Responsibility during the entire 'closure' process including fiscal management, environmental management, all decontamination procedures, decommissioning operations and residuals management, as required under CRAMP will be authorised by the Boliden Group (AB).

In the event of an unplanned / unexpected and temporary cessation of operations financial costs will be borne by the Company.

3.2.1 Oversight

Implementation of this plan will be undertaken under supervision of the three key statutory government agencies; EPA, MCC and GRISO, and in consultation with the key stakeholder (refer to Table 2-2).

Regular meetings with key stakeholders, progress reviews against success criteria indicators, governance reporting, annual decommissioning reports and drawdown on Financial Provision (FP) will continue throughout the closure and aftercare phases.

3.3 KEY COMPONENTS OF CEP

The CEP will outline the closure activities, resources and timelines required to effectively implement the CRAMP. CEP key component will include:

- Detailed closure activities
- Resource allocation
- Timelines and scheduling
- Risk Management
- Stakeholder engagement
- Monitoring and Reporting
- Quality Control Measurement (Validation/compliance)
- Aftercare management

The CEP will be dynamic and adjusted as new information or technologies become available or to address any emerging issues.

3.4 DETAILED CLOSURE ACTIVITIES

The following closure activities are required to address any risk of pollution and return the site to a satisfactory state:

- Plant, equipment and infrastructure decontamination and decommissioning.
- Backfilling of underground workings
- Flooding / rewatering of the underground mine
- Raw materials, products and waste disposal and/or recovery
- Contaminated land treatment, removal and/or disposal
- Reinstatement of ecological and agricultural resources
- Surface and groundwater hydrology and quality
- Closure and rehabilitation of the tailing's storage facility
- Operation of the Passive Water Treatment system
- Post closure monitoring and maintenance
- Communication of the Closure Plan

An adaptive management approach to refine and adjust closure activities based on monitoring data results and stakeholder feedback will be applied throughout the process.

3.4.1 Minesite Closure Activities

The 'closure period' for the Knockumber mine site is envisaged to take 2 years and aftercare a further 5 years. Tasks involved in the closure and aftercare include:

- Surface and underground plant, equipment and infrastructure decommissioning, decontamination and removal and/or disposal
- Soil and Groundwater investigations
- Contaminated land treatment, removal and/or disposal
- Decommissioning mine ventilation shafts
- Backfilling and surface settling monitoring
- Environmental monitoring
- Services - water pumping, ventilation, miscellaneous
- Governance reporting
- Closure project team / supervision / independent assessments

3.4.2 TSF Closure Activities

The 'closure period' for the TSF is envisaged to take 2 years. After that, the CRAMP will move to 'Aftercare period.' One year following completion of tailings deposition capping of the tailings surface will commence. 'Aftercare' at the TSF is divided into three distinct phases spanning 30 years. Tasks involved in closure and aftercare include:

- Closure and rehabilitation of the tailings storage facility
- Provision and operation of the Passive Water Treatment system
- Cap and Stability monitoring of the TSF
- Environmental monitoring
- Governance reporting
- Rehabilitation of Simonstown borrow area
- Closure project team / supervision / independent assessments

BTM are committed to implementing progressive rehabilitation activities throughout the mine's operational life to reduce the final closure burden. The capping of Stages 5A is ongoing and associated with the operational phase of the TSF.

3.4.3 CEP Timelines and Schedules

A comprehensive timeline outlining the sequence and duration of closure activities with key milestones and targets to track progress will be established.

Evaluation of progress on achieving these milestones will be assessed through the following:

- Description of closure activity.
- Objective
- Target date for completion
- Quarterly Progress % rate
- Monitoring / measurement
- Specific success criteria to evaluate success
- Quality Control measurement tools (Validation/ compliance)

Progress reports will be shared with the statutory authorities and key stakeholders.

3.5 SUCCESS CRITERIA

The closure strategy will be underpinned by a set of success criteria which be used as framework for validation of closure and restoration performance. The achievement of these success criteria will be verified through a monitoring / measurement process with approval from the Regulatory Authorities prior to commencement of closure activities.

Assessing progress and ultimately demonstrating specific success criteria has been met will involve the following quality control measurement tools:

- monitoring, data collection and reporting.
- ensuring regulatory compliance
- conducting independent audits and assessment
- long-term post-closure monitoring

An adaptive management approach to refine and adjust closure activities based on monitoring data results and stakeholder feedback will be applied throughout the process.

Key success criteria indicators which include overall closure objectives and performance goals are presented in Table 3-1. More specific success criteria will be established closer to the Life of Mine. BTM will engage regulators, local communities, and other key stakeholders to agree on success criteria prior to commencement of closure activities.

Table 3-1 Key Success Criteria

Aspect	Success Criteria Indicators
Environmental Success Criteria	<ul style="list-style-type: none"> • Water Quality - Meet regulatory standards in surrounding water bodies • Ecological Restoration – Restoration of facilities as agreed with aim to increase biodiversity. Landscape where required.
Safety and Stability Success Criteria	<ul style="list-style-type: none"> • Public Safety – Secure access to site and potential hazards • Physical Stability – Surface settlement and stability monitoring to ensure no outstanding issues with stability or integrity

Aspect	Success Criteria Indicators
	<ul style="list-style-type: none"> • Chemical Stability - Prevent release of harmful substances into the environment. All plant, equipment and infrastructure decommissioned and decontaminated
<p>Regulatory and Compliance Success Criteria</p>	<ul style="list-style-type: none"> • Monitoring and reporting - Establishing effective monitoring programs and transparent reporting to stakeholders • Regulatory compliance- meet all regulatory requirements • Other commitments – ICMM; GISTM • Financial Provision – sufficient funds to cover full cost of implementing CRAMP
<p>Social and Community Success Criteria</p>	<ul style="list-style-type: none"> • Community Engagement - active and ongoing engagement with local communities throughout the closure process • Cultural Heritage - Protection of culturally important sites (St, Annes church and Holy well)
<p>Sustainable Development Success Criteria</p>	<ul style="list-style-type: none"> • Sustainable Land Use - post-closure land use that benefits the environment and local communities • Best Available Techniques and technologies – use best practice and innovative technologies to enhance remediation

3.5.1 Closure Objectives and performance Goals

The success criteria will include overall closure objectives and performance goals.

Closure performance goals for the *minesite* are summarised as:

- Maintain environmental/public health and safety
- Confirm there is no risk of environmental pollution
- Complete backfill in underground mine to minimise surface subsidence
- Restoration of groundwater to baseline conditions
- Water and air quality will meet regulatory standards

- Decontamination, decommissioning and removal offsite of surface buildings, equipment, infrastructure and materials for treatment in line with relevant regulations
- Preserve or reinstate agricultural and ecological resources

Closure performance goals for the *Tailings Storage Facility* are summarised as:

- Maintain environmental/public health and safety
- Prevention of long-term pollution
- TSF structural stability and integrity
- Provision of adequate tailings encapsulation
- Provision of adequate erosion protection
- Provision of adequate surface drainage
- Design of closure elements to maximise durability and minimise maintenance requirements and post-closure active care

Closure performance goals for the *Closure Cap* are:

- Cap has been engineered according to design details
- Cap has been successfully vegetated
- Cap drainage is performing according to design

Progressive rehabilitation of TSF is ongoing (20 hectares of Stage 5A North). This aside from a mechanism of trialling rehabilitation techniques will allow for monitoring over extended periods and act as a test programme to demonstrate the successful implementation of the rehabilitation plan before active closure begins.

Closure performance goals for the *Passive Treatment System* are:

- Is final discharge meeting the criteria detailed in the IE/Discharge licence
- Other measurements and benefits will include ecosystem services, including flood risk assessment benefits, biodiversity, improvements in water quality and carbon sequestration and are detailed in Chapter 7 and Table 7-4.

Criteria for successful Long-term Aftercare Management are presented in Table 8-6.

3.6 RESOURCE ALLOCATION

BTM will ensure adequate resources are secured and available for successful closure to include financial provision and a dedicated CRAMP project team.

3.6.1 Financial Provision

BTM have an established and appropriate Financial Provision (FP) sufficient to underwrite the current CRAMP (full review and update of all costings conducted in 2024).

The PF provides for 'contingency' applied from November 2016, following a review of then CRAMP by statutory agencies (EPA, MCC and DECC) considering the stage/development of CRAMP at that time. The same contingency levels have been applied in this CRAMP:

- 10% to the closure decommissioning and reclamation of the Mine site
- 33% to the closure decommissioning and reclamation including provision of the passive treatment system (PTS) of the tailings Storage facility (TSF)
- 10% contingency added to the Aftercare, Monitoring and Maintenance

The existing financial instrument is by means of a cash deposit (held by MCC with a current value of €14.8 million) and a Bank Guaranteed Bond (Danske Bank). It is proposed that a Bond approved instrument¹ be put in place that will cover the FP of the updated CRAMP in agreement with the three statutory Agencies (EPA, MCC and DECC).

There is also an approved FP in place for Unknown Liabilities, quantified by means of an Environmental Liabilities Risk Assessment (ELRA) which consider the risk of 'unplanned' events occurring during the operation of a facility that could result in unknown liabilities. BTM have undertaken a comprehensive and fully costed ELRA and have FP in place for 'Worst Case Scenario' (Major Dam Breach) by means of a bond.

Details on FP mechanisms are presented in Chapter 9 with closure and aftercare management activities costings detailed in Chapter 10.

¹ Based on the EPA template for Financial Provision.

3.6.2 Cramp Project Team

Upon closure of operations, planned or in the event of an unplanned /unexpected / abandonment closure scenario a **CRAMP Project Team** will be established. The team will ensure the closure process is executed to comply with requirements under CRAMP and achieve established closure success criteria.

The CRAMP Project Team will oversee all necessary communication ensuring appropriate information transfer with relevant authorities and key stakeholders and continued regulatory compliance and reporting during all decommissioning and aftercare operations.

3.6.2.1 Roles and Responsibilities

The CRAMP Project team will consist of the following personnel with defined roles and responsibilities for implementation and compliance with requirements under CRAMP as follows:

- CRAMP Project Manager
- Environmental Engineer
- Environmental Technician
- Project Engineer at TMF

The CRAMP project team and workload percentages are presented in Table 3-2 with defined responsibilities in Table 3-3. Associated costings are provided in Chapter 10, Table 10.3-1. Each position will be engaged on a fulltime basis during the initial 2-year period of closure and transition to a reduced workload throughout the aftercare period. A consulting engineer will be retained for the stable aftercare phase at the TMF spanning years 16 through 30.

Table 3-2 CRAMP Project Team and workload percentages

Role	Period / Phase		
	Closure (Years 0-2)	Active Aftercare (5 years)	Passive Aftercare (10 years)
CRAMP Project Manager	100%	40%	20%
Environmental Engineer	100%	40%	20%
Environmental Technician	100%	20%	Not required
Project Engineer at the TSF	100%	40%	20%

Table 3-3 CRAMP Project Team Roles and Responsibilities

Role	Closure Responsibility
CRAMP Project Manager	<ul style="list-style-type: none"> • Overall responsibility for delivery of Mine Closure Project and implementing closure activities within budget • Responsible for maintaining environmental/public health and safety • Overall responsibility for ensuring compliance with statutory and non-statutory requirements • Responsible for communication of closure plan and engagement with key stakeholders throughout process • Draw down on FP • Responsible for ensuring transparent and detailed specified documentation is maintained
Environmental Engineer	<ul style="list-style-type: none"> • Responsible for governance/compliance reporting • Responsible for implementing comprehensive monitoring programme to meet regulatory standards • Responsible for raw materials, products and waste disposal/recovery • Establishing specific success criteria indicators • Establishing quality control measurement tools to evaluate progress on achieving success • Responsible for on-site supervision of contractors and managing site services
Environmental Technician	<ul style="list-style-type: none"> • Overall responsibility for conducting compliance sampling and monitoring • Coordinate independent assessment of monitoring data • Ensure monitoring programme is appropriate to achieve regulatory compliance standards • Responsible for operation of passive water treatment.
Responsible Tailings Facility Engineer	<ul style="list-style-type: none"> • Overall responsibility for implementing maintenance and surveillance aspects and closure design for the TSF • Responsible for on-site supervision of contractors and managing site services and reporting

3.7 MONITORING AND REPORTING

A comprehensive monitoring programme to track environmental, stability and social indicators will be implemented. The data collected will assess progress against defined success criteria.

IE License, Environmental Management systems and planning conditions throughout operations have ensured rigorous water and air monitoring and control measures are in place. Water quality is monitored at an extensive network of monitoring boreholes, private wells and surface water locations around the mine site and TMF with an Independent review of all hydrogeological monitoring and water quality monitoring results conducted annually. Continuous ambient air monitoring and compliance monitoring at air emissions points is carried out independently by an INAB accredited contractor to meet ISO 17025:2005 requirements and the EPA Air Emissions Monitoring guidance (AG2).

Environmental Monitoring Programmes during closure and aftercare based on Schedules within current IEL are presented in Chapter 8 with associated costings in Chapter 10.

An adaptive approach to monitoring will be taken to allow for refining and adjustments to the monitoring programme based on monitoring results and feedback from statutory agencies. If post-closure monitoring indicates that success criteria are not being met additional remediation measures will be implemented.

Governance/compliance reporting to statutory agencies will be ongoing through closure and aftercare management phases. Transparent and detailed documentation of all closure activities and compliance efforts will be maintained throughout the closure process.

Regular and transparent reporting to statutory agencies and key stakeholders on the progress and outcomes of closure activities will be undertaken as part of the CEP.

3.8 STAKEHOLDER ENGAGEMENT

Consistent and transparent engagement involving key stakeholders is fundamental to ensure stakeholder input is relevant and representative throughout the closure process.

BTM have an efficient communication and feedback mechanism for engaging with the public and local communities allowing the Company to provide regular updates and where

community concerns and issues can be directly raised and addressed. This forum (scheduled quarterly meetings) will be used to provide a means of incorporating stakeholder feedback into the closure plan and ensure the expectations of local communities are understood and managed effectively.

This forum will also provide a means to share regular and transparent information and details of the closure plan, progress and outcomes of closure activities and reviews against success criteria indicators. Leading up to and in the early stages of closure BTM will increase the frequency of these meetings from quarterly to monthly.

BTM will engage with community and other key stakeholders' engagement throughout the closure process. The 'open-door' policy with access to the public at Environmental Department office during business hours will remain.

3.9 POST-CLOSURE MANAGEMENT

3.9.1 Aftercare Monitoring

BTM will be responsible for 'aftercare' until the EPA accepts surrender of the IEL as specified under section 48 of the Waste Management Act, 1996 as amended.

The Aftercare' environmental monitoring programme, which will be agreed with the Agency, will follow existing IEL monitoring schedules at existing monitoring points throughout the closure and active aftercare phase and until monitoring indicates that a steady state within required regulatory criteria is achieved.

In the long-term passive care phase, the frequency of monitoring will reduce progressively into the stable phase. Pollution control systems will be maintained and protected throughout the aftercare period.

Inspection, maintenance and water quality testing of the ICW Passive Treatment system will be required in aftercare management.

Operational surface subsidence monitoring will continue for five years through the closure and into the aftercare period and until data warrants a cessation of monitoring.

Review of all hydrology, hydrogeology and geotechnical data will be conducted by external consultants and associate reports produced.

Details of the aftercare monitoring, maintenance and management is presented in Chapter 8.

3.9.2 Future Land Use planning

Both the minesite and tailings storage facilities will be restored to comply with current and future Planning Conditions and future land zoning.

In the current Navan Development Plan (2021-2027) an area to the front of the Knockumber mine site is zoned *E2 General Enterprise and Employment*. It is believed that in time the remainder of the Knockumber site will be rezoned to accommodate light industrial or commercial end uses. The focus of the existing CRAMP is to reclaim the mine site to an agricultural end use in accordance with the original planning permission (ref. P73/125 granted by Meath County Council in 1973). It is not anticipated that the TSF which has a 30-year aftercare requirement period will be reclaimed to an agricultural land use.

A strategy for post-closure land use that will benefit the environment, and local communities will be developed.

3.10 CLOSURE PLAN VALIDATION

A final validation report (completed by a qualified independent consultant) which will include a certificate of completion to verify that all closure success criteria have been adequately addressed, will be produced upon the successful completion of the Closure Plan.

The validation report will consider all required closure criteria and will be endorsed and agreed jointly by the three key statutory authorities (EPA, DECC and MCC).

BTM will seek to surrender the IE Licence upon the submission of a Validation Report and completion of aftercare monitoring as required.

CHAPTER 4 SURFACE DECOMMISSIONING AND REMEDIATION

4.1 INTRODUCTION

This chapter details the Knockumber Site Surface Decommissioning Programme.

The final end use of the minesite complex is presently unknown. In advance of closure. In the current version of the Navan Development Plan (2009-2015) part of the front of the site is zoned *E4 “to provide for small and medium sized industries of a local type nature to develop and for the displacement of non-compatible town centre commercial uses in accordance with an approved Framework Plan”*. It is anticipated that in time the remainder of the main mine site will be rezoned to accommodate light industrial or commercial end uses.

BTM will liaise with statutory and other key stakeholders to develop a mutually acceptable and sustainable end use of the site. However, the focus of this CRAMP is to reclaim the site to an agricultural end use in accordance with the existing planning permit for the facility.

In 2024 a review to reflect existing conditions at the surface facility was conducted. This review included applying 2024 market industry rates (obtained from a third party contractor/quantity surveyor) to all costings associated with closure and aftercare activities (Appendix 4.1 refers).

The scope of 2024 CRAMP review and update comprised:

- Assessing and quantifying changes to surface facilities since the 2016 CRAMP. Any new buildings, changes to internal building layouts, new infrastructure, etc were quantified and added/amended to provide a current assessment of surface facilities;
- Undertake a general review of the 2016 CRAMP and update any notable items that may not have been accounted for;
- Review assumptions made in the 2016 CRAMP and assess whether these assessments are still valid, reasonable, and relevant; and
- Review all unit rates and costs (for steel, cladding, concrete, hardcore, etc) and update closure costings with 2024 market rates.

4.2 OVERVIEW OF SURFACE SITE

The surface site comprises an area of 72 hectares. The topography is generally level with the industrial footprint (hardstanding /buildings) screened with rough vegetation and trees. There are a number of raised earth mounds across the site, which act as visual and/or noise attenuation bunds. The minesite includes features and buildings presented in Figure 4-1.

- Administration and canteen building
- Ore storage shed (teepee).
- Processing plant (mill) and Autogenous Mill
- Concentrate storage and train loading shed.
- Store buildings
- Engineering maintenance buildings
- Laboratory
- Fuel storage tanks
- Roads and car park areas
- Surplus rock storage area
- Drainage management system including surface ponds



Figure 4-1 Overview of Knockumber Surface Site Facilities

4.2.1 Geology

Geological Survey of Ireland (GSI) data indicate that the bedrock geology underlying the site consists of limestone and shale of the Lucan Formation. Four fault lines traverse the site, two run north-east south-west in orientation on the eastern side of the site and two run east west to the west of the site. A section of the water management system to the east of the site is underlain by coarse to fine grained tuff of the Britstown Formation.

According to the GSI, subsoil consists of made ground of industrial origin across the majority of the site, with till derived from limestones surrounding the site. Alluvium is recorded west of the site.

The overburden is up to 10 m in thickness and consists primarily of boulder clay. Gravel fill has also been used on site.

4.2.2 Hydrogeology

According to the GSI website, the bedrock aquifer beneath the mine site is classified as a “Locally Important Aquifer – Bedrock which is Generally Moderately Productive”. The GSI’s classification of vulnerability of the underlying aquifer is “Moderate” vulnerability.

The groundwater body (GWB) at the site is the Trim GWB (IE_EA_G_002) classed as a productive fissured bedrock aquifer.

Under normal conditions groundwater is likely to flow north towards the River Blackwater, however dewatering as part of mine activities is likely to have depressed the water table and altered groundwater flow direction.

4.3 OVERVIEW OF SURFACE DECOMMISSIONING PROGRAMME

BTM have a dedicated Asset Management software system (IBM MAXIMO) to manage and track all physical assets such as plant, equipment, buildings, infrastructure, mobile fleet, with each item assigned a unique ‘asset number’. The system is kept up to date with any asset decommissioned or removed off-site removed from the register. Upon closure assets with resale value will be sold as part of the Assets Disposal Process.

Surface decommissioning will be undertaken in a scheduled manner and is broken-down into the following stages:

- Decontamination of infrastructure
- Building / infrastructure dismantle and disposal
- Site works, levelling, backfilling, and disposal
- Site remediation and return to a suitable land for future use.

All decommissioning / dismantling of buildings, infrastructure and storage tanks will be carried by specialist contractor whose contract terms will require strict operation within the relevant quality, safety, and environmental standards and in accordance with relevant Irish and European waste management regulations.

All warehousing, storage sheds, mill buildings (*transfer house, AG mill house, main processing plant, loadout and laboratory*) mine building (*tee pee, production hoist, compressor houses and fixed plant buildings*) and other buildings, rendered surplus to requirements post-closure, will be surveyed and demolished within one year.

Prior to the demolition and/or removal of any building, service or item of plant, a careful examination will be made to establish its level of contamination with any of the following materials or residues: fuels, oils and greases; process reagents and chemicals and ore or concentrates.

All contaminants will be removed, drained or flushed from all plant, tanks and pipelines. All residues containing fuels, oils and other hydrocarbon contamination will be removed off-site and re-cycled or disposed of by a licensed waste contractor. Accumulated fines and sludges from the water treatment ponds will be fed through the mill processing plant prior to its final cessation. All conveyors, feed lines and storage tanks will be decontaminated and decommissioned. When all material has been processed in the mill, the main processing area can be surveyed and decommissioned.

Prior to decommissioning or dismantling, all services connected to buildings and other structures will be disconnected and removed. The ESB substation will be assessed and rendered safe by the ESB.

All demolition materials will be segregated and exported from site, to appropriately licensed or permitted facilities for recovery/disposal.

It is anticipated that the main administration building will remain on site for the duration of the decommissioning and restoration stages. The final use or demolition of this building will be subject to the final end-use of the site and the potential for the establishment of a mine heritage aspect to the after use of the site.

4.4 DECOMTAMINATION

4.4.1 Infrastructure and Plant

All buildings, infrastructures and plant will be hosed down or flushed out with high pressure freshwater. The residual wash water will be intercepted in the site drainage system and if contaminated will be sent to the TSF or of compliant with discharge quality limits treated via the onsite surface settlement ponds. Any material containing lead or zinc will be put through the processing plant to extract the metals.

During and after demolition, further high-pressure washing will be undertaken as necessary to ensure that all materials are clean and contaminant free.

4.4.2 Materials and Residues

Any unused and uncontaminated materials will be contained / packaged and labelled, as legally required, prior to return to the supplier as provided by contractual agreement.

Any residual waste remaining onsite will be disposed of via licensed waste contractor and in accordance with conditions of IE Licence in place at time of closure.

Fuels and Oils

All stocks of fuels and oils will be collected, compatibly bulked, labelled and returned under contractual agreement to the supplier. All oils in plant and equipment scheduled for decommissioning and disposal will be drained to waste oil storage tanks. Waste oil will be removed by licensed waste contractor for recovery. All storage tanks will be decontaminated prior to decommissioning and exported off-site

Maximum quantities of bulk fuel stored on site are shown in Table 4-1. The fuel tank farm (upgraded in 2017) consists of five double skinned tanks and associated dispensing points and transfer pipework, pumps and equipment.

Table 4-1 Maximum Quantities of Bulk Fuel an Oil stored onsite

Fuel / Oil Type	Maximum Stored
Ultra Low Sulphur Diesel	70,000 L
Divided into hydraulic oil, engine oil and kerosene	53,000L
Road Diesel	9,000L
Waste Oil	9,000L
AdBlue tank (unused)	9,000L

Process Chemicals and Dangerous Substances

All uncontaminated and unused reagents and chemicals will be returned to the supplier as provide by contractual agreement. Dangerous substances (defined in COMAH Regulations) are stored onsite up to the following maximum quantities presented in Table 4-2.

Table 4-2 Maximum Quantities of Dangerous Substances stored onsite

Chemical / Substance	Maximum Amount (Tonne)
Sodium Cyanide	4
Zinc Sulphate	24
Copper Sulphate	100
SIPX	40
PAX	20
Methyl Isobutyl Carbinol (MIBC)	20
Ammonium Nitrate Bulk Emulsion	50
Sodium Nitrite	1
Danofloat 507/Auxillary Collector	25
LPG Propane	4
Ultra Los Sulphur Diesel	54
Petroleum products including kerosene	54
Lead Concentrate	5,000
White Spirits	0.5
Lockset resin	31.5
Oxygen	0.54
Acetylene	1.32

Any laboratory reagents remaining will be returned to supplier or removed by a licensed waste contractor.

Residual Ore and Concentrates

Ore remaining in the coarse ore store or concentrate in the concentrate storage shed will be fed through the mill process.

Cement

Large quantities of cement used on the mine for shotcrete and within the underground backfill and stored in surface silos. All remaining stocks will be utilised during the closure operations or removed from site for re-use.

Explosives

BTM contracts out the provision of bulk emulsion explosives to a licensed contractor (Orica). Emulsion based explosives are supplied on a needs basis with a 50 tonne maximum quantity stored on site. Electric and non-electric detonators packaged in airtight bags or cartons are stored underground. On closure any un-used explosives will be returned to suppliers.

4.4.3 Surface areas and Soils

When all surface building have been dismantled and removed from site, all hardstanding and hardcore will be excavated and removed. The hardcore used on site is inert in nature (refer to Section 4.6.1). However, in areas where tanks and pollution risk activities were, special investigation will be undertaken to assess any potential contaminant risk. Subject to the outcome of the contaminant risk assessment, the hardstanding and hardcore will be either be used for backfilling voids or exported offsite for treatment as contaminated material.

Ste investigations were undertaken in 2022 as part of the IEL P0516-04 Review process and A *Soil and Groundwater Baseline Report* produced (presented in Attachment 1). The assessment included non-targeted and targeted (3 locations in the area surrounding the fuel farm) soil investigations undertaken at 20 locations across the site. Soil results concluded that hydrocarbons in area surrounding the fuel farm are below baseline level limits. The report concludes that there is no notable impact from Relevant Hazardous Substances (diesel, kerosene, zinc concentrate, waste oil and lead concentrate) in the soil or groundwater at the Knockumber minesite.

In line with requirements of Industrial Emissions Directive (IED) (2010/75/EU)¹, monitoring per 'Baseline Report' should be undertaken every five years in groundwater and every ten years in soils. In this regard BTM will undertake groundwater monitoring in 2027 and soil in 2032.

4.5 BUILDINGS AND INFRASTRUCTURE DISMANTLE

All demolition will be carried out in accordance with industry standards and good practice as described in British Standard BS6187:2000 Code of Practice for Demolition. Before any demolition works commence a detailed survey and examination of the structure will be carried out aided by the listing of building parts (assets) in the Asset Management Register and available plans of the original design (and subsequent modifications).

All services connecting to buildings/structures will be disconnected, dismantled or diverted before work commences. Once each structure is completely dismantled the materials will be divided into the following categories:

- Reinforced concrete and blockwork - this will be crushed and used as bulk fill material to backfill surface voids (ventilation shafts)
- Structural steelwork, steel tanks, metal cladding and steel decking – these will be cleaned/decontaminated, removed offsite and sold as scrap
- Metal stairs and walkways; roof finishes, external doors and windows and soft strip out – cost of demolishment will equate scrap value
- Fixed Plant, Machinery & Equipment – these will be removed off site and disposed of through an asset disposal process
- Metal cladding, conveyors, stairs, handrails and other miscellaneous steel items - these will removed off-site and sold as scrap.

A breakdown of building elements and associated costs to dismantle and scrap are presented in Tables 4-3 and 4-4 in Appendix 4-1. Costings are presenting showing costs to dismantle less scrap value.

¹ Under the Industrial Emissions Directive (IED) (2010/75/EU), licenced sites are required to assess their inventory of Relevant Hazardous Substances which, as a result of their hazardousness, mobility, persistence and biodegradability (as wells as other characteristics), are capable of contaminating soil or groundwater and which are used, produced and/or released by the installation.

4.5.1 Reinforced Concrete and Block work

Reinforced concrete walls, columns and foundations associated with buildings will be demolished, crushed, and stockpiled for use as bulk fill material. All reinforcement will be segregated from the concrete and removed off-site and sold as scrap.

There is an estimated 24,940 m³ of concrete which will be demolished and crushed at a rate of €37.90/ m³. This amounts to a total cost of €945,226.

Also included in this element is blockwork located within the buildings. There is an estimated 12,662 m² of block work. The rate for crushing block work is €16.00/m² amounting to a total cost of €202,592.

4.5.2 Structural Steel

The current market value (April 2024) for scrap steel is €195 per tonne. Accounting for an associated dismantling cost (current market rate of €59.40/tonne applied) the net value per tonne of scrap steel is €135.60. The total quantity of structural steel on the site is 4,260 tonnes, therefore a net gain of €577,656.

4.5.3 Steel Tanks

There is a total of c.763 tonnes of steel in tanks around the mine site and mill building. Some tanks are no longer in use but are still present on site available if required. As with the structural steel these tanks have a net value of €135.60/tonne providing a net gain of € 103,462.80.

4.5.4 Metal Cladding

There is c.42,950m² of metal sheet cladding on the site broken into: c.12,500 m² of insulated cladding; c.28,000 m² of un-insulated cladding; and 2,500 m² of corrugated sheeting.

The scrap value for this material at current market levels (April 2024) is €156/ tonne. This scrap rate has been used to offset the cost of dismantling the materials.

The breakdown of the metal cladding costs can be summarised as follows:

- Dismantle and scrap of insulated cladding – c.€601,430.
- Dismantle and scrap all un-insulated metal cladding, corrugated galvanised, circular corner flashing and louvres – c.€584,419

4.5.5 Steel Decking

There is c.300 tonnes of steel decking on the site comprising c.18,500 m² of 38mm deck and c.6,000 m² of 64mm deck.

Accounting for cost of disposal and applying the scrap metal value of €195/tonne, the overall cost of disposal of steel decking is c.€231,000.

4.5.6 Roof Finishes

Roof finishes relate to an insulated built-up roof system with a felt “torch-on” type membrane finish. This is found primarily on the older site building with newer buildings having a cladding type covering (covered in section 4.5.4).

The total quantity of roof finishes is c.20,000 m² and the cost of removal and disposal is €14.00/m² giving a total cost of c.€280,000 for this item.

4.5.7 External Doors & Windows

A relatively small cost/liability exists for the removal of external windows and doors. The cost to remove and dispose of windows amounts to c.€2,775 with doors amounting to c.€6,560.

4.5.8 Metal Stairs, Walkways and similar

There is a significant quantity of stairs, gantries and walkways in the various buildings around the site which will be removed and sold as scrap. Accounting for dismantle costs a scrap value of €156/tonne has been applied. The net costs for this are:

- Removal of elevated walkways and stairs – c.€3,560.
- Removal of floor chequer plate – c.€15,900.
- Removal of steel grating to floors – c.€1,126.

4.5.9 Soft Strip-Out

A “soft strip-out” refers to following: Internal door and joinery; stud partitions and ceilings; furniture, fixtures and fittings; electrical and plumbing installation; and sanitary ware. A general allowance for each building based on its size and nature has been applied. With electrical installation strip-out, electrical cabling will have a scrap value. The total cost for soft strip-out for the site is c.€219,000.

4.5.10 Fixed Plant, Machinery & Equipment

There is a significant and extensive quantity of fixed plant and equipment located within the buildings. While it has a resale value, estimating this value is difficult due to the technical nature of the goods and removal and transport costs have to be accounted for.

Although the resale value of the materials will outweigh removal costs, it will be assumed that the resale value will equate to the removal cost and are thus deemed cost neutral.

A summary of costs associated with decommissioning buildings is presented in Table 4-5

Table 4-5 Decommissioning Site buildings

Item	Cost
Building Components	€2,575,350.20
Soft Strip-out	€219,000.00
Fixed Plant / Machinery / Equipment (Cost Neutral)	€0
Sub Total	€2,794,350.20

4.6 SITE-WORKS, LEVELLING EXCAVATION AND DISPOSAL

A breakdown of site-works, levelling, excavation and disposal elements and associated costs are presented in Tables 4-9 to 4-13 in Appendix 4-1.

4.6.1 Decommissioning Hardcore

Hardcore describes porous broken/crushed rock materials which make up site roadways, the basement of buildings, car parks and hardstanding areas and water pond embankments. Breakdown of hardcore quantities is presented in Table 4-6.

Table 4-6 Breakdown of hardcore quantities

Item/Area	Quantity m ³
Roads	41,660.64
Hardstandings carparks	115,277.50
Ponds	2,533.00
Building foundations	56,641.80
Total Amount of Hardcore	216,112.94

It is proposed to:

- Leave hardcore roadways in-situ to accommodate access to land post closure.
- Leave hardstanding in carparks in situ and cover with suitable material
- Hardcore in pond embankment will be levelled into the pond depression
- Leave hardcore under buildings in-situ and cover with suitable material

Hardcore will be used to fill the depressions around the ventilation raises (RAR 3 and 6 and FAR 2).

4.6.2 Roads, Carparks and Hardstandings

The area of roads, carparks and hardstandings amounts to c.200,000m² broken down into bituminous tarmac, concrete hardstandings and hardcore as shown in Table 4-8.:

Table 4-8 Decommissioning Roads

Item	Area m²	Volume m³
Bituminous tarmac roads (incl spray & chip)	59,344	
Concrete hardstandings	16,250	3,704
Hardcore	143,855	156,938

It is proposed to:

- Remove and dispose of bituminous tarmac offsite
- Concrete in hardstanding areas will be excavated, concrete crushed, reinforcement removed (if present) and stockpiled for use as backfill in mine voids.
- Leave hardcore in carparks and hardstanding areas in-situ and cover with suitable material

Unit rate cost for the removal and disposal of bituminous tarmac is €7.20/m² decommission concrete is €37.90/ m³. The breakdown of costs associated with these site works are presented in Tables 4-9 an 4-10 in Appendix 4-1 and summarised as follows:

- Removal and disposal off-site of bituminous tarmac: € 233,078.40
- Excavate and crush and place concrete hardstanding: € 140,381.60
- Hardcore in roadway will be left in-situ @ €0.00

4.6.3 Water Management System Ponds

After all water and residual sediments are emptied, each of the water management system ponds will be backfilled by bulldozing the raised pond walls/berms into the pond voids themselves. It is assumed that by doing this the ponds themselves will consume the surrounding berms with no surplus materials remaining.

If and where necessary, inert fill material will be imported and used to complete backfilling. At each of the respective pond site all emplaced backfill materials should be compacted and completed with a sufficient surface gradient to minimise direct infiltration of rainfall and facilitate surface run-off away from the pond areas.

Table 4.11 in Appendix 4-1 outlines the breakdown of costs associated with decommissioning the surface ponds giving a total costing of €150,157.80.

4.6.4 Screening Berms

There are many screening berms throughout the site (buildings, site perimeter, ventilation shafts). These berms are essentially stockpiles of useful material (clay and stone) which will be utilised post closure for land restoration.

The total volume of materials associated with these screening berms is c.122,092 m³, which is made up of 105,000 m³ of clay and 17,093 m³ of rock. The movement and placement of clay is costed at €3.50/ m³ and the relocation of rock and placement of rock in mine portal is costed at €6.70/m³. Table 4.12 in Appendix 4-1 outlines the breakdown of costs associated with decommissioning the screening berms a total costing of €482,023.10.

4.6.5 Buried Pipelines

There are three main types of buried pipelines on the site – concrete, high density polyethylene (HDPE) and ductile iron. The treatment of these pipes is as follows:

- Concrete pipes – excavate trench, crush/demolish pipe in-situ and backfill the trench. Taking an average rate of €31.20/m this amounts to a total cost of c.€108,451.
- HDPE pipes – excavate trench, remove pipe and dispose offsite and backfill trench. Using as rate of €28.80/m this amounts to a total cost of c.€426,240.
- Ductile Iron – excavate trench, remove pipe and sell for scrap and backfill trench at cost of c.€710,440.
- Alvenius pipe - excavate trench, remove pipe at a cost of c.€64,484.

The discharge pipeline that runs alongside the rail line and into the River Boyne will be left in-situ. The tailings and reclaim water pipelines (replacement of 5.1 km both from the TSF to north of the River Blackwater was undertaken in 2023/2024) will be left in situ.

Table 4-13 in Appendix 4-1 outlines the quantities and rates associated with these works. The total cost of decommissioning all buried pipelines is €1,309,615.

4.6.7 Mine Ventilation Shafts

There are 10 active ventilation shafts (Fresh Air Raises and Return Air Raises). Closure of these will involve placement of a surface plug seal, leaving the remainder of the shaft open below the plug. Where access excavations were required to establish stable collar locations in bedrock at RAR 3, RAR 7 and FAR 2, these excavations will be backfilled with overburden material following placement of the surface plugs. For further details on the planned approach to closure of all FARs and RARs and conceptual design of the reinforce concrete plugs, see Section 5.7.

Costs in relation to decommissioning mine shafts and raises (surface plug and backfilling) are presented in Tables 4-14 and 4-15. The total costing for these works is €511,776.00.

Table 4-14 Cost associated with Decommissioning Mine Shafts and Raises

Item	Rate (2024)	Cost (2024)
Mine Shafts	€216.00	€27,216.00
Mine Portals	€216.00	€23,976.00
Fresh Air Raise	€216.00	€73,224.00
Return Air Raise	€216.00	€140,400.00
Total Costing		€264,816.00

Table 4-15 Cost associated with Backfilling around Ventilation Raises

Item	Volume (m ³)	Rate (2024)	Total Cost
RAR No. 3 N and S - Kells Road	8,800	€3.50	€30,800.00
FAR No. 2 Magazine	3,750	€3.50	€13,125.00
RAR 6	58,010	€3.50	€203,035.00
Total Costing			€246,960.00

4.6.7 Site Enclosures

The quantity of perimeter fencing is 6,600 linear metres (including fencing at ventilation shafts RAR6 and RAR7). Working on an average cost of €8.45/Lin m for the removal and disposal, this leaves a total cost of €55,770.

A summary of costs for Decommissioning Site infrastructure is presented in Table 4-14.

Table 4-14 Decommissioning Site Infrastructure

Item	Cost	Reference in CRAMP
Roads	€142,077.60	Appendix 4.1 Table 4–9
Car parks, hardstanding	€373,460.00	Appendix 4.1 Table 4–10
Water Management System Ponds	€150,157.80	Appendix 4.1 Table 4–11
Screening Berms	€482,023.10	Appendix 4.1 Table 4–12
Buried Pipelines	€1,309,615.80	Appendix 4.1 Table 4–13
Mine shafts and ventilation raises	€511,776.00	Tables 4-14 and 4-15
Perimeter fencing	€55,770.00	Section 4.6.7
Total	€3,024,880.30	

4.7 SITE REMEDIATION

The mine site occupies a total area of 72 hectares (ha). The mine site is generally flat lying and where not covered by hardstanding, buildings, plant and other ancillary infrastructure, the site is vegetated or planted. An area amounting to 50 ha of the site needs remediation.

The current planning permission for the site stipulates that upon closure, the site is to be returned to agricultural land use. With this in mind, works undertaken in Sections 4.4 to 4.6 addresses the dismantling and removal of all mine site buildings, plant, and ancillary infrastructure, ponds, ventilation shafts and levelling the site using excavated hardcore and soil material from screening berms. Once these works have been completed, the quality of surface soils would likely not be considered suitable for ‘agricultural’ use.

To assess suitability the site will be systematically surveyed for surface soil contamination by sampling and laboratory analysis in accordance with EPA procedures and guidelines. Checks will be made for heavy metals and hydrocarbons. Particular attention will be paid to soils beneath the reagent stores, fuel and lubricant storage areas, maintenance areas, mill, covered

stockpiles and coarse ore storage area, where isolated areas with higher levels of contamination may occur. Investigations will be conducted in these areas in line with soil and groundwater investigations conducted in 2022 (section 3.4.3 refers).

A risk assessment process will be used to determine acceptable threshold concentrations within the soils to determine the safe levels of contamination for the proposed agricultural use of the site, in accordance with EPA or relevant UK guidelines such as CLEAR. Any soils containing levels of contaminants in excess of the threshold concentrations would be removed to the TSF or disposed of at an appropriate facility off-site.

Until the surface soil contamination survey and associated risk assessment are carried out to support decisions regarding the final rehabilitation and associated cost it is considered likely that up to 50 hectares of the site may require rehabilitation with a good quality soil cover. This will provide a growth medium for crops and vegetation. Some degree of soil stabilisation would also need to be undertaken which has been allowed for in the corresponding cost estimates.

Based on the general land capability criteria presented in Morrey (1991) and summarised in Table 4-15, an estimated soil cover depth of 500 mm of appropriate quality will be more than adequate for agricultural land use, both arable and grazing types.

Table 4-15 Generalised Land Capability Criteria

Land Class	Criteria	Rehabilitation Required
Wetlands (including moist deciduous grassland/forest)	Shallow water table – 50 % volume gleyed	Complete reinstatement
Arable land	pH 5.0 – 8.4 EC < 4 dSm ⁻¹ HC > 1.5 mm/h	Soil depth ≥ 500 mm Rocks < 10 % volume
Grazing land	As for arable land, pH ≥ 5.5	Soil depth ≥ 200 mm Rocks < 50 % volume Min. 1:3 slope
Wilderness (unmanaged grassland)	Too stressful for any agricultural production	Soil depth ≥ 150 mm

Source: Morrey, D.R (1991). *Closure Cost Management for Mines*

The ground surface will be contoured to an appropriate landform. Stockpiled soils including subsoil from screening berms will be re-spread and slopes graded to shallow profiles appropriate for shedding surface water. Additional inert soil will be imported.

Once the site landform has been fully graded and recontoured and the topsoil has settled, the final surface water drainage system will be installed.

The costs associated with overlaying the site with a 400 mm layer of boulder clay and a 100mm layer of topsoil, (or soil conditioner) along with allowances for soil stabilisation and seeding are outlined in the Table 4-16.

Table 4-16 Estimated soil contamination survey and rehabilitation costs

Item Description	Unit	Quantity	2024 Rate	Costs
Soil contamination survey				
Drainage Geocomposite	m ²	50,000	€4.88	€244,000.00
Protective geotextile	m ²	50,000	€2.30	€115,000.00
Soil available on site	m ³	105,000	€3.50	€367,500.00
Subsoil to be imported	m ³	145,000	€3.50	€507,500.00
Re seeding	ha	50	€675	€33,700.00
				€1,267,750.00

4.8 SURFACE WATER MANAGEMENT

4.8.1 Existing Water Management System

The site water management system comprises a series of water management ponds used for temporary storage from various sources, to facilitate handling of reclaim water from the TSF, settlement of sediments and water treatment prior to reuse and/or discharge to the River Boyne (SW1).

A schematic of the site water management system is shown in Figure 4-2, and locations of the ponds shown in Figure 4-3 with corresponding functions summarised in Table 4-17.

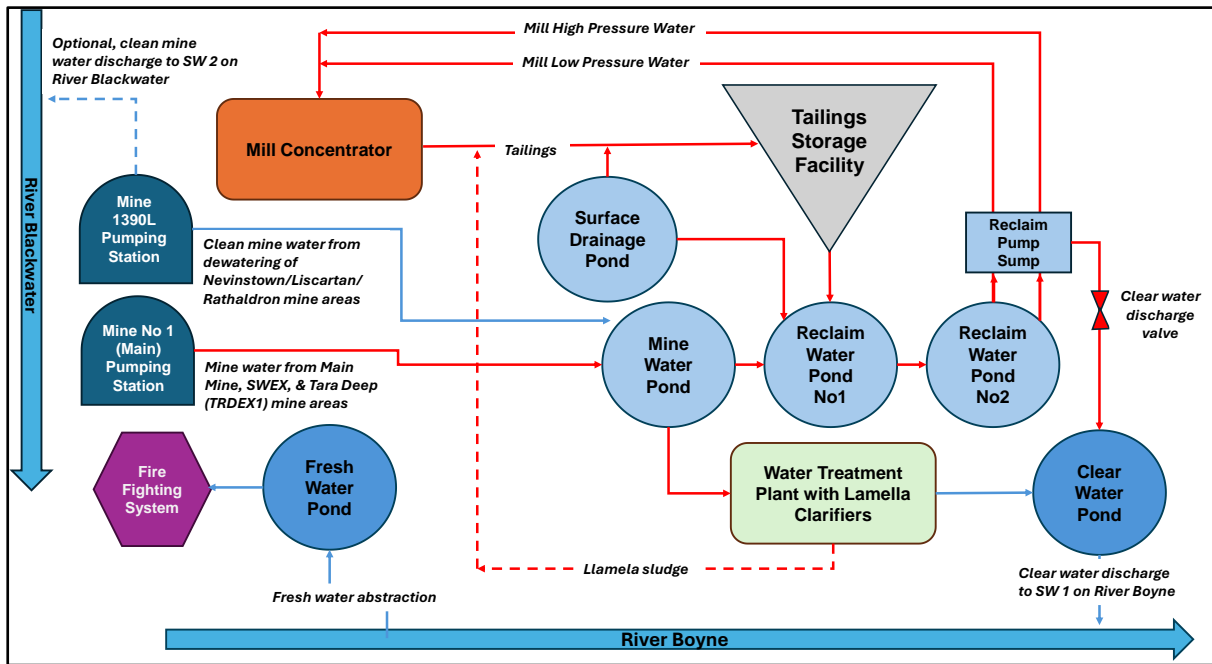


Figure 4-2 Site Water Management System

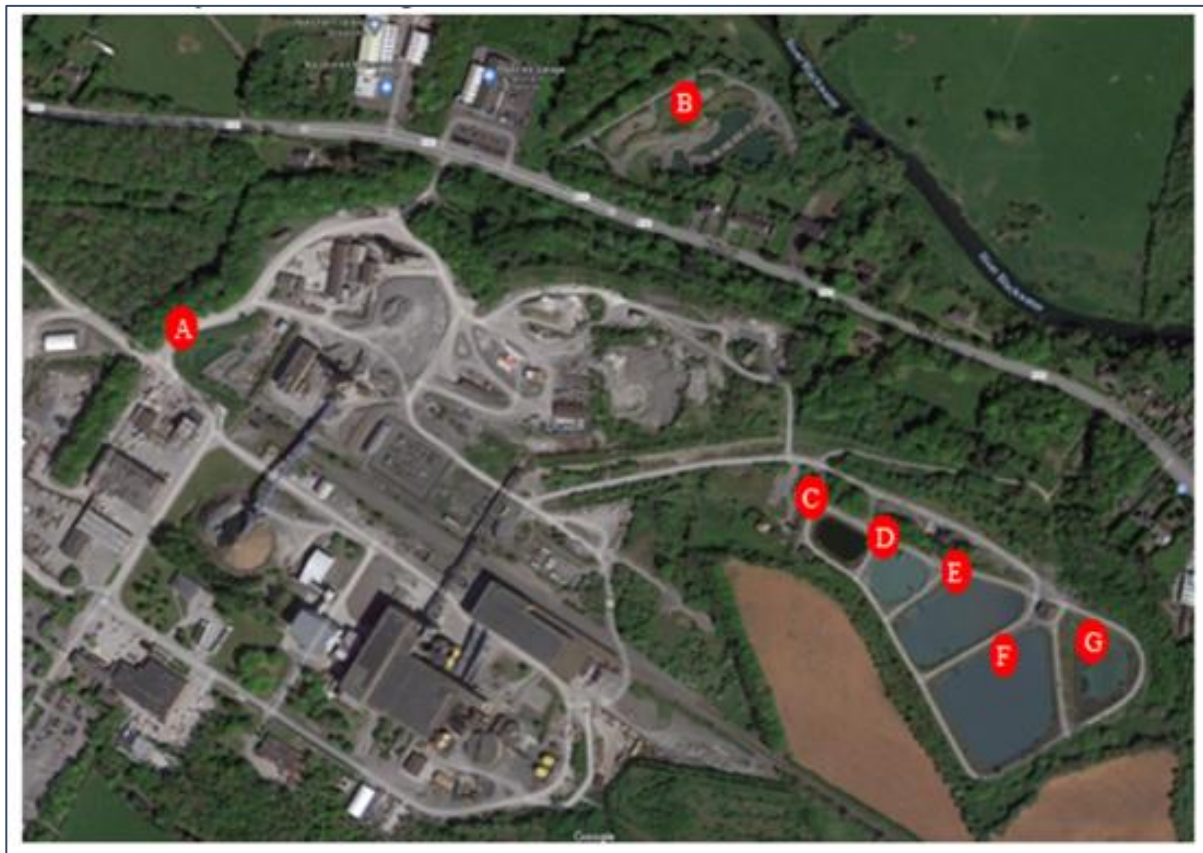


Figure 4-3 Location of Water Management Ponds

Table 4-17 Function of Water Management Ponds

Pond No.	Pond	Function
A	Onsite surface drainage Pond	Collects storm water runoff from the site and acts as a settlement pond for water clarification. allows for settlement. Overflow discharges to Pond B and in turn to Pond E.
B	Offsite surface drainage pond	Collection and settlement of local surface water runoff and overflow from Pond A prior to discharge to Pond E.
C	Fresh Water Pond	This pond receives fresh water pumped from the River Boyne for use for supply to fire-fighting ring main.
D	Mine Water Pond	This pond receives mine water pumped from the Main (No1) pump station of underground dewatering system. It feeds water to treatment plant including lamella clarifiers prior to discharging to Clear Water Pond (G). Overflow is directed to Pond E.
E	Reclaim Pond No 1	Receives overflow water from Pond D and reclaim water from the TSF to facilitate settlement prior to controlled overflow to the to Reclaim Pond No 2.
F	Reclaim Pond No 2	Receives overflow water from Reclaim Pond No 1 for continued settlement prior to controlled flow to the reclaim pump sump and supply to the water treatment plant, then discharge to the Clear Water Pond (G).
G	Clear Water Pond	Flow from this pond to Emission point SW1 on the River Boyne is controlled to maintain discharge within IEL limits.

The principal source of process and operational water is derived from the mine dewatering system. Groundwater inflows entering the mine through water bearing fissures are conveyed under gravity to sumps and pumping stations and then pumped in stages to two locations at surface:

- Clean water from the Nevinstown mine area – which is discharged directly to the River Blackwater at Emission Reference Point SW2
- All other groundwater inflows from deeper mine areas (Main Mine, SWEX, TRDEX 1) are pumped to the surface 'Mine Water Pond' (D).

A small amount of fresh water is pumped from the River Boyne to the Fresh Water Pond (C) for supply, when necessary, for fire-fighting purposes.

A portion of the process water generated on site is treated with ferric sulphate and flocculants to remove antimony. The treated water then passes through lamella filters (reduce suspended solids) prior to controlled discharge to the Clean Water Pond (G) and then to the River Boyne at Emission Reference Point SW1.

Discharge from the Clear Water Pond to the River Boyne at SW1 is continuously monitored to comply with conditions and schedule in IEL. The system will shut down automatically if water is not compliant with Emission Limit Values (ELVs) ceasing discharge. An automated hydrometric gauging station in the River Boyne records real time water flow to ensure there is a dilution factor of at least 100:1 available in the River Boyne.

Groundwater collected from the Nevinstown mine area in underground reservoir has minimal or no contact with the orebody is pumped directly to surface and discharged at Emission Reference point SW2 to the River Blackwater. This discharge is continuously monitored, and the system will shut down automatically if water is not compliant with Emission Limit Values (ELVs) ceasing discharge.

4.8.2 Water Management During Closure Activities

The water management system, including some of the mine pumping stations, the surface water drainage system, settlement ponds and treatment plant, will continue in operation during the closure phase and into the early aftercare period.

Water quality monitoring will continue throughout the closure and aftercare periods based on the monitoring schedule in IEL and until such time as it meets regulatory standards in the surrounding water bodies and to the satisfaction of the Regulatory Authorities.

Any associated wastewater that might arise during decommissioning and associated decontamination activities will be treated within the water management system. In the event that waste oils or associated sludges are generated during the decontamination process, these will be disposed offsite by licensed waste contractors.

During the aftercare phase the water management ponds will be decommissioned by running all contaminated water and accumulated sediments from the ponds through the process plant and discharging residual slurries to the TSF. Where specific pond water is measured and determined to be compliant with IEL discharge limits, this will be discharged to the River Boyne at SW1.

During the subsequent aftercare phase and following excavation of the pond waters each of the pond areas will be backfilled as described in Section 4.6.3, surface profiling will be completed to minimise rainfall infiltration and facilitate surface water runoff away from the pond areas and toward a post closure site surface water drainage system of appropriate design for future agricultural land use.

4.8.3 Cessation of Discharge to River Blackwater

Once the underground pumps are turned off and the mine begins to rewater there will no longer be a requirement to discharge this groundwater. It is anticipated that groundwater discharge to point SW2 on the River Blackwater will cease within the first 6 months following closure.

4.8.4 Cessation of Discharge to River Boyne

When the underground workings have been cleared of all potentially hazardous material, the underground pumps will be turned off and the zone of dewatering influence will begin to rewater with the rebound of groundwater levels. Once the underground dewatering pumps are turned off and water is not being pumped to the Mine Water Pond at surface there will no longer be a requirement to discharge large volumes of water from the site. Discharge from the Clear Water Pond to the River Boyne at SW1 will cease.

The onsite water management ponds and treatment plant will remain operational throughout the closure and restoration phases and for a period into aftercare phase to facilitate any required handling and/or treatment of surface water runoff or contact water.

4.8.5 Management of Site Water Runoff

At the end of decommissioning, when all major structures and materials have been removed and dealt with, the ground surface will be contoured to an appropriate landform. Stockpiled soils including subsoil from screening berms will be re-spread and slopes graded to shallow profiles appropriate for shedding surface water. If required additional suitable fill material will be imported. This will depend on future land zoning objectives at the time of closure.

Once the site landform has been fully graded and recontoured and the topsoil has settled, the final surface water drainage system will be installed. A system of surface ditches will be constructed along field boundaries, designed such that there will be no ponding or undrained areas. Field boundary ditches will be designed and constructed to reflect the natural surface

drainage and convey surface water runoff to a main collector ditch along the eastern boundary of the site and facilitate discharge to the watercourses draining into the River Blackwater.

Areas of heavy soil with poor internal drainage will be locally drained as necessary, with a piped field drain system, comprising perforated pipes with permeable backfill, discharging to a field boundary ditch. Any such drainage system will be designed in accordance with required drainage practices to suit future post closure land use.

Appendix 4-1 Tables

Breakdown of Building and Infrastructure elements and associated Dismantle and Disposal Costs

Table 4-3 Decommission, dismantle and disposal of building elements													
	Area (m ²)	Height (m)	Void to be filled	Reinforced concrete (m3)	Hard core below B'ldg	Solid Block Work (m2)	Hollow Block Work (m2)	Structural Steel Tons	Stairs Walkways Linear M	Ch. Plate 6mm Sq. M	Tank Steel		32mm Grating Sq. M
											Plate	Stiffeners	
											Tons	Tons	
Building													
Stores	1002	5.76	641	240	401	139	273	39	8	0	0	0	0
Eng./Workshops	2058	10.25	1420	597	823	176.4	1411	157	20	0	0	0	0
Washbay	398.5	9.1	1198	401	797	0	0	19	0	0	0	0	0
Mine Dry	2150	7.4	1582	722	860	378	1974	315	37	0	0	0	0
Laboratory	711.5	5.2	420	135	285	198.3	754.6	24	0	0	0	0	0
Compressor House	645.9	11.66	1297	1039	258	0	1830	102		0	0	0	0
Headframe Production	77.02	36.91	590	536	54	0	0	109	36				103
Service Tunnel			537	537	0	0	0	0	0		0	0	0
Dust Collect - Conv. 41001	40	17	37	37	0	0	0	21	40	100	0	0	0
Coarse Ore Store	2124	26.7	45344	260	45084	0	0	232	0	0	0	0	0
Hopper/41002 tunnel etc.			1322	1322	0	0	0	0	0	0	0	0	0
Transfer House	297.7	24.8	282	163	119	0	0	98			0	0	
Loadout	3961	18	3379	1794	1585	0	143.6	534		691	0	0	
Conv. Supports + Gallery		Varies	182.4	182.4	Incl.	0	0	96		1573	0	0	
Conv. Supports + Gallery		Varies	0	0	0	0	0	194			0	0	
Mill Plant	6840	23.3	27360	6282.2	2736	2577	457.6	1614			0	0	
AG Mill	1188	25.7	4758.3	1262.0	237.0			164.0	253	54			85
Canteen	368	3	294	92	147.2	195	0	0			0	0	
Waste Shed	900	10	720	270	360	0	0	50			0	0	
External Bins and Tanks													
Fine Ore Bins Building		33.05	Incl	1550.7	Incl.	0	0	102	70				
Fine Ore Bins - Steel Bins		18.35	Incl		Incl.	0	0	0			145	28.6	
Lime Bins	98	18.55	Incl	72.3	Incl.	0	0	9	0		55.1	9.8	
Soda Ash Bin	49	20.72	Incl	36.1	Incl.	0	0	8	0		18.9	4.7	
Cement Bins	98	15.14	Incl	123.5	Incl.	0	0	19			54.4	16.9	
Sand Tanks	510.8	15	Incl	1122.1	Incl.	0	0	10	84		136.3	23.9	
Sulphuric Acid Tanks	450	8.7	Incl	235.3	Incl.	62.4	0	7	Incl		65	8	
Zinc Thickener	660.5	6	Incl	0	Incl.	0	0	25			113	14.1	
Lead Thickener	148.5	4.9	Incl	0	Incl.	0	0	12			28.3	3.5	
Thickener P'house + Tunnel	45	4	Incl	251	Incl.	0	0	14					
Bulk Oil Storage													
Bunker Oil Tank	57.76	11	46.21	0	Incl.	0	0	0	0		38.8	1.2	

Table 4-3 Decommission, dismantle and disposal of building elements													
	Area (m ²)	Height (m)	Void to be filled	Reinforced concrete (m3)	Hard core below B'ldg	Solid Block Work (m2)	Hollow Block Work (m2)	Structural Steel Tons	Stairs Walkways Linear M	Ch. Plate 6mm Sq. M	Tank Steel		32mm Grating Sq. M
											Plate	Stiffeners	
											Tons	Tons	
Diesel Oil Storage(1)	57.76	5.5	46.21	0	Incl.	0	0	0	0		22.3	1.2	
Diesel Oil Storage(2)	134.6	12	107.65	43.5	Incl.	0	0	0	0		50.7	1.4	
Oil Pumphouse	50.41	3	40.33	13.1	Incl.	32.6	0	4	0		0	0	
Loadout Sedimentation Tank	1000	3	3000	1240	400	0	0	0	0		0	0	
Pumphouses & Ancillary Buildings													
Fresh Water Pumphouse	76.8	4.7	61.4	112.6	38.4	143.6		1.2	0		0	0	
Reclaim Water Pumphouse	108.1	5.3	86.5	316.6	54.1	191		2.5	0		0	0	
Pond Overflow Chambers				317.8	101.3	0		0	0		0	0	
Potable Water Dist. P'house	65.3	4	52.2	46.5	62.6	115.4		1.3	0		0	0	
Boyne Pumphouse	65.3	4	52.2	234.4	52.6	160.8		3.7	Incl		0	0	
Transf. Switchgear Rm	59.2	4.1	47.3	263.8	89.6	7.4		7.4	3.5		0	0	
Dev. Shaft Winder + Frame	400		320	250	160	0	200	60	0	0	0	0	0
Mech + Elect Workshop	500		400	170	200	0	400	15	0	0	0	0	0
RAR No 1 and 2			Incl.	120	60	0	0	30	0	0	0	0	0
RAR No. 3 N and S			Incl.	600	60	0	0	0	0	0	0	0	0
FAR No. 1			Incl.	60	200	0	0	0	0	0	0	0	0
FAR No. 2 N & S			Incl.	160		0	0	0	0	0	0	0	0
FAR No. 3			Incl.	90	100	0	0	0	0	0	0	0	0
Leach Tanks			Incl.	400	Incl	0	0	0	0	0	32	5	0
Nevinstown Decline			Incl.	60	0	0	0	0	0	0	0	0	0
Mag + Ancillary Bldgs			1192	1236	1317	318	556	165					
CRAMP Document Section			4.6.1	4.5.1	4.6.1	4.5.1	4.5.1	4.5.2	4.5.8	4.5.8	4.5.3	4.5.3	4.5.8
2024 Total Quantities			96575	24940	56642	4662	8000	4260	552	2418	648	115	188
2024 industry Rate / Unit			€4.5	€37.90	€6.70	€16.00	€16.00	€135.60	€13.80	€11.80	€135.60	€135.60	€11.80
2024 Dismantle Costs			€0.0**	€945,226.0	€379,501.4	€74,592.0	€128,000.0	-	€7,617.6	€28,532.4	-	-	€2218.4
Less Market Scrap Value								€577,656	€4,056.0	€12,636.0	€87,868.8	€15,594	€1,092.0
2024 TOTAL COST			€0.0**	€945,226.0	€379,501.4	€74,592.0	€128,000.0	-€577,656	€3,561.6	€15,896.4	-€87,868.8	-€15,594	€1,126.4

** This item is costed elsewhere.

Sub total €866,785

Table 4-4 Dismantle and Disposal of Building Elements											
	Metal Cladding					Steel Decking		Roof Cover & Insulation	Roof Timbers	Ext. Windows	Ext. Doors
	HH Robertsons Sheet		Corrugated Galvanised	Circular Corner Flashing	Louvre (m²)	Roof	Floor				
	Insulated (m²)	Uninsulated (m²)				38mm	64mm				
						(m ²)	(m ²)				
Building				Lin. M				Lin. m	(m²)	(m²)	
Stores	797	0	0	0	0	1002	83	1044	0	8	63
Eng./Workshops	1571	0	0	0	21	2058	438	2058	0	43	259
Washbay	0	423	0	0	0	259	0	279	0	0	37
Mine Dry	1219	0	0	0	23	2353	1915	2207	0	186	46
Laboratory	560	0	0	0	0	711	0	745	0	53	17
Compressor House		1494	0	0	31	121	0	607	998	4	62
Headframe Production		1202	0	0	64	77	0	77	0	0	6
Service Tunnel	0	0	0	0	0	0	0	0	0	0	0
Dust Collect - Conv. 41001	408	0	0	0	0	38	0	38	0	0	5
Coarse Ore Store	2916	0	0	0	0	0	0	0	0	0	0
Hopper/41002 tunnel etc.	0	0	0	0	0	0	0	0	0	0	0
Transfer House	755	784	0	0	0	286	0	286	0	0	22
Loadout	0	6239	0	0		3956	63	3956	0	0	110
Conv. Supports + Gallery	0	6349	0	2332	0	0	0	0	0	0	0
Conv. Supports + Gallery	0	0	0	0	0	0	0	0	0	0	0
Mill	4222	3066	0		85	6840	3459	6840	0	46	123
Autogenous grinding Mill		4825									20
Canteen	0	0	0	0	0	0	0	450	2200	30	10
Waste Shed	0	1200	0	0	0	0	0	1000	0	0	60
External Bins and Tanks											
Fine Ore Bins Building	0	1307	0	0	0	336	0	0	0	0	0
Fine Ore Bins - Steel Bins	0	0	0	0	0		0	0	0	0	0
Lime Bins	0	0	0	0	0	0	0	0	0	0	0
Soda Ash Bin	0	0	0	0	0	0	0	0	0	0	0
Cement Bins	0	0	0	0	0	0	0	0	0	0	0
Sand Tanks	0	0	0	0	0	0	0	0	0	0	0
Sulphuric Acid Tanks	0	0	0	0	0	0	0	0	0	0	0
Zinc Thickener	0	0	0	0	0	0	0	0	0	0	0
Lead Thickener	0	0	0	0	0	0	0	0	0	0	0
Thickener P'house + Tunnel	0	171	0	0	0	49	0	49	0	0	2
Bulk Oil Storage											
Bunker Oil Tank	0	0	0	0	0	0	0	0	0	0	0
Diesel Oil Storage(1)	0	0	0	0	0	0	0	0	0	0	0
Diesel Oil Storage(2)	0	0	0	0	0	0	0	0	0	0	0
Oil Pumphouse	0	82	0	0	0	50	0	50	0	0	0
Loadout Sedimentation Tank	0	0	0	0	0	0	0	0	0	0	0
Pumphouses & Ancillary Buildings											

Table 4-4 Dismantle and Disposal of Building Elements											
	Metal Cladding					Steel Decking		Roof Cover & Insulation			
	HH Robertsons Sheet		Corrugated Galvanised	Circular Corner Flashing	Louvre (m2)	Roof	Floor		Roof	Ext.	Ext.
	Insulated (m2)	Uninsulated (m2)				38mm	64mm		Timbers	Windows	Doors
					(m²)	(m²)	Lin. m	(m²)	(m²)	(m²)	
Fresh Water Pumphouse	0	161.1	0	0	1.4	75	0	75	0	0	
Reclaim Water Pumphouse	0	213.2	0	0	1.4	106	0	106	0	0	
Pond Overflow Chambers	0	0	0	0	0	0	0	0	0	0	
Potable Water Dist. P'house	0	126.3	0	0	1.4	63.7	0	63.7	0	0	4.8
Boyne Pumphouse	0	0	0	0	7	65.3	0	65.3	0	0	7
Transf. Switchgear Rm	0	133.6	0	0	0	59.2	0	59.2	0	0	6.7
Dev. Shaft Winder + Frame	0	0	900	0	0	0	0	0	0	0	0
Mech + Elect Workshop	0	0	875	0	0	0	0	0	0	0	0
RAR No 1 and 2	0	300	0	0	0	0	0	0	0	0	0
RAR No. 3 N and S	0	0	0	0	0	0	0	0	0	0	0
FAR No. 1	0	0	0	0	0	0	0	0	0	0	0
FAR No. 2 N & S	0	0	0	0	0	0	0	0	0	0	0
FAR No. 3	0	0	0	0	0	0	0	0	0	0	0
Leach Tanks	0	0	0	0	0	0	0	0	0	0	0
Nevinstown Decline	0	0	0	0	0	0	0	0	0	0	0
Mag + Ancillary Bldgs			725	0	0	0	0	0	0	0	0
CRAMP Document Section	4.5.4	4.5.4	4.5.4	4.5.4	4.5.4	4.5.5	4.5.5	4.5.6	4.5.7	4.5.7	4.5.7
2024 Total Quantities	12449	27994	2500	2332	235	18455	5958	20005	3198	370	875
2024 industry Rate / Unit	€63.80	€44.00	€30.80	€8.70	€5.90	€11.30	€13.60	€14.00	€0.70	€7.50	€7.50
2024 Dismantle Costs	€794,246.2	€1,231,736	€77,000	€20,288.4	€1,386.5	€208,541.5	€81,028.8	€280,070	€2,238.6	€2,775	€6,562.5
Less Market Scrap Value	€192,816.0	€677,196	€6,630	€56,472.0	€5,694.0	€44,226.0	€14,274.0	-	-	-	-
2024 TOTAL COST	€601,430.2	€554,540	€70,370	-€36,183.6	-€4,307.5	€164,315.5	€66,754.8	€280,070	€2,238.6	€2,775	€6,562.5

Subtotal €1,708,565.5

Table 4- 9 Decommissioning Roads

Road Number	Road Location	Length (m)	Width (m)	Area (m ²)	Tarmac			Spray/Chip	Hardcore		
					Depth (m)	Area (m ²)	Quantity (m ³)	Area (m ²)	Depth (m)	Quantity (m ³)	
1	Entrance Road	328	7.3	2394.4	0.15	2394.4	359.16	-	0.6	1436.64	
1.1	Additional for corners etc for 1 above	-	-	200	0.15	200	30	-	0.6	120	
2	Security to Portal	680	6	4080	0.05	4080	204	1360	1	4080	
3	Link from Item 2 to Kells Road	90	6	540	-	-	-	-	1	540	
4	Sec. Junc. to Acid tanks to Washbay	990	6	5940	0.05	5940	297	3960	1	5940	
5	Link Road Laboratory to Loadout	181	6	1086	0.05	1086	54.3	724	1	1086	
6	Mill Buildings Access Road South 1	-	-	460	0.05	460	23	-	1	460	
7	Mill Buildings Access Road South 2	-	-	340	0.05	340	17	-	1	340	
8	Mill Buildings Access Road South 3	-	-	300	0.05	300	15	-	1	300	
9	Mill Buildings Access Road North	-	-	300	0.05	300	15	-	1	300	
10	Canteen	90	4	360	0.05	360	18	-	0.5	180	
11	Sec Junc. To Stores	1150	1	1150	0.05	1150	57.5	-	1	1150	
12	Fuel Tanks to Tyre Centre	177	6	1062	0.05	1062	53.1	531	1	1062	
13	Sec. Junc. to Core Shed	166	6	996	0.05	996	49.8	664	1	996	
14	Additional for corners etc for 2 - 13 above	-	-	500	0.05	500	25	-	1	500	
15	Magazine Road	660	7.3	4818	-	-	-	-	1	4818	
16	Road within Magazine Area	331	6	1986	-	-	-	-	0.6	1191.6	
17	Fresh Air Raise 4	270	5	1350	-	-	-	-	0.5	675	
18	Waste Storage roads	840	6	5040	-	-	-	-	1	5040	
19	Portal to RAR No.2 & Reclaim Pond Rd	420	6	2520	-	-	-	-	1	2520	
20	Portal to Reclaim Ponds	790	7.3	5767	-	-	-	-	1	5767	
21	Kells Road RAR No. 3	360	6	2160	-	-	-	-	0.5	1080	
22	Crest of Mine Water/Reclaim ponds etc.	1332	4	5328	-	-	-	-	0.3	1598.4	
23	Kells Road Pond Access	250	4	1000	-	-	-	-	0.3	300	
24	Far No. 1 Access (Kells Road)	150	4	600	-	-	-	-	0.3	180	
CRAMP Document Section						Table 4-14		Table 4-14		4.6.1	
2024 Total Quantities						50277.4		12494		7239	41660.64
2024 industry Rate / Unit								€7.20		€7.20	€0.00*
2024 TOTAL COST								€89,956.80		€52,120.80	€0.00

* Hardcore in roadways will be left in-situ.

Table 4-10 Decommissioning of Car Parks and Hardstanding Areas (Costs to excavate and stockpile)

		General Dimensions			Tarmac			Spray & Chip	Concrete			Hardcore	
		Length (m)	Width (m)	Area (m ²)	Depth (m)	Area (m ²)	Quantity (m ³)	(m ²)	Depth (m)	Area (m ²)	Quantity (m ³)	Depth (m)	Quantity (m ³)
Carparks													
1	Carpark 1	-	-	8750	0.05	2061	103	6689	-	-	-	0.6	5250
2	Carpark 2	-	-	4650	0.05	798	40	3852	-	-	-	0.6	2790
3	Carpark 3	-	-	920	0.05	0	0	920	-	-	-	0.6	552
4	Knockumber House	-	-	900	0.05	0	0	900	-	-	-	0.6	540
5	Toyota parking area at Minedry	-	-	1735	0.05	435			0.2	1300	260	1	1735
Hardstandings								12361					
6	Minedry	-	-	1896	0.05	1896	95	-	-	-	-	1	1896
7	Laboratory	-	-	950	-	-	-	-	0.2	90	18	0.6	570
8	Stores to Workshops Slab	62	26	1612	-	-	-	-	0.2	1612	322	1	1612
9	Mobile Workshop Plant Standing Area A	62	30	1860	-	-	-	-	0.2	1860	372	1	1860
10	Mobile Workshop Plant Standing Area B	-	-	1490	-	-	-	-	-	-	-	1.8	2682
11	Mill Building Slab North	-	-	1070	-	-	-	-	0.2	1070	214	1	1070
12	Mill Hard Standing North	-	-	2800	-	-	-	-	-	-	-	1	2800
13	Mill Hard Standing West	-	-	5670	-	-	-	-	-	-	-	1.4	7938
14	Mill Hard Standing East	-	-	15100	-	-	-	-	-	-	-	1.4	21140
15	Loadout West	-	-	560	0.05	560	28	-	-	-	-	1	560
16	Loadout East	-	-	250	0.05	250	13	-	-	-	-	1	250
17	Fixed Plant												
18	Hard Standing	-	-	5650	-	-	-	-	-	-	-	1.5	8475
19	Fixed plant to Railway Line	-	-	20500	-	-	-	-	-	-	-	1.5	30750
20	ORICA Compound	35	35	1225	-	-	-	-	0.3	1225	368	0.5	612.5
21	QME Tent Base	23	40	920	-	-	-	-	0.3	920	276	0.5	460
22	QME Batching Plant	25	25	625	-	-	-	-	0.3	625	188	0.5	312.5
23	110kV Substation	35	35	1225	-	-	-	-	0.45	1225	551	0.5	612.5
Storage Areas													
24	Stores Compound												
25	Main Compound	-	-	5720	0.05	1650	83	-	0.15	3350	503	1	5720
26	Sheds	-	-	880	-	-	-	-	0.15	880	132	1	880
27	Direct Charge Compound	-	-	4900	-	-	-	-	-	-	-	1	4900
28	Tyre Centre Storage Area	-	-	500	-	-	-	-	-	-	-	1	500
29	Mill Storage Tent Base	15	20	300	-	-	-	-	0.3	300	90	0.5	150
30	AG Storage Tent Base	23	40	920	-	-	-	-	0.3	920	276	0.5	460
Storage Bund Areas													
32	Direct Charge Compound	8	8	128	-	-	-	-	0.15	128	19	-	-

		General Dimensions			Tarmac			Spray & Chip	Concrete			Hardcore	
		Length (m)	Width (m)	Area (m ²)	Depth (m)	Area (m ²)	Quantity (m ³)	(m ²)	Depth (m)	Area (m ²)	Quantity (m ³)	Depth (m)	Quantity (m ³)
33	Chemical Offloading Bund	9.6	4.6	44.16	-	-	-	-	0.2	44	9	-	-
34	Waste Oil Storage Bund	30	20	600	-	-	-	-	0.15	600	90	-	-
35	Mine Dry Oil Tank Spill Area	7	7	49	-	-	-	-	0.15	49	7	-	-
36	Fixed Plant Oil Tank Bund	4.7	4.2	19.74	-	-	-	-	0.15	20	3	-	-
37	Warehouse Oil Tank Bund	4.8	3.6	17.28	-	-	-	-	0.2	17	3	-	-
38	Knockumber House Oil Tank Bund	4	3.7	14.8	-	-	-	-	0.2	15	3	-	-
	Railway Track	610											
39	Single Track	50	5	250	-	-	-	-	-	-	-	1	250
40	Double Track	90	10	900	-	-	-	-	-	-	-	1	900
41	Triple Track	470	15	7050	-	-	-	-	-	-	-	1	7050
CRAMP Document Section							4.6.2		4.6.2		4.6.2		4.6.1
2024 Total Quantities						102650.98							
2024 industry Rate / Unit													
2024 TOTAL COST													
						€55,080.00		€177,998.40			€140,381.60		€0.00

* Hardcore in carparks and hardstanding areas will be left in-situ and covered with suitable material to ground level.

Table 4-11 Decommissioning Water Management Ponds

	Length (m)	Pond Elevations (m) A.M.D.			Pond Dimensions			Quantities		
		Crest of Pond Wall	Base of Pond Wall	Bottom of Pond	Average			Total (m ³)	Clay (Overburden) (m ³)	Hardcore (m ³)
					Height Wall	Base Width	Top Width			
Fresh Water Pond	163	1578.35	1573.6	1573	4.75	23	4	10,452	10,037	416
Mine Water Pond	170	1578.35	1574.6	1573	3.75	19	4	7,331	7,000	332
Reclaim Pond No. 1	248	1578.35	1574.6	1573	3.75	19	4	10,695	10,211	484
Reclaim Pond No. 2	342	1578.35	1574.6	1573	3.75	19	4	14,749	14,082	667
Clear water pond	326	1578.35	1574.6	1573	3.75	19	4	14,059	13,423	636
Kells Road Pond									8,000	
CRAMP Document Section									4.6.3	4.6.3
2024 Total Quantities									62,753	2,533
2024 industry Rate / Unit									€2.30	€2.30
2024 TOTAL COST									€144,331.90	€5,925.90

Total cost € 150.157.80

Table 4-12 Decommissioning Screening Berms

	Length	Elevation	Average	Average	Average	Average	Total Quantity (m ³)	Quantity Clay (m ³)	Quantity Rock (m ³)
			Height	Base	Top	Surface			
			(m)	Width (m)	Width (m)	Area (m ²)			
Screening Berms									
Portal to RAR No.2	355	1579.5	5.5	24	4		11360	5680	5680
South of RAR No. 2	45		3	16	4		810	810	
Storage Area at Portal	175	1577.5	3	12	3		2362	2362	
Portal to Magazine/Washbay Junction	340	1580.5	5.5	24	4		10880	10880	
Compressor House Pond and Road	200	1578	2.5	13	2		2100	2100	
Fixed Plant and Compressor House Pond	28	1576	1.8	9	2		199		199
Compressor House and Pond	106	1576	2.7	12	1.5		986		986
Workshop and DC Compound	125	80.5/81.7	5	24	4.2		3862	3862	
Magazine/Washbay Junction to Tiphead	100	1581	2.5	13	4		1450		1450
Stores Compound and Tiphead	160	1581	2.5	10	3		1760		1760
Magazine Road 1 and Tiphead	350	1582.5	3.2	22	4.5		8103	8103	
Magazine Road 2 and Tiphead	80		2.5			1060	2650	2650	
East side of Tiphead (North)	110		2.5			990	2475	2475	
East side of Tiphead (South)	180		3			7780	23340	23340	
South side of Tiphead	125		1.5			2400	3600	3600	
Metal, Timber, Waste Oil etc.	390		1.4	5.5	0.75		1336		1336
Barrels	150		1.4	5.5	0.75		514		514
Kells Road FAR No. 1	200		2	12	5		2700	2700	
Kells Road RAR No. 3 (N &S)	265		4.5	22	7		10335	5168	5168
Magazine FAR No.3	165		3.5	14	5		3630	3630	
RAR5 compound							5000	5000	
Additional stockpiled							22640	22640	
CRAMP Document Section									4.6.4
2024 Total Quantities							122,092	105,000	17,093
2024 industry Rate / Unit								€ 3.50 or 4.38	€ 6.70
2024 TOTAL COST								€ 367,500	€ 114,523.10

Total €482,023.10

Table 4.13 Decommission Buried Pipelines (excavate/strip and remove off site)

Pipeline Description.	Location	Type	Size	Length HDPE	Length Concrete	Length Ductile iron	Length Alvenius	Comments
Reclaim Process L.P.	Reclaim ponds to Mill	Ductile Iron	500mm			705		
	Branch to Service Tunnel	Ductile Iron	100mm			175		
Reclaim Process H.P. (previously Fresh Water)	Reclaim ponds to Mill Plant	Ductile Iron	350mm			760		
	Branch to Service Tunnel	Ductile Iron	100mm			175		
Mine Services Water	Reclaim ponds to Service Tunnel	HDPE	200mm	770				
	Branch to Washbay	HDPE	100mm	150				
Mine Water	Service Tunnel to Reclaim Ponds	Ductile Iron	450mm			730		
	Branch to Mine Water Pond	Ductile Iron	450mm			40		
Fire Main	Fresh Water Pond to Ring Main	Ductile Iron	250mm			285		
	Link within Ring Main	Ductile Iron	250mm			75		
	Branch to Mine Service tunnel	Ductile Iron	250mm			90		
	Ring Main	Ductile Iron	200mm			1380		
	Branches to Buildings	Ductile Iron	150mm			265		
	Branches to Hydrants (12 No. Double)	Ductile Iron	150mm			60		
Fresh Water Supply	Boyne Pumphouse to Fresh Water Pond	Ductile Iron	350mm			2678		Railway Track
Potable Water	Town Supply to Fresh Water Pumphouse							
	Fresh Water Pond to Ring Main	Ductile Iron	150mm			285		
	Branch to Service tunnel	Ductile Iron	150mm			90		
	Ring Main	Ductile Iron	150mm			1380		
	Branches to Buildings	Ductile Iron	100mm			165		
Mine Site Drainage	Kells Road Pond to Reclaim Ponds	Ductile Iron	250mm			740		
	Branch to Mill	Alvenius	200mm				360	
Mine Sludge	Service tunnel to Mill Tailings Pumpbox	Ductile Iron	100mm			310		
	Branch to Mine Water Pond	Ductile Iron	100mm			475		Not used
Tailings Line	Tailings P'box to R'town Booster Pump	HDPE	630mm	3510				Railway Track
	Booster Pump to Stage 3	HDPE	630mm	2000				
	Booster Pump to Stage 4A	HDPE	630mm	3520				Surface
Randalstown Flushline	Reclaim Pumps to Booster Pump	HDPE	315mm	650				St 3 Middle Wall
		Steel	300mm				600	Stage 1 Toe
Reclaim Line	Randalstown Ponds to Reclaim Pumps	HDPE	800mm	4200				Railway Track (3100)
Clear Water Discharge	Clear water Pond to Boyne	Concrete	825mm		2211			Railway Track
	Diffuser pipe in Boyne	Steel	600mm				26	
West Diversion Stream	Computer Building to Kells Road	Concrete	1200mm		985			
Eastern Stream	Comprs'r House Pond to Kells Road Pond	Concrete	1200mm		280			
CRAMP Document Section								
2024 Total Quantities					14800	3476	10863	986
2024 industry Rate / Unit					€ 28.80	€ 31.20	€ 65.40	€ 65.40
2024 TOTAL COST					€ 426,240.00	€ 108,451.20	€ 710,440.20	€ 64,484.40

CHAPTER 5 UNDERGROUND DECOMMISSIONING

5.1 INTRODUCTION

This chapter describes decommissioning of the underground mine following cessation of mining operations and details:

- decommissioning of underground plant, equipment, services and all associated elements;
- backfilling, geotechnical (structural stability) and post closure settlement;
- existing and post-closure hydrogeological conditions and mine rewatering; and
- decommissioning of mine ventilation systems and shafts.

5.1.1 Tara Orebody

The main Tara orebody dips to the Southwest and is continuous along strike. The mining area is made up of distinct but integrated sectors (from up-dip to down-dip) as follows:

- Nevinstown (including Liscartan/Rathaldron)
- The Main Mine
- The Southwest Extension (SWEX)
- Tara deep; currently an exploration project

The Main Mine was the original area of mining at Tara (mining commenced in 1979). The Nevinstown Extension is located immediately northeast of the Main Mine (mining commenced in 2004). SWEX is located immediately to the southwest (mining commenced in 2004). Tara Deep is located to the south of SWEX and is hydraulically isolated from other three mining areas by the P and D fault zones (Figure 5.1 Refers).

Figure 5.1 also shows the town of Navan and the Blackwater River, which flows above the mine workings in the Nevinstown and Rathaldron sectors of the mine. The Blackwater River joins the River Boyne within the town to the south.

The topography of the area is flat to gently undulating, with an overall slight topographic gradient to the northeast, towards the River Blackwater, and to the southeast, towards the River Boyne. The flood plain of the River Blackwater varies from about 130 to 215 m in width, with a prominent break of slope on its northern margin.

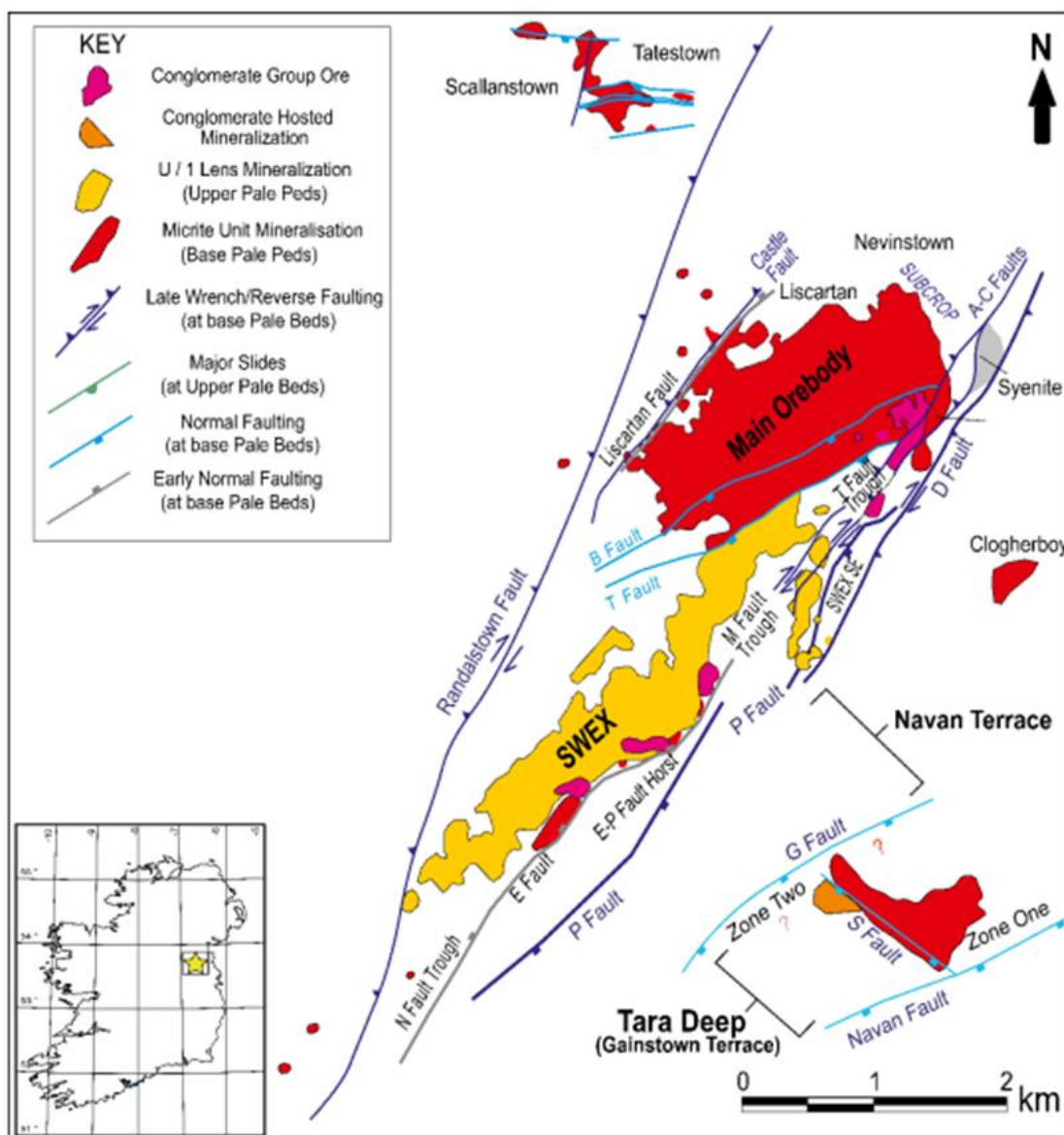


Figure 5-1 Navan Orebody

5.2 CLOSURE PLANNING

The underground mine decommissioning operation will comprise the following main aspects:

- Decommissioning of plant and services;
- Ensuring long-term mine stability backfilling; and
- Sealing of mine ventilation shafts

To allow for the full and safe implementation of the closure execution plan, the dewatering and mine ventilation systems will be maintained in operation until backfilling operations have been completed, and all underground plant has been removed or decommissioned. Pumping from the mine will then cease.

Underground workings are progressively backfilled as mine development works advance. Therefore, the extent of post closure decommissioning is relatively limited. During the operational phase, following excavation of the orebody, all underground mine developments are 'backfilled'. The design and on-going operation of the mine incorporates progressive decommissioning of works into the mine design, which significantly reduces the requirements of final decommissioning and restoration of underground workings (detailed in section 5.4).

In the final years of production mining will be planned to enable progressive decommissioning of mine infrastructure. The deepest areas of the mine (SWEX) will be mined out first and decommissioned with production focused on the upper region of the 'main mine' close to the production shaft.

On a progressive basis obsolete plant and infrastructure (water pumps, air fans, crushers, conveyors, electrical panels etc.) will be decommissioned as part of normal mine operations and will be budgeted accordingly. Such costs are not therefore detailed in the CRAMP.

It is anticipated based on experience at both Lisheen and Galmoy Mines that the restoration of groundwater levels to near baseline conditions will occur within 3 to 4 years.

5.3 DECOMMISSIONING OF UNDERGROUND PLANT AND EQUIPMENT

Immediately following the cessation of mining activities, the dewatering and ventilation systems will be maintained in operation to permit the completion of the decommissioning of the underground workings, plant and equipment.

The objective is to remove the maximum quantity of plant and equipment from the mine. However, it will not be possible to remove all items during the retreat process and the infrastructure required for same. Plant and equipment with resale value, and not required for withdrawal purposes, will be recovered from underground working and brought to surface (to be sold as part of the Assets Disposal Process).

Any plant and equipment deemed appropriate to remain permanently underground will be itemised and rendered safe in environmental terms.

- All plant and equipment will be drained of fuel, oil and lubricants, they will be cleaned out with detergents and all this material will be recovered to the surface for appropriate disposal.
- The plant and equipment will be stripped of all rubber components or other materials, as required.
- All underground storage tanks (containing fuels, oils, grease and additives) will be all recovered to the surface for appropriate decontamination and decommissioning.
- All duct, pipes, cables ladders and landings in declines and shafts will be assessed and removed as appropriate, so as not to obstruct or hinder the permanent sealing of openings and mine opening conduits

When deemed appropriate, the underground ventilation system will be terminated. The termination of the ventilation system may be phased and commensurate with the decommissioning and health and safety requirements of the mine. As Fresh Air Rise and Return Air Rises become defunct, the fans systems will be decommissioned and the surface structure removed.









Each of the open shafts and vent raises will be plugged at the surface with a suitably engineered concrete plug.

When all underground decommissioning has been completed, the dewatering system will be terminated (pumping stopped), and the underground workings will be allowed to re-water with natural groundwater (detailed in section 5.5).

5.4 GETECHNICAL ASSESSMENT OF UNDERGROUND WORKINGS

5.4.1 Geotechnical Assessment

The mine operates to the specification of a Ground Control Management Plan (GCMP), which details all support that must be placed into the workings to ensure there is adequate ground support and any potential surface subsidence risk is managed. Development drifts and other excavations/underground openings are assessed on a case-by-case basis by the BTM Geotechnical Department. Adequate rock support is installed by means of rock bolts, shotcrete, and in single instances, cable bolts. The ground support issued for the ordinary drifts enhances the primary stability of underground workings. Main infrastructure such as workshops, crusher station and others undergo a more thorough analysis and receive a higher safety factor due to their size and function. An overview of different ground support classes stipulated as per the Ground Control Management Plan (GCMP) is Figure 5-2

Class	Drift Support Class (Minimum required support)	
C3	Shotcrete before bolting every round Shotcrete 50 mm back and shoulders 1.5 x 1.5 m bolting pattern in the back	
D	Shotcrete before bolting every round Shotcrete 50 mm full profile 1.5 x 1.5 m bolting pattern in the back	
F	Shotcrete before bolting every round Shotcrete 50 mm full profile 1 x 1 m bolting pattern in the back	
G	Bolt walls Spacing 1.5 m, 3 each side	
S1	Shotcrete before bolting every round Shotcrete 50 mm back and shoulders 1.5 x 1.5 m bolting pattern down to 1 m above floor	
S2	Shotcrete before bolting every round Shotcrete 50 mm back and shoulders 1 x 1 m bolting pattern down to 1 m above floor	
J	Shotcrete before bolting every round Shotcrete 50 mm full profile 1.5 x 1.5 m bolting pattern down to 1 m above floor	
K	Shotcrete before bolting every round Shotcrete 50 mm full profile 1 x 1 m bolting pattern down to 1 m above floor	

The Drift Support Classes are issued periodically by Boliden Tara Mines Ltd. for planning purposes, and represent the minimum required support. They are supplemented by instructions on Survey layouts. If you are in any doubt contact your supervisor and the Geotechnical Engineers. Anders Nystrom 06-07-2018 revision.

Figure 5-2 Ground Control Management Plan (GCMP)

5.4.2 Surface Settlement Control (Mining Methods)

Mining methods employed which include longhole open stoping and drift and slash, utilise both natural and artificial pillars to mitigate subsidence risks. Artificial pillars are constructed using cementitious backfill or development rock. Both methods require primary stopes to be filled with cementitious backfill to facilitate secondary stope mining. Secondary stopes often employ hydraulic cementitious fill to optimise backfilling rates which reduces the requirement for above-ground tailings storage. Completed stopes are tightly packed with either development rock material or hydraulic fill. Minor roof collapses in most stopes do not significantly affect surface subsidence due to the bulking factor of loose materials. However, Nevinstown stopes necessitate tight geotechnical support and high-strength hydraulic backfill to prevent overbreak and ensure stability due to their proximity to surface.

Surface settlement is managed and mitigated by retaining permanent (yielding) pillars of rock in strategic locations to provide direct support to the hanging wall rock mass. The primary controls and prevention measures, include stable individual stopes, tight stope filling, and the retention of an array of permanent yielding pillars to resist hanging wall deflection. These preventive pillars are designed to yield to avoid stress concentrations and movements in the surrounding rock. In some instances, regional or barrier pillars are left in place to facilitate safer mining operations and improve the overall stability of underground mining blocks.

Yielding pillars (natural support) and tight backfilling (artificial pillars) are employed throughout all underground workings. In sensitive areas, a greater number of permanent pillars are retained, and the backfill material consists of a stronger cement-based composition. Following individual geotechnical assessments, roof support in open stopes may be reinforced by installing cable bolts along the stope back to prevent excessive dilution during mining operations.

As mine development progresses, underground workings are incrementally backfilled. The selection of backfilling material, either development rock or cemented backfill (hydraulic fill), aligns with the overall mass balance of the operation. Once mining activities are completed, additional waste rock from other sources, such as other pits, may be used if deemed suitable for underground storage. In the absence of ore production, cemented backfill will cease, and tailings sand will be mixed with cement for hydraulic filling underground. As a result, the extent of post-closure decommissioning is relatively limited.

5.4.3 Nevinstown (Crown Pillar) Stopes

As part of permission to mine stopes in Nevinstown, the sequence has been pre-determined to be a few active stopes at a time (maximum of 3) spaced out to minimise any occurring subsidence in the overburden above. Further, stopes in Nevinstown will always have to be tightly filled with cementitious backfill and supported with an excessive safety factor to minimise ground movement for the duration of mining and post-mining. This is done by means of tight rebar bolt and cable bolt spacing.

5.4.4 Independent Geotechnical Assessment

In 2003 BTM engaged Australian Mining Consultants (UK) Ltd. (AMC) to conduct an independent geotechnical study of the underground workings, specifically focusing on the Nevinstown extraction area due to its shallow depth and associated risks of surface settlement and ground stability. The AMC geotechnical assessment addressed the following issues:

- The potential for surface settlement
- The stability of the underground mining
- The stability of strata beneath the River Blackwater
- Potential for water ingress to mine workings beneath the River Blackwater
- Definition of a detailed and long-term geotechnical monitoring strategy for BTM

Itasca Consulting AB, independent consultants engaged by BTM to conduct two-year rolling review of geotechnical conditions for Liscartan, Rathaldron, Nevinstown and SWEX, conclude that appropriate prevention measures are being implemented and are effective. Most recent Review Report is presented in Attachment 2.

In 2024 Itasca conducted a geotechnical review of closure initiatives and is presented in Attachment 3.

5.4.5 Surface Settlement and Convergence Monitoring

Historical Monitoring

BTM has been monitoring surface settlement since mining commenced in the late 1970s, using approximately 270 surface levelling stations. Over 30 years of operations, the data

indicates a maximum of 70mm of surface settlement, centred over the main mining area. This low order of surface settlement is attributed to the competence and strength of the overlying rocks, appropriate mine development design, and extraction techniques, including retaining long-term rock pillars and the longhole-stoping with backfill mining method. The network covers the Main Orebody, Nevinstown, Liscartan, and the Rathaldron extension. In April 2022, a new base station was installed together with additional levelling points following that. As a supplement to the precise levelling measurements, an InSAR measurement campaign was conducted in 2021.

Shaft Pillar

Modelling of historic surface subsidence as well as future possible subsidence resulting from extraction of the shaft pillar was reported by Csicsek (2017). In this study, it was estimated that vertical displacements would increase by 15–30% from the initial predictions of 200–250 mm for the life-of-mine reported in AMC in 2003, i.e., being in the range of 250 to 300 mm. Mining of the shaft pillar has commenced, and as a complement to the surface settlement monitoring, an extensometer has been installed near the shaft and the T-fault that intersects the shaft, to monitor any movements that may develop near or along the fault.

Future Settlement Predictions

The AMC modelling, calibrated from historical data, provides a basis for estimating future settlement. The analysis demonstrates a good agreement between changes in mining activity underground and consequent changes in surface settlement. The predicted settlement for the Nevinstown area, at a depth of 50m below ground level, is calculated as 200-250mm.

5.4.6 Post-Excavation and Closure Settlement

Surface settlement is expected to continue post-excavation and closure of the mine, albeit at a gradually decreasing rate. This reduction in settlement will occur as the backfill provides increased resistance to hanging wall relaxation until equilibrium conditions are achieved. Additionally, the rebound of groundwater levels to their natural state will further resist continued settlement. AMC estimates that equilibrium could be reached within a 2-4 year timeframe.

The surface impact from crown pillar mining is also considered insignificant in the long term, given the use of comprehensive rock support and backfilling of all stopes. The long-term surface influence from shaft pillar mining is expected to be minimal. Historical data and geotechnical assessments suggest a minor potential for settlement in areas with geological structures, which are predicted to remain stable near the surface. The actual maximum radial extent of regional settlement is anticipated to be smaller than indicated in the AMC elastic model due to conservative input estimates. No influence on groundwater is expected since the water table is already below the crown pillar due to past mining activities, coupled with the established respect distance to the River Blackwater.

Post closure independent geotechnical reports will be provided annually. Surface subsidence measurements at 96 stations will continue for 5 years through closure and into aftercare period until sufficient data warrants a cessation of monitoring.

5.5 HYDROGEOLOGICAL CONDITIONS UNDER CURRENT MINING

5.5.1 *Hydrogeological Units*

The underground mining areas of Nevinstown, Liscarton, Rathaldron, Main Mine and SWEX, and more recent Tara Deep exploration drift are all interconnected by tunnels at various levels. The host geology of these areas can be divided into four main hydrogeological units, shown in cross-sections in Figures 5.3, 5.4 and 5.5, and summarised as follows:

- **Overburden/surficial deposits**, including the River Blackwater flood plain deposits, the Whistlemount channel and the glacial till sequence (boulder clay with sand and gravel lenses)
- **Weathered UDL**, where the original rock fabric has been variably broken down, so that the unit contains higher porosity and groundwater storage. The weathered zone of the UDL is often tapped by domestic and agricultural wells.
- **Competent UDL**, which comprises a strongly layered sequence of limestones, shaley limestones, shales. Most of the units have very low permeability but discrete layers of continuous fracturing do occur at numerous horizons. To date, a correlation of the fractured and permeable horizons has not been possible
- **Pale Beds**, which forms the main groundwater unit and hosts much of the ore. Most of the production mining of the Tara orebodies occurs in the Pale Beds groundwater unit, which is permeable and drainable. The Pale Beds shows some karst features and is generally interconnected, but compartmentalization across the main structures is evident (although many of these are now mined through).

The UDL unit generally thickens to the southwest and south. The sequence is strongly layered, with most layers being of low permeability. It therefore creates a vertical hydraulic barrier between the mining horizon and the near-surface groundwater system. However, it is known that sub-vertical geological structures do occur through the UDL, and the unit is also penetrated by exploration drill holes and other mining infrastructure.

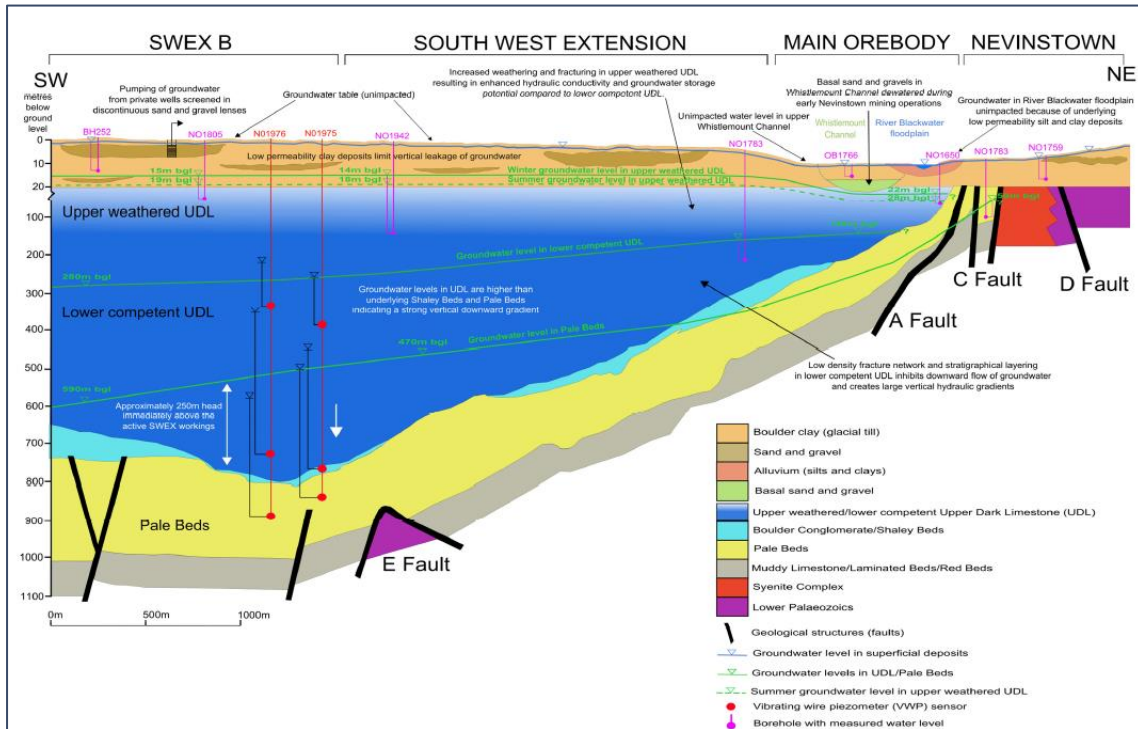


Figure 5.3 NE - SW hydrogeological cross section - Nevinstown, Main Mine and SWEX

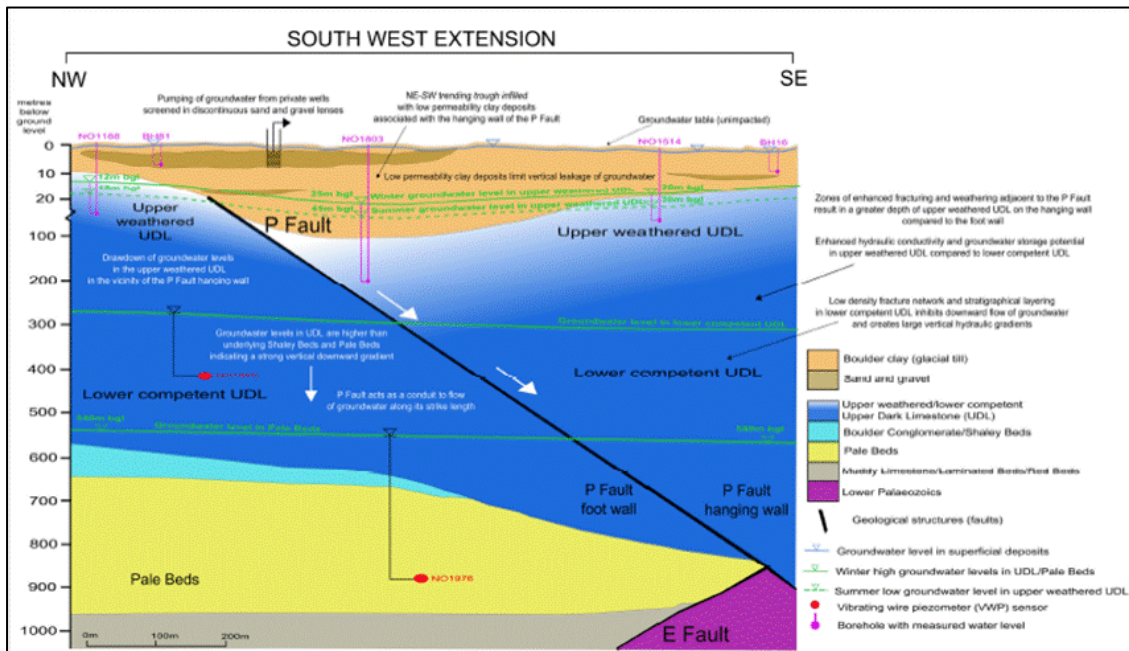


Figure 5.4 NW - SE hydrogeological cross section - SWEX

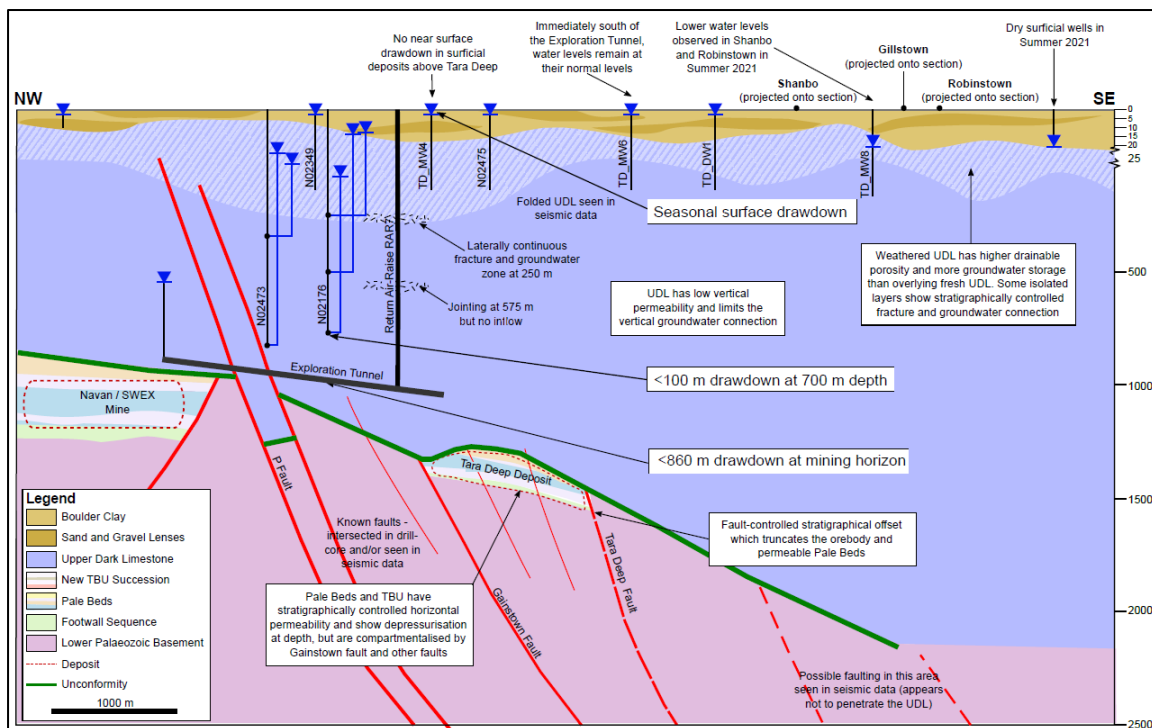


Figure 5.5 NW - SE hydrogeological cross section – TRDEX1

5.5.2 Groundwater recharge

Groundwater recharge is the process of water moving downward from the ground surface to the underlying geological formations. Groundwater recharge is mostly derived from infiltration of precipitation and local runoff. Meteorological data indicates that, for an average year between April and July, the effective rainfall (and therefore recharge) is zero. August and September also typically have low effective precipitation, with some years historically also having zero. A typical seasonal cycle of the soil moisture balance and recharge is as follows:

- Summer: High rate of evapotranspiration and soil moisture removal; increasing soil moisture deficit; rainfall events cause near-surface infiltration, but the water is removed from the soil profile by evapotranspiration.
- Autumn: High soil moisture deficit, which has been gradually built up over the summer months; infiltration from rainfall events is stored in the near-surface soils, even though evapotranspiration rates are low; little water percolates downward below the extinction depth and becomes recharge.
- Winter: The soil moisture deficit that was built up during the summer months becomes progressively replenished by on-going infiltration due to precipitation events. At some

point, the soil moisture deficit is used up and breakthrough occurs, and the percolating water moves downward below the capture zone of the root system; the water is able to move downward below the extinction depth and become recharge to the groundwater system.

- Spring: The soils are fully saturated, and any rainfall is transmitted rapidly downward below the root zone to become recharge. Late winter or spring is usually the period of high-water availability, so most or all of the annual recharge may occur during this period. As ambient air temperatures increase, so evapotranspiration rates also rise, and the soil moisture deficit starts to build up as summer approaches.
- It should be appreciated that both the annual rainfall amounts, and the seasonal pattern of rainfall, are highly variable, so the actual recharge in any one year is likely to significantly vary year-on-year. In 2020 and 2021, there was abnormally low rainfall recorded during the late winter and spring, at the time when most of the groundwater recharge would normally be expected to occur. Therefore, the actual groundwater recharge was significantly below average

Actual recharge

Studies and empirical monitoring results from the Lisheen and Galmoy Mines indicate that, under dewatered conditions, mean annual recharge to those mines was around 275 mm/yr. Applying this to Tara over a recharge area of 13 km² (the contributing sub-crop area of the Pale Beds) corresponds to an estimated recharge 'flow' of about 400 m³/hr (9,600 m³/day), which forms about 70% of the overall mine water balance; and is considered to be reasonable.

Dewatering induced leakage across fault boundaries

Under active dewatering conditions, a minor amount of recharge is also likely derived due to inward leakage across the surrounding fault blocks (the Randalstown fault to the northwest and the P-Q fault system to the southwest). It is not possible to quantify this directly, but all indications are that the fault systems form strong barriers across strike. The main evidence for this is: (i) the hydraulic barrier formed by the Randalstown fault in the up-dip (Randalstown) area, (ii) the fact the inflow rates to the mine have not been head-dependent, and (iii) the general lack of drawdown influence seen in the Palaeozoic rocks.

5.5.3 *Groundwater in superficial deposits*

A groundwater table occurs within the alluvial deposits of Liscartan and Rathaldron. This water table is typically encountered within 1 to 4 m of ground surface. The water table is closest to the surface in lower lying areas along the River Blackwater.

The formation of multiple (unsaturated) vadose zones within the hydrostratigraphic sequence overlying the Nevinstown workings limits the rate of leakage of groundwater from the superficial deposits into the UDL (where present), and from the UDL into the Pale Beds, in response to the depressurisation of the Pale Beds. The following sequence is seen:

- Shallow water table in the alluvium.
- Intermediate water table in the UDL, at typically 20±50 m depth.
- Deep water table in the Pale Beds, at typically 30±170 m depth.

In up-dip areas, where the UDL is absent, two water tables occur, one in the superficial deposits and one the Pale Beds. Field inspections made by Water Management Consultants (WMC) in the UDL free area of Nevinstown throughout 2005, and during May 2006, confirmed that shallow groundwater conditions in the superficial deposits are largely unchanged as a result of the mining of Nevinstown.

Although there are no superficial monitoring wells overlying the Nevinstown area, there are a number of surface depressions and pits in which surface expressions of near-surface groundwater can be observed. Because of the presence of the vadose zone, when incremental drawdown occurs within the Pale Beds, as a result of mining the Liscartan and Rathaldron application areas, the downward leakage from the alluvium does not increase.

To date, superficial groundwater levels and moisture contents in the alluvial deposits have not been significantly altered on a site-wide scale. None of the alluvial monitoring wells above the Main Mine or SWEX show any consistent trends of declining water levels.

An observed cavity in the 1530 HWEX2 heading, north of the river at Nevinstown was transmitting near-surface groundwater, from superficial deposits directly above the cavity, downwards into the underground workings. The initial observed flow rate to the cavity was about 0.4 l/second, but the flow rate through the fracture zone above the cavity varied with rainfall. Although such local features may transmit water from superficial deposits downward into shallow workings, the associated vertical flow zones are discrete, occurring only in areas

of extensive jointing and cavity development, and contribute relatively minor amounts to the total groundwater inflow to the mine workings.

The basal sands and gravels of the Whistlemount Channel have dewatered as they have lost groundwater by leakage into the UDL faster than water from the river has leaked through the clayey till to recharge them. The till itself has remained saturated.

5.5.4 Groundwater in UDL

The UDL sequence is strongly layered and generally forms a low permeability vertical barrier to groundwater between the overlying superficial deposits (alluvium) and the underlying dewatered Pale Beds. Carbonate jointing tends to be restricted to the thicker beds. Such jointing typically remains within the individual beds. The joints are usually carbonate infilled.

Occasional beds within the sequence exhibit more open jointing and/or fracturing giving them some groundwater flow potential, apart from faults, cross-cutting structures are rare. Close to faults, the UDL is often folded. The folding can be tight.

Significant regional groundwater flow is not thought to occur within the UDL. In the Nevinstown and Rathaldron areas, the Pale Beds beneath much of the alignment of the Blackwater river are overlain by low permeability and strongly layered UDL rocks. The UDL “cover” occurs within the central part of Nevinstown and to the south. The UDL “cover” is absent in the area where the F1 and the A Fault Zones cross the river in Nevinstown. It is also absent in most of the up-dip area to the north of the river.

Vertical leakage occurs from the UDL into the underlying Pale Beds. As a result, all monitoring points within the UDL above Nevinstown have shown a significant amount of drawdown (typically 20-50 m). However, UDL groundwater levels above Nevinstown are stable, and have shown little change since mid-2004. As a result of leakage from the UDL downward into the Pale Beds, a vadose zone (unsaturated zone) has opened up within the upper part of the UDL, often beneath saturated superficial deposits. The vadose zone opened up shortly after the commencement of the dewatering of the Main Mine. The incremental local bedrock drawdown due to Nevinstown has not significantly modified the character of the vadose zone.

In the Rathaldron area, and in the area to the north and northeast of Nevinstown, the UDL cover is mostly absent.

To the southwest, drawdown has occurred in the UDL as a result of inflows into SWEX. Above SWEX, much of the downward leakage within the UDL is thought to occur down old mineral exploration drill holes.

5.5.5 Groundwater in Pale Beds

The available monitoring data indicate the Pale Beds to be the main groundwater bearing unit in the Main Mine, Nevinstown, and the Liscartan, Rathaldron mining areas and the proposed mine area of Tara Deeps. The permeability and predominant groundwater flows paths within the Pale Beds are associated with discrete faulting, joint sets and bedding plains. At Nevinstown, Pale Beds groundwater is observed to flow along prominent northwest trending joint sets. The density of open jointing may be higher close to the main structural zones, such as the F1 fault. The overlying UDL contributes a minor amount of water, but mostly as a result of vertical downward leakage with dewatering of the underlying Pale Beds.

Under pre-mining conditions, groundwater discharged from the Pale Beds by upward leakage through the alluvial deposits to the lower part of the Blackwater flood plain area. It is expected that most of the active groundwater circulation would have occurred in the upper 50-100 m of the outcrop area of the Pale Beds, with the groundwater flow becoming increasingly more static down-dip.

The Nevinstown monitoring data show that, since early 2005, Pale Beds groundwater levels have been fairly steady, responding mostly to seasonal variations in rainfall and groundwater recharge. Below the central part of the Nevinstown orebody, current groundwater levels beneath the river are inferred to be about -136 to -117 mBOD (1,390-1,410 mAMD), representing over 150 m of relative drawdown. To the north of the Blackwater river, groundwater levels rise fairly rapidly in the un-mined area. At about 900 m northeast of the river in Nevinstown, groundwater level elevations are currently about 23 to 33 mODM (1,550-1,560 mAMD).

Groundwater levels in the Pale Beds between Nevinstown and the Liscartan appear to be similar in elevation to those in the central part of Nevinstown. The behaviour of the groundwater system indicates a low drainable porosity for the Pale Beds. The short-term flow increases that have occurred as a result of mining the stopes have been low and would indicate overall values of drainable porosity of less than 0.01 (although values are likely to be

locally higher in areas of greater cavity development). This is typical of a groundwater system dominated by fracture flow with low matrix porosity.

Within the immediate area of the Main Mine and Nevinstown, groundwater is observed to flow along prominent northwest trending joint sets. The density of open jointing may be higher closer to the main structural lineaments, such as the F1 Fault. The most recent monitoring data continue to support the concept that the F1 Fault Zone is the main conduit feeding water into the Nevinstown workings and the Main Mine.

The main inflows to Nevinstown are associated with NW trending joint sets in the Pale Beds that are connected to the F1 Fault Zone. The available water chemistry data also indicate that virtually all of the water makes in the Main Mine and Nevinstown are representative of young, calcium-bicarbonate type water flowing within the Pale Beds.

There is virtually no chemical signature of river water in the underground water makes apart from two instances. The first was the former groundwater inflow zone where the North Exploration Decline passes below the Whistlemount Channel (1500 NDEX2). The initial flow from this zone was about 0.4 l/s (5 gpm), but the zone has been dry since early 2006. The second was N00022 on the flood plain of the river, where seasonal flood waters directly entered the drill hole.

5.5.6 Groundwater in Palaeozoic Units

Observations to date for the groundwater system around Tara indicate the Palaeozoic rocks are generally of low permeability and are expected to form a barrier to the spread of drawdown away from and beneath the mine workings.

Currently, the only available groundwater monitoring data for the Palaeozoics is for the area immediately to the northeast of Nevinstown (N01765). The Palaeozoics in this area are in fault contact with the Pale Beds. Close to the area where significant drawdown has occurred within the Pale Beds, it would be expected that some drawdown would propagate into the margins of the Palaeozoic rocks. However, because of their low overall permeability, it is not expected that significant district-scale drawdown would occur any distance into the Palaeozoic rocks.

5.5.7 *Structural control on groundwater flow*

The regional groundwater flow system within the Pale Beds is inferred to be fault bounded. As a result, the area of high drawdown associated with the pumped mine dewatering system is limited to the local area, as follows:

- To the south and southeast, the area of high drawdown is bounded by the D fault zone
- To the northeast and north, the area of high drawdown is limited by the presence of the Palaeozoic rocks
- To the northwest, the presence of the Liscarton fault and other NE trending structural zones limits the spread of drawdown within the Pale Beds in this direction
- To the southwest, the Pale Beds occur at increasing depths below the UDL.

5.6 POST CLOSURE HYDROGEOLOGICAL CONDITIONS AND RE-WATERING

Three main hydrogeological units will have most influence for closure and post closure rewatering of the underground mine areas of Nevinstown, Liscarton, Rathaldron, Main Mine, SWEX and the planned mining at Tara Deeps extension:

- Most of the mined ore occurs in the Pale Beds, which is a reef limestone and contains open joints and cavities. It is permeable at shallower levels. Below a depth of about 400 m or so, the permeability drops and is generally low throughout much of the SWEX orebody. The Pale Beds subcrops over an area of about 13-14 km² within Nevinstown, Liscarton and to the northwest. Most of the groundwater that enters the Nevinstown, Liscarton, Rathaldron and Main mine workings is young calcium-bicarbonate type water that has been derived from infiltration of rainfall and recharge over the subcrop area.
- Above the Pale Beds, the UDL (Upper Dark Limestone) comprises strongly bedded and mostly shaley limestone sequence. It has generally low lateral permeability and has a particularly low vertical permeability. It therefore forms a low permeability “roof” above the Pale Beds. However, some discrete sub-vertical groundwater flow paths may occur through the UDL sequence because of fault planes and old exploration drill holes that may remain open. The upper surface of the UDL can be weathered and there can be increased fracturing, permeability and groundwater storage in the weathered

zone. In particular, a SW-NE trending “trough” of weathered UDL material occurs above the SWEX workings and can reach up to 300 m in depth.

- The bedrock units are covered by variable superficial deposits (mostly glacial till and alluvium). Away from the Blackwater River valley, the glacial deposits can vary in thickness from less than 1 m to over 10 m and usually consist of boulder clay with sand and gravel lenses. Beneath the Blackwater flood plain area, sands and silts occur usually to a depth of about 10-15 m. The Whistlemount channel occurs mostly on the northwest side of the flood plain area and includes a linear basal gravel deposit which may extend up to 30 m depth.

5.6.1 Flooding of the underground workings and recovery of the groundwater system

When the dewatering pumps at stations 1390L, No 1 (Main) (1240L), No 4 (1110L), No 5 (752L), No 6 (660L), No 7 (700L), No 8 (627L), and Tara Deep are shut down, the water that is currently being pumped from the *Nevinstown, Liscarton, Rathaldron, Main mine, and SWEX* areas will flow down into the deeper levels of the workings and fill the interconnected mining voids from the bottom up. Therefore, most of the water that will flood the workings will continue to be derived from infiltration from the Pale Beds outcrop area and will be young calcium-bicarbonate type water. The deepest workings at SWEX and planned Tara Deep extension will fill with groundwater first, and then the Main mine and the Nevinstown, Liscarton and Rathaldron workings will progressively become flooded.

As the workings actively fill due to rewatering or groundwater level rebound, they will continue to act as a hydrogeological sink, as is currently the case during active mine dewatering operations. During recovery of the groundwater system, all groundwater will continue to flow inward to the workings, with no potential for migration of chemical constituents away from the immediate area of the underground workings.

The dewatering inflow rate to the Nevinstown, Liscarton, Rathaldron, Main mine and SWEX areas have varied between 135 to 200 l/s during the operational period of 2015 to 2023 and as a consequence of the temporary care and maintenance shut down in late 2023 to Oct 2024 average dewatering rates in 2024 reduced to approximately 131 l/s. It is anticipated that similar inflow rates will continue through the closure period and until recovery is nearly complete. The

rate of inflow is steady because of the strongly bounded nature of the Pale Beds groundwater block surrounding the workings. Most of the groundwater inflow into the Main mine occurs at an elevation of around 425 mBGL or above. Most of the groundwater inflow into Nevinstown occurs at about 275 – 375 mBGL. The inflows from the Pale Beds to the flooded workings will not be head dependent up to those levels. An additional 22.5-30 l/s inflow will enter the SWEX through the UDL from above. The water will flow sub-vertically downward along structures and through old drill holes and will mostly be calcium-bicarbonate-sulphate type water.

The contribution to the mine dewatering system from the floodplain deposits and the River Blackwater is minor. It is estimated that inflows derived from the river currently account for less than 2% of the total mine inflows. A similar situation is expected during the period of active mine closure.

The time required to flood the underground workings will be a function of the final mined void space and the percentage of the void space that is eventually backfilled. Based on the current mine plan, it is estimated that most of the recovery will occur within a period of 3-4 years, following which there will be a gradual and prolonged rise in water levels to achieve final stabilisation. The actual rate of recovery will depend on many variables relating to how mining proceeds over the coming years. The actual recovery rate is also strongly dependent upon climatic conditions (Precipitation, Evapotranspiration).

It may be advantageous to reduce the stabilisation time by pumping water from the Blackwater River into the workings. Such rapid filling and stabilisation has been successfully carried out at a number of mines in other countries and could be used to reduce the stabilisation time to about 2-3 years, or less, depending on how much water is used.

BTM already has the pumping equipment and pipelines available to do this, and the pumping head from the river to the mine portal would be relatively small.

In addition to reducing the time for physical stabilisation, rapid filling would enhance the chemical stabilisation of the flooded workings and likely provide an additional source of alkalinity and sediment. The sediment would provide a potential source of extra iron to enhance sequestration of metals.

5.6.2 Post closure recovery groundwater conditions

Once the workings are flooded and the groundwater system within the mine areas at Tara has stabilised, it is expected that the piezometric surface within the Pale Beds unit will be relatively flat over the entire footprint area of the mine given the interconnected nature of the mine workings. Following closure, there will be a minor amount of permanent drawdown in the Pale Beds (and the bottom part of the UDL sequence). Within the mining area, the Pale Beds groundwater will ultimately recover to an elevation of about 1,536-1,544 mAMD (9-17 mOD) (depending on climatic variations). Figure 5.6 presents the NE-SW hydrogeological section shown in Figure 5.3 with inferred, post closure groundwater conditions. The groundwater levels on the section are estimated based on the current conceptual hydrogeological supported by over 30 years of monitoring data and site observations.

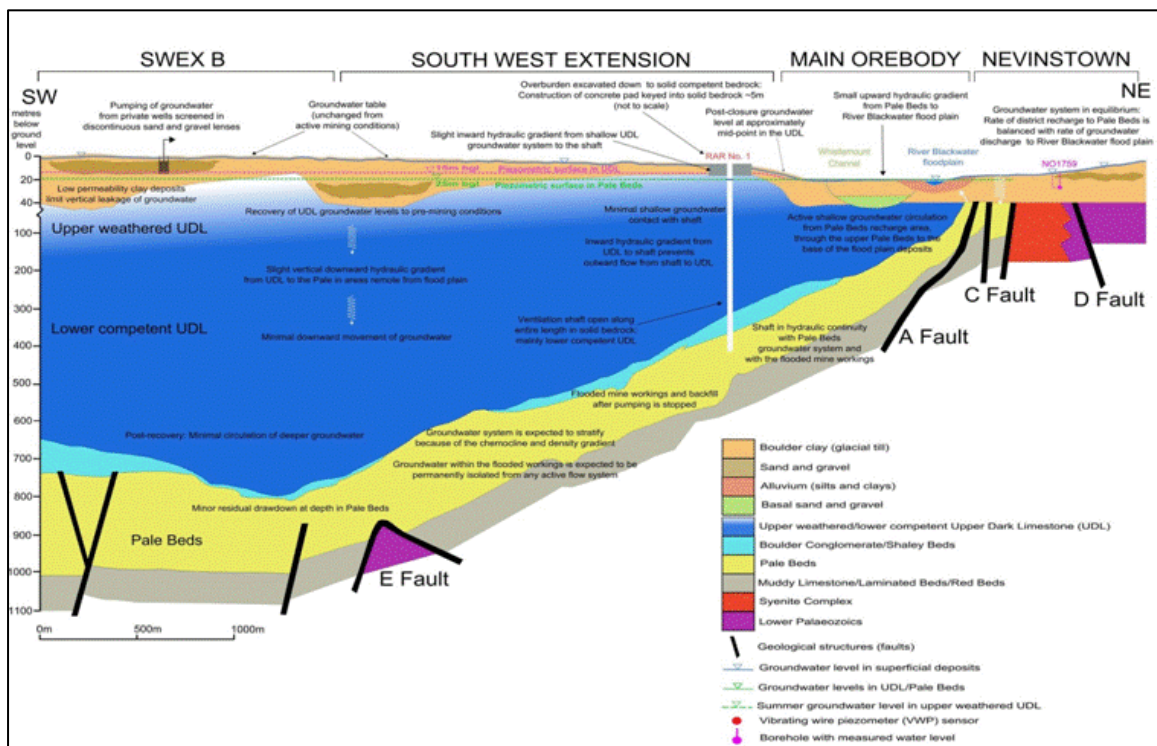


Figure 5.6 Long term post closure groundwater conditions

At the east end of overall mine area, there will be no residual drawdown, and there will be a slight upward hydraulic gradient from the Pale Beds below the flood plain. Beneath the northwest end of the project area, there will be minor residual drawdown, and there will be a slight downward hydraulic gradient to the Pale Beds below the flood plain. In the area of

Nevinstown, there will be a minor amount of permanent residual drawdown within the Pale Beds (between 1 and 5 m), and a slight downward hydraulic gradient. In the area of SWEX, there will be permanent residual drawdown within the Pale Beds at depth, but water levels in the upper weathered zone of the UDL are expected to recover to pre-mining conditions. As a result, there will be a permanent downward hydraulic gradient through most of the UDL sequence.

A downward hydraulic gradient has existed above the workings since mine excavation commenced. Over the entire mining area, the water table in the surficial deposits and upper part of the UDL is controlled by infiltration of rainfall and surface waters, so it is shallow. The water table broadly reflects topography. It is typically between 0 and 10 m depth (depending on variations in the local topography). The Blackwater River is the lowest natural hydraulic point in the Tara Mines footprint. The topography and water table increase going away from the Blackwater River.

This downward hydraulic gradient has developed because of the very large difference in total head between the surficial water table and the dewatered mine workings. As the UDL formation has mostly low vertical permeability, the greatest component of the downward hydraulic gradient occurs just above the mine workings, within the Pale Beds and/or the lower part of the UDL. The groundwater system in the overlying deposits is largely unimpacted.

If mine workings are active and dewatered, the formations immediately surrounding the workings have near-zero groundwater pressure. Thus, a large difference in total head exists between the surficial water table (zero pressure line; about 40-60 mODM) and the mine workings (zero pressure line; about -20 mODM in Nevinstown and about -840 mODM in TRDEX1 areas).

A diffuse hydraulic connectivity exists between the Nevinstown and Liscartan workings and the alluvial flood plain deposits of the Blackwater River. This is the area that produces the largest component of the mine inflow due to infiltration from surface to the Pale Beds subcrop footprint area. Following eventual shut down of the mine dewatering system, it is expected that the (flat) piezometric surface in the interconnected mine tunnels will eventually rise to approximately the same level as the alluvial water table below the River Blackwater flood plain. There will be no residual drawdown or downward hydraulic gradient below the flood plain.

Away from the River Blackwater flood plain (in the area of the Main Mine, SWEX and TRDEX1), because the surficial water table rises with topography, but the piezometric surface in the interconnected workings will remain flat at about the level of the flood plain, it is expected there will be a small downward hydraulic gradient through the UDL sequence which will remain post-closure. The magnitude of the downward gradient will be small, much lower than the downward hydraulic gradient observed during mining. Because of the relatively high lateral permeability and interconnectivity of the Pale Beds unit, a small downward hydraulic gradient likely also existed prior to mining. Most of the recharge to the mine workings enters Nevinstown and Liscartan due to infiltration of rainfall across the sub-crop footprint area of the Pale Beds unit. This water is good quality and is currently pumped directly to the River Blackwater through discharge point SW2. Following closure, the same water will be present in the flooded Nevinstown and Liscartan workings. Therefore, if any minor discharge from the mine workings upwards to the base of the River Blackwater floodplain deposits were to occur, the water would be expected to be the same quality as the current SW2 discharge.

The mining areas are strongly bounded by geological structures and lithological contacts. During mining, there is little impact on regional groundwater levels except in the area of the Pale Beds to the northwest of the mine. No further groundwater impacts are anticipated during closure. There is no deep regional groundwater flow in the area of the mine. Groundwater levels within the glacial and alluvial deposits above the bedrock will essentially be unchanged from pre-mining. Groundwater levels beneath the Blackwater flood plain will also be unchanged. It is anticipated that groundwater levels in the *Whistlemount* channel will fully recover.

Prior to mining, groundwater in the Pale Beds in the BTM area discharged into the flood plain deposits of the River Blackwater. Following mine closure and stabilisation of the groundwater system, some discharge from the flooded workings will also occur into the flood plain deposits of the River Blackwater. Water will begin to discharge from the workings once groundwater heads in the Pale Beds and the flooded workings rise above the water levels in the River Boyne. At that time, the original pre-mining groundwater balance will become re-established and the recovery of water levels will stabilise. This will occur when the district groundwater recharge to the Pale Beds, and through flow in the upper levels of the flooded workings, becomes balanced by the discharge from the Pale Bed to the alluvial flood plain deposits.

The discharge from the Pale Beds to the base of the flood plain deposits will occur in a diffuse zone mostly along the axis of the valley into the alluvial underflow system, rather than to bed

of the River Blackwater itself. The presence of clays and silts within the flood plain deposits will create a partial hydraulic barrier such that groundwater heads in the underlying bedrock can be expected to rise slightly above the groundwater levels in the flood plain deposits; to provide a sufficient upward hydraulic gradient to allow groundwater discharge to occur. As per pre-mining conditions, it is expected the post-closure upward head gradient will be small.

Upon closure, the only area of likely discharge of rebound inflow water from the mine workings will be through the diffuse upward connection between the Nevinstown and Liscartan workings and the base of the River Blackwater floodplain deposits. Because the water encountered in the Nevinstown and Liscartan workings is of good quality, no significant impacts are expected to occur post-closure following stabilization of the groundwater system.

Variations in the post-stabilisation groundwater level will also occur due to seasonal fluctuations in rainfall and groundwater recharge, and also in response to longer term climate change. Groundwater levels within the superficial glacial deposits away from the immediate flood plain area will be unchanged from pre-mining conditions and will be higher than groundwater levels within the Pale Beds

5.6.3 Potential geotechnical risks due to post closure groundwater rebound

Fault reactivation

Concern has been raised regarding potential reactivation of the main A-Fault geological structure beneath the River Blackwater floodplain deposits as a consequence of rebound of groundwater levels during post closure flooding of the mine workings. Pore pressures across the fault are currently monitored and are seen to be zero. Rebound of the groundwater system will return pore pressures in the fault zone to their natural state. As noted by Itasca, detailed analyses have previously been conducted in which a full groundwater rebound (up to the level of the River Blackwater) was simulated (Figueiredo & Świtła, 2018). The results showed that, with full groundwater pressure, slightly larger shear displacements were noted along fault planes, compared to the case with no groundwater pressure. However, the maximum fault displacements, for the most conservative case with full crown pillar extraction, was only a few millimeters and thus of no practical consequence.

Differential settlement in structural zones

As noted above in Section 5.6.2, within the dewatered Pale Beds and lower parts of the UDL, because all the mine workings are hydraulically interconnected, significant differential groundwater rebound rates are not expected. Above the mine workings, in the surficial deposits and upper UDL, the groundwater system is largely unimpacted by mining, so groundwater levels won't materially change following closure. As evidenced by the post-mining data from Lisheen and Galmoy, the re-establishment of natural pore pressure at the mining horizon and in the surrounding interconnected formations is expected to cause a very slight rebound (a few millimeters). This will be confirmed by monitoring.

Crown pillar stability

Groundwater rebound and flooding of the crown pillar and the re-establishment of pore pressures close to its natural state is expected to increase stability. As noted by Itasca, groundwater rebound and the re-establishment of pore pressures in the rock mass will increase resulting in lower effective stresses. Previous analysis (Figueiredo & Świtła, 2018) indicated no additional yielding or instability of the crown pillar due to increased pore pressures. Moreover, when flooded, the water will exert a hydrostatic normal pressure acting on the crown pillar, adding confinement and thus increasing its load-bearing capacity

5.6.4 Post closure water chemistry

During the initial phase of recovery of groundwater levels, water inflow will first enter the lower elevation headings and workings (SWEX and Tara Deeps) and will dissolve sulphate, zinc and other metals as it enters the mine. However, because all inflow comes from discrete fractures, joints and fissures in predominantly limestone and alkaline host rocks of the Pale Beds and UDL, the amount of mineral acidity dissolved will be reasonably low.

Most of the inflow during flooding will be the cleaner water that is currently entering the Nevinstown, *Liscarton* and *Rathaldron* workings. This water will flow down the decline and encounter the higher-sulphate water accumulating at the bottom. This water will itself dissolve some minor mineral acidity and sulphate from the wall rocks, but this is anticipated to be relatively limited given the alkalinity of limestone wall rocks of workings and cement backfill. The amount of mineral acidity dissolved will progressively decrease with time as the workings flood.

Once the lowest levels of the workings are flooded, the cleaner water inflow from Nevinstown will increasingly "float" on top of the water in the bottom of the workings. It is expected that there will be a slight density difference between the Nevinstown water (slightly lower density) and the inflow water in the deeper flooded SWEX workings (slightly higher density because of the higher total dissolved solids, particularly chloride and sulphate). A chemocline will likely evolve and it is expected that the deeper water in the flooded workings will become permanently stratified.

Once the workings flood, any oxidation of any previously exposed sulphide mineralisation (pyrite) in the workings wall rocks will effectively stop. Therefore, on-going generation of sulphate and metals will not occur. With time, the water in the deeper part of the workings will become strongly reducing. Depending on the matrix chemistry, there may be some on-going precipitation of metal sulphides which would act to improve the chemistry in the flooded workings in the long term. Because of the strongly lithological and fault bounded nature of the deeper workings, the water at depth will remain permanently isolated from the environment. Virtually all groundwater circulation will occur in the upper part of the workings (above 1,300 mAMD, 275 mBGL) where the water quality will be better.

5.6.5 *Development of a flooding plan for the mine*

A preliminary conceptual flooding plan for the mine has been developed. The plan will evolve, and detail will be added between now and the time of closure, currently 2034, as more information is gathered, and as the final mine plan, void space and backfill volume becomes better known. Further technical studies will include further development of numerical groundwater and hydrogeochemical model simulations to support final assessment, planning and costed engineering design for mine flooding / rewatering.

5.7 MINE VENTILATION SHAFTS

5.7.1 Description of current ventilation shafts

There are currently 10 active ventilation shafts (Fresh Air Raises and Return Air Raises) in the Nevinstown, Main Mine and SWEX mining areas (FAR No2 N&S, RAR No2, RAR No3 N&S, FAR No4, RAR No4, FAR No5, RAR No5, RAR No5 N) and 2 inactive ventilation shafts (RAR No1 and RAR No7). Figure 5.7 illustrates the surface locations of active and inactive shafts and Table 5.1 summarises corresponding location coordinates, diameters and depths.



Figure 5.7 Locations of existing and planned ventilation shafts (FAR and RARs).

When designing a permanent closure plan for the shafts, there are two key hydrogeological aspects that will need to be considered, as follows:

- All shaft locations have been optimised to minimise any contact with the groundwater system and to minimise any groundwater inflow to the voids. At each shaft location, the superficial glacial deposits have been excavated to rock head so that post-closure conditions will be unchanged from current conditions. The shafts have been located where there is minimal thickness of weathered UDL and minimal fracturing and groundwater inflow in the underlying fresh UDL.

- The final recovered water level within all shafts will be the same as the recovered water level within the Pale Beds. Therefore, at each shaft location, there will be a slight inward hydraulic gradient between the active groundwater flow system within the upper weathered zone of the UDL and the shaft.

Table 5.1 Summary of FAR and RAR locations, diameters and depths.

Name	Status	Collar Easting (ING)	Collar Northing (ING)	Collar Elevation (mODM)	Diameter (m)	Depth (m)
RAR 1	Inactive	8,106.37	5,246.78	45.29	3.8	168.0
FAR 2N	Active	7,689.88	5,263.75	42.59	3.6	324.4
FAR 2S	Active	7,689.79	5,240.92	43.11	3.6	325.2
RAR 2	Active	8,309.16	4,807.67	48.29	4.0	125.0
RAR 3N	Active	8,006.52	5,618.72	48.29	3.2	205.3
RAR 3S	Active	7,992.24	5,597.22	48.29	3.2	206.2
FAR 4	Active	5,315.32	5,039.63	70.67	4.0	839.2
RAR 4	Active	7,223.02	5,678.14	51.18	3.6	383.9
FAR 5	Active	5,351.97	5,111.09	73.29	4.0	841.6
RAR 5	Active	5,847.15	4,894.97	70.18	4.5	692.6
RAR 5N	Active	5,868.86	4,973.91	68.98	4.5	744.0
RAR 7	Inactive	5,597.06	2,668.74	57.49	5.0	993.7

The main focus for closure of the shafts is to provide a robust surface seal to prevent any access to the shaft and to prevent any surface runoff from entering the shaft. The surface plug must be water tight and must be designed to minimize the potential for any long term erosion or degradation. The thickness of the plug will vary for each shaft depending on the nature of the rockhead and the amount of weathering along joints seen in the original site investigation. This will be considered in the detailed plug design for each of the shafts.

The shafts are lined with concrete/grouted and sealed in the overburden. As a result, there is no risk to the shallow groundwater system from the rebounding deep groundwater table. The depth of the surface plug should be below the final water level in the shaft, and below any conceivable zone of long term water level fluctuation.

The post-closure groundwater heads in the shafts are expected to fluctuate between 36 mAOD to 44 mAOD, some 20 to 25 m below ground level (depending on location), owing to seasonal variations.

An extensive characterization program was carried out for precise bore drilling and construction of each shaft. The shafts have been designed such that:

- The superficial glacial materials were less than 5 m thick and were subsequently removed prior to shaft construction. The shafts have been sealed and lined through the shallow overburden and keyed into the solid bedrock to ensure geotechnical stability and to prevent the ingress of shallow groundwater to the void.
- Only a limited thickness of weathering and fracturing in the UDL was penetrated by any of the shafts.
- Contact with structural features such as the P-Fault was minimised as part of the optimization program.
- Where any open fractures or joints were encountered, these features were pressure grouted and sealed to minimise ingress of groundwater and increase stability.

The shafts are open along almost their entire length in UDL bedrock. The UDL is known to be a strong competent rock mass. To date, all shafts have remained open along their entire length and have not exhibited any signs of any instability or subsidence.

5.7.2 *Alternative approaches for permanent closure of mine shafts*

Mine shafts are typically closed using one of three approaches:

- Placement of a near-surface plug and seal, leaving the remainder of the shaft open below the plug.
- Backfilling of the shaft with porous material, with a surface plug and seal placed above the backfill material.
- Cementing of the shaft, with the surface plug and seal placed above the cement. However, full grouting of deep mine shafts is seldom carried out. Full grouting is not practical because the base of the shafts are open in the Pale Beds and are connected to the mine workings, so it would not be possible to control grout loss.

5.7.3 *Approach for shaft closure*

Based upon the hydrogeological setting of the mine and on the data from the investigation program for the shafts, it is not considered necessary to cement or backfill any of the shafts,

provided that a robust surface plug and seal is installed to below the zone of post-closure water level fluctuation.

The installation of a surface plug alone is considered adequate for the following reasons:

- There has been no instability observed in any of the shafts during the 45-year period of mine operations to date. Geotechnical instability is more likely to occur during active operations when there is no water within the shafts and there are significant pore pressure gradients in the side walls surrounding the shafts. Upon rewatering and flooding of the shafts, the water within the shafts will act to equalize the pore pressures in the side walls which will tend to increase the stability post-closure.
- The surface plug is installed to below the level of post-closure water level fluctuation, there will be no potential for oxidation of the walls of the shaft.
- Any minor flow from the upper UDL will be inward to the shaft. Very small inward groundwater gradients will occur. Therefore, there is no potential for outflow from the flooded shaft to cause contamination in the weathered UDL or in the superficial deposits. There is minimal risk to the near surface groundwater systems.
- The hydraulic behaviour of the shafts post-closure would effectively be the same whether they were backfilled or not. If porous backfill were to be placed in the shafts, there would still be the same potential for water to flow vertically. The risk of any impact from potentially contaminated groundwater would be the same whether the shafts were backfilled or not and would be non-existent because the slight hydraulic gradient.
- The post-closure groundwater system is expected to stratify. Any potential minor long term outflow from the base of the shafts would enter the inactive and permanently isolated groundwater within the flooded workings
- If the placement of backfill were to be considered in any of the shafts, some consolidation and settlement of the backfilled materials would be expected. This would create a void space below the surface plug.

Because all of the mine voids are internally interconnected and are also interconnected with the bottom of each shaft, the rising groundwater levels during closure can be monitored using the existing piezometer installations nearby. There is no need to monitor the rising water level in each individual shaft.

5.7.4 Conceptual design of surface plug

Based on the hydrogeological setting, the data collected during numerous site investigation programs, and observations made during over 35 years of mining and monitoring, it is considered that backfilling of the shafts is not required for permanent mine closure, provided that robust surface plugs and seals of sufficient depth are installed. The purpose of a plug is to:

- Make the shaft permanently safe.
- Eliminate the potential for any possible access by humans, domestic animals and wildlife.
- Prevent any possible instability of non-competent near-surface overburden materials
- Minimise the potential for any oxidation and degradation below the level of the plug.

There are many examples in Ireland, the UK and globally, of backfilling of shafts with surface plugs with no additional measures to ensure unauthorized access. At the surface, concrete plugs reinforced with rebar will be completed such that damage to the plug and access into the shaft is not possible. A conceptual design for the plugs (Figure 5.8 refers) was included in the 2023 CRAMP document.

The surface concrete plug must be installed so that its base is below the level of any post-closure fluctuation in the water level. It is acceptable to leave the shafts permanently without backfill because suitable measures have already been taken to ensure geotechnical stability of the near-surface ground conditions for raise bore drilling of the shafts.

All available data indicate no risk to the long term groundwater system, or to local groundwater users and/or receptors, by not backfilling the shafts, provided that surface plugs are in place to stabilize the near-surface glacial deposits and to prevent access to the void space. The long term hydrogeology will be identical whether porous fill material is placed or not.

Given the hydrogeological setting, the plugged shafts will have no potential to influence the River Blackwater or any of the flood plain deposits.

The original geological logs and hydrogeology data will be reviewed prior to finalising the design to ensure that the depth of the plug is below the surficial overburden materials (likely 10 m depth; to be confirmed prior to detailed design).

RAR 3, RAR 6 and FAR 2 which are set down to the bedrock). There will be a necessity to backfill the voids to ground level. Quantities of fill material are presented in Chapter 4.

Costings in relation to decommissioning mine shafts and raises have been updated with 2024 industry rates for placement of surface plugs and presented in Tables 10.5-1 and 10.5-2 in Chapter 10.

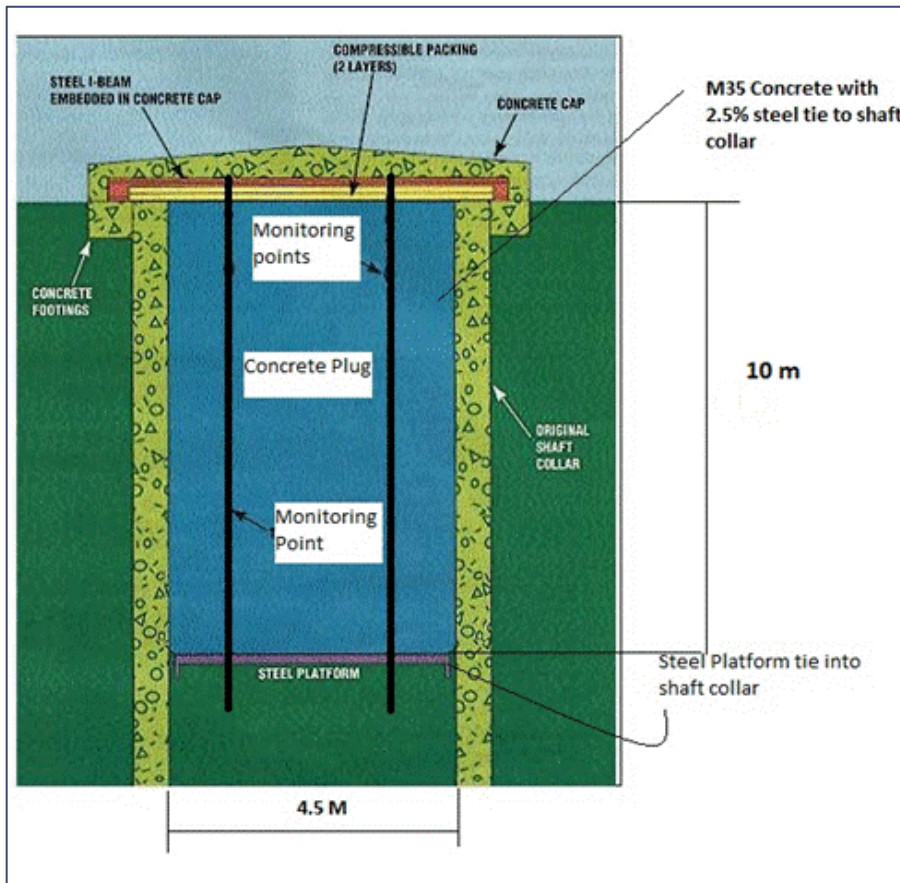


Figure 5.8 Conceptual design for mine shaft surface plug

CHAPTER 6 RANDALSTOWN TSF DECOMMISSIONING

6.1 INTRODUCTION

This chapter describes the closure, rehabilitation and restoration strategy for the Tailings Storage Facility (TSF).

The overall closure objective for the TSF is to achieve a final solution which reduces environmental liability and reintegrate disturbed lands into the surrounding landscape such that post remediation quality and capability will accommodate long term, sustainable after use.

This requires that the TSF remain in a safe and stable condition in the long term. It is expected that the TSF facility be physically stable under static and pseudo-static conditions, (such as earthquake-loading conditions) and that water management will be adequate for maintenance of embankment integrity. The outer slopes of the embankment walls, and the upper surfaces of the TSF should be protected from erosion by wind and surface water runoff.

The plan is to reintegrate land that has been disturbed by construction, operational and decommissioning activities into the surrounding landscape such that the post reclamation quality and capability of the disturbed areas will, where possible, resemble conditions prior to disturbance. In summary, the objectives are to:

- Maintain environmental/public health and safety;
- Maintain water quality;
- Maintain air quality;
- Preserve or reinstate agricultural and ecological resources; and
- Provide long term stability.

Costs associated with closure of the TSF Stages 5 and 6 inclusive of engineering costs, material handling, drainage, and surface revegetation are presented in Tables 10.6-1 through 10.6-6.

Oversight of closure activities will be undertaken by the Designer of Record (DOR) Klohn Crippen Berger (KCB).

6.2 OVERVIEW OF TSF/ EXISTING CONDITIONS

The TSF exists as a ring-dike configuration specifically built to accommodate the storage of tailings (waste material) from processing. The limestone in the tailings maintains the water at an alkaline pH, which allows the precipitation of all but traces of the metals remaining in solution following processing. The large surface area provides adequate aeration for aerobic degradation of the organic reagents, to assure a low B.O.D. concentration in the water.

The TSF encloses an area of approximately 250 hectares and has been built in 6 main stages since 1974. The timeline for each construction stage is presented in Table 6-1. Stages 1 to 5 of the TSF is enclosed by earth fill embankment walls which have been constructed from locally sourced natural materials (low permeable glacial clay till) and armoured with a layer of coarse material on the upstream slope. The walls are engineered to allow water percolate through them and be collected in the internal drainage system. Drainage water is directed to the outer perimeter interceptor channel (PIC) from where it is pumping back into the active storage dam. The most recent Stage 6 is a lateral extension to the north of stages 1 to 5 and is a composite lined facility. The existing dam crest elevation of Stage 5 and 6 is 67.3 mAOD (24m above ground level).

Table 6-1 Timeline for the Construction of the TSF

Stage	Planning Permit Ref.	Construction Period	Status
1	73/125	1975 to 1978	Filled and re-vegetated in 1988
2	74/732	1980 to 1983	Filled and re-vegetated in 1988
3	83/464	1985 to 1987	Filled in 2003
4	96/919	1998 to 2006	Raised facility over Stage 1, 2 and 3. Filled in 2006
5	NA901452	2011 to 2016	Raised Facility over Stage 4A tailings. Filled in 2020
6	NA160408 PL17.247707	2017 to 2022	Lateral Extension to Stages 1 to 5. Extant filling area: filling ongoing

6.2.1 Operation and Behaviour of the TSF

The tailings facility serves as a tailings repository while also providing temporary water storage. Tailings dam water management strategies aim to maintain geotechnical stability, conserve water resources, and enhance the chemical and physical quality of water before recycling for minerals processing.

The tailings slurry is conveyed from the mill to the TSF by a 630 mm diameter high density polyethylene (HDPE) delivery pipeline. The slurry is then discharged into the active facility by spigot deposition. The tailings surface is maintained as a concave plane, at a beach slope angle generally between 0.5% and 1% towards the location of the return water pumps. Internal pumps and a drainage line situated at the south end Stage 5A and 5B, and at the south-east corner of Stage 6 will convey water back to the processing plant at the mine site.

A perimeter interceptor channel surrounds the facilities. It receives surface run-off from the embankment. It also collects Stage 1, 2 and 3 seepage waters via a blanket of finger drains and intercepts flow from under the dam. The internal drainage system for Stage 4 and Stage 5 is directed to the perimeter interceptor channel by means of manholes, pipework and chutes. The PIC feeds into a collection sump at southern sector of the channel where the ground level is at its lowest from which all water is pumped back to the tailings pond. In 2022 regrading of the west and southwest was carried out to allow full gravity flow to the southern sump. This portion of the channel have been backfilled to ensure long term stability of the channel side slopes. A cross section of embankment walls is shown in Figure 6-1.

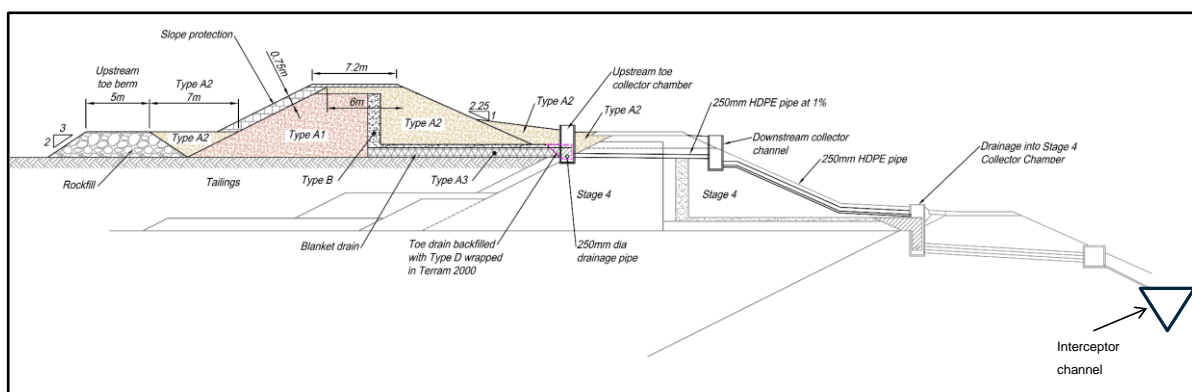


Figure 6-1 Cross section of Embankment Walls

Tailings water is routinely reclaimed back to the mine site for recycling in the mill process. Reclaimed water is pumped from the active dam to one of two reclaim water ponds that are

connected in series at the mine site. Reclaim water is mixed with mine clear water that overflows from the mine water pond. Water is pumped from the reclaim ponds to the mill via two mains, with excess water being discharged to the River Boyne at Emission Reference Point SW1 from a clear-water pond. Discharge of clearwater into the River Boyne is controlled and monitored and subject to IEL conditions.

6.3.1 Stability

The stability of the TSF has been established during the design and construction. This stability is then verified throughout the life of the structure by a comprehensive monitoring program which assesses the performance of the facility. Performance is measured through monitoring instrument installed around the facility, inspection by qualified personnel and periodic third-party safety audits.

Additional site investigations have been undertaken following those conducted as part of the original design. These include Cone penetration testing of the tailings, and drilling, sampling and testing of the embankment fill and foundation materials. These additional investigations further confirm the original design parameters on long term performance and stability of the TSF structures.

Updates to the facilities are made where required to conform with international best practice. BTM has committed to comply with the Global Industry Standard on Tailings Management (GISTM). This construction of a reinforcement buttress on the downstream slope and at the crest of the Stage 1, 2 and 3 stater embankments will provide additional support to the Stage 4 dam embankment wall and will enhance the long-term stability of the structure in line with higher standards of industry practice.

6.4.1 Water Quality

IE License, Environmental Management systems and planning conditions throughout operations at the TSF have ensured rigorous water monitoring and control measures are in place. Water quality is monitored at an extensive network of monitoring boreholes, private wells and surface water locations around the TSF.

An independent review of the hydrogeological, hydrological and water quality monitoring data collected at the TSF is conducted annually. The EC Environmental Objectives (Surface Waters) (Amendment) Regulations 2012 Environmental Quality Standards (EQS) values are used as a guide for comparison with measured concentrations in surface waters. The EC Environmental Objectives (Groundwater) Regulations SI No. 9 of 2010. Threshold values are used as a guide for comparison with measured concentrations in groundwater.

6.3 CLASSIFICATION OF THE TSF

6.3.1 Mining Waste Directive

The Randalstown TSF has been classified as a Category A facility according to the Mining Waste Directive (MWD).

Annex III of the MWD states that a waste facility shall be classified as Category A if:

- A failure or incorrect operation, e.g. the collapse of a heap or the bursting of a dam, could give rise to a major accident, on the basis of a risk assessment taking into account factors such as the present or future size, the location and the environmental impact of the waste facility; or
- It contains waste classified as hazardous under Directive 91/689/EEC above a certain threshold; or
- It contains substances or preparations classified as dangerous under Directives 67/548/EEC above a certain threshold

Commission Decision 2009/337/EC provides a methodology to ensure a common assessment of the above criteria and also provides guidance for assessing the consequences of a failure or incorrect operation. In Commission Decision 2009/337/EC it is stated that if the predicted consequences in the short or the long term of a failure due to loss of structural integrity, or due to incorrect operation of a mining waste facility could lead to serious danger to the environment, a mining waste facility shall be classified as Category A. At Article 4(3) (a-c) of the Commission Decision 2009/337/EC the definition of serious danger to the environment is expanded

As a Category A facility, the Randalstown TSF is subject to additional requirements under the legislation including a Major Accident Prevention Policy, Safety Management System and both Internal and Emergency Plans.

6.3.2 Global Industry Standard on Tailings Management

BTM is a member of the International Council of Mines and Metals (ICMM) and has also committed to implementing the Global Industry Standard on Tailings Management (GISTM). GISTM has its own classification of tailings facility in the event of failure and is based on Population at risk; Environment; health, social and Cultural; and Infrastructure and Economics.

The TSF is classified as a High Consequence based on the dam breach analysis conducted by Golder in 2020. It is important to note that the classification does not assess the likelihood of failure, only the consequence if the failure occurs.

6.4 WATER MANAGEMENT FOR CLOSURE

BTM has an operational water balance model in place and an established water management plan for the site. This is assessed on an ongoing basis and will be updated as the site transitions into closure and post closure.

Surface water management strategies are primarily aimed at controlling surface erosion, attenuating the release of dissolved and suspended solids transported by surface water runoff, and maintaining physical stability. The covering of the tailings with an inert soil cap will prevent erosion of the tailings from surface runoff.

Managed deposition of tailings before closure will provide a valley profile that is required for the cap and the tailings will beach at slopes of between 0.1% and 0.5%. This will allow surface water drainage and runoff to be confined to the decant structure adjacent to the south-west corner of Stage 5A and the south-east corner of Stags 5B and Stage 6. The decants will control surface runoff from precipitation after closure and drainage of the cap.

Surplus water that does not infiltrate the tailings, will be captured into the cap drainage system. This flow will eventually report to the decant system, a concrete cascade chute on the downstream slope of the dam wall and into a stilling basin. From the stilling basin, flow will discharge to the eastern perimeter channel and channel southwards to a proposed Integrated

Constructed Wetland (ICW) Passive Treatment System (PTS) located to the south of the existing TSF. The quality of this mine influenced water will improve with time as leaching of any contaminants in the near surface tailings directly beneath the cap reduces the available source.

The PIC located at the downstream toe of the dam walls, will collect surface water runoff from the downstream slope of the embankment walls, the perimeter road, and the internal drainage of the embankment dams. During winter, sections of the perimeter interceptor channel will intercept the groundwater as levels rise. Water will be collected and channelled along the existing perimeter channel, encompassing the TSF, to the proposed ICW system.

6.5 TSF CLOSURE - RESTORATION CAP DESIGN

6.5.1 General

It is proposed to install a 500mm inert soil cap cover over the tailings surface (Stage 1 to 6). The cap will:

- Provide a productive land asset that could be used for agriculture; managed sheep farming and/or wildlife conservation purposes;
- Minimise the possibility of long-term exposure of tailings and therefore tailings dusting;
- Minimise contaminant runoff from the surface;
- Reduce the migration of contaminants upwards to the surface; and
- Reduce the time frame between the post closure active phase, passive phase and finally the stable phase.

There will always be a risk of tailings dusting unless the tailings are covered by inert soil materials. The presence of soil together with healthy vegetation will prevent dusting and minimise the ingress of rainfall through the cap and into the tailings.

The restoration cap will consist of the following:

- A 500mm soil cap to support vegetation growth;
- Central access road rockfill berms which will provide primary access and drainage;

- Secondary access road rockfill berms; and
- Hedgerows.

6.5.2 Cap Profile

The restoration cap contours will generally follow the contours of the tailings profile.

It is proposed to shape the tailings profile by controlled spigotting and hence the cap profile for Stages 5A, 5B and Stage 6 (refer to figure 6-2). The cap will be profiled to the reclaim pumps. The reclaim pumps will be located in the southwest corner of Stage 5A, the southeast corner of Stage 5B, and the southeastern corner Stage 6 ensuring that these localities will be at the lowest points and the location of the reclaim ponds.

The cap contours will range from approximately 66.29 mAOD adjacent to the dam crest to 64.29 mAOD at the location of the return water sumps at a gradient of c. 0.5%. The Stage 5 cap will be shaped as two shallow valleys with axis towards the low areas at the location of the return water sumps. Considerable care will be required during the operational phase to prevent any build-up of tailings in the facility which would impede water flow to the reclaim ponds.

Topographic beach surveys are periodically undertaken on active and inactive cells to confirm the overall profile.

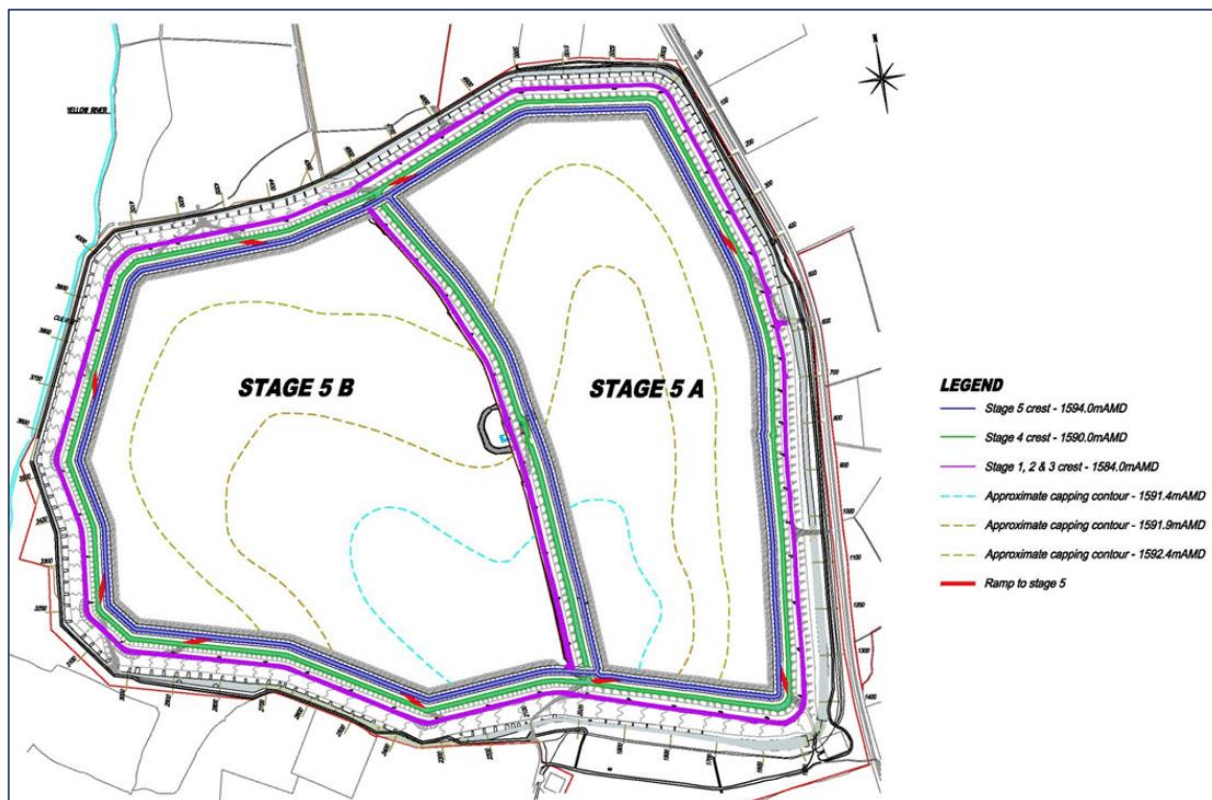


Figure 6-1 Surface Capping Contours of Stage 5

6.5.3 Cap Design

The growing medium consisting of soil is ideal for growing vegetation. Soil conditioners like compost will be used to improve the growing medium. The tailings are not net acid generating and therefore a low permeability cap to exclude oxygen or water is not required. In accordance with IE Licence Schedule C.4, Waste Monitoring, Annual Acid / Base Counting is conducted on a monthly basis.

Rock fill, either borrowed locally or imported, is proposed to be used to build the access roads onto the tailings and form the drainage system in the cap.

The access roads would be 8 m wide. The rock fill haul roads would be placed on a geosynthetic (combigrid or geotextile) which is rolled out over the tailings surface. The geosynthetic layer would reduce rock losses into the tailings and prevent tailings migrating upwards due to the development of high pore pressures during loading. The thickness of rock placed on the tailings to form the haul roads would be initially approximately 800 mm. The haul roads will be used to import the layer of soil to be placed directly on the tailings. Once a

number of access roads are formed, the rock fill would be reduced in thickness to 500 mm and the material used to form future access roads.

To prevent the cap becoming waterlogged, a series of drains will be incorporated into the cap. The central access road will incorporate perforated pipes which directs water to the low areas to the south-west corner of Stage 5B and south-east corner of Stage 5B and Stage 6. It is envisioned that these would be 3 x 200 mm internal diameter pipes but will be confirmed as part of ongoing closure design. The central drainage system shall be installed to a minimum cover depth of 450mm.

The remaining secondary access roads will incorporate a single 200 mm internal diameter perforated pipe and will feed into the central drainage system.

The existing rehabilitation trials conducted on Stage 5 north included flat geosynthetic drains (pozidrains) at 25 m centres connected to the rockfill access roads. Pozidrain, or an equivalent approved product, is a high strength flexible polyethylene with a cusped core to allow the passage of water and a non-woven geotextile bonded onto the top surface to prevent the migration of soil or tailings solids into the drain. The drains come in 1 m wide drainage strips and varied thicknesses which can be placed directly on the tailings surface prior to placement of the soil and thus avoiding any excavation requirement after placement.

Ongoing assessment of the use and long-term effectiveness of the geosynthetic drains will be assessed as part of the capping design.

6.5.4 Capacity of Cap Drainage System

An assessment of the capacity of the proposed drainage system has been undertaken, which considers the following 3 scenarios:

- Scenario 1: Capacity of the drainage system to accommodate annual average rainfall conditions (i.e. annual average rainfall is assumed to be distributed evenly throughout the year);
- Scenario 2: Capacity of the drainage system to accommodate maximum average monthly rainfall conditions (i.e. average October rainfall is assumed to be distributed evenly throughout the month); and

- Scenario 3: Capacity of the drainage system to accommodate the 24-hour 1 year rainfall event.

The assessment assumes that a maximum of 20% of the total cap area (for either Stage 5A or 5B or proposed Stage 6) directs runoff to any individual 200 mm drain, due to the regular spacing of the 200 mm drain layout. The assessment also conservatively assumes that all rainfall reports to the drainage system and there are no losses, i.e. infiltration or evapotranspiration. Nor does it take into consideration the drainage capacity of the granular material forming the roads.

The assessment demonstrates that the proposed cap drainage system will have sufficient capacity to prevent water logging of the cap. The system is shown to have sufficient capacity to comfortably manage extended wet periods. In reality monthly rainfall will not be distributed evenly throughout the month, however it is expected that the excess capacity within the system will accommodate higher intensity and shorter duration events.

The capacity of the drainage system will be further assessed based on projected climate change impacts. The TSF capping layout of Stage 5 and Stage 6 is shown in Figures 6-3 and 6-4 respectively.

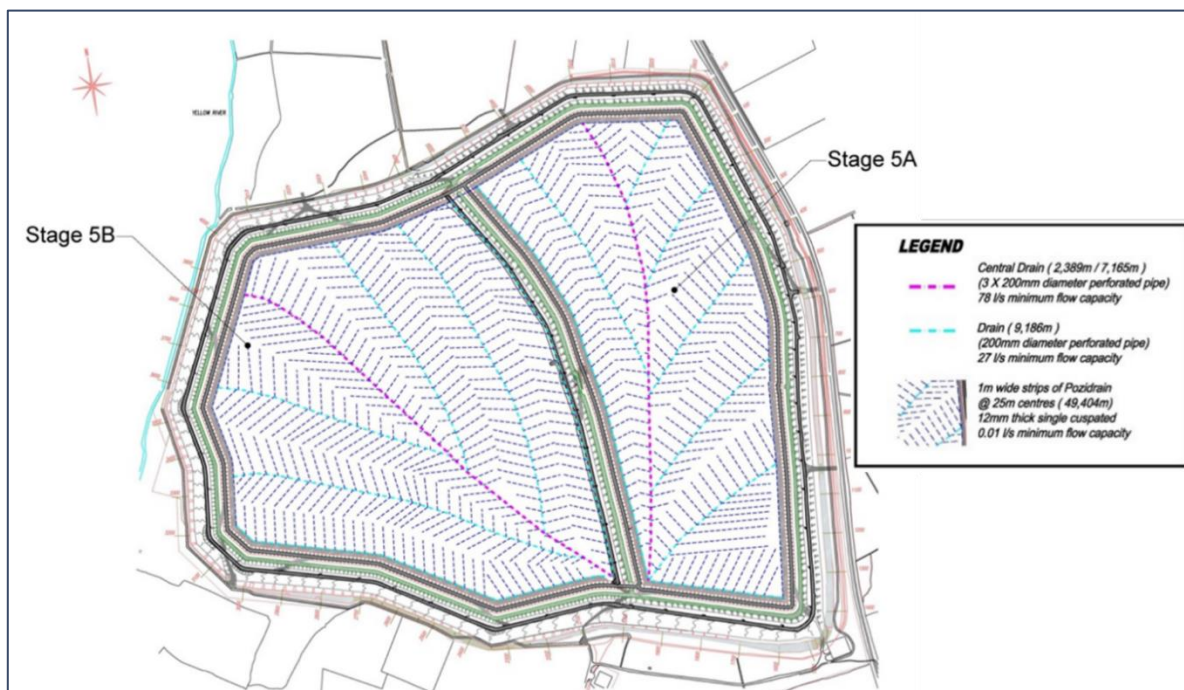


Figure 6-3 TSF Capping Drainage Layout Stage 5

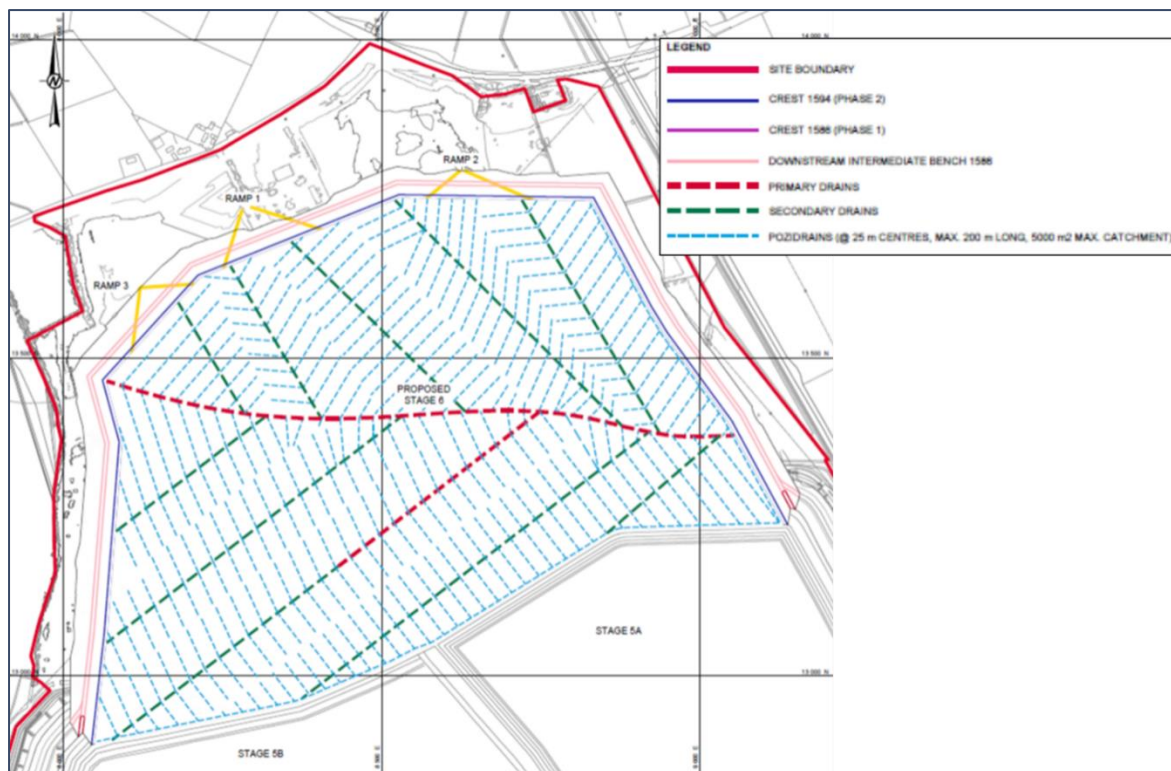


Figure 6.3 TSF Capping Drainage Layout Stage 6

6.5.5 Construction of Drainage System

Following the reduction of the access road depth of rock fill by 300mm and the grading of the camber, as described above a drainage trench will be required to be excavated along the centre lines of the access roads to the extent of the installed combigrid.

Particular care shall be taken as to not damage the installed combigrid and appropriate plant and method shall be utilised.

- Excavate and grade rock fill from the access road for the line of the drainage trench excavation to expose the combigrid previously installed;
- Install the bedding granular filter material above the combigrid;
- Install the drainage pipe(s) to the design invert elevation and grade;
- Surround the drainage pipe(s) with granular filter material;
- Re-install the excavated rock fill, in two layers of approximately 250mm, to reinstate the access road; and
- Re-grade rock fill to form camber for access road.

6.5.6 Cap Construction Process

The first stage of the operation will be the construction of the rockfill access roads which will be placed on a geosynthetic rolled out over the tailings. The width of the rockfill access road will be approximately 8 m and spaced approximately 200 m apart and will form part of the long-term drainage system of the cap.

The second stage will involve the placement of soil directly on top of the tailings. Soil will be placed by machinery operating from the rockfill access roads to form temporary access berms between the rockfill access roads. The soil thickness will be dependent on the performance of the tailings and could be made temporarily thicker if required. Trial work has been undertaken to understand the construction process required.

Settlement of the access roads and berms during construction will vary depending on the strength of the tailings and the loading (trafficking).

There are a number of factors which will assist in placing the cap on the tailings surface including:

- desiccation of the tailings;
- time of construction (prevailing metrological conditions);
- depth to water table in the tailings;
- slope of tailings;
- choice of construction plant;
- minimise plant vibration; and
- use of geo-fabrics.

A key factor to capping of the facility will be allowing the tailings to desiccate prior to any construction activity. Desiccations results in considerable strength gain of the upper layers of the tailings and the formation of a surface crust. This results in less deformation of the tailings during construction and reduces settlement and hence material losses during construction. The tailings would need a minimum of 1 year exposure, to include a full summer with construction commencing in the following April. Ideally, construction would be undertaken between April and September particularly for the placement of the soils which would be

considerably impacted by wet weather. The methodology for placement of the cap is shown in Figure 6-5.

It is further anticipated that Stage 5 and 6 will be decommissioned and reclaimed on a phased based prior to eventual full closure of the facility.

6.5.8 Cap Forming Material

The material will be sourced primarily from imported fill from third part licensed facilities.

BTM has progressed with sourcing and stockpiling suitable capping material derived from local construction development and this shall be an on-going process.

The total soil requirement is estimated to be approximately 900,000 m³.

This volume is based on a total surface area of Stage 5 and Stage 6 of 142 hectares and 58 hectares, respectively, and a soil cap thickness of 500 mm. The area of internal roadways has been removed but additional fill included for the hedgerows.

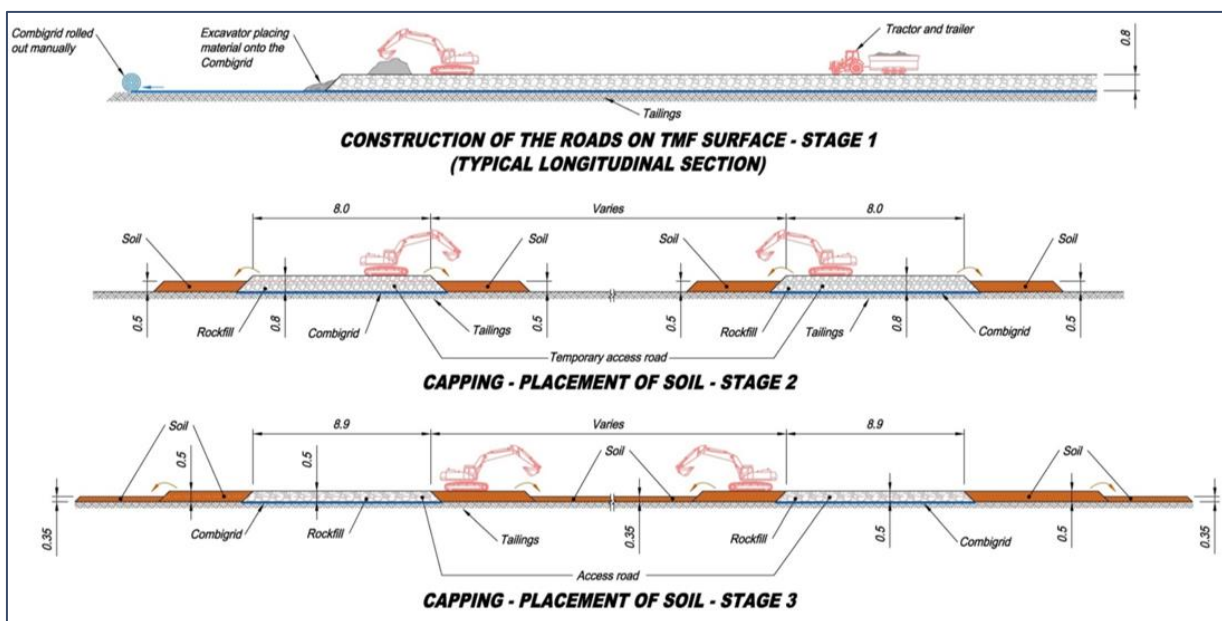


Figure 6-5 Cap Placement Methodology

6.5.8 Hedgerows

To allow for the planting of hedgerows, the soil thickness will be increased at the field boundaries by forming ridges 800 mm thick above the tailings surface and 2m wide. To prevent ponding on the upstream side of the hedgerow ridge, a 300 mm wide pea gravel (Type C) drain will be installed which will discharge surface water.

The oil requirement for hedgerow ridges is estimates to be approximately 28,000 m³.

6.8 DECANT SPILLWAY DESIGN

6.8.1 Flood Risk

There will be no permanent open water against the dam wall other than temporary ponding during major storm events.

This will be achieved by construction of a permanent decant spillway system. The decant system will control runoff from precipitation after closure and drainage of the cap. The spillway will be designed to accommodate normal discharge requirements and those resulting from the most extreme 1 in 10,000-year storm events.

6.8.2 Decant Spillway Design of Stage 5

It is proposed to install a spillway as the single final decant structure in the southeast corner of Stage 5B. The water will cascade down the dam wall along a stepped concrete chute, enter a stilling basin at the base of the downstream toe to dissipate the energy and merge with flows from the perimeter interceptor channel prior to passing into the ICW passive treatment system. The stilling basin will be constructed at an appropriate elevation to allow discharge over the perimeter interceptor channel. The invert levels will be determined during the capping.

The Stage 5 reclaim sump, to prevent scouring, will be protected with gabion mattresses. It is anticipated that the sump will be backfilled with rock fill over the tailings. The depth of rock fill together with the gabion mattresses will be a minimum of 2m over the tailings and placed to the invert level of the inlet at Stage 5.

The intake and outlet width of the spillway will be 8 m and will have a gradient of 2% over a length of 50m.

From the Stage 5B crest the water will spill into a concrete cascade chute some 140m in length, at an average gradient of 16.4% and width of 4m. The cascade chute will transition from 8m to 4m over a length of 20m.

6.8.3 Decant Spillway Design Stage 6

The spillway will be located in the south-east corner of the Stage 6 dam wall where the reclaim pumps are located. The water will be discharged into the eastern perimeter interceptor channel. The design will be a simple open spillway system. The invert levels will be determined during the capping.

The spillway will exit to a concrete cascade chute on the downstream slope of the dam wall and into a stilling basin to reduce the energy of the flow.

The intake width of the spillway is 4m. From the Phase 2 crest, the water spills into a concrete cascade chute some at an average gradient of 1V:3.5H and width of 2.5m. The cascade chute will transition from 4m to 2.5m over a length of 3.75m.

From the stilling basin, flow will discharge to the eastern perimeter channel and channel southwards to the proposed ICW passive treatment system located to the south of the existing TSF.

The Stage 6 reclaim sump, to prevent scouring, will be protected with gabion mattresses. It is anticipated that the sump will be backfilled with rock fill over the tailings. The depth of rock fill together with the gabion mattresses will be a minimum of 2m over the tailings and placed to the invert level of the inlet at Stage 6.

For premature closure the wall would be cut down to accommodate a lower tailings level.

6.9 REHABILITATION TO DATE

BTM are progressing with a large trial capping area at the northern extent of Stage 5A, in order to validate the capping design and construction methodology, and to get an early assessment of the water quality of cap runoff.

The following design risks were identified prior to the trial capping works:

- Depth of rock fill required for the access roads to preclude excess pore pressures in the tailings during equipment traffic movements.
- Depth of soil beneath operating equipment in the hauling and placement process to preclude excess pore pressure generation in the tailings.
- Depth of soil beneath operating plant in the grading, harrowing and seeding process to preclude excess pore pressure generation in the tailings.
- Selection of Construction equipment - would equipment ground pressures when loaded and during operation be excessive? would smaller equipment with lower ground pressure be preferable to increasing the soil depth?
- Operator performance - may be lacking in experience and training for working with the particular items of equipment and directly on tailings.

These risks were largely identified and managed during the construction of the Phase 1 capping works and the experience gained by the Contractor was evident in the Phase 2 capping works.

Observations during the construction of the Phase 1 capping works led to the following key elements being implemented:

- Combigrid installation for the base of all access roads.
- Enhanced vegetation cover on the tailings to provide natural basal reinforcement.
- Planned and directed construction equipment specification and operating methodology.
- Limiting construction operations on the capping during unsuitable weather conditions.

Bases on these trials the soil cap has been increased to 500mm. The modification to the cap design was based on experience gained during phases 1 to 4 of the capping trials on Stage 5A North where 20 hectares was progressively rehabilitated over a period from 2020 (Figure 6-5 refers).



Figure 6-6 Capping trial Area in the Stage 5A north

6.10 LONG-TERM MONITORING DURING

The TSF will require a vast level of monitoring and aftercare management which has been divided into three distinct phases:

- Active Aftercare Monitoring and Management (5 years post closure phase)
- Passive Aftercare Monitoring and Management (10 years post Active Aftercare phase)
- Stable Aftercare Monitoring and Management (15 years post Passive Aftercare phase)

The long-term monitoring and surveillance program will be assessed and modified as the facility advance through the aftercare phases. Monitoring requirements will be based on the performance of the rehabilitation and water and air quality meeting regulatory standards.

Oversight of all closure activities will be undertaken by the Designer of Record (DOR) Klohn Crippen Berger (KCB).

The monitoring program will include physical, geochemical and ecological stability.

Environmental monitoring will continue in line with schedules in IEL with frequency reduced as aftercare progresses. Independent review of all hydrogeological, hydrological and water quality monitoring data collected will continue through to the stable aftercare phase.

In recent years stability monitoring systems have been automated allowing remote and real-time monitoring. BTM is progressing towards full automation of all critical instrumentation during the operational phase of the facility.

Governance reporting requirements to include Annual Performance Report, Hydrogeological Report and SEED audits will be carried out by external consultants.

The long-term aftercare management programme for the TSF is detailed in Chapter 8.

Key success criteria indicators which will include overall closure objectives and performance goals for the TSF will be established closer to the Life of Mine.

CHAPTER 7 PASSIVE WATER TREATMENT

7.1 INTRODUCTION

The closure of the Tailings Storage Facility (TSF) requires a robust and sustainable approach to managing mine-influenced water (MIW) to ensure compliance with regulatory water quality standards and to mitigate potential environmental impacts. During operations, MIW and runoff from the perimeter interceptor channel are actively managed within the TSF, where they were either reused in ore processing or discharged to the River Boyne under strict regulatory control.

Following the cessation of mining activities and the decommissioning of the TSF and existing water treatment plant at the mine site complex an alternative water treatment solution will be required to manage and treat water at the TSF. The primary water quality concerns post-closure relates to elevated levels of metals, sulphates, and other contaminants present in MIW. Without proper treatment, these substances could pose a risk to downstream water bodies, necessitating an effective, long-term remediation strategy. As per Schedules in IEL P0516-04 water quality in the perimeter interceptor channel, as well as groundwater monitoring wells surrounding the TSF, is monitored on a monthly basis. The results from this monitoring, along with flow rate data, have been used to determine the most appropriate strategy for ensuring that discharge water meets water quality standards in the surrounding waterbodies. Various treatment options have been considered, including active treatment, passive treatment, dilution, and a combination of these approaches and evaluated in terms of effectiveness, operational costs, long-term sustainability, and environmental impact. Based on this assessment, a Passive Treatment System (PTS), specifically an Integrated Constructed Wetland (ICW), has been selected as the most viable solution.

This chapter explores the design, construction, and long-term management of an Integrated Constructed Wetland (ICW) as a passive treatment system for managing mine water at the TSF. It begins with an overview of passive treatment systems, their benefits, and the natural processes involved in metal removal. The proposed ICW design is then outlined, considering site suitability, water balance, water quality requirements and discharge from the ICW.

7.1.1 Passive Treatment System

Passive treatment systems are designed to improve water quality using only naturally available energy sources, such as gravity, microbial metabolism, and chemical energy, with minimal ongoing maintenance. The PIRAMID Consortium defines passive in-situ remediation as an engineered system that prevents, diminishes, or treats contaminated waters at the source, requiring only infrequent maintenance while operating effectively over its design life. Unlike active treatment systems, which often rely on mechanical and chemical inputs, passive treatment systems mimic natural processes in a controlled environment, facilitating contaminant removal through biological, chemical, and physical mechanisms.

Two passive treatment technologies were investigated with meso-scale trials implemented at the TSF: Integrated Constructed Wetlands (ICWs) and Sulphate-Reducing Bioreactors (SRBRs). Following these trials coupled with extensive field trials and case studies, including the successful implementation and outcomes observed with passive systems at the Galmoy Mine, BTM has determined that the ICW approach as the most sustainable passive treatment system to address the treatment and drainage management needs from the TSF, while requiring minimal operational oversight. ICWs provide supplementary environmental benefits, including biodiversity enhancement, carbon sequestration, and landscape integration, which contribute to a positive post-closure environmental legacy.

7.1.2 Integrated Constructed Wetlands Overview

An Integrated Constructed Wetland (ICW) is proposed as a passive Nature Based treatment system for the treatment and management of drainage from the TSF. ICWs are shallow (typically 150-250mm) surface-flow wetlands, which mimic the biological functions of naturally occurring wetland habitats and densely vegetated with a selection of native emergent plant species. These plants facilitate the environment needed for a variety of biological, chemical and physical processes to occur, that will aid in the treatment of wastewaters from a variety of sources. Each ICW design is site-specific and differs from other constructed wetlands in that they are designed to facilitate the widest possible ecological conditions typically found in natural wetlands. The system strives to achieve a 'Landscape Fit', encouraging habitat restoration and biodiversity as well as being more aesthetically appealing. ICWs have larger area requirements than other constructed wetland designs which facilitates increased hydraulic residence time, increasing treatment efficiency. Moreover, the larger area

requirement further benefits biodiversity through the development of wetland habitat and resource provision. The final design and development of an ICW will be prepared in line with the guidance document for ICWs published by the Department of Environment, Heritage and Local Government, Ireland (Integrated Constructed Wetlands Guidance Document for Farmyard Soiled Water Domestic Wastewater Applications, 2010).

7.1.3 Key Benefits of an ICW

A key feature of ICWs in contrast to other treatment approaches is the robustness and versatility of the systems. The ICW concept delivers from an environmental, economic and social perspective, providing a range of benefits to humans and the natural world that other concepts simply cannot match. These benefits include:

- The ‘total’ management of water (all water on a site is given due consideration)
- Lower capital costs (typically >60% saving on capital) compared to alternative, more conventional treatment methods;
- Utilisation of available local/on-site materials for construction of ICW
- Low operation and maintenance costs (typically >90% less than conventional systems)
- Controlled discharge of intercepted water by releasing water gradually from the intercepting ICW cells (even diminishing or eliminating surface water discharge). This is of special significance at Tara Mines, where large volumes of water may be generated during heavy precipitation events
- Capture/retrieval (recycling) of water-vectored materials such as phosphorus, nitrogen, various metals and organic matter
- Carbon sequestration (storage) – accumulating vegetation necromass
- Development of new wetland-dependent habitats and resources
- Facilitate awareness of the value of wetlands (and nature generally)
- Opportunities for recreation and education
- Robust system capable of withstanding extreme load variations (weather events and seasonal fluctuations)
- Sustainable design and construction ensuring a long operational life (50-100+ years)
- Minimal management and capacity for self-regulation (stable system)
- The site is not irrevocably lost and is ideally enhanced in the long-term facilitating further development
- Creation of a widely-lost wetland habitat, facilitating biodiversity gain onsite

-
- Addresses legislative requirements; Water Framework Directive, Nitrates Directive, Convention on Biological Diversity
 - Takes a broader ecological approach rather than one solely based on environmental considerations alone.

7.1.4 Integrated Constructed Wetland Treatment

ICW systems provide management and treatment of their respective through-flowing waters through a wide range of physical, biological and chemical processes and mechanisms. These differ slightly both between ICW designs and within any given ICW system, due to site-specific elements, such as topography and on-site soils.

One of the key design considerations for an effective ICW is that of hydraulic retention within the treatment cells. The retention time within the system provides conditions for the best performance outcomes. The duration of time that waters remain in the treatment cell, the greater the degree of treatment and management. Extended hydraulic retention time within ICW cells allows for protracted interaction between through-flowing waters and the vegetation stands and the biofilms that cover their surfaces. Additionally, it also ensures that there is increased interaction between substrates, accumulated necromass and organic material, where sequestration, absorption and adsorption are most prevalent.

The impeded through-flowing waters in a free surface flow wetland must also displace the existing waters within any given cell. As displacement of waters occurs, there is also passive diffusion and dilution of incoming flows with that of the existing water column. This displacement and diffusion of flows through an ICW lessens the risk of preferential flow pathways, increases residence time and lends towards chemical reactivity between bio-films, substrates and waters.

The slowing of waters through the ICW is achieved through the construction and planting process, due to the flat, level base of the ICW coupled with the dense vegetation cover. These impeded flows can lose substantial volume due to evapotranspiration by the vegetation, which typically surpasses evaporation rates of open water. As water levels can drop through this process, the relative surface area to the water column increases, further enhancing the treatment processes of the system as a whole.

The primary vegetation types used in ICWs are native emergent plant species (helophytes). These species have evolved to enable their roots to successfully grow in soils with no available or limited oxygen. Growing vertically through and above the water column, they provide a support structure for the highly functional biofilms that are the 'work-horses' of the treatment system. Additionally, the vegetation provides oxygenation to the water column and soils.

With a dense coverage of above ground foliage, a high leaf area index and varying phenotypical heights, the selected wetland species have evapotranspiration rates of up to 1,000mm/ha/yr, further decreasing through flow and increasing retention time and treatment efficiency. These plant species provide for substantial volumes of water losses to the atmosphere throughout the year, though they vary seasonally. Increased rates of evapotranspiration coincide with reduced flows in surface waters during summer months. Where an ICW is appropriately designed, scaled and operated, and subject to 10 environmental conditions, there is a likelihood that there will be zero discharge from the ICW during periods of extended good weather. This minimises risks to any receiving surface waters to which the ICW is connected.

As open biological systems, the hydrology of an ICW is complex and can be highly variable. At least 6 different flow-paths across, through, above, below and between the intercepting emergent vegetation and between cells may apply. These collectively contribute to the durability of the ICW in adapting to variable flows from a given source, such as MIW from the TMF at Randalstown, which will be climate driven. Flows from the TMF to the ICW are driven by rainfall events, resulting in variable hydraulic loading to the system. The multitude of hydraulic pathways through the treatment cells, coupled with the segmented design, ensures that the establishment of preferential flow pathways through the cells is minimised. This in turn increases overall residence time, allowing for improved treatment functionality.

The helophyte vegetation canopy intercepts precipitation year-round reducing through-fall, losing water through transpiration and influencing water loss through evaporation. To these may be added precipitation, ground water infiltration/exfiltration and embankment runoff, as well as seasonal factors such as freezing or prolonged drought. Notwithstanding these complexities, the performance of all monitored ICW systems including an existing ICW for mine drainage over more than 20 years have shown them to be sustainable efficacious treatment additions to the Irish landscape whilst also providing many important additional ecosystem services.

7.1.5 Processes of Metal Removal

The main processes involved in metal removal is presented in Table 7-1.

Table 7-1 Processes in Metal Removal

Medium	Processes
Vegetation	Ion uptake/translocation Adsorption Organic decomposition Filtration
Water	Evaporation Dilution Complex formation Decomposition Microbial oxidation/reduction Precipitation
Substrate	Microbial oxidation/reduction Ion exchange Precipitation Adsorption Chelation Chemical (organic) decomposition

Cation exchange capacity (CEC) is the measure of ability of a substrate to adsorb positively charged ions (such as metal ions) by exchanging them for other ions bound to the molecular structure of the substance. The process requires a continuous supply of fresh organic matter (produced by the plants - detritus).

Due to the robust nature of the wetland species selected for an ICW, they can tolerate elevated heavy metal concentrations. The wetland plants play a vital role in metal removal by providing organic material for adsorption as well as absorbing some metals themselves. Moreover, the highly active biofilm, facilitated by the dense root structures of the plants, will result in significant metal reductions through bioaccumulation.

The hydrology of an ICW is one of the most important factors in the initial establishment and subsequent optimal function of the system. The permanent or periodic saturation of a wetland results in anaerobic conditions in the soil under which wetland biogeochemical processes occur. These processes cause the development of characteristic wetland soils, which support a dominant plant community adapted to living in saturated soils (Sheoran et al, 2006, Mitsch and Gosselink, 1993, ITRC, 2003). The concentrations of heavy metal ions removed from solution in wetlands is determined by interacting processes of settling, sedimentation, sorptions, co-precipitation, cation exchange, photodegradation, phytoaccumulation, biodegradation, microbial activity and plant uptake (Sheoran et al, 2006).

The known ability of wetlands to reduce metal and sulphate concentrations has been further examined by BTM through the set-up of meso-scale and pilot-scale ICW trials the TSF.

7.2 PROPOSED INTEGRATED CONSTRUCTED WETLANDS DESIGN

BTM have engaged the services of *VESI Environmental* who are globally recognised as the pioneers of Integrated Constructed Wetlands and involved in the successful ICW design at Galmoy Mine to design a site specific ICW and its associated features to manage and treat water flows from TSF. The estimated annual design flow to the ICW is approximately 800,000 m³, with monthly and daily variations influenced by seasonal meteorological conditions.

7.2.1 Water Balance and Flow Variability

A preliminary seasonal water balance assessment has been conducted, indicating that water inflows and outflows will vary throughout the year, with no significant flows during summer months. The estimated influent and effluent discharge volumes for each season are summarised below in table 7-2.

Table 7-2 ICW Water Balance

Flow Rates	Season			
	Spring	Summer	Autumn	Winter
Influent discharge m ³	170,138	-74,258	221,742	462,108
ICW effluent discharge m ³	154,725	-51,435	198,565	475,215
ICW Daily average m ³	1,710	0	2,206	5,280

7.2.2 Water Quality Considerations

As the influent water quality is expected to be variable over time a conservative approach to water quality management has been adopted in the ICW design. As the TSF surface is not yet fully capped and final runoff water quality data is unavailable, the design has incorporated available water quality data from perimeter interceptor channel and considered water quality data from the capped TMF at Galmoy Mines to ensure effective treatment.

7.2.3 ICW Design Area, Suitability and Construction Materials

The proposed ICW, to be located to the south of the TSF, will comprise seven treatment cells, covering 126,585 m², designed to manage and treat flows from the TSF post-capping. Water will flow by gravity from the TSF cap and interceptor channel into Cell 1, then sequentially through each of the seven treatment cells before being discharged into the Blackwater River at the southeast corner of the site (Figure 7.1 refers). The system is designed to accommodate all hydrological conditions, including storm events and dry periods, ensuring effective water management year-round. Detail of the cell treatment areas is available in table 7-3

Table 7-3 ICW Cell Treatment Areas

ICW Cell No.	Treatment Area
Cell 1	11,364m ²
Cell 2	15,020 m ²
Cell 3	21,051 m ²
Cell 4	17,176 m ²
Cell 5	21,933 m ²
Cell 6	21,907m ²
Cell 7	18,134m ²
Total	126,585 m²

Site investigations and desk studies has been conducted to assess site suitability for ICW implementation. The findings indicate that the onsite materials will be suitable for constructing the cell embankments and natural liner. These soils provide effective treatment and containment of waters within the system while ensuring protection of both surface and groundwater sources. The natural maximum permeability of the site's soil is estimated at 1x10⁻⁸ m/s, ensuring effective water containment.

Recognising that initial inflows will have the highest concentrations of nutrients, metals, and trace elements, additional environmental risk mitigation measures will be implemented. Specifically, Cells 1 and 2 will be lined with a suitable artificial liner, such as bentonite or HDPE, to prevent contamination. These liners will be covered with a minimum of 750mm of subsoil and clays, with an additional 300mm of topsoil as the final layer. Cells 3 to 7 will be underlain with a natural clay liner of at least 500mm thickness, along with a 300mm topsoil

substrate. Cells 5-7 will incorporate a 500mm-thick natural clay liner, also overlaid with a 300mm topsoil substrate to maintain system integrity. Typical cross sections and details of ICW are shown in Figure7-2.



Figure 7-1 Proposed ICW Layout

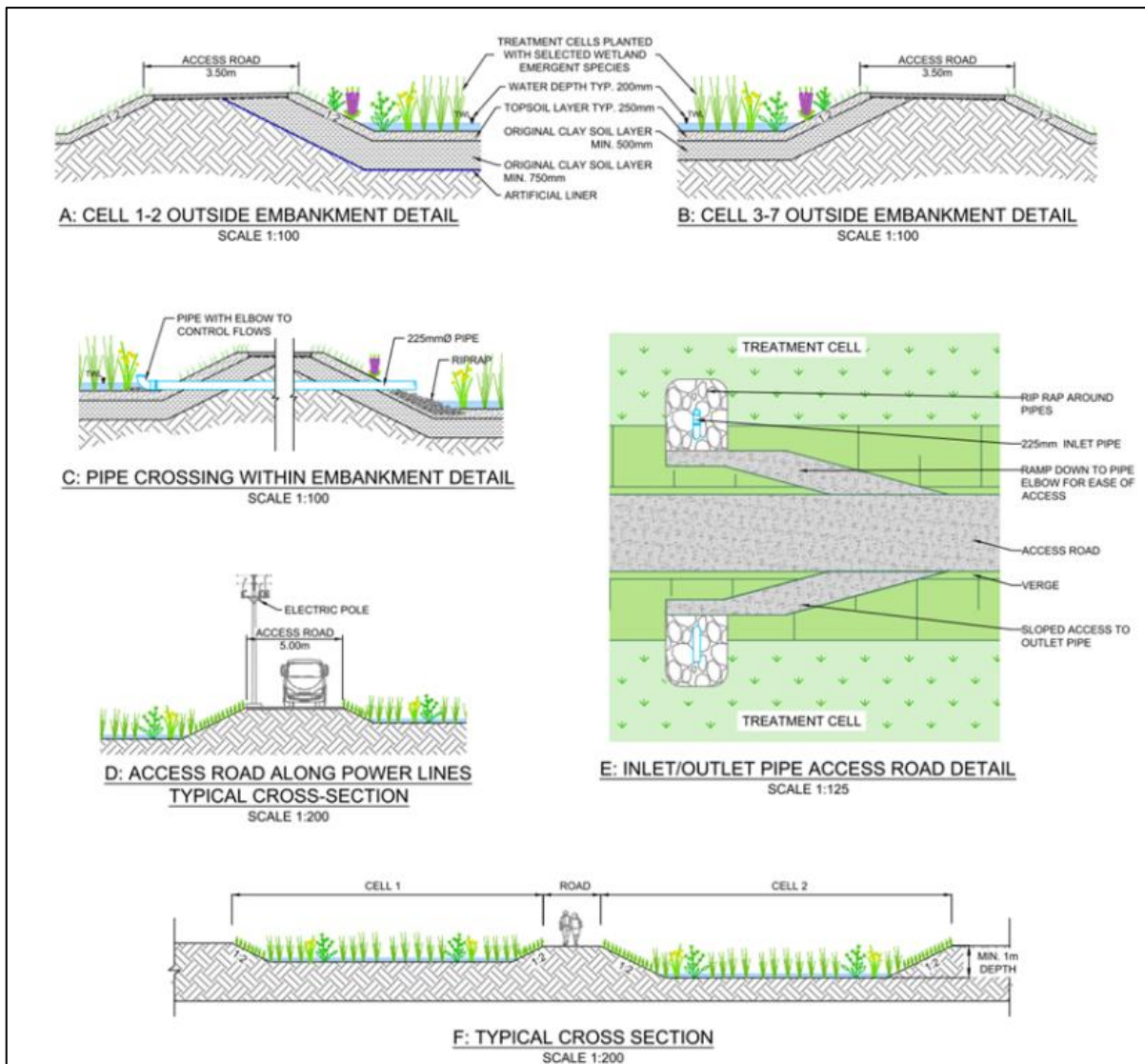


Figure 7-2 Typical cross sections and details of proposed ICW

7.3 CONSTRUCTION OF THE ICW

The construction of the ICW will primarily involve earthworks, including levelling, excavation, and soil placement for the enclosing embankments and access roadways.

The overall shaping of the ICW cells is expected to take between 9 to 12 months with construction ideally carried out between March and October or longer.

7.3.1 ICW Construction Process

The wetland will be constructed in sequence, beginning with Cell 1 and progressing downwards to Cell 7. The process involves:

- Stripping and Stockpiling Topsoil - topsoil from the ICW area will be removed and stored for later use as a growing medium for wetland vegetation.
- Excavation and Shaping of Cells - Underlying subsoils will be excavated to the design levels, and excess material will be used to construct the surrounding embankments.
- Use of Excavated Material - large volumes of excess cut material will be repurposed for the final cap of the TMF, while high-clay content material will be stockpiled for the natural liner in the ICW cells. Granular material, rock, and gravels will be removed and used in the TMF cap.

7.3.2 Base and Embankment Preparation

As clays and subsoils are placed in the cell bases, they will be tracked and compacted to achieve the required permeability. Permeability will be verified through in-situ testing (e.g., Falling Head Tests), ensuring a maximum permeability of 1×10^{-8} m/s. If permeability standards are not met, reworking and retesting will be conducted.

Once the base preparation is complete, the topsoil layer (300mm) will be reintroduced to support wetland vegetation. This topsoil will remain uncompacted to promote vegetation establishment, biofilm formation, and ease of planting.

7.3.3 Final ICW Structure and Water Management

Each treatment cell will have an operational water depth of 150mm to 250mm, with the capacity to handle increased depths during high rainfall events. Embankments will have a minimum height of 1m to accommodate high precipitation and necromass accumulation. Cell slopes will have gradients between 1:1.5 and 1:2, while the upper embankments will be 4m wide where feasible, allowing for maintenance access.

Water flow between cells will be controlled via 300mm diameter interconnecting pipes, placed at the base of each cell. Adjustable bends on outlet pipes will allow water level regulation, while additional pipes or overflow structures will ensure stormwater management.

A minimum of 1000mm of compacted cohesive material will be placed at the base of each cell, with the upper 500mm achieving low permeability.

To enhance stability and biodiversity, embankments will be seeded with a mix of grass and wildflower species which will reduce erosion risks and contribute to biodiversity targets for the ICW.

7.3.4 Testing and Monitoring

Following construction, field permeability tests will be conducted to verify that the required permeability has been achieved across the wetland base and embankments. Surface and groundwater monitoring will be carried out to confirm that the ICW effectively manages mine-influenced water (MIW) while protecting both surface and groundwater sources.

7.3.5 Access and Site Maintenance

A well-planned access network is critical for maintenance and operational needs. The site will be accessible via existing roads to the north and northeast of the site. A 5m-wide major access road will run through the site to provide vehicular access to the high-voltage power line that crosses the area. Smaller 3.5m-wide access roads will ensure safe movement across the ICW, minimising risks to personnel.

7.3.6 ICW Water Levels and Management

The ICW system will accommodate fluctuations in hydraulic loading, ensuring stable through-flow and extended hydraulic retention, which will help minimise the occurrence of large flushes or plug flows discharging from the system.

Under normal operating conditions, the ICW will maintain a water depth of 150-250mm. However, deeper sections may be incorporated within Cell 1 and Cell 2, if required, to enhance the management of inflowing waters and provide aeration cascades.

Effective water level management is critical for the operation and maintenance of the ICW:

-
- Low water levels can stress wetland-dependent species, reducing treatment efficiency.
 - Excessively high-water levels may also compromise treatment performance, particularly during early plant establishment, when environmental stressors can hinder growth.

To address this, water levels will be manually adjustable via an adjustable elbow on the outlet of each treatment cell, allowing operators to raise or lower levels as needed to maintain optimal system function. Additionally, each treatment cell will be equipped with a water depth gauge to monitor water levels and ensure proper adjustments are made to maintain efficiency. These will provide flexibility in managing hydraulic loads while ensuring the long-term effectiveness of the ICW in treating inflowing waters.

7.3.7 Site Suitability Assessment for ICW

Site investigations and desk study findings conducted to evaluate the feasibility of an ICW at the proposed location to the south of the TSF. Assessments confirms that onsite materials are suitable for constructing the necessary embankments and natural liner. The native soils exhibit a maximum permeability of 1×10^{-8} m/s, providing the required barrier to exfiltrating waters.

Additional detailed assessments will be required to ensure full site characterisation and to support the final ICW design. The construction methodology will prioritise environmental efficiency by maximising the use of locally sourced materials where feasible. Imported soil or gravel will be used only where necessary, particularly for roadway surfacing.

This approach aligns with best practice environmental management and ensures regulatory compliance. Further assessments and design refinements will be undertaken in consultation with the relevant authorities to meet all applicable environmental standards.

BTM propose to construct and operate a full scale ICW during the operational phase of the TSF with final discharge from the ICW being pumped back into the active TSF.

7.4.7 DISCHARGE TO RIVER BLACKWATER

It is anticipated that the final discharge from the ICW will be directed towards the Blackwater River at the southeast corner of the site (Figure 7-3 refers). While the specific discharge characteristics are yet to be fully determined, the ICW is expected to provide a level of treatment that aligns with regulatory water quality standards. The system design will manage hydraulic flows effectively, allowing for gradual release and minimising the risk of sudden discharges.



FIGURE 7-3 POSSIBLE ROUTE TO THE RIVER BLACKWATER

7.5 DISCHARGE QUALITY AND FLOW MANAGEMENT

7.5.1 Pollutant Removal Efficiency

The proposed ICW at Randalstown is designed to effectively manage and treat contaminants in mine-influenced water through passive treatment processes. Initial findings from the BTM meso-scale ICW trial programme have demonstrated the effectiveness of ICWs in removing heavy metals and sulphates, with documented sulphate removal rates of 70–80%.

Additionally, operational data from the Galmoy Mines ICW confirms that a well-designed ICW can efficiently regulate hydraulic flows and reduce pollutant loads in through-flowing waters. These insights, along with site-specific water quality data, have informed the design and performance expectations for the ICW at Tara Mines.

7.5.2 Hydraulic Discharges

The capped TSF will generate an estimated 800,000 m³ of runoff per year, requiring effective treatment and discharge regulation. The ICW has been designed to accommodate seasonal variations in flow, following a pattern observed at similar facilities, including Galmoy Mines. Key hydraulic flow characteristics include:

- A 10% annual reduction in discharge volumes due to natural attenuation and retention.
- No discharge during summer months, as high evapotranspiration rates significantly reduce water output.
- A gradual recommencement of flows in autumn, typically in late September, as storage capacity is restored.

The ICW will be strategically positioned south of the TMF, serving as a buffer between the tailings facility and receiving surface waters, ensuring sustainable management of hydraulic discharges.

7.5.3 Water Quality Objectives and Regulatory Compliance

The ICW system has been designed to meet the water quality requirements set out by national and EU regulatory frameworks, including the Water Framework Directive and discharge limits outlined in IEL P0516-04. Key contaminants identified for treatment include zinc, manganese, sulphates, aluminium, lead, nickel, total ammonia, and suspended solids.

Baseline MIW concentrations have been determined through long-term monitoring efforts and expected post-treatment values have been projected based on the documented performance of similar passive treatment systems.

7.6 LONG TERM MONITORING AND MAINTENANCE PLAN

To ensure the ongoing effectiveness of the ICW, a structured monitoring and maintenance program will be implemented. Regular water quality monitoring will be carried out at multiple locations throughout the system to track contaminant levels, flow rates, and overall system performance. Vegetation health will also be assessed periodically to ensure that plant communities remain effective in contaminant uptake.

Maintenance and periodic inspections of the ICW system will be required and will primarily involve the removal of accumulated sediments, routine vegetation management, and inspections to identify and address potential system inefficiencies. There will be a need to supplement materials such as stone at inlet and outlet areas and materials to ensure upkeep and effective operation.

Given the passive nature of the treatment system, these interventions are expected to be infrequent and low-cost compared to traditional active treatment solutions:

- In Active Aftercare there will be requirements for routine checks and maintenance with possible supplement materials to ensure the upkeep and operation of the ICW.
- In Passive Aftercare (year 6 to 15) there will be a need to supplement materials such as stone for inlet and outlet areas and other materials as needed.
- While routine inspections will be required in Stable Aftercare period the design of the ICW is set-up to minimise maintenance. Any replanting of cells required plants can be obtained from cells within the system.

7.7 SUCCESS CRITERIA INDICATORS FOR AN ICW AT TSF

Key success criteria indicators include overall closure objectives and performance goals will be used for validation of effectiveness of the ICW.

Key success criteria for the ICW are presented in Table 7-4.

Table 7-4 Key Success Criteria

Aspect	Success Criteria Indicators
Water Quality and Treatment Efficiency	<ul style="list-style-type: none"> • Compliance with EPA Discharge limits for key contaminants (Zn, Pb, SO₄, Fe, Mn, pH, TSS) • Reduction in heavy metals and sulphates to meet acceptable water quality standards in surrounding waterbodies (river Blackwater) • Stable pH within neutral to slightly alkaline range (6.5 to 8.5) • Long-term monitoring data shows no increasing trend in contaminants
Hydrological Functionality and Wetland Stability	<ul style="list-style-type: none"> • Sustained water retention and flow-through capacity without excessive clogging, short-circuiting, or stagnant zones. • No seasonal waterlogging or excessive drying that would reduce treatment effectiveness. • No uncontrolled discharge pathways via groundwater seepage
Vegetation Health and Ecological Performance	<ul style="list-style-type: none"> • Successful establishment of wetland vegetation for contaminant uptake and natural filtration. • No significant die-off or invasive species dominance that could reduce treatment function. • Healthy presence of bio-indicator species (e.g., macroinvertebrates, amphibians, birds) within 5 years, showing ecological balance
Structural Integrity and Maintenance Requirements	<ul style="list-style-type: none"> • Substrate stability maintained - no significant erosion, subsidence, or sediment accumulation requiring frequent dredging • Flow control structures remain operational with no major repair needed in active aftercare • No major maintenance interventions - replanting, dredging required beyond planned maintenance in stable aftercare
Long-term Sustainability and Passive Operation	<ul style="list-style-type: none"> • No active chemical dosing required for pH control or metal precipitation such as lime addition. • Capacity to handle extreme weather events (drought, heavy rainfall) without system failure or excessive overflow.

Aspect	Success Criteria Indicators
	<ul style="list-style-type: none"> • Self-sustaining system with natural microbial and vegetative processes continuing to function effectively
<p>Regulatory Compliance and Monitoring Maintenance Requirements</p>	<ul style="list-style-type: none"> • No exceedances of discharge limits triggering enforcement actions or requiring active intervention. • On-site and downstream water quality monitoring data show stable or improving trends over 10+ years. • Wetland classified as "functionally effective" by independent review of monitoring data
<p>Integration into BTM Closure Plan and Stakeholder Acceptance</p>	<ul style="list-style-type: none"> • No unresolved concerns from community or environmental groups. • Potential for long-term beneficial use, such as habitat creation or integration into local water stewardship initiatives.

7.8 COSTINGS

Summary costs associated with the ICW design are presented in Table 10.7-1 and detailed in Table 7-3. Inspection and maintenance of the ICW during aftercare will be required with costing presented in Table 10.7-2.

Table 7-5 Provision of ICW Passive Treatment System

Item	Description	Costs €
1	Earthworks - ICW Cells	€1,072,116.43
<p>Excavation of sub-soils to design levels (cell 1-7), including temporary stockpiling of suitable material for reuse as cell base liner and planting medium.</p> <p>Placement of artificial liner on cell 1-2 bases and sloped embankments.</p> <p>Placement of clay soils in layers to cell base design levels and to form embankments, minimum 750mm clay layer on bases of cells 1-2 and 500mm clay layer on bases of cells 3-7, compacted to form stable embankment sides.</p>		

Item	Description	Costs €
2	Pipework and Manholes	€108,000.00
<p>Supply and installation of new 300mm diameter PVC pipe from pick up point to Cell 1 inlet</p> <p>Supply and installation of 300mm diameter uPVC inlet pipes between ICW cells and backfilled with excavated material to ensure seal</p> <p>Elbow on outlet points to control flows from ICW cells</p> <p>Supply and construction/installation of concrete manhole to connect gravity flow pipework between cells</p> <p>Supply and construction/installation of concrete manhole, 1200mm diameter at Cell 7 outlet with concrete base and rings, sealable cover with lockable lid, inlet pipe connection, out flow pipe connection, stainless steel V-notch plate</p> <p>Supply and installation of 300mm diameter uPVC outlet pipe from Cell 7 manhole to discharge point (existing surface water drain)</p>		
3	Testing equipment and telemetry	€4,900.00
<p>Conduct two no. falling head permeability tests in each of the ICW cells</p> <p>Supply and installation of water level gauge in ICW cells</p>		
4	Landscaping and signage	€528,522.00
<p>Supply and planting of ICW cells</p> <p>Parkland mix applied to side slopes of ICW cells, and ancillary areas</p> <p>Supply and installation of sampling point signs (A4) aluminium panel on galvanized poles with caps</p> <p>Supply and installation of cell number signs (A4) aluminium panel on galvanized poles with caps</p>		
5	Handover	€6,500.00
<p>Provide as-built survey in CAD format in accordance with Works Requirements</p> <p>Provide digital file of Progress Photographs taken throughout the works</p> <p>Provide Safety and Health File</p> <p>Handover site in demobilised, clean state free from construction materials and waste</p>		
Grand Total		€1,720,038.00

CHAPTER 8 AFTERCARE MANAGEMENT

8.1 INTRODUCTION

This chapter provides details on Aftercare Management Plan and long-term monitoring strategy following closure of facilities at the mine site and Tailings Storage Facility (TSF).

The closure of the mine and tailings storage facilities necessitates a robust aftercare management plan to ensure environmental stability, regulatory compliance, and long-term sustainability. The aftercare strategy and monitoring framework aims to mitigate risks, safeguard water quality, and maintain ecological balance post-closure.

The aftercare management plan is predominately associated with monitoring and assurance reporting to demonstrate the facilities are not having any impact on the environment. The data will act as an indicator of any additional improvement works that may be required.

Commencement of the aftercare management period is subject to the completion of an 'active closure period' which is envisaged to take 2 years following cessation of mining operations.

BTM will be responsible for 'aftercare' until the EPA accepts surrender of the IEL, as specified under Section 48 of the Waste Management Act, 1996 as amended.

BTM are committed to implementing progressive rehabilitation activities throughout the mine's operational life to reduce the final closure burden. The capping of Stages 5A at the Tailings Storage Facility is ongoing and associated with the operational phase of the TSF.

8.1.1 Objectives

The aftercare plan aims to:

- Ensure the long-term stability of the TSF and associated infrastructure.
- Protect surface and groundwater quality from residual contaminants.
- Restore and rehabilitate the surrounding environment to pre-mining conditions where possible.
- Monitor geotechnical stability to prevent failure or erosion.
- Comply with regulatory obligations and maintain public safety.

8.2 ACTIVE CLOSURE PERIOD

The 'closure period' following cessation of mining operations is envisaged to take 2 years and following that will move into an 'aftercare' period.

The physical decommissioning and removal of buildings and infrastructure on the mine site are expected to be complete within two years. One year following completion of tailings deposition capping of the tailings surface will commence.

During this active closure period environmental monitoring will continue as per IEL requirements with a gradual transition to a long term 'passive care' monitoring regime. Monitoring for the most part will be carried out by the Environmental Technician as part of the CRAMP project team. Monitoring data recorded during this closure period can be used to validate changes to the monitoring programme in aftercare with agreement from the EPA.

Annual surface subsidence measurements at the mine by precise will continue for 5 years through closure and into the aftercare period until sufficient data warrants a cessation of monitoring. Monitoring data will be reviewed by an external consultant and reported annually to Authorities. Stability monitoring at the TSF will be carried out in sections of the facility identified in Risk Assessment exercise conducted every 2two years.

During this closure period, as in operation, compliance reporting to Authorities will continue.

8.3 AFTERCARE PERIOD

'Aftercare' at the minesite is envisaged to take a minimum of 5 years (based on the experience at both Lisheen and Galmoy Mines).

The TSF will require a greater level of monitoring and aftercare management and has been divided into three distinct phases:

- **Active** Aftercare Monitoring and Management (5 years post closure phase)
- **Passive** Aftercare Monitoring and Management (10 years post Active Aftercare phase)
- **Stable** Aftercare Monitoring and Management (15 years post Passive Aftercare phase)

8.4 MINESITE AFTERCARE MANAGEMENT

Environmental Monitoring

In the 'closure' period environmental monitoring will continue as per IEL requirements with frequency reduced as 'aftercare' progresses. Monitoring will be carried out by the Environmental Technician as part of the CRAMP project team. Monitoring data recorded during the closure period can be used to validate changes to the monitoring programme in aftercare with agreement from the EPA.

Monitoring results will be compared with appropriate environmental quality standards as a basis for establishing performance of the overall closure activities.

The proposed Aftercare Monitoring programme is presented in Table 8-1 with associated costings presented in Tables 10.8-3 and 10.8-4.

Table 8-1 Mine Site Environmental Monitoring Programme

Monitoring	No. of locations	Monitoring Frequency
Return Air Raises	6	Bi-annual
Ambient Air	3	Monthly
Dust Deposition	6	Monthly
Surface Water Discharge – SW1	1	Weekly
Surface Water Discharge – SW1	1	Monthly
Surface Water - River samples	6	Monthly
Noise Monitoring	2	Continuous
Groundwater – Site Remediation	16	Annual
Groundwater Level Monitoring	15	High Frequency Acquisition (10-15 Minute)
Mine water inflows	All underground areas	Monthly
Mine Inflow quality	10	Bi-Annual
Rising Mine Water Levels	All underground areas	Monthly
Vibrating Wire Piezometers		Continuous
Surface Levelling Stations	96	Annual
Soil at ventilation shafts	16	Annual
Vegetation at ventilation shafts	16	Annual

Surface Settlement Monitoring

Annual surface subsidence measurements by precise levelling at 96 measurement stations will continue for 5 years through the closure period and into the aftercare period until sufficient data warrants a cessation of monitoring.

Monitoring results will be carried out by an external surveyor and reviewed by external consultant and reported annually to Authorities. When subsidence has trailed off as expected monitoring will be ceased, with a final report and dataset produced

Governance Reporting

Governance reporting will continue throughout aftercare. (Table 8-2 refers). Responsibility and costs associated with the EPA Annual Environmental Report will be borne by the Environmental Engineer and Annual Decommissioning Report divided between the CRAMP Project Manager and Environmental Engineer. Hydrology and geotechnical data review will be conducted by external consultants. Associated costs are presented in Table 10-3.3.

Table 8-2 Minesite Closure and Aftercare Governance Reporting

	Closure (2 years)	Aftercare (5 years)
EPA Annual Environmental Report	Annual	Annual
Mine Hydrology Report	Annual	Annual
Geotechnical Reporting	Annual	Annual
Decommissioning Report	Annual	Annual

8.5 TSF AFTERCARE MANAGEMENT

One year following completion of tailings deposition capping of the tailings surface will commence.

Environmental Monitoring at the TSF

Similar to the minesite environmental monitoring will be conducted in accordance with schedules within the current IEL throughout the 'closure' period (Table 8-3 refers). The monitoring programme, which includes the frequency of sampling, number of sampling

locations and suite of analytical parameters, will be adjusted as necessary subject to agreement from the EPA as aftercare progresses. Monitoring data recorded and feedback from statutory authorities will be used to justify changes to the monitoring programme. For some aspects, such as noise, monitoring will be completely phased out. Associated costings for environmental aftercare monitoring is presented in Tables 10.8-5 to 10.8-8.

The independent review of hydrogeological, hydrological and water quality monitoring data collected at the TSF will continue through to the stable aftercare phase.

Table 8-3 TSF Environmental Monitoring Programme

Monitoring	No. of locations	Monitoring Frequency
Ambient Air	3	Monthly
Dust Deposition	6	Monthly
Groundwater - Boreholes	34	Monthly
Groundwater – Domestic Wells	10	Quarterly
Surface Water - River samples	6	Monthly
Perimeter Interceptor Channel	4	Monthly
ICW - Inflow	1	Weekly
ICW - Outflow	1	Weekly
Noise Monitoring	2	Continuous
Groundwater – Site Remediation	16	Annual

Stability Monitoring at the TSF

Most of the measurement instruments at the TSF is automated, to include Casagrande and vibrating wire piezometers. These provide online real-time readings for all instruments with alarms set to signal any deviation from 'normal' operation. While manhole weir measurements and inclinometers are currently read manually BTM is progressing towards full automation of all critical instrumentation during the operational phase of the facility.

Instrumentation maintenance and calibration contracts are in place to ensure functionality and reliability of these systems. The integration of these technologies has reduced operational and maintenance costs while enhancing the accuracy and reliability of BTM's monitoring systems. Instrumentation maintenance and calibration service contracts are in place.

During closure and aftercare phases, stability monitoring will be carried out in sections of the facility identified in Risk Assessment exercise conducted every 2 years or in response to a change in Life of Mine. The TSF Stability monitoring programme is presented in Table 8-4 and will be reduced over time. There is provision for costs associated with instrumentation maintenance and calibration service in closure and aftercare periods.

Table 8-4 TSF Stability Monitoring Programme

TSF Stage	Monitoring	No. of locations	Monitoring Frequency
1 and 2	Casagrande Piezometers	11	Monthly
3	Casagrande Piezometers online measurements	6	Continuous
4A	Casagrande Piezometers online measurements	6	Continuous
	Vibrating Wire Piezometers online measurements	10	Continuous
	Deep Vibrating Wire Piezometers	3	Monthly
	Manhole Wier measurements	4	Quarterly
	Inclinometers	6	Bi-annual
4B	Casagrande Piezometers online measurements	6	Continuous
	Manhole Wier measurements	4	Quarterly
	Inclinometers	9	Bi-annual
5A	Vibrating Wire Piezometers online measurements	10	Continuous
	Casagrande Piezometers online measurements	6	Continuous
	Manhole Wier measurements	4	Quarterly
5B	Vibrating Wire Piezometers online measurements	10	Continuous
	Casagrande Piezometers online measurements	6	Continuous
	Manhole Wier measurements	4	Quarterly
6	Casagrande Piezometers online measurements	10	Continuous
All Stages	Settlement Monuments	5	Quarterly

TSF Inspections

Monitoring will also include routine inspections of:

- Downstream embankment walls for evidence of erosion, seepages, slope instability
- TSF internal drainage
- Surface drainage and outfall from decant spillway
- Integrity of vegetation cover on capped surfaces
- Perimeter Interceptor Channel – vegetation growth, blockages, pump malfunction
- Presence of Invasive Species

Maintenance of vegetation of the embankment will be required throughout aftercare and cost provision has been accounted for.

TSF Governance Reporting Requirements

During closure and aftercare phase, the TMF Project Engineer will carry out several key operations including data validations, inspections, database maintenance and record upkeep with external consultants conducting periodic reviews of the data.

As per IEL Schedule C.5 a Safety Evaluation of Existing Dam (SEED) audit should be carried out at a minimum frequency of every 15 years. However as a member of ICMM, BTM is committed to meeting requirements of GISTM, which requires a Dam Safety Review (DSR) be undertaken every 10 years. A SEED Audit is equivalent to a Dam Safety Review (DSR). A SEED audit will be carried out three times during the Aftercare Management period

Details of Governance Reporting to include Annual Performance Report, Hydrogeological Report and SEED audits are provided in Table 8-5 with associated costings in Table 10.3-3.

Table 8-5 TSF Governance Reporting Requirements

	Closure and Aftercare Period		
	Closure & Active Aftercare (7 years)	Passive Aftercare (10 years)	Stable Aftercare (15 years)
TMF Performance Report	Annual	Annual	Every 3 years
TMF Hydrogeological Report	Annual	Annual	Every 2 years
SEED Audit	Every 10 years Not requires in active aftercare	Every 10 years Once in passive aftercare	Every 10 Years twice in Stable aftercare

Integrated Constructed Wetland at the TSF

BTM plan to construct a Passive Treatment System (PTS), specifically an Integrated Constructed Wetland (ICW) to features to manage and treat water flows from TSF during its operational life

To ensure the ongoing effectiveness of the ICW, a structured monitoring and maintenance program will be implemented post closure of the TSF. Maintenance and periodic inspections will primarily involve the removal of accumulated sediments, routine vegetation management, and inspections to identify and address potential system inefficiencies. There will be a need to supplement materials such as stone at inlet and outlet areas and materials.

Given the passive nature of the treatment system, these interventions are expected to be infrequent and low-cost compared to traditional active treatment solutions:

- In Active Aftercare there will be requirements for routine checks and maintenance with possible supplement materials to ensure the upkeep and operation of the ICW.
- In Passive Aftercare (year 6 to 15) there will be a need to supplement materials such as stone for inlet and outlet areas and other materials as needed.
- Routine inspections will be required during the Stable Aftercare period; however, the ICW is designed to minimise maintenance. If replanting of cells is needed, plants can be sourced from within the system.

Costs associated with routine inspections and materials provision are presented in Table 10.7-2 while water quality monitoring costs are provided under the TSF environmental aftercare monitoring costings presented in Tables 10.8-5 to Tables 10.8-8.

8.6 SUCCESS CRITERIA

The aftercare management plan will be underpinned by a set of success criteria which will be used as framework for validation of closure and restoration performance. The long-term criteria for successful aftercare management are presented in Table 8-6.

Table 8-6 Long-term Criteria for Aftercare Management

Category	Success Criteria
Environmental Stability	<p><u>Water Quality Compliance</u> Groundwater and surface water meet regulatory standards consistently for at least five consecutive years.</p>
	<p><u>Erosion Control Effectiveness</u> No significant soil loss, slope failure, or structural failure of the TSF, validated through annual geotechnical assessments.</p>
	<p><u>Air Quality Standards</u> Dust emissions remain within permissible levels, with no exceedances reported for three consecutive years.</p>
Ecological Recovery	<p><u>Revegetation Coverage</u> >90% native plant survival rate within rehabilitated areas, with continuous vegetation growth.</p>
	<p><u>Wildlife Return</u> Return and sustained presence of key indicator species across multiple monitoring cycles.</p>
	<p><u>Soil Health</u> No residual contamination affecting plant growth, with soil nutrient levels comparable to pre-mining conditions.</p>
Regulatory and Community Acceptance	<p><u>Regulatory Compliance</u> No non-compliance notices or regulatory penalties issued over a ten-year period.</p>
	<p><u>Community Satisfaction / Acceptance</u> No unresolved community grievances, with stakeholder feedback indicating trust in monitoring and management efforts.</p>
Long-Term Structural Integrity	<p><u>TSF and Infrastructure Stability</u> No significant structural deformations or failures recorded in geotechnical surveys over a decade.</p>
	<p><u>Groundwater Flow Stabilisation</u> No unexpected fluctuations in groundwater levels that could indicate persistent contamination or subsidence.</p>
	<p><u>Long-Term Viability of Rehabilitation Measures</u> Adaptive management strategies successfully implemented to address any emerging post-closure issues.</p>

8.7 FINAL VALIDATION

Final validation is the conclusive phase of the aftercare management plan, ensuring that all environmental, structural, and social commitments have been successfully implemented and sustained over time. The validation process includes comprehensive performance assessments, regulatory audits, and stakeholder reviews before formal validation and closure sign-off.

BTM will be responsible for 'aftercare' until the EPA accepts surrender of the IEL, as specified under Section 48 of the Waste Management Act, 1996 as amended.

CHAPTER 9 FINANCIAL PROVISION

9.1 INTRODUCTION

This chapter describes the financial measures, funds and mechanisms provided for the closure, rehabilitation, restoration and aftercare of the Mine Site and Tailings Storage Facility.

Under Irish environmental law, the EPA require licensees to make adequate financial provision to manage potential environmental liabilities which may occur as a result of their 'licensed activities'. Financial Provision requires putting in place a financial instrument to cover:

- the full cost of responding to and remedial measures if an incident occurs; and
- the costs of closure/decommissioning/restoration/aftercare/management

9.2 ENVIRONMENTAL LIABILITY

Environmental liabilities are sub-divided into two categories: 'unknown' and 'known' liabilities'.

- The **unknown liabilities** are defined as the risk of environmental liabilities occurring due to unexpected events. Unknown liabilities are quantified by means of an Environmental Liabilities Risk Assessment (ELRA).
- The **known liabilities** are defined as the planned or anticipated liabilities associated with closure, restoration and aftercare management of the site. Known liabilities are quantified by means of a Closure, Restoration and Aftercare Management Plan (CRAMP).

9.3 UNKNOWN LIABILITIES

Unknown liabilities, quantified by means of an ELRA, consider the risk of unplanned events occurring during the operation of a facility that could result in unknown liabilities. In accordance with IEL Condition 12.2.2, BTM have undertaken a comprehensive and fully costed ELRA to accord with EPA Guidance on *Assessing and Costing Environmental Liabilities (2015)* and the additional *Guidance on Environmental Impairment Liability Insurance (2017)*.

The ELRA, undertaken by an independent and appropriate qualified consultant using the recommended 'risk management approach', addresses liabilities from both past and present activities and costings identified for executing the CRAMP.

9.3.1 Environmental Impairment Liability Insurance

BTM achieves its financial provision obligations with respect to environmental liabilities through the *Environmental Impairment Liability Insurance* mechanism, which meets the requirements of Section 4.6 of the Financial Provision Guide.

9.4 KNOWN LIABILITIES

This CRAMP document has been prepared to meet EPA IEL Conditions 10.2.1 (closure plan) and 12.3.1 (financial provision) and in accordance with EPA Guidance documents for known liabilities at closure.

9.4.1 Enforced Early Closure

Upon closure of operations, planned or in the event of an unplanned /unexpected / abandonment closure scenario the CRAMP will be initiated and a CRAMP Project Team established. Details of the CRAMP project team to include defined roles and responsibilities for implementation and compliance with requirements under CRAMP are presented in Chapter 3 *CRAMP Implementation* with associated costings in Chapter 10.

9.4.2 Short term or Temporary Closure

An unplanned / unexpected closure is short term or temporary in nature (period up to 12 months) and comparable to a full 'Care and Maintenance' situation. It is envisaged that such an event (unplanned / unexpected closure) may occur as a result of one or several of the following:

- Low commodity prices
- Increased external production costs
- Increased energy costs
- Market factors outside of Company control
- Industrial relation issues

During temporary cessation of works (as in 2001/2002 and more recently in 2023/2024) the mine will operate on a “full care and maintenance” basis, whereby the mine continues to operate, however it does not undertake ore extraction or produce ore concentrate. Emissions, control and environmental monitoring will continue as specified in conditions and schedules of most recent Industrial Emissions License. In the event of a short term or temporary closure financial operating costs will be borne by the parent Company (Boliden AB).

9.5 FINANCIAL PROVISION (FP) INSTRUMENTS

FP requires putting in place a ‘financial instrument’ to cover costs associated with implementing the CRAMP. There are a number of mechanisms available for making a FP: secured fund; on-demand performance bond; parent company guarantee; charge on property and/or insurance.

BTM have separate financial instruments in place for ELRA and CRAMP.

9.5.1 Financial Provision Instrument - ELRA

The EPA have approved the FP for the ELRA by way of a bond (*LS Approval Notice on 11.11.2021*). This bond terminates on the expiry date of 31/12/2030.

9.5.2 Financial Provision Instrument - CRAMP

BTM have an established and appropriate FP sufficient to underwrite the current CRAMP. The existing financial instrument is by means of a cash deposit (held by MCC with a current value €14.8 million) and a Bank Guaranteed Bond (Danske Bank).

It is proposed that a Bond approved instrument¹ be put in place that will cover the FP of the updated CRAMP in agreement with the three statutory Agencies (EPA, MCC and DECC) prior to its implementation.

¹ Based on the EPA template for Financial Provision.

9.6 FINANCIAL PROVISION

BTM have appropriate FP in place to cover identified known and unknown environmental liabilities.

The estimated cost of unknown liabilities relating to operational activities (Worst Case Scenario – Major Dam Breach), including contingency, is €12,514,062.

The financial provision for CRAMP (updated in August 2024 to include agreed contingency) is €23,305,814.30.

9.6.1 Contingency

In November 2016, following a review of the CRAMP by the key statutory agencies (EPA, MCC and DECC) and a subsequent request to provide contingencies considering the stage/development of the CRAMP at that time, BTM applied the following contingencies:

- 10% to the closure decommissioning and reclamation of the mine and mine site infrastructure;
- 33% to the closure decommissioning and reclamation including provision of the passive treatment system (PTS) of the tailings management facility (TMF); and
- 10% contingency added to the Aftercare, Monitoring and Maintenance

These level of contingencies (agreed by the statutory Agencies) are applied in this CRAMP.

CHAPTER 10 COSTINGS

10.1 INTRODUCTION

This chapter deals with the costings associated with implementing the CRAMP. In 2024 a review to reflect existing conditions was conducted with 2024 market industry rates (obtained from a third party contractor/quantity surveyor) to all costings associated with closure and aftercare activities applied.

Under a scenario where the site is deemed to have fully terminated operations, the CRAMP will be implemented in full, in consultation with the key statutory authorities (EPA, MCC and DECC) and other key stakeholders. BTM will seek to draw down on the financial provision set aside for this event.

10.1.1 Responsibility

*The overall responsibility and management of CRAMP in the event of closure will be undertaken by the **Boliden Group**. Responsibility during Closure and Aftercare Management including financial management, environmental management, all decontamination procedures, decommissioning operations and residuals management, as required under CRAMP will be authorised by the Boliden Group.”*

Costings associated with CRAMP implementation is separated into the following components:

- CRAMP Implementation;
- Knockumber surface site decommissioning and restoration;
- Underground decommissioning
- TSF Rehabilitation and Restoration
- Passive Treatment System
- Aftercare Management

For ease of update following the annual review process in line with IEL conditions or significant change in the operational process, permitted activities, major emission points etc. all costs associated with the various phases/components of closure have been numbered as per their respective chapter in this document:

- Costings associated with closure activities described in Chapter 3 *CRAMP Implementation*, are presented in Section 10.3;
- Costings associated with closure activities described in Chapter 4 *Knockumber Surface Site Decommissioning Programme*, are presented in Section 10.4 with further details in Appendix 4-1;
- Costings associated with closure activities described in Chapter 5 *Underground Decommissioning*, are presented in Section 10.5;
- Costings associated with closure activities described in Chapter 6 *Tailings Storage Facility (TSF) Rehabilitation and Restoration*, are presented in Section 10.6;
- Costings associated with closure activities described in Chapter 7 *Passive Treatment System*, are presented in Section 10.7;
- Costings associated with closure activities described in Chapter 8, *Aftercare Management*, are presented in Section 10.8; and
- Total closure costings of mine site and TSF facilities are presented in Section 10.9.

10.2 CONTINGENCY

In November 2016, following a review of the CRAMP by the key statutory agencies (EPA, MCC, DECC) BTM were requested to provide/apply the following contingencies:

- 10% to the closure decommissioning and reclamation of the mine and mine site infrastructure;
- 33% to the closure decommissioning and reclamation including provision of the passive treatment system (PTS) of the tailings management facility (TMF); and
- 10% contingency added to the Aftercare, Monitoring and Maintenance

These levels of contingencies are applied in this CRAMP.

10.3 COSTINGS FOR CRAMP IMPLEMENTATION (CRAMP CHAPTER 3)

BTM will provide and ensure adequate resources are secured and available for successful closure to include financial provision and a dedicated CRAMP project team. The Project team will consist of the following personnel with defined roles and responsibilities for implementation and compliance with requirements under CRAMP:

- CRAMP Project Manager
- Environmental Engineer
- Environmental Technician
- Project Engineer at TMF

Each position will be engaged on a fulltime basis during the initial 2-year 'closure' period and transition to a reduced workload throughout the 'aftercare management' period. A consulting engineer will be retained for 'stable' aftercare phase at the TMF (spanning years 16 - 30).

Table 10.3-1 CRAMP Implementation personnel costings

Item	Annual Cost (€)	Total (€)
Closure Phase (Years 0-2)		
CRAMP Project Manager	€ 80,000	€ 160,000
Environmental Engineer	€ 50,000	€ 100,000
Environmental Technician	€ 35,000	€ 70,000
Project Engineer at the TSF	€ 60,000	€ 120,000
Total Closure Phase		€ 450,000
Active Aftercare (5 Years)		
CRAMP Project Manager	€ 32,000	€ 160,000
Environmental Engineer	€ 20,000	€ 100,000
Environmental Technician	€ 7,000	€ 35,000
Project Engineer at the TSF	€ 24,000	€ 120,000
Total Active Aftercare		€ 415,000
Passive Aftercare (10 years)		
CRAMP Project Manager	€ 16,000	€ 160,000
Environmental Engineer	€ 10,000	€ 100,000
Project Engineer at the TSF	€ 12,000	€ 120,000
Total Passive Aftercare		€ 380,000
Stable Aftercare (15 years)		
Consulting Engineer	€ 15,000	€ 225,000
Total Passive Aftercare		€ 225,000
TOTAL		€1, 470,000.00
Cost € Including EPA requested Contingency		€1, 617,000.00

Independent review of all hydrology, hydrogeology and geotechnical data will be conducted by external consultants. Governance/compliance reporting to statutory agencies will be ongoing through closure and aftercare management phases. Provision for governance reporting is presented in Tables 10.3-2 and 10.3-3.

Table 10.3-2 Costings for Minesite Closure and Aftercare Governance Reporting

Item	Frequency	Annual Cost (€)	Period Total (€)
Closure (2 Years)			
EPA Annual Environmental Report	Annual	-	-
Mine Hydrology Report	Annual	€10,000	€20,000
Geotechnical Reporting	Annual	€8,000	€16,000
Decommissioning Report	Annual	-	-
Total Closure Phase			€36,000
Aftercare (5 Years)			
EPA Annual Environmental Report	Annual	-	-
Mine Hydrology Report	Annual	€10,000	€50,000
Geotechnical Reporting	Annual	€8,000	€40,000
Decommissioning Report	Annual	-	-
Total Aftercare Period			€90,000
TOTAL			€126,000.00
Cost € Including EPA requested Contingency			€138,600.00

Table 10.3-3 Costings for Tailings Storage Facility Closure and Aftercare Governance Reporting

Costings for TMF Closure and Aftercare Governance Reporting									
Period	Closure and Active Aftercare Management (7 years)			Passive Aftercare Management (10 years)			Stable Aftercare Management (15 years)		
Item	Frequency	Annual Cost (€)	Total (€)	Frequency	Annual Cost (€)	Total (€)	Frequency	Annual Cost (€)	Total (€)
TMF Performance Report	Annual	5,000	35,000	Annual	5,000	50,000	every 2 years	5,000	40,000
TMF Hydrogeological Report	Annual	4,000	28,000	Annual	4,000	40,000	every 2 years	4,000	32,000
SEED Audit	Not required			Every 10 years	75,000	75,000	Every 10 years	75,000	150,000
Period Total	€63,000			€165,000			€222,000		
Total Costings for TMF Closure and Aftercare Governance Reporting							€450,000.00		

10.4 COSTINGS FOR MINESITE DECOMMISSIONING AND RESTORATION PROGRAMME (CRAMP CHAPTER 4)

The Knockumber Minesite Surface Decommissioning Programme will be undertaken in a scheduled manner and broken-down into the following stages;

- Decontamination of infrastructure
- Building / infrastructure dismantle and disposal
- Site works, levelling, backfilling, and disposal
- Site remediation and return to a suitable land for future use.

The cost of decommissioning site buildings to include dismantle and soft strip-out is presented in Table 10.4-2 with assets (fixed plant / machinery and equipment) set at cost neutral (as requested by EPA). A detailed breakdown of building/infrastructure elements and associated costs are presented in Appendix 4-1.

Costs to decommission site infrastructure and remediate the site to are presented in Tables 10.4-1 and 10.4-3 respectively.

A summary of costings for the Knockumber Site Decommissioning Programme to include 10% contingency agreed with the EPA in 2016 in Table 10-4.4.

Table 10.4-1 Decommissioning Site Infrastructure

Item	Total 2024 Costs (€)
Roads	€142,077.60
Car parks, hardstanding	€373,460.00
Water Management Ponds	€150,157.80
Screening berms	€482,023.10
Buried Pipelines	€1,309,615.80
Mine shafts and ventilation raises	€511,776.00
Perimeter fencing	€55,770.00
Total Decommissioning Site Infrastructure Costs	€3,024,880.30

Table 10.4-2 Decommissioning Site Buildings

Item	Total 2024 Costs (€)
Building Components	€2,575,350.20
Soft Strip-out	€219,000.00
Fixed Plant / Machinery / Equipment (Cost Neutral)	€0
Total Decommissioning Site Buildings Costs	€2,794,350.20

Table 10.4-3 Site Remediation / Reclamation to Agricultural End-Use

Item	Total 2024 Costs (€)
Drainage Geo-composite (2024 rate of €4.88/m ²)	€244,000.00
Protective Geotextile (2024 rate of €2.30/m ²)	€115,000.00
Handling of soil available on site (2024 rate of €3.50/m ³)	€367,500.00
Subsoil Importation (2024 handling rate of €3.50/m ³)	€507,500.00
Reseeding of 50 Ha (2024 rate of €674/ ha)	€33,700.00
Total Site Remediation Costs	€1,267,750.00

Table 10.4-4 Site Decommissioning Programme Summary Costs

Item	Total 2024 Costs (€)
Site preparation {Decommissioning site infrastructure }	€3,024,880.30
Demolition/decommissioning of site infrastructure	€2,794,350.20
Site Remediation	€1,267,770.00
TOTAL DECOMMISSIONING COSTS	€7,086,980.50
Cost € Including EPA requested Contingency	€7,795,678.55

10.5 COSTINGS FOR UNDERGROUND DECOMMISSIONING PROGRAMME (CRAMP CHAPTER 5)

Closure of the underground mine following cessation of mining operations includes:

- decommissioning of underground plant, equipment, services and all associated elements;
- backfilling, geotechnical (structural stability) and post closure settlement;
- existing and post-closure hydrogeological conditions and mine rewatering; and
- decommissioning of mine ventilation systems and shafts.

Underground workings are progressively backfilled as mine development works advance. Therefore, the extent of post closure decommissioning is relatively limited. Progressive decommissioning is incorporated into the mine design, which significantly reduces the requirements of final decommissioning and restoration of underground workings.

Other closure activities include environmental and surface settlement monitoring; governance reporting; decommissioning and backfilling of mine ventilation shaft and raise backfilling; water pumping; ventilation; and updating Soil and Groundwater Baseline Report.

Costs in relation to decommissioning mine shafts and raises (surface plug and backfilling) are presented in Tables 10.5-1 and 10.5-2 respectively are included in the overall costings of the mine site closure and aftercare management (Table 10.8-1 refers) .

Costs associated with closure and aftercare management to include environmental and stability monitoring are presented in Tables 10.8-3 and 10.8-4.

Table 10.5-1 Cost associated with Decommissioning Mine Shafts and Raises

Item	Rate (2024)	Cost (2024)
Mine Shafts	€216.00	€27,216.00
Mine Portals	€216.00	€23,976.00
Fresh Air Raise	€216.00	€73,224.00
Return Air Raise	€216.00	€140,400.00
TOTAL		€264,816.00

Table 10.5-2 Cost associated with Backfilling around Ventilation Raises

Item	Volume (m ³)	Rate (2024)	Total Cost
RAR No. 3 N and S - Kells Road	8,800	€3.50	€30,800.00
FAR No. 2 Magazine	3,750	€3.50	€13,125.00
RAR 6	58,010	€3.50	€203,035.00
TOTAL			€246,960.00
Total Costs associated with Decommissioning Shafts and Raises			€511,776.00
Cost € Including EPA requested Contingency			€562,953.60

10.6 COSTINGS FOR TAILINGS STORAGE FACILITY (TSF) REHABILITATION AND RESTORATION (CRAMP CHAPTER 6)

A summary of the closure and restoration costs of the TSF to include provision for Passive Treatment System and 33% contingency are presented in Table 10.6-5 with engineering costs associated with capping and revegetating the tailings surface in Tables 10.6-1 to 10.6-4.

Progressive rehabilitation of TSF is ongoing (20 hectares of Stage 5A North). This aside from a mechanism of trialling rehabilitation techniques will allow for monitoring over extended periods and act as a test programme to demonstrate the successful implementation of the rehabilitation plan before active closure begins.

Table 10.6-1 Engineering Costs for Capping and ancillary works TSF Stage 5

Item Description	Unit	Quantity	Rate	2024 Cost (€)
Capping				
Access Rock for Road (Available on site)	€/m ³	59,000	€3.75	€221,250
Soil placement (500mm Cap)	€/m ³	610,000	€3.50	€2,135,000
Soil for hedgerows/ridges (available on site)	€/m ³	15,500	€3.50	€54,250
Combi Grid	€/m ²	96,000	€3.50	€336,000
Gravel Drains	€/m	13,000	€3.50	€45,500
Pipe work 300mm	€/m	2,400	€6.00	€14,400
Pipe work 200mm	€/m	10,400	€4.50	€46,800
Sub Total				€ 2,853,200

Item Description	Unit	Quantity	Rate	2024 Cost (€)
Ancillary Works				
Spillway, Cascade and Stilling Basin	€	1	€ 100,000	€ 100,000
Pipe to Blackwater	€ / m	1580	€ 98.00	€154,840
Interceptor Channel Grouting				€300,000
Sub Total				€554,840
Total				€ 3,408,040.00

Table 10.6-2 Engineering Costs for Capping and ancillary works TSF Stage 6

Item Description	Unit	Quantity	Rate	2024 Cost (€)
Capping				
Access Rock for Road (Available on site)	€/m ³	43,560	€ 3.75	€ 163,350
Capping Soil (placement costs with 500mm cap)	€/m ³	290,000	€ 3.50	€ 1,015,000
Hedgerow Soil ridges (Available on site)	€/m ³	12,766	€ 3.50	€ 44,681
Combi-grid	€/m ²	54,450	€3.50	€ 190,575
Peagravel Drains	€/m	1,490	€3.50	€ 5,215
Pipework 200mm	€/m	8,240	€4.50	€ 37,080
Sub Total				€ 1,455,901
Ancillary Works				
Spillway, Cascade and Stilling Basin	€	1	100,000	€ 100,000
Total				€ 1,555,901.00

Table 10.6-3 Revegetation for TSF Stage 5

Stage 5 TMF Capping Area and Dam Wall Downstream Slopes			
Description	Quantity	Rate	2024 Cost (€)
Pasture (100% cap)	142 hectares	€ 675 / ha	€ 95,850
Hedgerows	12,900 lin. / m	€ 7.60 / lin./m	€ 98,040
Stock proof fencing	12,000 lin./m	€ 4.60 / lin./m	€ 55,200
Terrace woodland	20,800 transplants	€ 3.60 / transplant	€ 72,000
	500 feathers	€ 30 / feather	€ 15,000
Total			€ 336,090.00

Table 10.6-4 Revegetation for TSF Stage 5

Stage 6 TMF Capping Area and Dam Wall Downstream Slopes			
Item Description	Quantity	Rate	2024 Cost (€)
Pasture (100% cap)	58 hectares	€ 675 / ha	€ 39,150
Hedgerows	7,092 lin./m	€ 7.60 / lin./m	€ 53,900
Stock proof fencing	14,184 lin./m	€ 4.60 / lin./m	€ 65,246
Terrace woodland	19,400 transplants	€ 3.60 / transplant	€ 69,840
	405 feathers	€ 30 / feather	€ 12,150
Total			€240,286.00

Table 10.6-5 Closure and Remediation of the Tailings Storage Facility

Item	Total 2024 Cost (€)
Engineering Cost for Capping and Ancillary works Stage 5	€ 3,408,040.00
Engineering Cost for Capping and Ancillary works Stage 6	€ 1,555,901.00
Revegetation Cost Estimate for Stage 5 TMF Closure	€ 336,090.00
Revegetation Cost Estimate for Stage 6 TMF Closure	€240,286.00
ICW Passive Treatment System Coat Estimates	€ 1,720,038.43
Total Costs associated with Closure of TSF	€7,260,355.43
Cost € Including EPA requested Contingency	€9,656,272.72

Costings for restoration of 24 ha of the Simonstown Borrow Pit area (11.5 ha complete) are provided in table 10.6-6 below and included in the Table 10.8-2 Summary of TSF Closure and Aftercare Costs.

Table 10.6-6 Rehabilitation of Simonstown Borrow Area

Item Description	Quantity	Rate	2024 Cost (€)
Soil placement (350 mm cover)	84,000 m ³	3.50 €/m ³	€294,000
Pasture (100% cap)	24 hectares	€ 675 / ha	€16,200
Hedgerows	2,935 / m	€ 7.60 / lin./m	€22,306
Stock proof fencing	4,965 lin./m	€ 4.60 / lin./m	€22,839
TOTAL			€355,345.00
Cost € Including EPA requested Contingency			€390,879.50

10.7 COSTINGS FOR PASSIVE TREATMETN SYSTEM (CRAMP CHAPTER 7)

Following years of operational experience with meso-scale Integrated Constructed Wetlands (ICW) trials of a passive treatment system designed by VESI, coupled with the successful outcomes observed with similar ICW treatments at Galmoy, BTM have determined that the ICW system as the most sustainable passive treatment system for addressing the treatment and management needs of drainage from the TSF. Summary costs associated with the ICW design are presented in Table 10.7-1 and detailed in Chapter 7.

Routine inspection, maintenance and provision of supplement materials to ensure the upkeep and operation of the ICW system will be required through aftercare. Given the passive nature of the treatment system, these interventions are expected to be infrequent and low-cost compared to traditional active treatment solutions. The cost for routine inspection and materials provision in Aftercare are presented in Table 10.7-3.

Table 10.7-1 Provision of ICW Passive Water Treatment System at the TSF

Item	Description	Price
1	Earthworks - ICW Cells	€1,072,116.43
2	Pipework and manholes	€108,000.00
3	Testing equipment and telemetry	€4,900.00
4	Landscaping and signage	€528,522.00
5	Handover	€6,500.00
TOTAL		€1,720,038.43
Cost € Including 33% EPA requested Contingency		€2,287,651.11

Table 10.7-2 ICW Passive Water Treatment System Aftercare Maintenance Costs

Item	Frequency	Cost (€)	Total (€)
Active Aftercare (Years 6 to 15)			
Inspection and Maintenance	Annually	12,000	€ 60,000
Materials	Year 3	5,000	
	Year 5	15,000	€ 20,000
SubTotal			€ 80,000
Passive Aftercare (Years 6 to 15)			
Inspection and Maintenance	Annually	10,000	€ 100,000

Item	Frequency	Cost (€)	Total (€)
Materials	Year 8	15,000	
	Year 11	35,000	
	Year 15	5,000	€ 65,000
SubTotal			€ 165,000
Stable Aftercare (Years 16 to 30)			
Inspection and Maintenance	Annually	5,000	€ 75,000
Materials	Year 18	5,000	
	Year 21	15,000	
	Year 25	5,000	
	Year 28	5,000	€ 35,000
SubTotal			€ 110,000
TOTAL costs associated with ICW Aftercare			€ 355,000.00
Cost € Including EPA requested Contingency			€ 390,500.00

10.8 COSTINGS FOR AFTERCARE MANAGEMENT (CRAMP CHAPTER 8)

The 'Aftercare' period for the Knockumber mine site is envisaged to take 5 years while 'Aftercare' of the at the TSF is divided into three distinct phases:

- Active Aftercare Monitoring and Management (5 years post closure phase)
- Passive Aftercare Monitoring and Management (10 years post Active Aftercare phase)
- Stable Aftercare Monitoring and Management (15 years post Passive Aftercare phase).

A summary of Total Costings for the Closure and Aftercare Management and Monitoring of the Knockumber Minesite and the TSF are presented in Tables 10.8-1 and 10.8-2 respectively and detailed in Chapter 8.

In the 'closure' period environmental monitoring will continue as per IEL requirements with frequency reduced as 'aftercare' progresses. Monitoring will be carried out by the Environmental Technician as part of the CRAMP project team. Monitoring data recorded during the closure period can be used to validate changes to the monitoring programme in aftercare with agreement from the EPA. Costings associated with each phase of closure and aftercare monitoring and maintenance are presented in Tables 10.8-3 to 10.8-7.

Table 10.8-1 Summary of Closure and Aftercare Costs for Knockumber Minesite

Closure and Aftercare Monitoring and Maintenance	Total 2024 Costs (€)	Cost € including EPA requested Contingency
Minesite Closure (0-2 years)	€86,010.72	€94,611.79
Minesite Aftercare (5 years)	€129,416.80	€142,358.48
CRAMP Project Team	€1,470,000.00	€1,617,000.00
Soil and Groundwater Baseline Report	€30,000.00	€33,000.00
Electricity (water pumping, ventilation, miscellaneous)	€1,000,000.00	€1,100,000.00
Governance Reporting	€126,000.00	€138,600.00
Mineshafts, ventilation raises and backfilling	€511,776.00	€562,953.60
TOTAL	€3,353,203.52	€3,688,523.87
Total Cost € including EPA requested Contingency		€3,688,523.87

Table 10.8-2 Summary of TSF Closure and Aftercare Costs

Closure and Aftercare Monitoring and Maintenance	Total 2024 Costs (€)	Cost € including EPA requested Contingency
TMF Closure (0-2 years)	€73,543.44	€80,897.78
TMF Active Aftercare (5 years)	€163,495.70	€179,845.27
TMF Passive Aftercare (10 years)	€139,614.60	€153,576.06
TMF Stable Aftercare (15 years)	€81,257.60	€89,383.36
Governance Reporting	€450,000.00	€495,000.00
ICW Passive Treatment System Maintenance	€355,000.00	€390,500.00
Rehabilitation Simonstown borrow area	€355,345.00	€390,879.50
EPA Enforcement Costs	€200,000.00	€220,000.00
Public Liability Insurance	€150,000.00	€165,000.00
Total Cost € including EPA requested Contingency	€1,968,256.34	€2,165,081.97

Table 10.8-3 Minesite Environmental Monitoring Closure Costs (Years 0 to 2)

Monitoring	Monitoring Frequency	Monitoring / Laboratory Costs	Costs / year	Cost in Closure Period
Atmospheric Monitoring				
Return Air Raises (6 locations)	Bi-annual	€4,200.00	€8,800.00	€17,600.00
Ambient Air (3 locations)	Monthly	€30.00	€1,080.00	€2,160.00
Dust Deposition (6 locations)	Monthly	€30.00	€2,160.00	€4,320.00
Surface Water Discharge Points				
River Boyne (SW1)	Weekly	€122.00	€6,344.00	€12,688.00
River Blackwater (SW2)	Monthly	€86.00	€1,032.00	€2,064.00
Noise Monitoring				
Noise Stations (2 stations)	Continuous		€3,000.00	€6,000.00
Groundwater Monitoring				
Site Remediation Boreholes (16 locations)	Annual	€360.00	€5,750.00	€11,500.00
Groundwater levels		CRAMP project team		
Mine water Inflows				
All underground areas	Monthly	CRAMP project team		
Inflow Quality mentioning (10 locations)	Bi-annual	€86.00	€1,720.00	€3,440.00
Rising mine water levels				
All underground areas	Monthly	CRAMP project team		
Vibrating Wire Piezometers	Continuous	CRAMP project team		
Surface Settlement Monitoring				
Surface levelling Stations (96 locations)	Annual	€500/day x 15 days	€7,500.00	€15,000.00

Monitoring	Monitoring Frequency	Monitoring / Laboratory Costs	Costs / year	Cost in Closure Period
Surface Water Monitoring				
River samples (6 locations)	Monthly	€48.03	€2,305.44	€4,610.88
River samples (6 locations)	Quarterly	€98.08	€2,353.92	€4,707.84
Soil & vegetation				
Soil - ventilation shafts (16 locations)	Annual	€28.00	€448.00	€896.00
Vegetation - ventilation shafts (16 locations)	Annual	€32.00	€512.00	€1,024.00
TOTAL				€86,010.72

Table 10.8-4 Minesite Environmental Monitoring Aftercare Costs (5 Years)

Monitoring	Monitoring Frequency	Monitoring / Laboratory Costs	Costs / year	Cost in Closure Period
Atmospheric Monitoring				
Ambient Air (3 locations)	Monthly	€30.00	€1,080.00	€5,400.00
Dust Deposition (6 locations)	Monthly	€30.00	€2,160.00	€10,800.00
Surface Water Discharge				
River Boyne (SW1)	Continuous / monthly	€122.00	€6,344.00	€31,700.00
Noise Monitoring				
Noise Stations (2 stations)	Year 1		€3,000.00	€3,000.00
Groundwater Monitoring				
Site Remediation Boreholes (16 locations)	Years 2 and 5	€360.00	€5,750.00	€11,500.00

Monitoring	Monitoring Frequency	Monitoring / Laboratory Costs	Costs / year	Cost in Closure Period
Groundwater levels		CRAMP project team		
Mine water Inflows				
All underground areas	Monthly	CRAMP project team		
Inflow Quality monitoring (5 locations)	Bi-annual	€86.00	€860.00	€4,300.00
Rising mine water levels				
All underground areas	Monthly	CRAMP project team		
Vibrating Wire Piezometers	Continuous	CRAMP project team		
Surface Settlement Monitoring				
Surface levelling Stations (96 locations)	Annual (Years 1 to 3)	€500/day x 15 days	€7,500.00	€22,500.00
Surface Water Monitoring				
River samples (6 locations)	Monthly	€48.03	€3,485.16	€17,290.80
River samples (6 locations)	Quarterly	€98.08	€1,201.20	€6,006.00
Soil & vegetation				
Soil - ventilation shafts (16 locations)	Year 2 and 4	€28.00	€448.00	€896.00
Vegetation - ventilation shafts (16 locations)	Year 2 and 4	€32.00	€512.00	€1,024.00
River Sediment Sampling				
River Boyne and Blackwater	Year 2	€5,000.00	€10,000.00	€10,000.00
River Boyne	Year 5	€5,000.00		€5,000.00
			TOTAL	€129,416.80

Table 10.8-5 TSF Environmental Monitoring Closure Costs (2 years)

Monitoring	Monitoring Frequency	Monitoring / Laboratory Costs	Costs / year	Cost in Closure Period
Atmospheric Monitoring				
Ambient Air (3 locations)	Monthly	€30.00	€1,080.00	€3,160.00
Dust Deposition (6 locations)	Monthly	€30.00	€2,160.00	€4,320.00
Groundwater Monitoring				
Boreholes (34 locations)	Monthly	€16.87	€4,588.64	€9,177.28
Boreholes (34 locations)	Quarterly	€71.07	€9,665.52	€19,331.04
Domestic wells (10 locations)	Quarterly	€71.07	€2,558.52	€5,117.04
Surface Water Monitoring				
River samples (6 locations)	Monthly	€48.03	€2,305.44	€4,610.88
River samples (6 locations)	Quarterly	€98.08	€2,353.92	€4,707.84
Interceptor Channel (4 locations)	Monthly	€18.42	€589.44	€1,178.88
Interceptor Channel (4 locations)	Quarterly	€63.44	€1,015.04	€2,030.08
Noise Monitoring				
Noise Station - Maintenance Contract	Continuous	External Contract	€1,500.00	€1,500.00
Effectiveness of PTS				
Inflow and Outflow	Weekly	€50.05	€5,205.20	€10,410.40
Stability Monitoring				
Instrumentation Maintenance	Annual Charge	€2,000.00	€2,000.00	€4,000.00
Instrumentation Calibration	Annual Charge	€2,000.00	€2,000.00	€4,000.00

Monitoring	Monitoring Frequency	Monitoring / Laboratory Costs	Costs / year	Cost in Closure Period
			TOTAL	€73,543.44

Table 10.8-6 TMF Environmental Monitoring Active Aftercare Costs (5 years)

Monitoring	Monitoring Frequency	Monitoring / Laboratory Costs	Costs / year	Cost in Active Aftercare Period
Atmospheric Monitoring				
Ambient Air (3 locations)	Monthly	€30.00	€1,080.00	€5,400.00
Dust Deposition (6 locations)	Monthly	€30.00	€2,160.00	€10,800.00
Groundwater Monitoring				
Boreholes (34 locations)	Monthly	€16.87	€5,735.80	€28,679.00
Boreholes (34 locations)	Bi-annual	€71.07	€4,832.76	€24,163.80
Domestic wells (9 locations)	Bi-annual	€71.07	€1,279.26	€6,396.30
Surface Water Monitoring				
River samples (6 locations)	Monthly	€48.03	€2,305.44	€11,527.20
River samples (6 locations)	Quarterly	€98.08	€2,353.92	€11,769.60
Interceptor Channel (4 locations)	Quarterly	€18.42	€768.42	€3,843.40
Noise Monitoring				
Noise Station - Maintenance Contract	Continuous	3 years	€1,500.00	€4,500.00
Effectiveness of PTS				
Inflow and Outflow - Year 1 and 2	Weekly	€50.05	€5,205.20	€10,410.40

Monitoring	Monitoring Frequency	Monitoring / Laboratory Costs	Costs / year	Cost in Active Aftercare Period
Inflow and Outflow - Years 3 to 5	Monthly	€50.05	€1,201.20	€6,006.00
Stability Monitoring				
Instrumentation Maintenance	Annual Charge	€2,000.00	€2,000.00	€10,000.00
Instrumentation Calibration	Annual Charge	€2,000.00	€2,000.00	€10,000.00
Embankment Vegetation Maintenance				€20,000.00
TOTAL			€163,495.70	

Table 10.8-7 TMF Environmental Monitoring Passive Aftercare Costs (10 years)

Monitoring	Monitoring Frequency	Monitoring / Laboratory Costs	Costs / year	Cost in Closure Period
Groundwater Monitoring				
Boreholes (22 locations)	Bi-annual	€71.07	€3,127.08	€31,270.80
Domestic wells (9 locations)	Bi-annual	€71.07	€1,279.26	€12,792.60
Surface Water Monitoring				
River samples (6 locations)	Quarterly	€98.08	€2,353.92	€23,539.20
Effectiveness of PTS				
Inflow and Outflow	Monthly	€50.05	€1,201.20	€12,012.00
Stability Monitoring				

Instrumentation Maintenance /Calibration	Annual Charge		€20,000.00
Embankment Vegetation Maintenance			€40,000.00
TOTAL			€139,614.60

Table 10.8-8 TMF Stable Aftercare Costs (15 years)

Monitoring	Monitoring Frequency	Monitoring / Laboratory Costs	Costs / year	Cost in Closure Period
Groundwater Monitoring				
Boreholes /Domestic Wells (12 locations)	Bi-annual	€71.07	€1,705.68	€25, 585.200
Surface Water Monitoring				
River samples (6 locations)	Bi-annual	€98.08	€1,176.96	€17,654.40
Effectiveness of PTS				
Inflow and Outflow	Monthly	€50.05	€1,201.20	€18,018.00
Embankment Walls Vegetation Maintenance				€20,000.00
TOTAL			€81,257.60	

10.9 TOTAL CRAMP COSTINGS

An overview of total costs to implement CRAMP is presented in Table 10.9.

Table 10.9 Overview of Total Closure and Aftercare Costs

Closure, Decommissioning, Rehabilitation and Aftercare	Total 2024 Cost (€)	Cost € including EPA requested Contingency
Knockumber site Surface Decommissioning Programme	€7,086,980.50	€7,795,678.55
Rehabilitation of the TSF	€7,260,355.43	€9,656,272.72
Minesite Closure and Aftercare costs	€3,353,203.52	€3,688,523.87
TSF Closure and Aftercare costs	€1,968,256.34	€2,165,081.97
TOTAL CRAMP COST	€19,668,795.79	€23,305,557.11

Attachment 7-2-1



Tara Mines



BOLIDEN TARA MINES

**Industrial Emissions Licence P0 516-04
Proposed amendment to IEL Condition 6.13.1**

May 2025

Report Date : 6th May 2025
Prepared for : Boliden Tara Mines DAC
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1 Introduction

Boliden Tara Mines DAC, operating under Industrial Emissions Licence (IEL) P0 516-04, has two licensed discharge consents to surface waters:

- SW1 – Discharge to the River Boyne
- SW2 – Discharge to the River Blackwater

This request is specifically associated with the SW1 discharge to the River Boyne (Figure 1).

The licensee is requesting agreement to allow discharge at SW1 that the River Boyne dilution factor may be not less than or equal to 75:1, as required, from the current dilution factor of 100:1 specified in IEL condition 6.13.1 during the summer months April through to September only.

IEL Condition 6.13.1 states:

"Unless otherwise agreed by the Agency, the dilution factor in the Boyne River when discharge is taking place at SW1 shall not be less than 100:1".

This proposal is considered essential to allow greater flexibility in the site water management system, enabling more consistent discharge to take place throughout the year. The required 100:1 dilution factor is restrictive during the drier summer months (April to September) of the year. It is intended that the proposed reduction of the dilution factor to not less than or equal to 75:1, as required (April to September), will facilitate improved water management from an operational perspective, by reducing the volume of surplus process water that is currently stored within the water management system during the drier summer months when flows in the River Boyne are at their lowest.

The licensee will demonstrate the necessity for the change and that with corresponding reduction of the dilution factor, discharge at SW1 will continue to remain compliant with maximum discharge volumes and Emission Limit Values (ELVs) for all corresponding water quality parameters as specified in Schedule B.2 of the IEL P0516-04 (see Appendix A) and with corresponding EU water quality regulations.



Figure 1 Location of SW1 and monitoring points on River Boyne

2.0 Background

There are two main sources of water that must be dealt with by the water management system at the Tara mine operation:

- 80% - Water ingress to the mine – Groundwater inflows collected and pumped from the mine.
- 20% - Surface run-off – Precipitation collected at the surface facilities: (Mine site and Tailings Storage Facility (TSF))

Water is used in the mining process much of which is recycled for repeated use. Excess water is discharged to the receiving environment in compliance with IEL P0 516-04.

The licensee is seeking approval to allow greater flexibility in managing the site water balance which has changed significantly in the past number of years for the following reasons:

- Increase in mine water
- Decrease in water storage capacity
- Lower discharge volumes

2.1 Increase in mine water

Since 2019 and during normal mine operations between 2020 and 2025 the quantity of mine water has increased from c. 450 m³/h to 654m³/h¹.

This is due to the following main factors:

- 1) The resumption of mining operations in the upper region of the mine known as the *Nevinstown orebody*².
- 2) Progressive increase in the size of the mine workings. Each year the mine increases due to the addition of 15,000 metres of development headings and the mining of c. 2.3 million tonnes of ore.
- 3) Surplus of mine water inflows from the Tara Deep exploration decline (TRDEX1).

2.2 Decrease in water storage capacity

The TSF acts as a permanent repository for mine tailings waste while also acting as a part of the water management system. Water in the TSF is a sum of 'process water' pumped to the facility from the mill/concentrator and that collected from direct precipitation on the TSF.

Water collected in the TSF is recycled to the processing plant for reuse and the excess is treated before discharge at SW1 on the R. Boyne.

The storage capacity of the TSF is obviously finite, and this capacity reduces consistently as the quantity of tailings stored increases.

Storing surplus volumes of water outside that considered normal is contrary to best practice and IEL condition 6.15³.

The safety and integrity of the dam structure depends on careful management of the quantity of water stored.

2.3 Lower volume of water discharged

The water balance relies on keeping the system in equilibrium:

$$\{ \text{Water In} = \text{Water in storage} + \text{Water Out} \}$$

The ability to discharge water consistently is important to maximise the volume discharged to the receiving environment while maintaining the quantity of water in storage to a minimum.

In accordance with IEL condition 6.13.1. water can only be discharged to the River Boyne at SW1 when the dilution factor (*river flow: discharge flow*) is equal to or greater than 100:1.

¹ Cubic metres per hour

² Planning permission NA171232.

³ Condition 6.15 The licensee shall ensure that the TMF is not designed or used for water storage other than the storage required for the normal treatment of liquid and solid phases of the tailings slurry.

The flow rate in the River Boyne varies seasonally and responds rapidly to precipitation events. Typically, the flow rate in the Boyne is at its lowest during drier months (April to September) and highest during wetter months (September to March).

Consequently, the volume of water discharged varies in response to the flow rates prevailing at any particular time. During relatively dry periods, excess water needs to be temporarily stored within the water management system, and then discharged to the River Boyne when the river flow rates increase.

Excess water, that cannot be discharged, must be stored temporarily.

In recent years the data has shown changing weather patterns resulting in drier summers with more prolonged periods of low precipitation ergo lower river water flow in the River Boyne.

More recently this pattern of drier conditions and lower summer flows is most pronounced in the years 2019, 2022 and 2024 (see Appendix B).

3.0 Proposed Change

The licensee is requesting the agency agree to allow discharge to the River Boyne at a dilution ratio not less than or equal to 75:1, as required, (25% reduction) from the 100:1 dilution ratio currently specified in IEL Condition 6.13.1.

The proposed implementation of the change to the dilution factor will be undertaken as follows:

- a) The effective dilution factor is reduced to not less than or equal to 75:1
- b) The discharge at SW1 continues to remain compliant with maximum discharge volumes and corresponding ELVs for specific water quality parameters in IEL-P0516-04 (see Appendix A).

4.0 Impact Assessment

Discharge at SW1 during the period 1st April to 31st August would continue to comprise treated process water from the Clear Water Pond (CWP).

Treated process water will be discharged at the following maximum concentrations, see Table 1.

Table 1 Process Water Quality (CWP)

Parameter	Concentration. (mg/l)	IEL-ELVs (mg/l)
Sulphate, SO ₄	356	1500
Zinc, Zn	0.066	2
Antimony, Sb	0.271	0.8
Arsenic, As	0.013	0.5
Chromium, Cr	0.002	0.1
Copper, Cu	0.006	0.5
Lead, Pb	0.003	0.1
Iron, as Fe	0.014	1
Aluminium, Al	0.08	
Cadmium, Cd	0.004	0.1
Mercury, Total Hg	0.001	0.005
Cyanide, CN	0.05	0.2
Ammoniacal Nitrogen N	1.4	
Phosphate, Ortho P	0.02	2
Total Nitrogen	15	50
BOD	1.28	20
COD	15	100
Suspended Solids	4.89	30

4.1 Assimilative Capacity Calculation

The potential effect on the receiving waters downstream of SW1 is calculated on the basis of the assimilative capacity of the river under low flow conditions during the summer months, the 95% ile flow rate for the River Boyne, see Table 2.

The assimilative capacity of the receiving waters is defined as the maximum amount of contaminant load the flow system can accommodate without exceeding specified water quality standards.

The following mass balance equation is applied to estimate the downstream concentrations of specific water quality parameters:

$$C \text{ Downstream} = \frac{(F \text{ River } 95\%^{ile} \times C \text{ Background}) + (F \text{ Effluent} \times C \text{ Effluent})}{(F \text{ River } 95\%^{ile} + F \text{ Effluent})}$$

Where:

- **C Downstream** - is the resultant concentration downstream of the point of discharge (SW1)
- **F River 95%^{ile}** - is the River Boyne flow exceeded 95% of the time
- **C River** - is the concentration of each parameter in the river upstream of the point of discharge (SW1)

- **F Effluent** - is the discharge flow (SW1)
- **C Effluent** - is the concentration of each parameter in the discharge waters

F: River Boyne flow

In keeping with best practice, the receiving stream flows of the River Boyne (F River) are based on detailed hydrometric flow data collected from the Navan stream flow gauge (No. 07009) on the River Boyne, located some 0.86Km upstream of SW1 point of discharge. As shown in Table 2, the low flow or 95%ile flow, the flow exceeded 95% of the time, is calculated for the 1976 to 2025 flow data set for the Navan stream flow gauge.

Table 2 Rive Boyne Flow Statistics⁴

DURATION PERCENTILES								
Flows equalled or exceeded for the given percentage of time (m3/s) (Data derived for the period 1976 to 2025)								
1%	5%	10%	25%	50%	75%	90%	95%	99%
106.387	67.166	53.237	36.285	18.558	7.977	4.686	3.687	2.345

R.Boyne 95%ile flows	m³/hr	m³/d
	13,273	318,557

4.2 Assimilative Capacity Analyses

Assimilative capacity calculations were undertaken for the following scenarios to fully assess likely effects on water quality of the receiving waters of the River Boyne, as a result of reducing the dilution ratio to not less than or equal to 75:1, as required (April through September), at SW1 and discharging under current baseline conditions and future proposed conditions:

Scenarios:

- 1) **Baseline:** current IEL discharge conditions with 100:1 dilution ratio and discharge water from CWP with a blend of treated mine water and reclaim water from the Mill /TSF circuit.
- 2) **Proposed dilution ratio of not less than or equal to 75:1, as required,** and discharge water from CWP with a blend of treated mine water and reclaim water from the Mill /TSF circuit.

As follows, Table 3 presents the results of the assimilative capacity calculations for Scenario 1 - current baseline conditions for discharge at SW1, with the corresponding ambient concentrations for the River Boyne water (C Background Boyne), the blended mine water and reclaim/process water discharge concentrations at SW1 (C Effluent), and compares the resultant downstream concentrations for the

⁴ Office of Public Works (OPW) hydrometric network. Navan weir: 07009. [Office of Public Works](#)

current 100:1 dilution ratio, with the corresponding ELVs and maximum admissible concentrations of EU/EC water quality regulations.

The resultant concentrations for Scenario 2 are shown in Table 4, with the proposed change to the dilution ratio to not less than or equal to 75:1 and discharge of a blend of treated mine water and reclaim water from the Mill /TSF circuit.

Both scenarios, including Scenario 2 representing the proposed reduction of the dilution ratio to 75:1, demonstrate full compliance with corresponding ELVs for each of the specific water quality parameters and mass loading ELVs for antimony (1.08 Kg/hr) and Total Nitrogen (972 Kg/d or 40.5 Kg/hr). Resultant concentrations for downstream receiving waters also reflect full compliance with all corresponding MACs for EU/EC water quality regulations (Drinking Water, Surface Waters and Salmonid Waters). A summary comparison of assimilative capacity calculation results for actual discharge conditions (Scenario 1) with those for proposed discharge conditions (Scenario 2) are presented in Table 5.

Table 3 Scenario 1 – Baseline: 100:1 dilution ratio with discharge of treated mine water and reclaim/process water

F River 95^{ile} is equal to 13,273 m³/hr : F Effluent is 132.7 m³/hr

	C Background (Boyne) (mg/l)	C Effluent (Reclaim water from CWD) (mg/l)	C Downstream. Concentration (Boyne) (mg/l) / Mass loading (Kg/h)	ELVs (mg/l) / (Kg/h)	Regulatory Limit (mg/l)	EU/EC Regulations	Compliant Y/N ?
Sulphate	43	356	46.105	1500	187.50	MAC DwR ⁵	Yes
Zinc	0.02	0.066	0.020	2	0.10	MAC SwR ⁶	Yes
Antimony	0.001	0.271	0.004 / 0.036	0.8 / 1.08	0.005	MAC SwR	Yes
Arsenic	0.00064	0.013	0.001	0.5	0.025	MAC SwR	Yes
Chromium	0.002	0.002	0.002	0.1	0.03	MAC SwR	Yes
Copper	0.002	0.006	0.002	0.5	2.00	MAC DwR	Yes
Lead	0.002	0.003	0.002	0.1	0.01	MAC DwR	Yes
Iron, as Fe	0.15	0.014	0.149	1	0.20	MAC DwR	Yes
Aluminium, Al	0.10	0.08	0.100		0.20	MAC DwR	Yes
Cadmium, Cd	0.00013	0.004	0.00017	0.1	0.005	MAC DwR	Yes
Mercury, Total Hg	0.00001	0.001	0.00002	0.005	0.00005	MAC SwR	Yes
Cyanide, CN	0.02	0.05	0.02	0.2	0.05	MAC DwR	Yes
Ammoniacal Nitrogen N	0.04	1.4	0.053		0.09	MAC SwR	Yes
Phosphate, Ortho P	0.02	0.02	0.02	2	0.045	MAC SwR	Yes
Total Nitrogen	4.00	15	4.109 / 1.995	50 / 40.5	50.0	MAC DwR	Yes
BOD	2.0	1.275	1.993	20	2.2	MAC SwR	Yes
COD	15	15	15.000	100	40	Salmonid Waters Regulations ⁷	Yes
Suspended Solids	6	4.894	5.989	30	25	Salmonid Waters Regulations	Yes

⁵ S.I. No. 122/2014 - European Union (Drinking Water) Regulations 2014.

⁶ S.I. No. 272/2009 - European Communities Environmental Objectives (Surface Waters) Regulations 2009 as amended

⁷ S.I. No. 293/1988 - European Communities (Quality of Salmonid Waters) Regulations, 1988

Table 4 Scenario 2 – Proposed reduction of dilution ratio to 75:1 and discharge of blend of treated mine water and reclaim/process water

F River 95^{ile} is equal to 13,273 m³/hr : F Effluent is 177 m³/hr

	C Background (Boyne) (mg/l)	C Effluent (Reclaim water from CWD) (mg/l)	C Downstream. Concentration (Boyne) (mg/l) / Mass loading (Kg/h)	ELVs (mg/l) / (Kg/h)	Regulatory Limit (mg/l)	EU/EC Regulations	Compliant Y/N ?
Sulphate	43	356	47.119	1500	187.50	MAC DwR ⁸	Yes
Zinc	0.02	0.066	0.021	2	0.10	MAC SwR ⁹	Yes
Antimony	0.001	0.271	0.005 / 0.048	0.8 / 1.08	0.005	MAC SwR	Yes
Arsenic	0.00064	0.013	0.001	0.5	0.025	MAC SwR	Yes
Chromium	0.002	0.002	0.002	0.1	0.03	MAC SwR	Yes
Copper	0.002	0.006	0.002	0.5	2.00	MAC DwR	Yes
Lead	0.002	0.003	0.002	0.1	0.01	MAC DwR	Yes
Iron, as Fe	0.15	0.014	0.148	1	0.20	MAC DwR	Yes
Aluminium, Al	0.10	0.08	0.100		0.20	MAC DwR	Yes
Cadmium, Cd	0.00013	0.004	0.00018	0.1	0.005	MAC DwR	Yes
Mercury, Total Hg	0.00001	0.001	0.00002	0.005	0.00005	MAC SwR	Yes
Cyanide, CN	0.02	0.05	0.02	0.2	0.05	MAC DwR	Yes
Ammoniacal Nitrogen N	0.04	1.4	0.058		0.09	MAC SwR	Yes
Phosphate, Ortho P	0.02	0.02	0.02	2	0.045	MAC SwR	Yes
Total Nitrogen	4.00	15	4.145 / 2.655	50 / 40.5	50.0	MAC DwR	Yes
BOD	2.0	1.275	1.990	20	2.2	MAC SwR	Yes
COD	15	15	15.000	100	40	Salmonid Waters Regulations ¹⁰	Yes
Suspended Solids	6	4.894	5.985	30	25	Salmonid Waters Regulations	Yes

⁸ S.I. No. 122/2014 - European Union (Drinking Water) Regulations 2014.

⁹ S.I. No. 272/2009 - European Communities Environmental Objectives (Surface Waters) Regulations 2009 as amended

¹⁰ S.I. No. 293/1988 - European Communities (Quality of Salmonid Waters) Regulations, 1988

Table 5 Comparison of Existing (Scenario 1) Vs Proposed (Scenario 3) based on assimilative capacity assessment

<i>Parameter</i>	<i>Resultant Concentrations with reclaim water (CWD) and 100:1 dilution ratio</i>	<i>Resultant Concentrations with mine water and 75:1 dilution ratio</i>	<i>Comment</i>
	<i>mg/l</i>	<i>mg/l</i>	
Sulphate	46.105	47.119	Higher than current
Zinc	0.020	0.021	Higher than current
Antimony	0.004 / 0.036	0.005 / 0.048	Higher than current
Arsenic	0.001	0.001	Same as current
Chromium	0.002	0.002	Same as current
Copper	0.002	0.002	Same as current
Lead	0.002	0.002	Same as current
Iron, as Fe	0.149	0.148	Less than current
Aluminium, Al	0.100	0.100	Same as current
Cadmium, Cd	0.00017	0.00018	Higher than current
Mercury, Total Hg	0.00002	0.00002	Less than current
Cyanide, CN	0.02	0.02	Same as current
Ammoniacal Nitrogen N	0.053	0.058	Less than current,
Phosphate, Ortho P	0.020	0.020	Same as current,
Total Nitrogen	4.109 / 1.995	4.145 / 2.655	Higher than current
BOD	1.993	1.990	Less than current
COD	15.000	15.000	Same as current
Suspended Solids	5.989	5.985	Less than current

The data presented in Tables 4 and 5 illustrate that based on the results of assimilative capacity calculations, the proposed reduction of the dilution ratio to greater than or equal to 75:1, during summer months (April to Sept), would not compromise the water quality in the river downstream of the discharge at SW1 on the River Boyne with respect to current ELVs and EU/EC water regulations.

5 Measurement and Controls

The site water management system is controlled by an ABB process control system which is monitored 24/7 by the plant operators in the mill control room. The site water management system comprises a series of water management ponds used for temporary storage from various sources, to facilitate handling of reclaim water from the TSF, settlement of sediments and water treatment prior to reuse and/or discharge to the River Boyne (SW1).

A schematic of the site water management system is shown in Figure 2, and locations of the ponds shown in Figure 3 with corresponding functions summarised in Table 6.

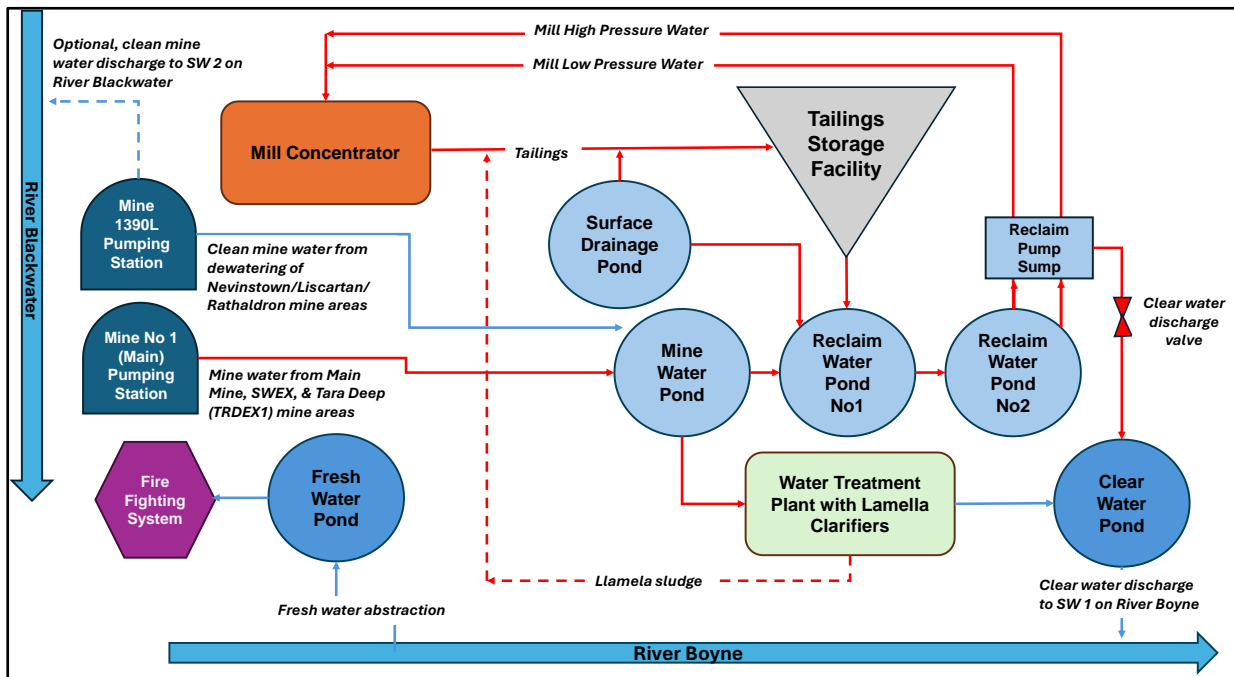


Figure 2 Site Water Management System

The principal source of process and operational water is derived from the mine dewatering system. Groundwater inflows entering the mine through water bearing fissures and faults are conveyed under gravity to sumps and pumping stations and then pumped in stages to two locations at surface:

- Clean water from the Nevinstown mine area – is discharged directly to the River Blackwater at Emission Reference Point SW2.
- All groundwater inflows from deeper mine areas (Main Mine, SWEX, TRDEX 1) are pumped to the surface 'Mine Water Pond'.

A small amount of fresh water is pumped from the River Boyne to the Fresh Water Pond for supply, when necessary, for fire-fighting purposes.

A portion of the process water generated on site is treated with ferric sulphate and flocculants to remove antimony. The treated water then passes through lamella filters (to reduce suspended solids) prior to controlled discharge to the Clean Water Pond and then to the River Boyne at SW1, Figure 1.

Discharge from the Clear Water Pond to the River Boyne at SW1 is continuously monitored to comply with conditions and schedule in IEL. The system will shut down automatically if water is not compliant with Emission Limit Values (ELVs) ceasing discharge. An automated hydrometric gauging station in the River Boyne records real time water flow to ensure the effective dilution factor available in the River Boyne remains compliant with the IEL.

Groundwater collected from the shallower Nevinstown mine area in the underground sump at 1390L has minimal or no contact with the orebody is pumped directly to surface and discharged at Emission Reference point SW2 to the River Blackwater. This discharge is continuously monitored, and the system will shut down automatically if water is not compliant with Emission Limit Values (ELVs) ceasing discharge.

Monitoring

- Currently a composite sample of the discharge is collected daily from the Clear Water Pond, prior to gravity conveyance to the SW1 point of discharge.
- Currently samples are collected from the River Boyne, upstream (T0A) and downstream (T0B), of the discharge point (SW1) on a monthly basis.

6 Conclusions

- The ability to discharge excess water is fundamental to the continued operation of the mining operations at Tara Mines.
- Storing surplus volumes of water outside that considered normal is contrary to best practice and IEL condition 6.15¹¹
- If the quantity of process water in storage continues to increase this may compromise existing storage capacity at the TSF and result in the licensee having to revert to the agency with a plan for urgent intervention.
- The proposed modification of the SW1 discharge dilution factor to 75:1 is considered to be a sustainable approach to mitigating further build-up of water in storage in the system during the drier, summer months.
- The Company has demonstrated that the water system can be managed to ensure compliance with the receiving water regulatory standards.

¹¹ Condition 6.15 The licensee shall ensure that the TMF is not designed or used for water storage other than the storage required for the normal treatment of liquid and solid phases of the tailings slurry.

- The Company is committed to operating in an environmentally sustainable manner and to maintain continued compliance with its Industrial Emissions Licence.

APPENDIX A – IEL – P0516-04 – Schedule B.2

B.2 Emissions to Water

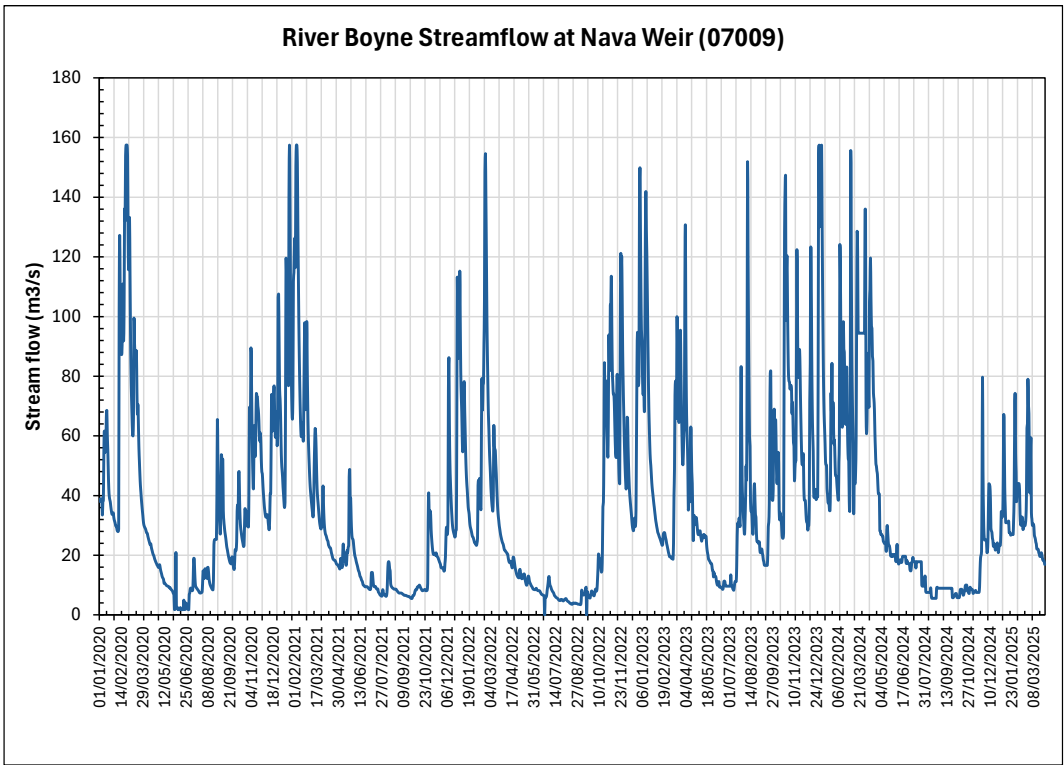
Emission Point Reference No: SW1
Name of Receiving Waters: River Boyne
Location: Outlet from Clear Water Pond
Volume to be emitted: Maximum in any one day: 64,800 m³
 Maximum in any one hour: 2,700 m³

Parameter <small>Note 1</small>	Emission Limit Value	
Temperature	1.5 °C <small>Note 2</small>	
pH	6- 9	
	mg/l	Mass loading
BOD	20	972kg/day
COD	100	
Suspended Solids	30	
Total Nitrogen	50	
Total Ammonia (as N)	5	
Total Phosphorous (as P)	2	
Molybdate Reactive Phosphorus (as P)	0.5	
Sulphate	1500	1.08kg/hr
Zinc	2	
Lead	0.1	
Copper	0.5	
Iron	1	
Cadmium	0.1	
Arsenic	0.5	
Antimony	0.8	
Cyanide	0.2	
Total Chromium	0.1	
Mercury	0.005	

Note 1: In the case of zinc, lead, copper, iron, cadmium, arsenic, cyanide, chromium and mercury the limit refers to the dissolved concentration, i.e. the dissolved fraction of a water sample obtained by filtration through a 0.45 µm filter or any equivalent pretreatment.

Note 2: Not greater than a 1.5°C rise in ambient temperature outside the mixing zone.

APPENDIX B – STREAM FLOW DATA FOR NAVAN WEIR (2020-2025)



	m3/s
01/01/2020	43.69
01/02/2020	92.21
01/03/2020	68.90
01/04/2020	22.46
01/05/2020	10.77
01/06/2020	2.88
01/07/2020	9.88
01/08/2020	21.14
01/09/2020	26.77
01/10/2020	31.75
01/11/2020	58.94
01/12/2020	56.00
02/01/2021	83.94
01/02/2021	91.60
01/03/2021	40.85
01/04/2021	21.79
01/05/2021	23.57
01/06/2021	13.13
01/07/2021	8.92
01/08/2021	9.70
01/09/2021	6.50
01/10/2021	11.26
01/11/2021	20.63
01/12/2021	45.46
01/01/2022	49.39
01/02/2022	67.45
01/03/2022	39.26
01/04/2022	17.64
01/05/2022	11.66
01/06/2022	7.61
01/07/2022	6.63
01/08/2022	4.17
01/09/2022	6.46
01/10/2022	37.34
01/11/2022	79.32
01/12/2022	51.25
01/01/2023	79.39
01/02/2023	26.15
01/03/2023	53.73
01/04/2023	48.48
01/05/2023	22.01
01/06/2023	10.31
01/07/2023	25.02
01/08/2023	46.16
01/09/2023	33.10
01/10/2023	66.31
01/11/2023	68.17
01/12/2023	60.79
01/01/2024	72.46
01/02/2024	67.23
01/03/2024	84.59
01/04/2024	75.97
01/05/2024	23.76
01/06/2024	18.61
01/07/2024	15.79
01/08/2024	7.50
01/09/2024	8.39
01/10/2024	7.72
01/11/2024	17.02
01/12/2024	26.73
01/01/2025	36.69
01/02/2025	42.25
01/03/2025	25.85