Boliden Tara Mines Limited

IPPC Licence Ref. No. P0 516-01

Annual Environmental Report (AER)

January – December 2011

Submitted by:

Boliden Tara Mines Limited

Environmental Department

Knockumber,

Navan, Co. Meath

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Section 1 Management of the Activity

1.1 Report Overview

This Annual Environmental Report (AER) for Boliden Tara Mines Limited presents environmental information for the period from the 1st January 2011 to 31st December 2011.

Section 1 provides a brief description of the Company and provides details on the existing Environmental Management System in place including the Objectives and Targets for 2011 (review) and 2012 (proposed).

Section 2 presents summary information on monitoring data, energy and water consumption, waste management, environmental incidents and complaints for 2011. Also included are copies of the relevant PRTR Emissions and Waste Transfers summary tables.

Section 3 presents annual and licence specific reports.

1.2 Facility Information Summary

IPPCL Registration No.	P0516-01
Operator Name	Boliden Tara Mines Limited
Operator Address	Knockumber, Navan, Co. Meath, Ireland.
National Grid Reference (12 digit 6E,6N)	Main Site: 284877E, 267985N Tailings Facility: 285160E, 271557N
NACE Code	0729
Main Economic Activity	Mining of non-ferrous metal ore
Class of Activity	Schedule 1 Class 1.3 The extraction and processing (including size reduction, grading and heating) of minerals within the meaning of the Minerals Development Acts 1940 to 1999, where an activity involves— (a) a metalliferous operation, or (b) 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.
RBME Risk Category	A3

1.3 DESCRIPTION OF ACTIVITIES

Boliden Tara Mine Limited (Tara Mines), the largest operating zinc and lead mine in Europe, is located at *Knockumber*, 2 km from west of Navan in County Meath and 50 km northwest of Dublin. Originally sited in a rural area, expansion of Navan has resulted in the development of residential areas nearer to the mine although much of its surroundings remain flat agricultural land drained by prolific fishing rivers. The mine is currently divided into the following 3 sub-areas for management and planning:

- The Central Area known as the 'Main Mine' (first area to be mined and reserves have largely been depleted).
- The South West Extension (SWEX) is southwest of the Main Mine.
- Nevinstown is north of the Main Mine.

The River Blackwater, which flows into the River Boyne, passes over the orebody and forms a surface intersection feature between the 'Main orebody' and the 'Nevinstown orebody'.

The mine exploits the Zn-Pb deposit, which was discovered in 1970. The orebody lies between 50 and 1000 metres below the surface and extends over an area of 6.5 kilometres by 1.5 kilometers. The combination of a gently dipping orebody, together with a large geographical area, requires a mining method that utilises mobile equipment for ore haulage, rock drilling and explosives charging.

Development of the orebody commenced in 1973 and production mining and processing has been in operation since 1977. Tara currently produces between 2.6 and 2.7 million tonnes of ore per annum, resulting in 400,000 tonnes of zinc and lead concentrate.

Approximately 50% of the residual material is mixed with cement and returned to the mine as backfill to stabilise the worked out areas while the other 50% is pumped into the tailings storage facility (TSF) located 3km north of the mine site at Randalstown. The TSF, enclosing a footprint area of approximately 170 hectares, serves as containment for tailings to settle and consolidate, as well as a treatment storage area for the water which is circulated back to the processing plant at Knockumber prior to discharge under license to the River Boyne.

1.4 SIGNIFICANT DEVELOPMENTS / SITE ACTIVITY DURING 2011

IPPCL License Review

The Company was granted an IPC Licence from the EPA on 29th May 2001, Reference No 516. The licence was later amended to an IPPC Licence on the 9th June 2006 (Ref. No. P0516-01). A review application of Tara's IPPCL was submitted to the EPA in November 2010. The review application has outlined all changes and some proposed changes to the operation since the original IPC

Licence was granted. Further information has been requested on 7 occasions and all of information requested has been submitted.

Planning Applications

New Entrance and roadway to Randalstown TMF

In September 2011 Tara submitted a Planning Application to Meath County Council (MCC) for a new entrance to the Tailings Management Facility from the L-74141 (Milestown Road) at Randalstown, Navan, County Meath. Further information was requested and submitted in November and permission granted in January 2012.

Return Air Raise (RAR) 5 N

In December 2011 Tara submitted a Planning Application and associated Environmental Report to Meath County Council (MCC) for the development of a new mine return air shaft in the townland of Ardbraccan south-west of the main mine site. The proposed development to be known as Return Air Raise 5 North (RAR 5N) will provide additional ventilation to the SWEX area of the mine.

1.5 ENVIRONMENTAL MANAGEMENT SYSTEM (EMS) AT TARA

Environmental Management has always been at the core of operations at Tara since the development of the mine commenced in 1973. Today Tara's Environmental Management System (EMS) ensures the company achieves best practice in all areas of environmental management and compliance and is accredited to the internationally recognised ISO 14001:2004 EMS. All the requirements of this standard were incorporated into Tara's existing EMS, which was structured in accordance with the Integrated Pollution Prevention Control Licence (IPPCL) and all company activities and emissions are controlled, operated and maintained as set out in conditions of this licence.

Tara's Environmental Policy as defined by management is the driver for implementing and improving the Company's EMS. As part of this commitment, senior management has designated specific personnel with defined responsibility and authority for implementing the EMS. Resources include human resources and specialized skills, organizational infrastructure, technology and financial resources.

Tara is always looking at new ways to improve environmental management on site and reduce its impacts on the environment. Continual improvement is managed through Environmental Management Programme's (EMP) as required by the EMS. Tara maintains an Environmental Aspects Register, which identifies and lists all aspects of its activities and details information on their associated impacts, control measures, operating conditions, significance rating, monitoring, applicable operating procedures and applicable legal requirements. This register is updated as part of the management review process and takes account of any new developments on site.

The EMP documents the strategy for achieving the planned objectives and targets and:

- Identifies specific actions which are required to ensure that environmental objectives are achieved
- Assigns appropriate responsibilities for achieving each environmental objective
- Sets deadlines for achieving the various environmental objectives.

The most significant environmental aspects and associated impacts are considered when setting annual objectives and targets as well as identifying areas for improvement such as emissions to water, waste generation, nuisance and energy efficiency.

A review of the status of objectives and targets set for 2011 and proposed objectives and targets for 2012 are presented in Tables 1.1 and 1.2 below.

TABLE 1.1 ENVIRONMENTAL OBJECTIVES AND TARGETS PROGRAMME 2012 (IPPCL CONDITION 2.2)

PROCESS / ACTIVITY AND ASSOCIATED ASPECT	OBJECTIVE	TARGET	PROGRAMME	RESPONSIBILITY	TIMEFRAME
Effluent Discharge	Reduce concentration of Suspended Solids in mine water	5% reduction in SS in mine water Completion date 2Q 2012	Carry out laboratory and pilot plant testing. Install 4 new water clarifiers adjacent to the surface water ponds. All mine water will pass through these clarifiers prior to discharge to Boyne.	Mill Manager	End 2nd Q 2012
General	Site Remediation Plan of contaminated land	End 4Q 2012	Carry out contaminated land assessment of the mine site (main focus on contamination by metals and TPH's) Carry out a combination of trial pits and window sampling Map the site and locations sampled in GIS Based on results of sampling determine an optimum method of remediation on a priority basis and over a phased timeframe	Environmental Superintendent	1Q 2012 2Q 2012 2012 2012 - 2018
Sulphuric Acid Storage	Upgrade Sulphuric Acid System (Bund and Storage Tanks)	End 1st Q 2012	The sulphuric acid system has been decommissioned (currently sulphuric acid is not being used in the process). The two steel sulphuric acid holding tanks have been removed, inspected and repaired. The existing bund has been excavated and awaiting replacement. A 24hr bund integrity test (as per BS 8007:1987) will be carried out before re-commissioning system	Mill Manager	End 1Q 2012

PROCESS / ACTIVITY AND ASSOCIATED ASPECT	OBJECTIVE	TARGET	PROGRAMME	RESPONSIBILITY	TIMEFRAME
Effluent Discharge	Remove silt from Mine Water Pond	End 3rd Q 2012	Remove silt from Mine Water Ponds and recycle through Processing Plant	Mill Manager	End 3rd Q 2012
Waste Oil Handling in Mine	Replace waste oil storage tanks and upgrade water / oil separation system	3Q 2012	Replace waste oil storage tanks with double skinned tanks Install pump at water / oil separation system that can distinguish between the viscosity of oil and water	Mine Maintenance Manager	End 3rd Q 2012

Table 1.2 ENVIRONMENTAL OBJECTIVES AND TARGETS PROGRAMME 2011

OBJECTIVE	Target	Progress during 2011
Resource Consumption *Reduce quantity of potable water consumed by Company*	50% reduction by end 2011	Achieved 30% reduction Replaced old potable cast steel water line (with leakages) with new ring main polyethelene pipeline around the site Installed on-line flow meters at 'intake' to site and at the 5 main distribution points around the site Plan to install additional flow meters at other distribution points around site during 2012
Effluent Discharge *Reduced concentration of Suspended Solids in discharge to the River Boyne*	5% reduction in 2011	Not Achieved – Target has been extended to end 2Q 2012 Install new lamella like thickener unit and integrate into the water treatment system. All water exiting the mine will go through this thickner before entering the next stage of water treatment.
General Site *Site Decommissioning of obsolete fixed plan*	Q4 2010	Achieved. Decommissioned obsolete fixed plant; Crushing circuit, rod mill grinding circuit, 12 associated conveyor systems, 2 x fine ore bins & transfer house
Rehabilitation/ aftercare *Rehabilitation work in Simonstown borrow area*	3Q 2012	Achieved. Reinstated 500 meters of mixed hedging / trees planted and area fenced to simulate original field boundaries.

Section 2 SUMMARY OF MONITORING INFORMATION AND WASTE TRANSFER

This section presents summary information on all environmental monitoring, energy consumption and incidents and complaints received for the monitoring period 1st January 2011 to 31st December 2011.
All environmental monitoring has been carried out is in accordance with IPPCL conditions and interpretation of summary information is presented in this section of AER.

2.1 EMISSIONS TO ATMOSPHERE

In accordance with IPPCL Condition 5.2 monitoring and analysis of emissions to atmosphere is carried out as specified in Schedule 1(iii) of Tara's IPPCL.

Monitoring of emissions to atmosphere is carried out at emissions reference points listed in Table 2.1 below:

Table 2.1 Emissions to Atmosphere

Emission Reference Point No.	Location
A2 - 4	Concentrate Loadout Building
A2 - 5	Mine Vent Shaft Return Air Raise (RAR) 1
A2 - 6	Mine Vent Shaft Return Air Raise (RAR) 2
A2 - 7	Mine Vent Shaft Return Air Raise (RAR) 3 North
A2 - 8	Mine Vent Shaft Return Air Raise (RAR) 3 South
A2 - 9	Mine Vent Shaft Return Air Raise (RAR) 4
A2 - 10	Mine Vent Shaft Return Air Raise (RAR) 5

Emissions from the processing plant are from a single remaining point source ventilation stack on the concentrate storage building (**A2-4**). The remaining air emission sources are from mine return air shafts ventilating the underground workings in the mine.
Over the past number of years two major atmospheric emissions points have been decommissioned; **A2-1** zinc dryer stack and **A2-2** crusher ventilation stack. Mass emissions of metals to air have been reduced by 98% from 2005 figures.

Emissions to atmosphere data is submitted to the EPA on a quarterly basis and mass emissions for 2011 are presented in the AER/PRTR Reporting Workbook in Appendix 1.

All emissions to atmosphere during 2011 are in full compliance with emission limit values set out in IPPCL Schedule 1(i).

2.2 EMISSIONS TO WATER

Tara has only one 'diffuse source emission' to surface water, Emission Point Reference **SW1** of process effluent to the River Boyne. This discharge includes treated process water, excess mine water and surface water captured in the water management system. This excess, treated water is discharged at a flow dilution ratio of >100:1.

In accordance with IPPCL Condition 6.4 monitoring and analysis of process effluent emissions to water is carried out as specified in Schedule 2(ii).
Process effluent emissions data is submitted to the EPA on a quarterly basis. Mass emissions for 2011 are presented in the AER/PRTR Reporting Workbook in Appendix 1.

During 2011 there were 28 marginal exceedances of the emission limit value for Total Nitrogen (TN) from emission point SW1 (refer to Section 2.6 Incidents Summary). The principal source of TN in the discharge to the River Boyne is from residues of emulsion based explosives used during blasting.

An adjustment of the ELV for TN from 15mg/l to 50mg/l is currently being sought as part of the Company's IPPCL Review.

All other parameters are in full compliance with emission limit values set out in IPPCL Schedule 2(i).

2.3 Resource Usage / Energy Efficiency

Tara became a member of the Sustainable Energy Authority of Ireland's LIEN network in 1995 and joined SEAIs' Energy Agreements Programme in 2007. Tara became certified to the Irish Energy Management Standard IS 393 in 2008 and in October 2011 achieved certification to the European Energy Management Standard EN16001. Tara plans to remain at the forefront of Energy Management Systems in the mining sector and aims to achieve certification to the new international energy management standard ISO 50001 in October 2012.

Energy spend at Tara Mines is forecast to be in the region of €21.2 million for 2012. Energy efficiency and CO_2 reductions are an essential part of the Company's campaign towards sustainable development. Energy and water Usage is listed In Tables 2.2 and 2.3 below.

As part of our certified Energy Management System, Tara has established a comprehensive register of energy aspects and energy factors to identify significant energy users and energy drivers. This is updated in response to significant changes in our process as required by the energy standard and is used to help set energy objectives and targets and implement energy reduction programmes across the site. Copies of our EnMS, energy aspects register and energy audits are all available for inspection.

TABLE 2.2 Energy Usage on Site

Energy Use	2010 kWH	2011 kWH
Total	227,645,154	224,123,548
Electricity	185,307,904	180,055,865
Light Fuel Oil	42,337,250	44,067,683

Table 2.3 Water Usage on Site

Water Use	2010 m^3/year	2011 m^3/year
Groundwater	4,448,322	4,242,068
Surface water	4,800	10,800
Public Supply	163,283	118,378

2.4 Environmental Complaints / Incidents

There were a total of 12 complaints received during 2011 all in relation to blast vibration. All complaints are responded to in an appropriate manner. For many of the complaints relating to blast vibration a temporary monitoring station is set up at complainant's residence. Also if necessary an independent structural assessment is carried out. Complaints received in 2011 are listed in Table 2.4 below.

All incidents with potential for environmental impact during 2011 are presented in Table 2.5 below. All environmental incidents are reported to the Environmental Department who in turn deals with the notification to all regulatory bodies. All incidents are investigated and appropriate response carried out.

2.5 WASTE MANAGEMENT

2.5.1 Disposal/Recovery of Hazardous and Other Wastes

Tara is committed to environmental protection and the minimisation and prevention of pollution that may arise as a result of on-site operations.
Disposal or recovery of waste generated at Tara takes place as specified in Schedules 3(i) and 3(ii) of IPPCL.
Where practicable, waste is managed according to the Waste Management Hierarchy where prevention is the most favoured option and disposal a last resort when recycling and reuse is not possible.
Procedures and facilities are in place to enable the proper segregation and safe storage of waste materials on site. Only EPA pre-approved, licensed waste contractors remove waste materials.

Details of all waste materials generated on the Tara site including quantity, EWC Code recovery, disposal or treatment and final destinations have been reported in the AER/PRTR Reporting Workbook and are presented in Appendix 1.

2.5.2 Waste Disposal in the Landfill Area

The onsite landfill (approximately 8 ha) has not been used for the disposal of waste, since 2001 and there is no plan to use this facility in the future.

In the intervening period selected sections of this area have been used for the segregation and temporary storage, prior to removal off-site, of certain non-hazardous waste materials including waste steel, timber, rubber conveyor belt and waste tyres. The practice of temporary storage has also ceased since February 2010. A dedicated waste segregation compound now provides for the safe segregation and temporary storage of all non-hazardous waste streams.

This area is currently being used for the temporary storage of surplus mine rock. Most of this surplus rock is reused in the mine in construction and road building. During 2011 approximately 216,000 tonnes of rock was transported to the Tailings Storage facility and used to pre-load the footprint of Stage 4A tailings facility as part of pre-construction of Stage 5 tailings storage facility extension.

However monitoring of groundwater and surface water in this area of the site has continued on an annual basis and results are presented in Table 2.6 below.

2.5.3 Waste Disposal in the Tailings Management Facility

Tailings is pumped from the processing plant through a 630mm diameter high-density polyethylene delivery pipeline and deposited in Tailings Storage Facility (TSF) located 3km north of the mine site at Randalstown.

The volume of tailings pumped is measured continuously by flow meters. The tailings slurry is discharged in turn from a series of spigots located at 80m intervals around the periphery of the dam. The tailings solids settle out and a pond of supernatant water remains over the tailings surface. Discharge is controlled manually based on daily visual inspection of the dam to achieve even distribution.

The TSF has been constructed and operated in five stages, Stages 1, 2, 3 and the upstream Stage 4A and 4B raises. Stage 4B is currently active. Tailings tonnage and volume distribution into Stage 4B during 2011 is presented in Table 2.7.

The remaining storage capacity in Stage 4B is 653,657 tonnes (or 964,169 m3). The Stage 5 development will provide a total of 5.58 Mm^3 of tailings storage in two phases: 2.34m^3 in Stage5A and 3.24m^3 in Stage5B.

Table 2.7 Tailings Tonnage and Volume Distribution 2011

Month	Tonnage of Tailings Deposited (t)	Volume of Tailings Deposited (m^3)
January	124,164	87,439
February	104,597	73,660
March	123,295	86,827
April	85,187	59,991
May	126,002	88,734
June	148,426	104,525
July	87,909	61,908
August	125,788	88,583
September	117,258	82,576
October	75,547	53,202
November	149,803	105,495
December	130,146	91,652
Total for 2011	**1,398,146**	**984,593**

In accordance with Schedule 3(iv) of Tara's IPPCL a survey of tailings settlement is undertaken bi-annually. A 3D survey of deposited tailings at the edge of the dam and at regular intervals of the submerged tailings is carried out using a total station ('Geodimeter 600') and target (prism). Contour data are maintained at the Environmental Department Offices.

2.6 SUMMARY OF MONITORING INFORMATION

2.6.1 Surface Water Monitoring

Surface water monitoring is carried out in accordance with Schedule 4(i) of Tara's IPPCL. Surface water monitoring data is submitted to the EPA on a quarterly basis. A summary of monitoring data for 2011 is presented in Table 2.8 (values are based on average concentrations).

River and stream samples are taken monthly from 13 locations on the River Boyne, River Blackwater and its tributaries representing locations both upstream and downstream of the TSF, the mine site and the discharge point (SW1) to the River Boyne. Values indicate no discernable disparity between upstream and downstream samples.

The European Community Environmental Objectives (Surface Water) Regulations 2009 Environmental Quality Standards (EQS) values are used as a guide for comparison with measured concentrations in surface waters.

2.6.2 Groundwater Monitoring

Groundwater monitoring is carried out in accordance with Schedule 5(i) of Tara's IPPCL. A summary of monitoring data is presented in Tables 2.9 to 2.11 (values are based on average concentrations).

The existing groundwater monitoring network in the vicinity of the Randalstown TSF involves monthly sampling at 26 locations from overburden (OB) and bedrock (BR) boreholes and biannual sampling water from 12 domestic wells. The original groundwater monitoring network has evolved and expanded over the years as development has taken place.

All groundwater quality data is reviewed in line with relevant water quality standards. The European Community Environmental Objectives (Groundwater) Regulations 2010 Threshold values are used as a guide for comparison with measured concentrations in groundwater.

Sulphate is used as the indicator parameter for monitoring potential contamination of groundwater in the vicinity of the TMF. Sulphate concentrations in boreholes in the immediate vicinity of the TSF exceed Groundwater Regulations Threshold Values. Average sulphate concentrations have remained relatively consistent during 2011 at most of the sampling locations. In general, there is a decrease in measured sulphate concentration with increased distance from the interceptor channel (a designed catchment boundary drain around the TSF). However, there is an increase in sulphate concentrations to the southeast of the TSF whish is most likely due to the operation of Stage 4B and a decrease in groundwater levels in superficial deposits and bedrock which may be as a result of mine dewatering.

Elevated concentrations of parameters (manganese, potassium, ammonia) a consequence of natural geochemical influences or non-point source contamination (as may arise from agricultural practice) show no discernible pattern across the area, occurring both upstream and downstream of the TSF. The spatial distribution of these elevated concentrations means that the TSF is unlikely to be the source.

Of the 12 domestic well monitored, only 3 are in use and none for domestic purposes. Concentrations of manganese and potassium above the drinking water standards are consistent with the trend they are naturally occurring in groundwater in the area and their spatial distribution means the source unlikely to be the TSF.

2.6.3 Ambient Air Monitoring

Continuous ambient air monitoring is carried out at 6 sampling locations around the mine site and TSF in accordance with IPPCL Schedule 1(v) using Low Volume Sampling devises for suspended particulates and metals. The sampling method is a modification of European Standard EN 12341:199.
There were no exceedances of Emission Limit Values (ELV) during 2011 and levels are in compliance with Air Quality Standards Regulations SI 244 of 1987. A summary of 2011 monitoring data is presented in Table 2.12.

Dust deposition monitoring is carried out at 12 sampling locations around the mine site and TSF. Samples are collected on a monthly basis and analysed in accordance with IPPCL Schedule 1(v). Monitoring is performed using Bergerhoff gauges specified in the German Engineering Institute VDI 2119 entitled "Measurement of Dustfall Using the Bergerhoff Instrument (Standard Method)" in accordance with TA Luft Standard.
There was no exceedance of Emission Limit Values (ELV) during 2011. A summary of 2011 monitoring data is presented in Table 2.13.

2.6.4 Noise Summary Report 2011

Continuous noise monitoring is carried out at four fixed stations around the mine site. Noise monitoring is carried out continuously at one fixed station as a control measure during pre-construction / construction works at Tailings Storage Facility (TSF). Monitoring is carried out as per ISO 1996 Part 1.

Noise monitoring and control has played an important role in the Company's overall environmental management. Noise emissions are minimised / controlled through abatement operating procedures.

Noise emissions from the mine site plant are continuous and are the same for daytime and night time due to the 24 hr/ 7 day operation of the mine. Many individual noise sources are 'tonal' in character, however when these sources operate together reverberating 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 tailings storage facility (TSF) lies 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 have been associated with construction activity and temporary noise monitoring is carried out as required during the construction phase of the tailings facility extensions.

All site operations are at a level significantly below noise level limits set out in Condition 8.1;

Daytime	55dB (A) expressed as Leq, 1hour
Night-time	45dB (A) expressed as Leq, 1 hour

No complaints were received relative to noise from Tara activities during 2011 from any resident on the periphery of the mine site or TSF.
Full noise monitoring reports are maintained at Environmental Department Offices for examination during site inspections.

2.6.5 Vibration Summary Report

Continuous blast vibration (and air overpressure) monitoring is being carried out at 5 fixed location stations and at a minimum of 3 temporary locations around the mine site and SWEX area (the number of temporary locations depending on requests from residents). Monitoring is carried out as per ISEE Field Practice Guidelines for Blasting Seismographs.

All blasts are designed to generate low levels of ground vibration. The development blasting periods are daily from 06:00 – 07:00 hrs and 18:00 – 19:00 hrs while the production blasting period is from 18:00 – 19:00 hrs.

12 complaints were received during 2011 relative to blast vibration. Limits specified in IPPCL Condition 8.4 were not exceeded at any monitoring location during 2011;

Daytime	8mm/sec
Night-time	4mm/sec

Full vibration monitoring reports are maintained at Environmental Department Offices for examination during site inspections.

2.6.6 Monitoring at Tailings Management Facility (TMF)

Embankment settlement / movement of the TMF retaining wall are observed by a series of movement monitoring instruments. Horizontal movements are monitored by inclinometers and monitoring pegs while vertical movements are monitored by extensometers, settlement plates and monitoring pegs. (Refer to enclosed report *Annual Safety Inspection and Monitoring of Tailings Dam* by Golder Associates).

In accordance with Schedule 3(iv) of Tara's IPPCL embankment settlement / movement is surveyed at quarterly intervals at monitoring pegs installed on stages 4A and Stage 4B. This data is maintained at the Environmental Department Offices.

Table 2.4 Complaints Summary 2011

Date	Category	Brief Description of Complaint	Response to Complaint / Corrective Action
12th January 2011	Ground Vibration & drilling activity	Mr. Mc Evoy, Old Athboy Road, Navan phoned security to complain about a blast that occurred on 12/1/11	Spoke with Mr. Mc Evoy. There is ground vibration monitoring being carried out at locations which represent likely levels at this receptor. Blast vibration levels in this area are below a ppv level of 2mm/s .
21st January 2011	Ground Vibration	Mrs. Robinson, Kells Road, Navan phoned security to complain about a blast that occurred on 21/1/11	Spoke with Mrs. Robinson. A temporary monitoring station is set up periodically at this residence. Blast vibration levels in this area are normally below a ppv level of 2mm/s.
25th January 2011	Ground Vibration	Mr. Pagan, Boyerstown Raod, Navan phoned security to complain about a blast that occurred on 25/1/11	Spoke with Mr. Pagan. There is ground vibration monitoring being carried out within 100m of this receptor. Blast vibration levels in this area are below a ppv level of 2mm/s.
25th January 2011	Ground Vibration	Mr. Rogers, Boyerstown Road, Navan phoned security to complain about a blast that occurred on 25/1/11	Spoke with Mr. Rogers. The EPA has carried out monitoring alongside our ground vibration monitor at this location. Blast vibration levels in this area are below a ppv level of 2mm/s.
3rd February 2011	Ground Vibration	Mr. Mark Farrell, Complaints Officer, Meath County Council acted on a complaint made from a resident on Kells Road in relation to Tara Blasting	Spoke with Mr. Farrell and explained blasting routine and vibration levels in area. Blast vibration levels in this area are normally below a ppv level of 2mm/s.
15th April 2011	Ground Vibration	Mr. Ron Pagan, Boyerstown Road, Navan phoned security to complain about a blast that occurred on 15/4/11	Spoke with Mr. Pagan. There is ground vibration monitoring being carried out within 100m of this receptor. Blast vibration levels in this area are normally below a ppv level of 2mm/s.

Date	Category	Brief Description of Complaint	Response to Complaint / Corrective Action
20th April 2011	Ground Vibration	Mr. Tom Mc Evoy, Old Athboy Road, Navan phoned security to complain about a blast that occurred on 20/4/11	Spoke with Mr. Mc Evoy. There is ground vibration monitoring being carried out at locations which represent likely levels at this receptor. Blast vibration levels in this area are below a ppv level of 2mm/s.
9th July 2011	Ground Vibration	Mr. Jeffrey Ball, Knockumber Road, Navan phoned security to complain about a blast that occurred on 9/7/11	Spoke with Mr. Ball. There is a permanent station measuring vibration levels approx 100m for Mr. Ball's house. Blast vibration levels in this area are below a ppv level of 3mm/s.
16th July 2011	Ground Vibration	Mrs. Francis Rogers, Boyerstown Road, Navan phoned security to complain about a blast that occurred on 16/7/11	Spoke with Mrs. Rogers. The EPA has carried out monitoring alongside our ground vibration monitor at this location. Blast vibration levels in this area are below a ppv level of 2mm/s.
9th September 2011	Ground Vibration	Mr. Thomas Rogers, Boyerstown Road, Navan phoned security to complain about a blast that occurred on 9/9/2011	A vibration monitor has been set up on Mr. Rogers's property. The EPA has carried out monitoring alongside our ground vibration monitor at this location. Blast vibration levels in this area are below a ppv level of 2mm/s.
25th November 2011	Ground Vibration	Mrs. Joan Monaghan, Athboy Road, Navan phoned security to complain about a blast that occurred on 25/11/11	There is a permanent station measuring vibration levels approx 200m for this receptor. Blast vibration levels in this area have always been below a ppv level of 2mm/s.
8th December 2011	Ground vibration	Mrs. Pagan, Boyerstown Raod, Navan phoned security to complain about a blast that occurred on 08/12/11	Spoke with Mrs. Pagan. There is a monitoring station measuring vibration levels within approx 100m of this receptor. Blast vibration levels in this area are below a ppv level of 2mm/s.

2.5 Incidents Summary 2011

Date	Incident Nature	Cause of Incident	Corrective Action
17/06/2011 EPA Inspection	Non-Compliance with IPPCL Condition 7.5.2.	Development Works not agreed by Agency	Quantity and drawings of works undertaken to date and proposed development works submitted to Agency
25/08/11 EPA Audit	Non-Compliance with IPPCL Condition 9.6.1. Sulphuric Acid Bund failed to meet requirements of IPPCL	Operational Control	The sulphuric acid system was fully decommissioned and the two steel holding tanks have been removed repaired. The existing bund has been excavated and construction of a replacement is underway. There is a target to have this work completed in Q2 2012. The system will not be re-commissioned until the integrity of the new bund is verified (by passing a 24 hour hydrostatic test as per BS 8007:1987) and an integrity test report be forwarded to the Agency.
25/08/11 EPA Audit	Breech of ELV at Licenced Discharge Emission Ref Point SW1 to the River Boyne. Non-Compliance with IPPCL Condition 6.1 and Schedule 2(i) Total Nitrogen (TN) concentrations of 25.03mg/l versus ELV of 15mg/ at	Residue of explosives	An adjustment of the ELV for TN from 15mg/l to 50mg/l is currently being sought as part of an IPPC License review. The principal source of TN comes from the residues of explosives which are used during blasting. Tara sought a restructuring of the ELV during the period 2003/2004 to which the Agency agreed. At this time an evaluation of nitrogen discharge was carried out and demonstrated no detectable adverse impact on the receiving water.

Date	Incident Nature	Cause of Incident	Corrective Action
16/12/2011	Uncontrolled Release of Tailings and Carrying water	Adverse weather caused the tailings pipeline to contract and pull apart at a joint resulting in release of material (tailings and carrying water)	The impacted area where material was retained was cleaned up; the solid material was put through the processing plant and the carrying water pumped back to the on-site reclaim pond facility. A monitoring programme as part of a remediation plan approved by the Agency was carried out. This included monitoring of soils, sediments, groundwater and surface water. The section of uncovered pipeline has been covered with clay and the berm in the area of leakage extended. Ameliorative measures have been implemented to minimise the risk of recurrence of the incident including ➢ Implementing control measures to ensure immediate shutdown of the tailings pipeline upon activation of leak alarm ➢ Training of relevant personnel ➢ Update Emergency Preparedness Response Procedure
2011	28 marginal Breech's of ELV at Licenced Discharge Emission Ref Point SW1 to the River Boyne. Non-Compliance with IPPCL Condition 6.1 and Schedule 2(i)	Residue of explosives	An adjustment of the ELV for TN from 15mg/l to 50mg/l is currently being sought as part of an IPPC License review. The principal source of TN comes from the residues of explosives which are used during blasting.

Table 2.6 Landfill Monitoring 2011

	Unit	LSW 2	LBH 1	LBH 3	LBH 4
pH		6,75	7.1	7.08	6.82
Sp E Cond	***u*S/cm**	900	1468	978	1859
Total Oxidised Nitrogen as N	**(mg/l)**	0.61	0.47	1,95	1.05
Total Ammonical Nitrogen	**(mg/l)**	<0.19	0.29	<0.19	1.01
Sulphate	**(mg/l)**	38	431	72	649
Calcium	**(mg/l)**	123	361	169	361
Cadmium	**(mg/l)**	<0.0006	0.0007	0.0008	0.0038
Chromium	**(mg/l)**	<0.0007	<0.0007	<0.0007	0.0009
Chloride	**(mg/l)**	19.5	33.7	11.4	20.8
Copper	**(mg/l)**	<0.001	0.002	0.003	0.011
Cyanide	**(mg/l)**	<0.009	<0.009	<0.009	<0.009
Iron	**(mg/l)**	<0.19	<0.19	<0.19	<0.19
Lead	**(mg/l)**	<0.005	<0.005	0.007	<0.005
Magnesium	**(mg/l)**	6	39	10	28
Manganese	**(mg/l)**	0.033	0.186	0.04	1.23
Nickel	**(mg/l)**	0.002	0.005	<0.0001	0.084
Potassium	**(mg/l)**	1.49	3.1	0.65	4.58
Sodium	**(mg/l)**	10	32	7	14
Silver	**(mg/l)**	<0.0007	<0.0007	<0.0007	0.0017
Zinc	**(mg/l)**	0.006	0.06	0.013	12.3
Arsenic	**(mg/l)**	0.0025	<0.0008	<0.0008	0.0033
Barium	**(mg/l)**	0.081	0.041	0.096	0.073
Boron	**(mg/l)**	<0.12	<0.12	<0.12	<0.12
Fluoride	**(mg/l)**	<0.2	0.2	<0.2	<0.2
Phosphorous	**(mg/l)**	0.125	0.025	<0.019	0.023
Selenium	**(mg/l)**	0.0091	<0.0016	<0.0016	0.0137
Antimony	**(mg/l)**	<0.0032	<0.0016	<0.0016	<0.0016
Total Alkalinity $CaCO_3$	**(mg/l)**	298	351	386	433
Total Organic Carbon	**(mg/l)**	4	2	1	524
Benzene	**(ug/l)**	<0.1	<0.1	<0.1	<0.1
Toulene	**(ug/l)**	<0.1	<0.1	<0.1	<0.1
Ethylbenzene	**(ug/l)**	<0.1	<0.1	<0.1	<0.1
Total Xylene	**(ug/l)**	<0.2	<0.2	<0.2	<0.2

Table 2.8 Surface Water Monitoring

Parameter	EQS	Unit	TOA	TOB	T4	T5	T6	T7	T8	T10	T11	T12	T13	T14	T15
pH	**6-9**		8.0	8.1	8.2	8.1	8.2	8.1	8.1	7.9	8.1	8.1	8.0	8.0	8.1
Temperature		^{o}C	10.9	10.8	10.8	11.1	11	11.1	11	9.7	11.3	10.3	10.5	10.2	10.8
Sp E Cond.		*u*S/cm	675	696	448	640	668	410	719	769	450	659	739	660	625
Dissolved Oxygen		mg/l	9.2	8.9	8.6	8.8	8.9	10	9.4	7.5	9.7	9.1	8.4	9.3	9.4
Suspended Solids		mg/l	4.2	4.9	9.3	5.8	5.1	8.5	17.7	6.3	7.3	10.2	17.6	10.4	18.7
Nitrate as NO_3		mg/l	14	9	8	9	9	8	14	9	11	16	15	17	19
Sulphate		mg/l	45	52	28	44	42	24	56	55	26	41	39	29	61
Ammonia as NH_4	**0.140**	mg/l	0.05	0.10	0.05	0.06	0.05	0.05	0.07	0.05	0.05	0.05	0.07	0.05	0.05
Hardness as $CaCO_3$		mg/l	352	348	199	330	351	189	355	394	204	332	369	333	352
Zinc	**0.050**	mg/l	0.005	0.009	0.007	0.007	0.006	0.005	0.005	0.004	0.004	0.004	0.004	0.013	0.004
Lead	**0.0072**	mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.003	<0.002	<0.002	<0.002
Iron		mg/l	0.039	0.041	0.061	0.049	0.041	0.063	0.035	0.008	0.031	0.007	0.014	0.006	0.008
Cadmium	**0.0015**	mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.003	<0.002
Arsenic	**0.025**	mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Chloride		mg/l	21.8	22.8	16.9	21.2	22	17.2	19	23.4	17.9	21.7	18.1	19.0	20.7
Phosphorous		mg/l	0.041	0.056	0.052	0.04	0.065	0.05	0.06	0.02	0.05	0.03	0.05	0.02	0.04

Parameter	EQS	Unit	TOA	TOB	T4	T5	T6	T7	T8	T10	T11	T12	T13	T14	T15
Cyanide	**0.010**	mg/l	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015
Copper	**0.030**	mg/l	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.004	0.002
Chromium	**0.0047**	mg/l	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.002	0.002
Cobalt		mg/l	0.0003	0.0003	0.0004	0.0003	0.0003	0.0003	0.0003	0.0002	0.0004	0.0004	0.0003	0.0051	0.0003
Magnesium		mg/l	8	8	9	8	8	8	12	11	9	10	11	7	11
Manganese		mg/l	0.033	0.028	0.026	0.030	0.031	0.02	0.037	0.030	0.014	0.016	0.042	0.141	0.024
Nickel	**0.020**	mg/l	0.003	0.003	0.004	0.010	0.003	0.002	0.001	0.001	0.002	0.001	0.002	0.020	0.001
Mercury	**0.00005**	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Potassium		mg/l	2.24	2.46	2.49	2.44	2.25	2.47	2.50	2.65	2.53	1.58	2.49	3.98	2.45
Sodium		mg/l	10	11	8	10	10	8	8	11	8	10	8	7	9
Aluminium		mg/l	0.029	0.030	0.156	0.049	0.033	0.058	0.60	0.030	0.070	0.031	0.103	0.017	0.011
Antimony		mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Table 2.9 Bedrock Groundwater Monitoring

Parameter	EQS	Unit	OB1 (P1)	OB4 (P1)	BR1	BR2	BR3	BR4	BR5	BR6	BR7	BR8	BR9	BR10	GR1
Water Level		(mbgl)	6.40	3.10	10.46	6.73	5.03	6.04	0.99	4.77	3.59	1.37	5.19	4.06	2.21
pH			7.30	7.19	7.36	7.27	7.83	7.51	7.43	8.16	7.85	7.92	8.22	8.03	7.45
Temp (°C)		°C	10.21	10.61	11.53	10.96	11.14	11.53	11.42	10.95	11.01	10.66	11.38	11.72	10.40
Sp E Cond.	**1875**	*u*S/cm	1421	1191	711	883	479	678	658	275	502	422	324	391	757
Dissolved Oxygen		mg/l	8.36	3.78	4.95	5.67	4.14	5.32	5.22	5.22	5.185	5.04	5.92	5.39	2.81
Sulphate	**187.5**	mg/l	622	407	97	121	11	96	13	18	15	19	17	15	49
Manganese		mg/l	1.05	1.138	0.253	0.90	0.10	0.42	0.09	0.13	0.103	0.062	0.042	0.048	0.476
Zinc		mg/l	<0.05	<0.01	<0.011	<0.251	<0.004	<0.010	<0.006	<0.016	<0.005	<0.004	<0.006	<0.004	<0.004
Lead	**0.01875**	mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Iron		mg/l	<0.002	<0.020	<0.23	<0.22	<0.18	<0.04	<0.03	<0.002	<0.003	<0.002	<0.002	<0.003	<0.002
Cadmium	**0.00375**	mg/l	<0.002	<0.001	<0.001	<0.001	<0.0013	<0.0013	<0.0013	<0.0013	<0.0013	<0.0013	<0.0013	<0.0013	<0.002
Arsenic	**0.0075**	mg/l	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.010
Nitrite as N	**0.375**	mg/l	<0.011	<0.006	<0.006	<0.006	<0.019	<0.009	<0.006	<0.006	<0.006	<0.006	<0.007	<0.006	<0.023
Chloride	**187.5**	mg/l	25.5	22.2	20.7	14.6	15.4	17.2	15.4	19.9	29.8	14.5	15.2	23.7	16.3
Phosphorous		mg/l	<0.019	<0.019	<0.019	<0.019	<0.051	<0.019	<0.019	<0.025	<0.019	<0.035	<0.019	<0.019	<0.019
Cyanide	**0.0375**	mg/l	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.02

Parameter	EQS	Unit	OB1 (P1)	OB4 (P1)	BR1	BR2	BR3	BR4	BR5	BR6	BR7	BR8	BR9	BR10	GR1
Copper	**1.5**	mg/l	<0.006	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chromium	**0.0375**	mg/l	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.002
Cobalt		mg/l	<0.001	<0.001	<0.001	<0.006	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Magnesium		mg/l	76	27	15	21	21	18	35	14	29	22	15	14	23
Mercury	**0.00075**	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	**0.015**	mg/l	<0.016	<0.005	<0.002	<0.010	<0.002	<0.002	<0.004	<0.002	<0.002	<0.002	<0.002	<0.002	<0.013
Potassium		mg/l	5.9	2.6	1.8	1.5	5.0	1.6	2.9	1.5	2.1	2.2	1.2	3.3	1.5
Sodium		mg/l	36	21	16	14	21	9	127	8	19	15	15	21	14
Aluminium	**0.150**	mg/l	<0.039	<0.034	<0.035	<0.03	<0.03	<0.04	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.056
Selenium		mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Calcium		mg/l	318	238	123	148	48	133	82	21	28	27	32	37	131
Silver		mg/l	<0.001	<0.001	<0.001	<0.001	<0.002	<0.004	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Tellurium		mg/l	<0.055	<0.055	<0.055	<0.055	<0.055	<0.055	<0.055	<0.055	<0.055	<0.055	<0.055	<0.055	<0.001
Thallium		mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.005	<0.004	<0.004	<0.006	<0.004	<0.006	<0.009
Titanium		mg/l	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0007	<0.0004	<0.0022	<0.0004	<0.0004	<0.0004	<0.0006
Tin		mg/l	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.007	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Ammonia as NH_4	**0.175**	mg/l	<0.05	<0.05	<0.004	<0.01	<0.20	<0.06	<0.08	<0.27	<0.09	<0.10	<0.08	<0.06	<0.05

Table 2.10 Overburden Groundwater Monitoring

Parameter	EQS	Unit	OB1 (P2)	OB2	OB3	OB4 (P2)	OB5	OB6	OB7	OB8	OB9	OB11	OB12	OB13	OB14
Water Level		(mbgl)	5.57	6.32	3.82	3.10	*6.01*	4.99	3.52	3.56	0.99	5.44	3.38	4.17	1.98
pH			7.21	7.15	7.28	7.19	7.19	6.97	7.41	7.18	7.24	7.12	7.07	7.35	7.05
Temp (°C)		°C	9.65	11.18	10.10	10.61	10.59	10.65	10.33	10.20	10.41	10.90	11.04	10.86	9.51
Sp E Cond.	**1875**	mg/l	1536	1840	1028	1191	891	1173	481	1004	727	915	904	639	2950
Dissolved Oxygen		mg/l	6.13	6.94	6.83	3.78	5.40	6.09	8.93	4.93	6.35	6.32	6.78	7.65	8.61
Sulphate	**187.5**	mg/l	702	920	512	407	75	230	20	199	53	204	94	38	1855
Manganese		mg/l	0.749	0.065	0.043	1.138	0.161	1.735	0.017	0.203	0.030	0.027	0.332	0.022	2.781
Zinc		mg/l	<0.018	<0.124	<0.006	<0.011	<0.007	<0.006	<0.005	<0.008	<0.005	<0.004	<0.003	<0.005	<0.008
Lead	**0.01875**	mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Iron		mg/l	<0.005	<0.002	<0.002	<0.020	<0.002	<0.076	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cadmium	**0.00375**	mg/l	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	**0.0075**	mg/l	<0.010	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.001
Nitrite as N	**0.375**	mg/l	<0.021	<0.006	<0.006	<0.006	<0.006	<0.015	<0.006	<0.011	<0.016	<0.006	<0.006	<0.006	<0.006
Chloride	**187.5**	mg/l	43	48	30	22	15	29	23	35	16	18	29	19	89
Phosphorous		mg/l	<0.019	<0.019	<0.021	<0.019	<0.019	<0.019	<0.044	<0.035	<0.019	<0.046	<0.311	<0.061	<0.133
Cyanide	**0.0375**	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.025	<0.025	<0.02	<0.02	<0.02

Parameter	EQS	Unit	OB1 (P2)	OB2	OB3	OB4 (P2)	OB5	OB6	OB7	OB8	OB9	OB11	OB12	OB13	OB14
Copper	**1.5**	mg/l	<0.004	<0.005	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.003	<0.001
Chromium	**0.0375**	**mg/l**	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt		**mg/l**	<0.0006	<0.0009	<0.0007	<0.0010	<0.0011	<0.0015	<0.0006	<0.0006	<0.0006	<0.0006	<0.0007	<0.0008	<0.0006
Magnesium		**mg/l**	104	103	43	27	23	38	3	31	5	18	21	10	134
Mercury	**0.00075**	**mg/l**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	**0.015**	**mg/l**	<0.012	<0.010	<0.002	<0.005	<0.009	<0.007	<0.002	<0.003	<0.004	<0.003	<0.005	<0.002	<0.005
Potassium		**mg/l**	8.1	11.1	1.3	2.6	4.4	1.6	0.2	1.6	8.9	1.7	1.3	0.4	4.3
Sodium		**mg/l**	54	63	28	21	7	28	9	16	9	8	9	6	95
Aluminium	**0.150**	**mg/l**	<0.047	<0.033	<0.032	<0.034	<0.034	<0.032	<0.032	<0.032	<0.036	<0.032	<0.032	<0.032	<0.032
Selenium		**mg/l**	<0.003	<0.003	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Calcium		**mg/l**	395	390	253	238	179	274	96	181	132	147	193	133	551
Silver		**mg/l**	<0.002	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Tellurium		**mg/l**	<0.0001	<0.055	<0.055	<0.055	<0.055	<0.055	<0.055	<0.055	<0.055	<0.055	<0.055	<0.055	<0.110
Thallium		**mg/l**	<0.018	<0.011	<0.004	<0.011	<0.007	<0.004	<0.005	<0.004	<0.005	<0.007	<0.006	<0.004	<0.001
Titanium		**mg/l**	<0.0004	<0.0004	<0.0004	<0.0004	<0.0008	<0.0004	<0.0004	<0.0004	<0.0011	<0.0005	<0.0004	<0.0004	<0.0004
Tin		**mg/l**	<0.007	<0.005	<0.005	<0.010	<0.005	<0.005	<0.005	<0.005	<0.007	<0.007	<0.005	<0.005	<0.005
Ammonia as NH_4	**0.175**	**mg/l**	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.17

Table 2.11 Domestic Well Monitoring

Parameter	EQS	Unit	12R	16R	17R	18R	22R	23R	28R	29R	30R	32R	33R	35R
Water Level		(mbgl)	3.15	0.94	1.78	1.44	4.44	5.18	2.49	2.96	0.83	1.6	1.26	2.30
pH			7.04	7.78	7.64	7.28	7.29	7.20	7.10	7.26	7.24	7.40	7.45	7.37
Temp (°C)		°C	11.3	11.2	10.5	11.2	9.9	9.5	10.8	9.6	10.6	10.0	11.0	10.6
Sp E Cond.	**1875**	mg/l	711	257	450	597	463	366	518	659	444	631	563	483
Sulphate	**187.5**	mg/l	135	67	32	36	45	70	21	32	23	10	42	24
Manganese		mg/l	0.034	0.009	0.017	0.2375	0.0155	0.009	0.021	0.073	0.032	1.52	0.081	0.031
Zinc		mg/l	<0.019	<0.018	<0.018	<0.018	<0.023	<0.038	<0.010	<0.066	<0.008	<0.002	<0.010	<0.015
Lead	**0.01875**	mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Iron		mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.004	<0.040	<0.020	<0.002
Cadmium	**0.00375**	mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Arsenic	**0.0075**	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrite as N	**0.375**	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.03	<0.02	<0.06	<0.06
Chloride	**187.5**	mg/l	27	16	14	22	17	19	10	43	13	18	15	11
Phosphorous		mg/l	0.395	0.019	0.068	0.027	0.019	0.026	0.199	0.055	0.241	0.658	0.087	0.019
Cyanide	**0.0375**	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Copper	**1.5**	mg/l	<0.002	<0.014	<0.004	<0.020	<0.011	<0.009	<0.004	<0.009	<0.005	<0.002	<0.005	<0.003

Parameter	EQS	Unit	12R	16R	17R	18R	22R	23R	28R	29R	30R	32R	33R	35R
Chromium	**0.0375**	mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cobalt		mg/l	<0.0006	<0.0006	<0.0006	<0.0009	<0.0016	<0.0006	<0.0006	<0.0007	<0.0006	<0.0006	<0.0006	<0.0012
Magnesium		mg/l	14	7	10	19	9	10	8	26	6	8	7	9
Mercury	**0.00075**	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	**0.015**	mg/l	<0.002	<0.002	<0.003	<0.003	<0.002	<0.002	<0.003	<0.002	<0.003	<0.002	<0.004	<0.002
Potassium		mg/l	1.6	2.55	4.1	2.7	6.1	2.3	22.4	2.8	13.0	6.9	19.6	1.1
Sodium		mg/l	25	8	8	9	8	9	9	16	7	80	10	7
Aluminium	**0.150**	mg/l	<0.032	<0.032	<0.032	<0.032	<0.044	<0.042	<0.032	<0.032	<0.032	<0.035	<0.032	<0.032
Selenium		mg/l	<0.0064	<0.0016	<0.0021	<0.0022	<0.0022	<0.0018	<0.0017	<0.0018	<0.0016	<0.0024	<0.0020	<0.0016
Calcium		mg/l	158	52	99	127	95	66	102	132	129	143	118	114
Silver		mg/l	<0.0007	<0.0007	<0.0039	<0.0039	<0.0039	<0.0039	<0.0039	<0.0039	<0.0007	<0.0039	<0.0039	<0.0039
Tellurium		mg/l	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Thallium		mg/l	<0.008	<0.004	<0.005	<0.004	<0.005	<0.007	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Titanium		mg/l	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0005	<0.0004
Tin		mg/l	<0.005	<0.005	<0.010	<0.007	<0.005	<0.005	<0.005	<0.005	<0.006	<0.005	<0.005	<0.009
Ammonia as NH_4	**0.175**	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.07	<0.05	<0.80	<0.27	<0.05

Table 2.12 Ambient Air Monitoring Summary

Location	Units	Total Solids	Zinc	Lead	Cadmium	Arsenic	Nickel
DA 5	ug/m^3	8	<0.10	<0.01	<0.01	<0.01	<0.01
DA 4	ug/m^3	7	<0.10	<0.01	<0.01	<0.01	<0.01
DA 3	ug/m^3	12	<0.10	<0.01	<0.01	<0.01	<0.01
DA 1	ug/m^3	11	<0.10	<0.01	<0.01	<0.01	<0.01
DA 2	ug/m^3	20	<0.10	<0.01	<0.01	<0.01	<0.01
DA 6	ug/m^3	10	<0.10	<0.01	<0.01	<0.01	<0.01
Ambient Air Limits		**250**	**2**	**0.5**	**0.04**	**0.04**	**-**

Table 2.13 Dust Deposition Monitoring Summary

Monitoring Station	Units	Total Solids	Zinc	Lead	Cadmium	Arsenic	Nickel
DB 2	ug/m²/d	26	56	8	<0.7	<2.7	<3.2
DB 4	ug/m²/d	55	70	5	<0.5	<2.7	<3.8
DB 5	ug/m²/d	29	31	5	<0.5	<2.7	<2.7
DB 6	ug/m²/d	55	31	5	<0.6	<2.7	<2.7
DB 7	ug/m²/d	45	32	5	<0.7	<2.7	<2.7
DB 24	ug/m²/d	40	157	21	<0.7	<3.1	<3.0
DB 28	ug/m²/d	44	53	7	<0.5	<2.7	<2.7
DB 30	ug/m²/d	70	141	17	<0.7	<2.7	<3.2
DB 37	ug/m²/d	71	97	15	<0.7	<3.1	<3.3
DB 42	ug/m²/d	47	55	7	<0.6	<2.7	<2.8
DB 50	ug/m²/d	31	37	4	<0.8	<2.7	<3.3
DB 51	ug/m²/d	36	31	4	<0.5	<2.7	<2.7
ELV		**350**	**500**	**250**	**5.0**	**5.0**	

Section 3 ANNUAL AND LICENCE SPECIFIC REPORTS

3.1 Boiler Emission Test Report

As per IPPCL Condition 5.6, emissions to atmosphere from the oil fired boilers are measured annually. Results are presented in Table 3.1 below. All boilers are operated to give a smoke colour of less than shade number 1 on the Ringlemann chart.

Table 3.1 Summary of Flue Gas

Source	Temp. Range (°C)	Efficiency (%Gross)	Oxygen (%)	NOx as NO_2 (mg/Nm^3)	SOx as SO_2 (mg/Nm^3)
				Corrected to 3% Oxygen	
A1 – 1 (Engineering Office)	192 - 273	82.5	5.0	110	125
A1 – 2 Mine Dry	128 - 204	86.5	1.8	103	139
Mine Dry A1 - 3	129 - 139	85.2	7.3	146	127

3.2 Annual Acid-Base Counting

In accordance with Schedule 3(ii) Waste Analysis of Tara's IPPCL, Annual Acid / Base Counting of tailings are required. This provides a means of monitoring the performance and behaviour of tailings by forecasting its acid generating potential.

'Desk-based accounting' is a long-standing method for predicting the likelihood of acid mine drainage under site-specific circumstances and is determined by the amount of iron sulphide (pyrites) and calcareous minerals present in tailings.

Tailings samples with a neutralizing potential (NP) of more than 15mg of calcium carbonate ($CaCO_3$) equivalent per gram of tailings, and a reactive sulphur content of less than 0.5%, are likely to generate alkaline leachates, whereas tailings with NP values of less than 2mg of $CaCO_3$ equivalent and a sulphur content greater than 1.5% can be expected to produce acid leachate. In other words a ratio of 30: 1 (mg $CaCO_3$: %S) can be used as a guiding, but not definitive, threshold for determining whether acid tailings drainage is a real risk. Evidence in support of this strategy, which is supported internationally, is published in Ritcey, G.M (1989) *Tailings Management*, Elsevier Press (p.287-298).

APPLYING DESK-BASED ACCOUNTING PRINCIPLE FOR 2011

In 2011 the tailings material had an average $CaCO_3$ equivalent (calcium and calcium-magnesium carbonates combined) of 48.57 % and a total S content average of 3.146 %.

Using these average values the calculation based on equivalent per gram of sample for 2011, the ratio of mg $CaCO_3$: %S (486 : 3.1) was 154 : 1, more than 4 times clear of the acid generation risk value of 30:1.

3.3 TMF Safety Inspection Report

In accordance with IPPCL Condition 7.5.10 Golder Associates (UK) Limited was commissioned by Boliden Tara Mines Limited to undertake an annual safety inspection of the TMF. This report can be found in Appendix 2 and presents a discussion of results of monitoring data obtained between January and December 2011 and observations made during a site inspection visit on the 25th January 2012.

3.4 Review of Environmental Liabilities Insurance Cover

In accordance with IPPCL Condition 14.2 a comprehensive and fully costed Environmental Liabilities Risk Assessment (ELRA) was undertaken in 2002 and submitted to the EPA. There are no known environmental liabilities other than the cost required in implementing the 'Closure, Restoration and Aftercare Management Plan (CRAMP)'. and the ELRA concluded that the risk of unknown liabilities was covered under Public liability Insurance held by the Company.

A reassessment of this ELRA and current site operations was carried out as part of a review of CRAMP in 2009 and no further financial exposures determined. Therefore, the financial provision for unknown liabilities, in the form of Public Liability Insurance, is considered adequate to provide for financial provision for unknown liabilities from current operations.

The value of funding held as financial surety for the purpose of implementing CRAMP was €8.394 million as of 31st December 2011. In addition there is a bank guarantee in place to cover the remainder of closure costs.

Appendix 1

AER / PRTR Reporting Workbook

Guidance to completing the PRTR workbook

AER Returns Workbook

Version 1.1.13

REFERENCE YEAR	2011

1. FACILITY IDENTIFICATION

Parent Company Name	Boliden Tara Mines Limited
Facility Name	Boliden Tara Mines Limited
PRTR Identification Number	P0516
Licence Number	P0516-01

Waste or IPPC Classes of Activity

No.	class_name
1.3	##

Address 1	Knockumber
Address 2	Navan
Address 3	Co. Meath
Address 4	
	Meath
Country	Ireland
Coordinates of Location	-6.71611 53.6557
River Basin District	IEEA
NACE Code	0729
Main Economic Activity	Mining of other non-ferrous metal ores
AER Returns Contact Name	Brendan O'Reilly
AER Returns Contact Email Address	ailish.mccabe@boliden.com
AER Returns Contact Position	Environmetnal Superintendent
AER Returns Contact Telephone Number	046 9082563
AER Returns Contact Mobile Phone Number	087 2909220
AER Returns Contact Fax Number	046 9071269
Production Volume	0.0
Production Volume Units	
Number of Installations	0
Number of Operating Hours in Year	8760
Number of Employees	690
User Feedback/Comments	
Web Address	

2. PRTR CLASS ACTIVITIES

Activity Number	Activity Name
3(a)	Underground mining and related operations

3. SOLVENTS REGULATIONS (S.I. No. 543 of 2002)

Is it applicable?	
Have you been granted an exemption ?	
If applicable which activity class applies (as per Schedule 2 of the regulations) ?	
Is the reduction scheme compliance route being used ?	

4.1 RELEASES TO AIR Link to previous years emissions data | PRTR# : P0516 | Facility Name : Boliden Tara Mines Limited | Filename : P0516_2011(1).xls | Return Year : 2011 | 11/05/2012 15:13

SECTION A : SECTOR SPECIFIC PRTR POLLUTANTS

RELEASES TO AIR					Please enter all quantities in this section in KGs								
POLLUTANT		METHOD									QUANTITY		
			Method Used		A2 - 4 Loadout Stack	A2 - 6 RAR 2	A2 - 7 RAR 3 North	A2 - 8 RAR 3 South	RAR 4	RAR 5			
No. Annex II	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	Emission Point 2	Emission Point 3	Emission Point 4	Emission Point 5	Emission Point 6	T (Total) KG/Year	A (Accidental) KG/Year	F (Fugitive) KG/Year
17	Arsenic and compounds (as As)	M	OTH	Isokinetic Sampling to ISO 9096 & analysed by AA/ICP	0.009	0.0	0.0	0.0	0.0	0.0	0.009	0.0	0.0
18	Cadmium and compounds (as Cd)	M	OTH	Isokinetic Sampling to ISO 9096 & analysed by AA/ICP	0.018	0.0	0.0	0.0	0.0	0.0	0.018	0.0	0.0
23	Lead and compounds (as Pb)	M	OTH	Isokinetic Sampling to ISO 9096 & analysed by AA/ICP	0.552	0.0	0.0	0.0	0.0	0.0	0.552	0.0	0.0
24	Zinc and compounds (as Zn)	M	OTH	Isokinetic Sampling to ISO 9096 & analysed by AA/ICP	3.379	0.0	0.0	0.0	0.0	0.0	3.379	0.0	0.0
08	Nitrogen oxides (NOx/NO2)	M	OTH	Colorimetric Gas Detection Tubes	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

* Select a row by double-clicking on the Pollutant Name (Column B) then click the delete button

SECTION B : REMAINING PRTR POLLUTANTS

RELEASES TO AIR					Please enter all quantities in this section in KGs								
POLLUTANT		METHOD									QUANTITY		
			Method Used		A2 - 6 RAR 2	A2 - 7 RAR 3 North	A2 - 8 RAR 3 South	RAR 4	RAR 5				
No. Annex II	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	Emission Point 2	Emission Point 3	Emission Point 4	Emission Point 5	T (Total) KG/Year	A (Accidental) KG/Year	F (Fugitive) KG/Year	
06	Ammonia (NH3)	M	OTH	Colorimetric Gas Detection Tubes	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

* Select a row by double-clicking on the Pollutant Name (Column B) then click the delete button

SECTION C : REMAINING POLLUTANT EMISSIONS (As required in your Licence)

RELEASES TO AIR					Please enter all quantities in this section in KGs								
POLLUTANT		METHOD									QUANTITY		
			Method Used		A2 - 4 Loadout Stack	A2 - 6 RAR 2	A2 - 7 RAR 3 North	A2 - 8 RAR 3 South	RAR 4	RAR 5			
Pollutant No.	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	Emission Point 2	Emission Point 3	Emission Point 4	Emission Point 5	Emission Point 6	T (Total) KG/Year	A (Accidental) KG/Year	F (Fugitive) KG/Year
244	Total Particulates	M	OTH	Gravimetric Analysis	9.207	559.148	890.471	890.471	1561.779	2288.694	6199.77	0.0	0.0
215	**Hydrogen sulphide**	M	OTH	Colorimetric Gas Detection Tubes	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

* Select a row by double-clicking on the Pollutant Name (Column B) then click the delete button

Additional Data Requested from Landfill operators

For the purposes of the National Inventory on Greenhouse Gases, landfill operators are requested to provide summary data on landfill gas (Methane) flared or utilised on their facilities to accompany the figures for total methane generated. Operators should only report their Net methane (CH4) emission to the environment under T(total) KG/yr for Section A: Sector specific PRTR pollutants above. Please complete the table below:

Landfill: Boliden Tara Mines Limited

Please enter summary data on the quantities of methane flared and / or utilised	**T (Total) kg/Year**	**M/C/E**	**Method Used**		**Facility Total Capacity m3 per hour**	
			Method Code	**Designation or Description**		
Total estimated methane generation (as per site model)	0.0				N/A	
Methane flared	0.0				0.0	(Total Flaring Capacity)
Methane utilised in engine/s	0.0				0.0	(Total Utilising Capacity)
Net methane emission (as reported in Section A above)	0.0				N/A	

4.2 RELEASES TO WATERS

Link to previous years emissions data

| PRTR# : P0516 | Facility Name : Boliden Tara Mines Limited | Filename : P0516_2011(1).xls | Return Year : 2011 | 11/05/2012 15:13

SECTION A : SECTOR SPECIFIC PRTR POLLUTANTS

Data on ambient monitoring of storm/surface water or groundwater, conducted as part of your licence requirements, should NOT be submitted under AER / PRTR Reporting as this only concerns Releases from your faci

RELEASES TO WATERS					Please enter all quantities in this section in KGs			
POLLUTANT					QUANTITY			
			Method Used		SW 1 (Outlet form Clear Water Pond)			
No. Annex II	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	T (Total) KG/Year	A (Accidental) KG/Year	F (Fugitive) KG/Year
17	Arsenic and compounds (as As)	M	OTH	Composite sampler & analysed by ICP-MS	81.851	81.851	0.0	0.0
18	Cadmium and compounds (as Cd)	M	OTH	Composite sampler & analysed by ICP-MS	9.635	9.635	0.0	0.0
19	Chromium and compounds (as Cr)	M	OTH	Composite sampler & analysed by ICP-MS	10.571	10.571	0.0	0.0
20	Copper and compounds (as Cu)	M	OTH	Composite sampler & analysed by ICP-MS	12.193	12.193	0.0	0.0
23	Lead and compounds (as Pb)	M	OTH	Composite sampler & analysed by ICP-MS	49.15	49.15	0.0	0.0
12	Total nitrogen	M	OTH	Composite sampler & Spectrophotometric analysis	75150.016	75150.016	0.0	0.0
13	Total phosphorus	M	OTH	Composite sampler & analysed by ICP-MS	209.36	209.36	0.0	0.0
24	Zinc and compounds (as Zn)	M	OTH	Composite sampler & analysed by ICP-MS	1417.079	1417.079	0.0	0.0
			OTH		0.0	0.0	0.0	0.0

* Select a row by double-clicking on the Pollutant Name (Column B) then click the delete button

SECTION B : REMAINING PRTR POLLUTANTS

RELEASES TO WATERS					Please enter all quantities in this section in KGs				
POLLUTANT							QUANTITY		
			Method Used		SW 1 (Outlet from Clear Water Pond)				
No. Annex II	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	Emission Point 2	T (Total) KG/Year	A (Accidental) KG/Year	F (Fugitive) KG/Year
82	Cyanides (as total CN)	M	OTH	Composite Sampler & analysed by Distillation & Colormetric determination	243.215	0.0	243.215	0.0	0.0
21	Mercury and compounds (as Hg)	M	OTH	Composite Sampler & analysed by Hydrate generation / ICP	4.864	0.0	4.864	0.0	0.0

* Select a row by double-clicking on the Pollutant Name (Column B) then click the delete button

SECTION C : REMAINING POLLUTANT EMISSIONS (as required in your Licence)

RELEASES TO WATERS					Please enter all quantities in this section in KGs					
POLLUTANT										
			Method Used		SW 1 (outlet from Clear Water Pond)					
Pollutant No.	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	Emission Point 2	Emission Point 3	Emission Point 4	Emission Point 5	T (Total) KG/Year
238	Ammonia (as N)	M	OTH	Composite sampler & Spectrophotometric analysis	18632.613	0.0	0.0	0.0	0.0	########
205	Antimony (as Sb)	M	OTH	Composite sampler & analysed by ICP-MS	2880.518	0.0	0.0	0.0	0.0	2880.518
303	BOD	M	OTH	Composite sampler & 5 Day BOD Test	12536.646	0.0	0.0	0.0	0.0	########
306	COD	M	OTH	Composite sampler & analysed by Digestion & Colormetric determination	75444.45	0.0	0.0	0.0	0.0	75444.45
357	**Iron**	M	OTH	Composite sampler & analysed by ICP-MS	10.577	0.0	0.0	0.0	0.0	10.577
362	Kjeldahl Nitrogen	M	OTH	Composite sampler & Spectrophotometric analysis	20789.667	0.0	0.0	0.0	0.0	########
324	Mineral oils	M	OTH	Composite sampler & Gas Chromatrography (GC-FID)	99.289	0.0	0.0	0.0	0.0	99.289

327	Nitrate (as N)	M	OTH	Composite sampler & Spectrophotometric analysis	48404.625	0.0	0.0	0.0	0.0 ########
372	Nitrite (as N)	M	OTH	Composite sampler & Spectrophotometric analysis	5955.724	0.0	0.0	0.0	0.0 5955.724
343	Sulphate	M	OTH	Composite sampler & Gravimetric analysis	3305393.984	0.0	0.0	0.0	0.0 ########
240	Suspended Solids	M	OTH	Composite sampler & Gravimetric analysis	78049.501	0.0	0.0	0.0	0.0 ########

* Select a row by double-clicking on the Pollutant Name (Column B) then click the delete button

5. ONSITE TREATMENT & OFFSITE TRANSFERS OF WASTE

| PRTR# : P0516 | Facility Name : Boliden Tara Mines Limited | Filename : P0516_2011(1).xls | Return Year : 2011 | 11/05/2012 15:13

Please enter all quantities on this sheet in Tonnes

Transfer Destination	European Waste Code	Hazardous	Quantity (Tonnes per Year)	Description of Waste	Waste Treatment Operation	Method Used		Location of Treatment	Haz Waste : Name and Licence/Permit No of Next Destination Facility Non Haz Waste: Name and Licence/Permit No of Recover/Disposer	Haz Waste : Address of Next Destination Facility Non Haz Waste: Address of Recover/Disposer	Name and License / Permit No. and Address of Final Recoverer / Disposer (HAZARDOUS WASTE ONLY)	Actual Address of Final Destination i.e. Final Recovery / Disposal Site (HAZARDOUS WASTE ONLY)
						M/C/E	Method Used					
Within the Country	13 02 08	Yes	69.12	Waste Engine oil	R9	M	Volume Calculation	Offsite in Ireland	ENVA Ireland Limited,WCP-DC-08-116-01	Clonminam Industrial Estate,Portlaoise,County Laois,".",Ireland	ENVA Ireland Limited,W0184-01,Clonminan Industrial Estate,Portlaois,County Laois,".",Ireland	Clonminan Industrial Estate,Portlaois,County Laois,".",Ireland
Within the Country	13 07 03	Yes	50.9	Oily water	R9	M	Volume Calculation	Offsite in Ireland	ENVA Ireland Limited,WCP-DC-08-116-01	Clonminam Industrial Estate,Portlaoise,County Laois,".",Ireland	ENVA Ireland Limited,W0184-01,Clonminan Industrial Estate,Portlaois,County Laois,".",Ireland	Clonminan Industrial Estate,Portlaois,County Laois,".",Ireland
Within the Country	13 02 08	Yes	2.56	Waste gear oil	R9	M	Volume Calculation	Offsite in Ireland	ENVA Ireland Limited,WCP-DC-08-116-01	Clonminam Industrial Estate,Portlaoise,County Laois,".",Ireland	ENVA Ireland Limited,W0184-01,Clonminan Industrial Estate,Portlaois,County Laois,".",Ireland	Clonminan Industrial Estate,Portlaois,County Laois,".",Ireland
To Other Countries	16 01 07	Yes	4.886	Oil filters	R4	M	Weighed	Abroad	ENVA Ireland Limited,WCP-DC-08-116-01	Clonminam Industrial Estate,Portlaoise,County Laois,".",Ireland	R. D. Recycling,51727/1/KD,Centrum-Zuid,3017,Houthalen 3530,".",Belgium	Centrum-Zuid,3017,Houthalen 3530,".",Belgium
Within the Country	16 07 08	Yes	12.978	Oil Hoses	R4	M	Weighed	Offsite in Ireland	ENVA Ireland Limited,WCP-DC-08-116-01	Clonminam Industrial Estate,Portlaoise,County Laois,".",Ireland	Midland Scrap Metal Recycling,WMP 02/2008,Bellview Port,Waterford,".",".",Ireland	Bellview Port,Waterford,".",".",Ireland
To Other Countries	15 02 02	Yes	10.978	Solid Oily waste (rags/cloths)	D10	M	Weighed	Abroad	ENVA Ireland Limited,WCP-DC-08-116-01	Clonminam Industrial Estate,Portlaoise,County Laois,".",Ireland	KWA,E17012100,Graftstr,25 47475,Kamp-Linfort,".",Germany	Graftstr,25 47475,Kamp-Linfort,".",Germany
To Other Countries	15 02 02	Yes	8.87	Solid Oily waste (oil dri)	R1	M	Weighed	Abroad	ENVA Ireland Limited,WCP-DC-08-116-01	Clonminam Industrial Estate,Portlaoise,County Laois,".",Ireland	Lindenschmidt,E97095037, Krombacher Str 42-26,57223,Kreuztal,".",Germany	Krombacher Str 42-26,57223,Kreuztal,".",Germany
To Other Countries	07 06 08	Yes	3.29	Grease residues / sill bottoms	R1	M	Weighed	Abroad	ENVA Ireland Limited,WCP-DC-08-116-01	Clonminam Industrial Estate,Portlaoise,County Laois,".",Ireland	Lindenschmidt,E97095037, Krombacher Str 42-26,57223,Kreuztal,".",Germany	Krombacher Str 42-26,57223,Kreuztal,".",Germany
To Other Countries	16 05 04	Yes	0.29	Aerosols	R4	M	Weighed	Abroad	ENVA Ireland Limited,WCP-DC-08-116-01	Clonminam Industrial Estate,Portlaoise,County Laois,".",Ireland	REMONDIS,H0903790,Krautheim,".",".",".",Germany	Krautheim,".",".",".",Germany
To Other Countries	08 01 11	Yes	0.155	waste Paint/ paint cans	R3	M	Weighed	Abroad	ENVA Ireland Limited,WCP-DC-08-116-01	Clonminam Industrial Estate,Portlaoise,County Laois,".",Ireland	Nehlsen GmbH & Co. KG,D33300040,Riespot 4,28237 Bermen,".",".",Germany	Riespot 4,28237 Bermen,".",".",Germany
To Other Countries	11 01 13	Yes	0.862	degreasing wastes containing dangerous substances	R1	M	Volume Calculation	Abroad	Safety Kleen Ireland Limited,WCP-DC-09-1223-01	Unit 5,Airton Road,Tallagh,Dublin 24,Ireland	Solvent Resource Management Limited,TP/3334/SF,Weeland Road,Knottingley,West Yorkshire,WF11 8DZ,United Kingdom	Weeland Road,Knottingley,West Yorkshire,WF11 8DZ,United Kingdom
To Other Countries	15 01 10	Yes	6.882	Contaminated plastic drums	R12	M	Weighed	Abroad	Eco-Safe Systems Limited,WCP-DC-09-1203-01	Unit 1A,Allied Industrial Estate,Kylemore Road,Dublin 10,Ireland	JFC Plastics Limited,ER07199875,Unit 6 Goldicote Business Park,Stratford Upon Avon,Warwickshire,CV37 7NB,United Kingdom	Unit 6 Goldicote Business Park,Stratford Upon Avon,Warwickshire,CV37 7NB,United Kingdom

Transfer Destination	European Waste Code	Hazardous	Quantity (Tonnes per Year)	Description of Waste	Waste Treatment Operation	Method Used		Location of Treatment	Haz Waste : Name and Licence/Permit No of Next Destination Facility Non Haz Waste: Name and Licence/Permit No of Recover/Disposer	Haz Waste : Address of Next Destination Facility Non Haz Waste: Address of Recover/Disposer	Name and License / Permit No. and Address of Final Recoverer / Disposer (HAZARDOUS WASTE ONLY)	Actual Address of Final Destination i.e. Final Recovery / Disposal Site (HAZARDOUS WASTE ONLY)
						M/C/E	Method Used					
To Other Countries	15 01 10	Yes	1.91	Copper Sulphate Packaging	R3	M	Weighed	Abroad	Eco-Safe Systems Limited,WCP-DC-09-1203-01	Unit 1A,Allied Industrial Estate,Kylemore Road,Dublin 10,Ireland	ATM,No. 03/7623,NL 4782,PW Moerdijk,".",".",Netherlands	NL 4782,PW Moerdijk,".",".",Netherlands
To Other Countries	15 01 10	Yes	1.191	Xanthate Liner Packaging	R3	M	Weighed	Abroad	Eco-Safe Systems Limited,WCP-DC-09-1203-01	Unit 1A,Allied Industrial Estate,Kylemore Road,Dublin 10,Ireland	ATM,No. 03/7623,NL 4782,PW Moerdijk,".",".",Netherlands	NL 4782,PW Moerdijk,".",".",Netherlands
To Other Countries	15 02 02	Yes	6.779	Filter Cloths	R3	M	Weighed	Abroad	Eco-Safe Systems Limited,WCP-DC-09-1203-01	Unit 1A,Allied Industrial Estate,Kylemore Road,Dublin 10,Ireland	ATM,No. 03/7623,NL 4782,PW Moerdijk,".",".",Netherlands	NL 4782,PW Moerdijk,".",".",Netherlands
To Other Countries	16 06 01	Yes	7.198	Lead batteries	R4	M	Weighed	Abroad	Eco-Safe Systems Limited,WCP-DC-09-1203-01	Unit 1A,Allied Industrial Estate,Kylemore Road,Dublin 10,Ireland	G & P Batteries,SL 2035,Crescent Works,Willenhall Road,Darlaton,WS10 8JR,United Kingdom	Crescent Works,Willenhall Road,Darlaton,WS10 8JR,United Kingdom
To Other Countries	20 01 21	Yes	1.377	fluorescent tubes and other mercury-containing waste	R4	M	Weighed	Abroad	Eco-Safe Systems Limited,WCP-DC-09-1203-01	Unit 1A,Allied Industrial Estate,Kylemore Road,Dublin 10,Ireland	Claushuis Metals,MB/00091030/A,3899AH,Zeewolde,".",".",Netherlands	3899AH,Zeewolde,".",".",Netherlands
Within the Country	20 01 35	Yes	3.396	WEEE	R4	M	Weighed	Offsite in Ireland	Eco-Safe Systems Limited,WCP-DC-09-1203-01	Unit 1A,Allied Industrial Estate,Kylemore Road,Dublin 10,Ireland	The Recycling Village,WCP-MH-11-0005-01,Unit 21 Duleek Business Park,Commmons,Duleek,County Meath,Ireland	Unit 21 Duleek Business Park,Commmons,Duleek,County Meath,Ireland
To Other Countries	**18 01 03**	**Yes**	0.0046	Clinical waste	D10	M	Weighed	Abroad	Eco-Safe Systems Limited,WCP-DC-09-1203-01	Unit 1A,Allied Industrial Estate,Kylemore Road,Dublin 10,Ireland	SRCL Limited,CP 3930XL,Knowsthorpe Lane,Leeds,West Yorkshire,LS9 OPJ,United Kingdom	Knowsthorpe Lane,Leeds,West Yorkshire,LS9 OPJ,United Kingdom
Within the Country	20 01 25	No	1.104	edible oil and fat	R1	M	Weighed	Offsite in Ireland	Green BioFuels Ireland,P0829-01	Marshmeadows,New Ross,County Wexford,".",Ireland		
Within the Country	20 03 01	No	144.88	mixed municipal waste	D1	M	Weighed	Offsite in Ireland	AES,W0201-03	Drehid Landfill,Killinagh Upper,Carbury,County Kildare,Ireland		
Within the Country	17 01 07	No	284.14	mixture of concrete, bricks, tiles and ceramics other than those mentioned in 17 01 06	D1	M	Weighed	Offsite in Ireland	White River Landfill (Louth County Council),WL0060-02	White River Landfill ,Dunleer,County Louth,".",Ireland		
Within the Country	20 01 01	No	26.79	paper and cardboard	R5	M	Weighed	Offsite in Ireland	Panda Waste Services Limited,WPR 021/2	Ballymount Road,Walkinstown Road,Dublin 12,".",Ireland		
Within the Country	15 01 03	No	168.2	wooden packaging	R5	M	Weighed	Offsite in Ireland	Wilton Waste Recycling Limited,WFP-CN-10-0005-01(1)	Kiffa,Crosselough,Ballyjamesduff,County Cavan,Ireland		
To Other Countries	17 04 11	No	48.42	Scrap cable	R4	M	Weighed	Abroad	The Remet Company Limited,WML-80115 (DL409)	Cody Business Centre,9A Cody Road,Newham,London E16 4SR,United Kingdom		
To Other Countries	17 04 05	No	500.0	iron and steel	R4	M	Weighed	Abroad	FJ Church & Son Limited,EAWML/80771	Cantenary Works Manor Way,New Road Rainham,Essex,RM13 8RH,United Kingdom		
To Other Countries	17 04 05	No	529.04	iron and steel	R4	M	Weighed	Abroad	Hannah Metals Limited,CB/TE5300HW	Tanfield Industrial Park,Stanley,County Durham,DH9 9QF,United Kingdom		
Within the Country	16 01 03	No	110.66	end-of-life tyres	R5	M	Weighed	Offsite in Ireland	East Galway Waste Disposal Limited,WR 11-3	Lurgan,Killimore,Ballinasloe, County Galway,Ireland		

Transfer Destination	European Waste Code	Hazardous	Quantity (Tonnes per Year)	Description of Waste	Waste Treatment Operation	Method Used		Location of Treatment	Haz Waste : Name and Licence/Permit No of Next Destination Facility Non Haz Waste: Name and Licence/Permit No of Recover/Disposer	Haz Waste : Address of Next Destination Facility Non Haz Waste: Address of Recover/Disposer	Name and License / Permit No. and Address of Final Recoverer / Disposer (HAZARDOUS WASTE ONLY)	Actual Address of Final Destination i.e. Final Recovery / Disposal Site (HAZARDOUS WASTE ONLY)
						M/C/E	Method Used					
To Other Countries	15 01 01	No	7.934	Explosive paper and cardboard packaging	R5	M	Weighed	Abroad	Kruger Mills ,BJ 6666	Waterside,Disley,Stockport ,SK12 2HW,United Kingdom		

* Select a row by double-clicking the Description of Waste then click the delete button

Link to previous years waste data
Link to previous years waste summary data & percentage change

Appendix 2

Annual Safety Inspection Report of TMF

April 2012

BOLIDEN TARA MINES LTD

2011 Audit Tailings Dam Stages I, II, III, 4A and 4B

Submitted to:
Boliden Tara Mines Ltd
Knocknumber
Navan
Co. Meath
Ireland

REPORT

Report Number. 12514150008.500/A.0
Distribution:
Boliden Tara Mines Ltd - 8 copies plus 1 pdf
Golder Associates (UK) Ltd - 1 copy

Golder Associates

Executive Summary

Golder Associates (UK) Ltd has been retained by Boliden Tara Mines Limited to undertake the annual safety inspection audit for the Randalstown Tailings Management Facility (TMF). The annual auditing of the facilities commenced in the early 1990s and there is a considerable library of information relating to the performance of the TMF.

Tara Mines is Europe's largest zinc and lead mine located near the town of Navan in Co. Meath. The main orebody is hosted in Lower Carboniferous limestone and the process produces large quantities of tailings. Tara Mines typically produces between 2.6 and 2.7 million tonnes of ore per annum and approximately 60% of the tailings, 1.06 Mt, were discharged into the tailings facilities in 2011 whilst the remaining tailings were placed underground as backfill. Historically, approximately 48% to 52% of the mine tailings are discharged into the tailings facilities. The TMF has been built in five stages (I, II, III, 4A and 4B) during the period 1974 to 2006. Stage 5A is currently being constructed and Stage 5B will be constructed in the future.

Tara personnel have been undertaking the monitoring of the dam walls in accordance with Schedule 3(iv) of Tara's IPPC licence and the monitoring data is presented in Reference 1. As a significant proportion of the instruments were required to monitor the performance of the structure during construction and that Stages I, II and 4A are inoperative although potentially influenced by the construction of Stage 5A, recommendations regarding the future reporting of these instruments are made.

This audit report presents a discussion of the results of the monitoring data obtained between January 2011 and December 2011 and observations made during a site inspection visit on 25 January 2011 for Stages I, II, III, Stage 4A and Stage 4B.

The dam wall is in very good conditions showing no signs of distress. Vegetation both on the dam walls and perimeter interceptor channel needs to be managed to allow for visual inspection in the former case and to allow unhindered flow in the latter case. Areas of heavy gorse should be thinned to the extent that the wall can be visually inspected.

The instrumentation results obtained are within the normal range based on the design criteria as outlined in the report and these together, with observations made during the site inspection, indicate that the inactive dams and the active dam are in good operational condition.

There is reasonable correlation between the piezometric levels obtained by the vibrating wire piezometers and the Casagrande piezometers installed in the foundation tailings.

The piezometric levels in the downstream sectors of the Stage I, II, III, 4A and 4B dam walls are low or dry indicating that the internal drainage systems are working satisfactory. This also indicates that the factor of safety against dam wall stability failure of these structures is greater than 1.5 which is satisfactory. The piezometric levels in the glacial materials forming the foundations beneath the downstream shoulder of Stages I, II and III are low and indicate factors of safety against stability failure of these structures greater than 1.5 which is satisfactory. The piezometric levels in the foundation tailings beneath the downstream shoulders of Stages 4A and 4B indicate factors of safety against stability failure of these structures greater than 2 which is satisfactory.

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APPENDICES

1.0 INTRODUCTION

1.1 General

Golder Associates (UK) Ltd (Golder) has been retained by Boliden Tara Mines Limited (Tara Mines) to undertake the annual safety inspection audit for the Randalstown Tailings Management Facility (TMF).

Tara Mines is Europe's largest zinc and lead mine located near the town of Navan in Co. Meath. The main orebody is hosted in Lower Carboniferous limestone and the process produces large quantities of tailings. Tara Mines typically produces between 2.6 and 2.7 million tonnes of ore per annum and approximately 60% of the tailings, 1.06 Mt, were discharged into the tailings facilities in 2011 whilst the remaining tailings were placed underground as backfill. Historically, approximately 48% to 52% of the mine tailings are discharged into the tailings facilities. The TMF has been built in five stages during the period 1974 to 2006. Pre-Construction commenced on the sixth stage in the summer of 2011 and will be completed by the end of 2012.

Drawing 1 shows the site location and Drawing 2 shows the layout plan for the existing tailings dam facilities. All drawings are presented in Appendix A. Stages I and II were constructed to an elevation of 1584 m AMD (Above Mine Datum) filled and re-vegetated in 1988. Stage III was constructed between 1985 and 1987 to an elevation of 1584mAMD and was filled in March 2003. Construction of Stage 4A, a raised facility over the existing tailings in Stages I and II to an elevation of 1590mAMD, began in late summer of 1998 and was completed in July 2000. The Stage 4A tailings facility was filled by the end of 2006. The construction of Stage 4B to an elevation of 1590 m AMD, which is founded on the Stage III tailings, started in the summer of 2003 and the dam walls were completed in 2006. Stage 4B is currently operational. Stage 5A is being constructed above Stage 4A.

To date the total capacity of the tailings facilities, Stages I, II, III, 4A and 4B is approximately 35.6 Mt (25 Mm^3). Stage 5A and eventually Stage 5B will provide an additional storage of 2.34Mm^3 and 3.24Mm^3.

1.2 Report

Tara personnel have been undertaking the monitoring of the dam walls in accordance with Schedule 3(iv) of Tara's IPPC licence and the design recommendations and the monitoring data is presented in Reference 1. Graphical presentation of relevant data is presented in Appendix B. As a significant proportion of the instruments were required to monitor the performance of the structure during construction and that Stages I, II and 4A are inoperative, recommendations regarding the future reporting of these instruments are made in Section 6.

This audit report presents a discussion of the results of the monitoring data obtained between January 2011 and December 2011 and observations made during a site inspection visit on the 25th January 2012 for Stages I, II, III, Stage 4A and Stage 4B.

The following number and types of instruments are monitored.

Table 1: Monitoring Systems

Stage	Standpipe Piezometers	Vibrating Wire Piezometers	Inclinometers & Extensometers	Settlement & Monitoring Points	Weirs
I & II	20			93	6
III	30				6
4A	29	54	6	8	8
4B	33	47	10	12	5

The actual instruments monitored are tabulated in Appendix B.

To facilitate reporting and discussion of the monitoring data, Section 2 discusses Stages I and II, Section 3 with Stage 4A, whilst Section 4 with Stage III and Section 5 with Stage 4B. The summary of the general

condition of the tailings dams and recommendations relating to future monitoring procedures are discussed in Section 6.

2.0 MONITORING DATA, STAGES I AND II

2.1 General Observations

The dam wall is in good condition with no signs of distress. The grass could be better managed and shrubs have taken over significant areas of the slope particularly on the northern and eastern slopes. Moss has also started to displace grass in a number of areas.

Some very slight seepage/dampness was observed in the finger drains. Shrubs growing at the outlet of the finger drains should be thinned out. Also, shrubs growing along and adjacent to the perimeter interceptor channel should be thinned.

The perimeter road between the dividing wall and the south east corner of Stage 1 should be reinstated with a granular surface to provide access along this sector of the wall.

The base of the eastern perimeter interceptor channel (EPIC) should be cleaned of sediment and vegetation where possible. The channel is very deep in sections and access will be difficult. For the majority of its length, the perimeter interceptor channel is below the ground water level as indicated by the seepage indicators on both sides of the channel. No sloughing of the channel walls was observed although some minor erosion is present particularly where glacial till is exposed and not supporting vegetation.

2.2 Observations

Drawing 3 shows the plan location of the piezometers, seepage monitoring points and settlement points in Stages I and II.

The Casagrande standpipes, have generally been read at monthly intervals.

2.3 Seepage Observations

Drawings 3 and 6 indicate the plan locations of seepage monitoring points around the Stages I and II. There are six monitoring points in the EPIC around Stages I and II for which readings are available including immediately before the Sump 2125 formerly 3508 (Drawing 6) which collects most of its seepage water from the south and east walls of Stages I and II.

2.4 Interpretation of Piezometric Data

The piezometric elevations in Stages I and II to December 2011 are discussed below.

The monitored Casagrande piezometers in Stages I and II dam include surviving 'original' piezometers, as well as the additional piezometers installed at the end of construction of Stage 4A. There are no active piezometers in the divider dam wall separating Stages I & II from Stage III since tailings are present either side of the wall.

a) Stage I south dam: This includes 'original' piezometers 33, 34, 35 and 36, together with new piezometer 400F-cg, which monitor piezometric elevations close to the toe of the south dam wall. Piezometer 400F-cg is inoperative. The readings for the other piezometers indicate relatively low elevations typically between 1566.5 m AMD and 1570 m AMD, reflecting the presence of the nearby deepened Interceptor Channel. For part of the period 35 appears dry. Seasonal variations in readings are generally less than 1.0 m. Piezometer 34 dropped 2 m at the end of November but recovered by the next reading in December. This may be an error in reading.

   The second new piezometer, 400E-cg, at chainage 400, is close to the downstream crest edge of the dam, a short distance downstream from the chimney drain (Drawing 5b) and is dry.

b) Stages I and II east dams: This includes 'original' piezometers 61 and 63 (Drawing 3) and new piezometers 1000F-cg and 1600F-cg (Drawings 5c and 5d) which monitor piezometric elevations close to the toes of these dams. Piezometer 61 is fluctuating between 1573.7 m AMD and 1574.4 m AMD reflecting minor seasonal and rainfall intensity variations. Piezometer 63 appears to vary from 1574.5 m AMD to 1574.6 m AMD which are not too far of the base of the piezometer and these low values reflect the presence of the nearby deepened interceptor channel. The newer piezometer 1000F-cg gave readings between 1577.0 m AMD and 1577.5 m AMD before becoming non operational beyond June. 1600F-cg, gave values generally between 1577.4 m AMD and 1578.0 m AMD. The 'original' piezometers were installed at lower elevations and closer to the Interceptor Channel than the new piezometers and hence are more influenced by the Interceptor Channel draw down. These piezometers remained generally at constant elevation and the maximum fluctuations were no greater than 0.7 m during the period which is satisfactory.

'Original' piezometers 53, 54 and 62 and new piezometers 1000E-cg and 1600E-cg are close to the downstream crest edge of the dams (Drawings 3, 5c and 5d). The 'original' piezometer 53 shows a piezometric level generally between 1573.6 m AMD and 1574.0 m AMD. Piezometer 54 shows levels at elevations between 1575.5 m AMD and 1576.0 m AMD. These piezometers remained generally at constant elevation and the maximum fluctuations were no greater than 0.5m during the period.

The water level in piezometer 62 has been constant during the year from 1578.8 m AMD and 1578.9 m AMD. The piezometer appears non operational after June 2011. The water level in the piezometer has slowly increased from 1578.0 m AMD (effectively dry) to its current level of 1578.9 m AMD which is approximately 1.9 m above the piezometer base. This piezometer needs to be made operational or replaced.

The new piezometer, 1000E-cg, indicates a fluctuating water level from 1576.7 m AMD and 1577.5 m AMD. Piezometer 1600E-cg appears to be dry at 1577.1 m AMD.

c) Stage II north dam: 'Original' piezometers 65 and 67 (Drawing 3) and new piezometer 2200F-cg (Drawing 5e) monitor piezometric elevations close to the toe of the dam. Piezometer 65 shows piezometric heads of about 1.7 m above tip level and between 1574.1 m AMD (Dry) and 1575.8 m AMD, becoming dry in November 2011. Piezometer 67 shows a piezometric levels between about 1574.2 m AMD and 1575.1 m AMD. The new piezometer 2200F-cg indicates a piezometric level between 1579.1 m AMD and 1579.4 m AMD.

'Original' piezometer 66 and new piezometer 2200E-cg are close to the downstream crest edge of the dam (Drawings 3 and 5e). Piezometer 66 is dry and piezometer 2200E-cg currently appears to be dry.

In summary, the piezometric levels recorded by the 'original' and new piezometers in Stages I and II are stable and relatively low. It is apparent that the levels have not been affected by either the rise or fall in pond water level in Stage 4A. The water levels measured are within the design criteria which states that the phreatic surface in the downstream sector of the dam wall should not exceed two-thirds of the height of the dam wall for the safe operation of the facility.

2.5 Interpretation of Seepage Observations

The maximum cumulative seepage flow measurements along the eastern perimeter interceptor channel (EPIC) measured at Ch 2125 prior to entering the sump was 15.1 l/s in November 2011 and the minimum measured was 3.8 l/s in July. Much of the perimeter interceptor channel is below the ground water table resulting in a significant difference in the flow rates monitored during winter and summer.

Water quality is measured in the eastern perimeter interceptor channel and for station at chainage 2121 m immediately prior to the main sump at chainage 2125 m. The average, maximum and minimum values are tabulated below for pH and sulphate.

Table 2: pH and Sulphate Values for the EPIC

	pH	Sulphate
Average	8.0	480
Maximum	8.1	793
Minimum	7.9	7

The average sulphate value is about 20% lower than the average value recorded in 2010 with both the maximum and minimum values significantly lower. The values are also significantly below the sulphate values measured in the western perimeter interceptor channel as expected.

The elevated sulphate levels are partially derived primarily from the drainage system installed in Stage 4A which discharges into the EPIC via a series of manholes as discussed later together with seepage from the internal drainage system of Stages I and II. In terms of volume, the average seepage from the Stage 4A drainage system is currently only 0.14 l/s.

2.6 Monitoring Points

A series of monitoring points were installed on the downstream slope of Stage 1 at Chainages 525 m, 550 m, 575 m, 600 m, 650 m, 675 m and 700 m and between 12 and 14 points were monitored down the slope. The initial results were taken on the 22/12/2011 and based on the readings on the 07/03/2012, vertical movements were small and between +2mm (heave) and -4mm (settlement) in the vertical direction, between +4mm and -3mm in an easterly direction and between +3mm and -3mm in a northerly direction. These are within the general accuracy of the survey and the readings suggest no movement has occurred over this short period.

3.0 MONITORING DATA, STAGE 4A

3.1 General Observation

The dam wall is in very good conditions with no signs of distress or seepage observed. The grass is thriving along this stretch of dam wall.

3.2 Piezometric Observations

Drawing 3 shows the plan location of the piezometers and seepage monitoring points in Stage 4A. The plan shows the locations of the six instrument clusters at chainages 400, 1000, 1600, 2200, 2800 and 3400 used to monitor pore pressure development and movements during construction of Stage 4A. Also shown on the plan are the locations of three small clusters of vibrating wire piezometers installed at the upstream toe of the north-eastern corner of Stage 4A dam raise, at chainages 1670, 1820, and 1965, as well as individual vibrating wire piezometers installed at other chainages along the dam toe (with the exception at chainage 2880 where there are two piezometers).

Drawings 5a to 5g show the sections for the six instrument clusters. Drawing 5a is a typical section which provides a legend for the six cluster sections shown in Drawings 5b to 5g. The sections show the locations of vibrating wire piezometers installed in the tailings, inclinometers, combined inclinometers/extensometers, settlement plates and Casagrande standpipe piezometers.

Piezometers, both vibrating wire and Casagrande standpipes, have generally been read at every other month and monthly intervals.

3.3 Foundation Tailings and Dam Movement Observations

Drawing 4 shows plan locations of ground movement monitoring instruments in Stage 4A. These include the six instrument clusters, settlement plates and monitoring pegs installed at the upstream toe of Stage 4A dam

raise. As indicated earlier, Drawings 5a to 5g show sections for the six instrument clusters which include inclinometers, combined inclinometers/extensometers and settlement plates.

3.4 Seepage Observations

Drawing 3 indicates the plan locations of seepage monitoring points around the Stages 4A. Seepage flowing under and through the dam raise is collected in the downstream toe drain and discharged through 8 V-notch flow monitoring weirs shown in Drawing 3, along Stages I and II southern, eastern and northern dam walls. The collected seepages from these 8 weirs are then discharged to the perimeter interceptor channel along the downstream toe of Stages I and II. At the seepage collection points 33 and 37, along the divider dam next to Stage III (Drawing 3), pumps were installed to dispose of the seepage water to Stage 4B. For these two seepage points no V-notch weirs were installed and previously the amount of the seepage flow rate was obtained from monitoring the number of hours that the pumps were in operation. Since the start up of Stage 4B, these pumps have been disconnected and the seepage collection points are flooded or covered in tailings.

3.5 Interpretation of Piezometric Data

The piezometric elevations in Stages 4A, to December 2011, will be discussed in two sections:

- Stage 4A dam fill; and
- Tailings foundations of the Stage 4A dam raise.

3.5.1 Stage 4A Dam Fill

As shown in Drawings 5a to 5g, one Casagrande piezometer (A) was installed upstream of the chimney drain, a second Casagrande piezometer (B) was installed downstream of the chimney drain at the elevation of the top of the drainage blanket, and the third Casagrande piezometer (C) was installed close to (B) but around 0.7 m to 1.5 m higher, in the dam fill. Piezometer (D) was installed on the lower section of the downstream side of the dam wall above the drainage blanket and in the fill. It can be expected that piezometer (A), upstream of the chimney drain will respond to the rise in pond water level. Because of the sensitivity of the vibrating wire piezometers, they tend to respond rapidly to changes in pond water level (piezometric pressure). Those piezometers downstream of the chimney drain should read low piezometric values provided the chimney drain is functioning and any variations of level are most likely indicative of rainfall infiltration.

The pond water level rose during 2011 from 1587.0 m AMD to its current level at 1587.8 m AMD.

In cluster 400, the upstream piezometer (A) has been fluctuating through the year with a measured maximum piezometric head of 1588.0 m AMD which is slightly above the water level in Stage 4A. The minimum level recorded was 1585.1 m. This is not an issue to the stability of the dam as the upstream component of the dam wall is buttressed by the tailings.

In cluster 1000, the upstream piezometric level was 1586.3 m AMD at the end of 2011 and about 1.5 m below the water level in Stage 4A.

The upstream piezometric level in cluster 1600 fluctuated in 2011 from 1583.4 m AMD to 1584.8. The piezometric level at year end was 3.0 m below pond water level.

In cluster 2200, the upstream piezometer is currently reading 1583.6 m AMD some 3.4 m below the pond water level. The maximum water level measured through 2011 was 1583.7 m AMD and the minimum was 1583.5 m AMD.

In cluster 2800, the upstream piezometric head fluctuated between 1586.1 m AMD and 1587.6 m AMD. The final level is 0.2 m below the pond water level in Stage 4A.

The upstream piezometer in cluster 3400 is non operational as a result of construction activity on Stage 5A.

Generally, the piezometric surfaces upstream of the internal drainage system have varied between 1583.4 m AMD and 1588.0 m AMD. The variation in piezometric level upstream of the chimney drain is a function of the pond location and particularly, distance away from the dam wall. Also, the gradient through the fill forming the upstream shoulder of the dam wall steepens towards the chimney drain and therefore the piezometric reading will be dependent on the exact location of the piezometer in relation to the chimney drain. Other factors would be the depth of tailings adjacent to the wall and whether the tailings are fine slimes or the coarser total tailings. As discussed previously, the upstream dam wall is buttressed by the tailings and pond water so there are no stability issues on any of the upstream sections of the Stage 4 dam wall.

The majority the Casagrande standpipe piezometers installed downstream of the internal drainage system and in the fill B, C and D series are virtually dry or are impacted by rainfall infiltrating the surface of the dam wall as indicated by fluctuations in readings. This indicates that the internal drainage system is operating in accordance with the design intent. The more extensive fluctuations are listed below:

- 400C 1581.9 to 1583.4 m AMD.
- 1965B 1580.4 to 1582.3 m AMD.
- 1965D 1580.5 to 1582.4 m AMD..

These fluctuations do not impact on the overall stability of the dam walls.

The clusters at 2800 and 3400 which are located on the dividing wall between Stages 4A and 4B indicate that the downstream standpipes are responding to the movement in pond water as a consequence of operating Stage 4B. The rise in piezometric level on the downstream side of the dividing wall will not result in any stability issues as the downstream slope is buttressed by the water and tailings deposited in Stage 4B.

The downstream stability of the embankment is governed by the piezometric head in the downstream dam wall measured from the B and C series of piezometers. A stability sensitivity analysis has been undertaken to determine the acceptable level of head within the embankment for Stage 4A and Stage 4B. The analysis shows that the maximum acceptable level of piezometric head in the downstream shoulder of the dam wall under static conditions is 1587 m AMD, for which the corresponding factor of safety is 1.3. This would correspond to a piezometric head in the embankment wall equivalent to 60% of its height. However, this maximum piezometric head relates only to the head that would be read in the Casagrande piezometers B and C located directly downstream of the chimney drain. High piezometric levels in these would indicate that the drain is not functioning properly.

Under current conditions, the piezometric heads monitored in all piezometers in the dam wall of Stage 4A are acceptable in terms of the design criteria for the raise and that the internal drainage system is fully operational.

3.5.2 Tailings Foundations of the Stage 4A Dam Raise

The vibrating wire piezometers were installed in the foundation tailings to determine the rise in pore pressure during construction of the raise and have been continued to be monitored to determine the response of the piezometers due to the changes in pond water level.

Monitoring of the vibrating wire piezometers in the tailings foundations is undertaken to ensure that pore pressures are not excessive beneath the downstream toe of the Stage 4A raise caused by a rising pond water level. If the dam was completely impermeable, a rise in the pond water would result in an equal rise in the piezometric level in the foundation tailings. However, the dam raise, which incorporates a downstream drainage blanket, the existing Stages I and II dam walls or basin areas are not completely impermeable. Therefore, the actual response and the piezometric elevation are partly dependent on the location of the piezometer in terms of the distance from the upstream toe and hence pond water edge, distance from the drainage blanket and the depth of the piezometers. As a general guide, the piezometers closest to the upstream toe of the Stage 4A dam wall generally give higher piezometric levels reflecting the shorter seepage path from the pond water, further distance from the drainage blanket and the influence of the

potentially higher horizontal permeability of the tailings. The horizontal permeability of the tailings is anticipated to be at least ten times greater than the vertical permeability due to stratification during deposition. The deeper the piezometers are installed, generally the lower values of vertical permeability of the tailings for a given tailings grain size distribution can be expected which contribute to the variation in piezometric levels observed. Also, the piezometric levels are affected by any downward hydraulic gradient into the foundations and this would be considerably variable over the site.

3.5.2.1 Cluster 400

Cluster 400 shows a wide range of piezometric values both laterally across the base of the dam wall and vertically into the tailings. Generally, the piezometric levels were reasonably constant although that was some upward movement in the second half of the year in VW 400A and VW 400C as the pond water level rose from 1587 m AMD to 1587.8 m AMD.

Even though the pond water was reasonably stable for the year at 1587.0 m AMD, there tends to be peaks in the pore pressure response during the winter period. The largest fluctuation in piezometric pressure observed was in VW 400A, in the foundation tailings on the upstream side of the raise which varied between 1582.9 m AMD and 1584.8 m AMD. The current maximum difference in the piezometric level between the upstream toe piezometer and the deepest downstream piezometer is approximately 2.2 m. The lowest piezometric level is currently some 6.0 m (1581.0 m AMD (400B)) below the pond level. The highest 2011 piezometric level recorded was 1584.8 m AMD (400A) in the foundation tailings on the upstream dam side.

The piezometric levels in the foundation tailings on the downstream side of the dam wall were between 1581.8 m AMD and 1582.3 m AMD some 4.7 m below the pond water level. The piezometric levels in the downstream tailings foundation determine the overall stability of the dam wall raise.

3.5.2.2 Cluster 1000

The cluster at 1000 showed little fluctuation during the year. The highest readings were recorded in 1000G which varied between 1582 m AMD and 1582.5 m AMD and the lowest in 1000F which varied between 1578.6 m AMD and 1579.4 m AMD. These readings reflect the variable permeability of the tailings, the effectiveness of the internal drainage system in the dam wall and the general impact of a downward hydraulic gradient.

The piezometric levels in the foundation tailings on the downstream side of the dam wall were between 1581.6 m AMD and 1582.0 m AMD some 5m below the pond water level. The piezometric levels in the downstream tailings foundation determine the overall stability of the dam wall raise.

3.5.2.3 Cluster 1600

The cluster at 1600 clearly shows the impact of seasonal variations being at a maximum during the winter months. The variation observed were of the order of 1.7 m and is pressure related rather than due to seasonal rainfall.

The highest piezometric levels were measured in 1600D located in the foundation of the tailings on the downstream dam section of the raise. The levels monitored were between 1580.9 m AMD and 1582.6 m AMD some 4.4 m below the pond water level. The piezometric levels in the downstream tailings foundation determine the overall stability of the dam wall raise.

The lowest range of readings obtained was from 1600F and these values were between 1579.5 m AMD and 1581.4 m AMD.

3.5.2.4 Cluster 2200

The cluster at 2200 also reflects the seasonal affects, variable permeability of the tailings, the effectiveness of the internal drainage system in the dam wall and the general impact of a downward hydraulic gradient. The piezometric levels monitored in 2200E, upstream side of dam raise, varied between 1581.5 m AMD and 1583.2 m AMD which were generally the highest readings.

The lowest ranges of readings were obtained in 2200H located in the downstream foundations of the raise and were between 1580.7 m AMD and 1582.2 m AMD some 4.8 m below the pond water level. The piezometric levels in the downstream tailings foundation determine the overall stability of the dam wall raise.

3.5.2.5 Cluster 2800

The cluster at 2800, located on the dividing wall between Stages 4A and 4B show response to the increase in pond water level in Stage 4B. The highest piezometric level monitored is some 1.0 m below the Stage 4B pond water level and 0.2 m above the Stage 4A pond water level in December 2011. There has been a noticeable increase in the piezometric level reflecting the rise in pond water of Stage 4B which is operational and at a level of 1588.2 m AMD at the end of 2011. The lowest Stage 4B water level recorded during 2011 was 1586.0 m. The downstream piezometric levels in cluster 2800 are also rising with the pond level rise in Stage 4B. Levels have generally increased by 1.5 m. As the pond water continues to rise in Stage 4B, it can be expected that the piezometric levels will also increase. However, this will not result in instability of the dam wall as both the upstream and downstream sectors will be supported by the adjacent tailings and pond water.

3.5.2.6 Summary

The piezometric levels in the downstream tailings foundation of the dam wall will affect the long term stability of the dam wall except for the dividing wall between Stages 4A and 4B. The stability analysis indicates that as the piezometric level in the downstream sector of the foundation tailings increases, the factor of safety decreases as illustrated below.

Table 3: Piezometric Elv. vs FoS

Piezometric Elv. m AMD	Factor of Safety (Static)
1588.0	1.08
1587.5	1.20
1587.0	1.31
1586.5	1.40
1586.0	1.78
1584.0	2.00
1583.5	2.25

It is clear that the piezometric elevation in the tailings foundation on the downstream side of the dam wall should not exceed 1587 m or approximately 1.5 m below the maximum permissible pond water level. The recent monitoring data indicates that the maximum piezometric level in the downstream foundation tailings of the dam raise was 1582.6 m AMD (4.4 m below the current pond level at 1587.0 m AMD) which would indicate a current factor of safety greater than 2 for the Stage 4A raise which is satisfactory.

3.5.3 Selected Piezometers

A number of vibrating wire piezometers are currently monitored along the upstream toe section of the dam wall which were installed to monitor construction pore pressures and include: 120A; 340A; 1480A; 1670A and D; 1740A; 1820A, C, and D; 1920A; 1965A, C, and D; 2060A; 2850A; 2880A and B, and 3160A.

Piezometers 120A and 340A indicate maximum readings of 1580.9 m AMD and 1580.5 m AMD respectively. Piezometer 1670A, installed in the tailings foundations indicated a maximum value of 1581.2 m AMD while 1670D installed in the fill has been declining through the year and is currently reading 1581.8 m AMD. Piezometer 1820A, installed in the tailings foundations, has fluctuated through the year from a low value at tip level of 1580.3 m AMD to its current value of 1581.6 m AMD which are lower than measured in 2010.

Piezometers 1480A, 1740A, 1920A and 2060A also fluctuate but are all reading below 1582.0 m AMD.

Piezometers 2850 A, 2880A and 2880B are reading maximum values in 2011 between 1584.1 m AMD and 1584.7 m AMD which is below the pond water level in Stage 4B at 1588.2 m AMD. The piezometric level

have been reasonably constant reflecting the minimal movement of pond water level over the year. Piezometer 3160A is at a level of 1583.7 m AMD which is 4.5 m below the pond level in Stage 4B.

All of the above vibrating piezometers are located in the tailings foundation, on the upstream side of the dam raise wall and as such do not impact on the stability of the Stage 4A dam wall. Reading from these instruments should cease until Stage 5A is in operation.

Standpipe piezometers, 1865C, 1915C and 1960C are installed into the base of the fill and are effectively dry. Two standpipes have been installed at chainage 1965 (Standpipe B and D) into the tailings and these fluctuate by a maximum of 1.5 m due to seasonal affects.

3.5.4 Interpretation of Foundation Tailings and Dam Movement Observations

As indicated earlier, horizontal movements are monitored by inclinometers. Vertical movements are monitored by extensometers and settlement plates bi-annually. All the original monitoring pegs have now been buried by tailings and a total of 6 inclinometers have been buried (400A, 1000A, 1600A, 2200A, 2800A, and 3400A).

The location and initial elevation of the eight monitoring stations that were installed to replace the monitoring pegs buried by tailings are tabulated below.

Table 4: Monitoring Point Chainage and Elv.

Chainage South Wall	Elevation	Chainage North Wall	Elevation
200	1590.598	2050	1590.731
East Wall		**Middle Wall**	
600	1590.559	2500	1590.58
1100	1590.559	2900	1590.641
1600	1590.815	3400	1590.641

These have been impacted by the construction of Stage 5A and will be reinstated after the completion of the raise.

There were some serious issues with the inclinometer probe which ceased to operate during 2010 and the last readings measured were in August 2010. All the inclinometers have been recalibrated using an inclinometer probe from another manufacturer which was not completely compatible with the previous probe. Ten readings have been obtained since a new probe was used for monitoring.

Where heave has occurred from the data, this is possibly a result of survey error.

1) Horizontal movements recorded by inclinometers: Over the monitoring period, the inclinometers have indicated very small effective movements which are generally less than 10 mm.

2) Vertical movements monitored by extensometers: Over the monitoring period, only marginal vertical settlements (up to 4 mm) have been recorded by the extensometers from the previous readings.

3) Vertical movements monitored by the new monitoring points: Over the monitoring period, no discernible vertical settlement trends have been recorded by these points.

The movements discussed above have no impact on the integrity of the structure. To be of concern there would need to be a rapid change in movement over the six monthly monitoring periods or a gradual trend over a period of years. Once commenced, movement needs to be continuous and increasing over the monthly period. A trigger in terms of magnitude of movement would be 25 mm to 50 mm horizontal and 20 mm to 30 mm vertical over a six monthly period.

3.5.5 Interpretation of Seepage Observations

The seepage data from the eight monitoring points in Stage 4A (MH1-Weir 1, MH5-Weir 2, MH9-Weir 3, MH13-Weir 4, MH17-Weir 5, MH21-Weir 6, MH25-Weir 7, MH29-Weir 8) flow rates in the region of 0.0 l/s during the dry periods and up to a maximum of 1.3 l/s in MH 1-Weir 1. The flow rate in Weir 1 is significantly higher than the other weirs monitored and has increased with rising pond water level in Stage 4B. This weir is close to the Stage 4B on the southern sector and it would appear that it is influenced by the water level rise in Stage 4B. The design of the drainage systems operate separately but it is possible that water might be entering the slope protection material on Stage 1 and bypassing the clay plug installed where the toe drain use to be or alternatively it is entering the chimney drain along the dividing wall and discharging in Weir 1. The likely source for the seepage is the manhole in the vicinity of the reclaim pumps in Stage 5B. All other areas are covered in tailings which would throttle flow. The lowest flow recorded from this weir was 0.42 l/s which would also suggest that the flow rate is also influenced by seasonal affects (rainfall).

The second highest flow was recorded from Weir 8 (MH 29) which is adjacent to the Stage 4B in the northern sector. The peak flow measured was 0.32 l/s which is twice the flow recorded in Weir 5, the next highest flow rate.

The average flow all the weirs is 0.14 l/s although if Weir 1 was removed, the average flow would be only 0.06 l/s.

Eventually, the seepages monitored in Weir 1 will reduce as tailings infill the low spot created at the location of the reclaim pumps. Tara is also intending to pump the reclaim sump, housing the reclaim pumps, to reduce the water level in April 2012 to expose the manhole and then backfill the structure with concrete.

The seepage flows in Stage 4A have pH values between 6.7 and 8.5, which is similar to pH values monitored in 2010. The average sulphate levels were between 572 mg/l and 766 mg/l although the maximum and minimum values were 1599 mg/l and 13 mg/l. The sulphate values are similar to those obtained in 2010.

The results for the various periods are tabulated below for pH and sulphate in mg/l.

Table 5: pH and Sulphate Readings

	Feb-11		Jun-11		Aug-11		Nov-11	
	pH	Sulphate	pH	Sulphate	pH	Sulphate	pH	Sulphate
Average	7.4	572	7.7	751	7.6	756	7.7	766
Max	7.8	1329	8.3	1599	8.3	1599	8.5	1339
Min	6.9	16	6.9	13	6.7	62	7.0	18

The average sulphate readings are 50% of the values monitored in the active phase of Stage 4B (Table 10).

Four of the manholes, 9, 12, 15 and 29 gave low sulphate readings which were generally below 300 mg/l.

4.0 MONITORING DATA STAGE III

4.1 General Observation

The dam wall is in good condition with no signs of distress. The grass could be better managed and moss has started to grow in a number of areas. The moss absorbs water and makes the dam wall appear wet. A trial pit was excavated in the surface of the dam wall to a depth of 400 mm where moss had established at approximate chainage 2260 (Drawing 11) to determine whether the moss was growing as a consequence of the dam wall fill being wet. The trial pit indicated that the fill material was not wet but the moss was saturated.

Some very slight seepage/dampness was observed in the finger drains. Shrubs growing at the outlet of the finger drains should be thinned out. Also, shrubs growing along the northern sector of the dam wall and perimeter interceptor channel should be thinned.

A minor surface slough has occurred in the southern slope of the perimeter interceptor channel at approximate chainage 2400. This has not impeded the flow in the channel.

4.2 Piezometric Observations

Drawing 6 shows plan locations of five clusters of standpipe piezometers and seepage monitoring points in Stage III. Drawings 7a to 7e show the sections for the five clusters.

4.3 Seepage Observations

As indicated earlier, Drawing 6 shows the locations of the seepage monitoring points in the Interceptor Channel around Stage III. As discussed earlier, seepage flow into the sump at chainage 2125 emanates mostly from the eastern interceptor channel around Stages I and II. Seepage flow from Stage III is monitored from the adjacent weir at chainage 2128 (formerly 3507). Other weirs are at chainage 3025 m, chainage 3609 m and 3610 m (formerly 2139 m and 2140 m respectively), chainage 4045 m and chainage 4585 m. Sump at 3609 - 3610 (yellow river) collects seepage along the western interceptor from 3440 to 4980 and previously discharged directly into Stage 3. In July 03, to facilitate the construction of Stage 4B, seepage collected in this sump was pumped southward along the interceptor channel and pumped into Stage 4A from the sump at 2128. Since December 2007, the seepage flow into sump at 3609 - 3610 is pumped directly into Stage 4B.

4.4 Discussion

4.4.1 Interpretation of Piezometric Observations

The piezometric elevations observations will be discussed for each of the five clusters. Prior to the Stage 4B operation, the pond water elevation in Stage III remained around 1580.5 m AMD to 1582 m AMD. Stage 4B is now in operation and the pond water level has risen to 1588.2 m AMD in 2011.

All upstream piezometers were blocked due to 4B construction but they have been repaired and monitored since June 2005.

a) Cluster 1: These show little movement in piezometric elevations in either the dam wall or foundations. Piezometer 3/1/1 in the upstream shoulder of the dam shows a piezometric levels between 1575.1 m AMD and 1576.0 m AMD, some 12.2 m below the maximum pond level in Stage 4B.

   Piezometers 3/1/2 and 3/1/5 in the downstream shoulder of the dam are probably dry. Piezometers 3/1/4 and 3/1/6 are in the foundations under the downstream shoulder of the dam. They show some variation in water level through the year of between 0.5m and 1.6m or 1569.6 m AMD and 1572 m AMD.

   Piezometer 3/1/3 has been reactivated but shows no seasonal variation and is probably blocked. This instrument should be blown out and a rising head test undertaken or replaced.

b) Cluster 2: Piezometer 3/2/1 level has undergone minimal (<0.2 m) fluctuation in 2011 with a maximum level at 1574.3 m AMD. The level in Piezometer 3/2/4 has also undergone little fluctuation around 1573.7 m AMD to 1574.1 m AMD. The water level in Piezometer 3/2/3 is between 1571.5 m AMD and 1572.5 m AMD and similar to the 2010 readings.

   The others piezometers show little change in piezometric elevations in comparison with the previous period. The level in Piezometer 3/2/2 in the downstream shoulder of the dam was between 1573.4 m AMD and 1573.8 m AMD effectively dry for most of the monitoring period. The level in Piezometer 3/2/5 in the foundations under the downstream shoulder of the dam was between 1571.2 m AMD and 1571.5 m AMD.

Piezometer 3/2/6, under the downstream toe of the dam, shows water levels at 1567.9 m AMD at the beginning of the year, rising to 1569.3 m AMD by mid-year before dropping throughout the second half of the year to 1568.4 m AMD. The values are being influenced by rainfall infiltration/rise in groundwater. This piezometer appears to be effectively dry at the end of 2011.

c) Cluster 3: Piezometer 3/3/1 in the upstream shoulder of the dam indicated a piezometric elevation at between 1574.8 m AMD and 1575.2 m AMD in 2011. This is over 13 m below the pond water level.

The level in Piezometer 3/3/4 has also undergone little fluctuation around 1573.0 m AMD. The water level in Piezometer 3/3/3 also shows little fluctuation around 1569.1 m AMD and 1569.3 m AMD and similar to the 2010 readings.

The others piezometers show little change in piezometric elevations in comparison with the previous period. The level in Piezometer 3/3/2 in the downstream shoulder of the dam was between 1573.5 m AMD and 1573.9 m AMD effectively dry for most of the monitoring period. The level in Piezometer 3/3/5 in the foundations under the downstream shoulder of the dam was between 1569.1 m AMD and 1569.3 m AMD.

Piezometer 3/2/6, under the downstream toe of the dam, shows water levels between 1567.5 m AMD and 1569.2 m AMD and is being influenced by rainfall infiltration/rising groundwater.

d) Cluster 4: Piezometer 3/4/1 in the upstream shoulder of the dam indicated a piezometric elevations between 1574.0 m AMD and 1575 m AMD which is some 13.2m below the pond water level.

Piezometers 3/4/2 and 3/4/4 in the downstream shoulder of the dam show little change and are reading at an approximate elevation of 1575.0 m AMD to 1575.7 m AMD and 1572.2 m AMD to 1572.6 m AMD respectively. The other piezometers below the downstream shoulder of the dam, 3/4/3, 3/4/6 show little change and are reading at an approximate elevation of 1568.3 m AMD. Water level in Piezometer 3/4/5 varied between 1564.8 m AMD and 1568.36 m AMD and is being influenced by rainfall infiltration.

e) Cluster 5: Piezometers 3/5/1 in the upstream shoulder of the dam indicated a piezometric elevations between 1572.9 m AMD and 1573.3 m AMD which is some 15 m below the pond water level.

Piezometers 3/5/2 and 3/5/4 in the downstream shoulders of the dam show little change from the previous period at respectively 1568.9 m AMD and 1571.6 m AMD. Piezometers 3/5/3, 3/5/5 and 3/5/6 in the foundations under the downstream shoulder of the dam fluctuated throughout the year between 1564.0 m AMD and 1566.1 m AMD, which is a similar elevation to the 2010 starting water level.

The piezometers located in the upstream shoulder of the dam have had a varied response to the pond water changes measured in Stage 4B during 2011. Any of the increases in the piezometric levels monitored has no impact on the stability of the structure.

The piezometers in the downstream shoulder of the dam are either dry or giving low values indicating that the internal drainage system is fully operational. The water levels measured are within the design criteria which states that the phreatic surface in the downstream sector of the dam wall should not exceed two-thirds of the height of the dam wall for the safe operation of the facility.

4.4.2 Interpretation of Seepage Observations

The peak flow rates measured in the six V notch weirs of the western perimeter interceptor channel (WPIC), (chainages 2128 m, 3025 m, 3609 m, 3610 m, 4045 m and 4585 m) were for some weirs generally lower than those measured during the previous period. This is shown particularly at the V notch weir at chainage 3610 on the west dam wall. All the weirs show seasonal variations in cumulative flow rate.

The maximum cumulative seepage flow measurements along the western perimeter interceptor channel, prior to discharge into the sump peaked in December with a value of 6.4 l/s at Ch 2128. Although the highest value recorded in September was 6 l/s at Ch 4045, it is suspected that this may have been an error. During the dry periods flows dropped to 1 l/s.

Water quality is measured in the western perimeter interceptor channel and the results for pH and sulphate in mg/l are given below for the average, maximum and minimum values.

Table 6: pH and Sulphate Values for the WPIC.

	pH	Sulphate
Average	7.8	1342
Maximum	8.0	1860
Minimum	7.6	592

The sulphate values are slightly less than obtained in 2010. The average sulphate value for the WPIC is over two times the average value obtained for the EPIC.

5.0 MONITORING DATA STAGE 4B

5.1 General Observations

The dam wall is in very good conditions with no signs of distress or seepage observed. The grass is thriving along this stretch of dam wall.

5.2 Piezometric Observations

Drawing 8 shows plan locations of the six clusters of piezometer and seepage monitoring points in Stage 4B. Drawings 9a to 9f show sections for the clusters and these are termed 150, 510, 850, 1300, 1750 and 2200 based on their chainage location. Drawing 10 shows a typical section for the arrangement of the Casagrande standpipe piezometers. Readings have generally been obtained on a monthly basis.

5.3 Foundation Tailings and Dam Movement Observations

Drawing 11 shows plan locations of ground movement monitoring instruments in Stage 4B. These include the six instrument clusters, settlement plates and monitoring pegs installed at the upstream toe of Stage 4B dam raise. Drawings 9a to 9f also show sections for the six instrument clusters which include inclinometers, combined inclinometers/ extensometers and settlement plates.

Generally, the inclinometers/extensometers have been read quarterly and the settlement monitoring stations every 6 months but as previously stated there has been serious issues monitoring the inclinometers.

5.4 Seepage Observations

Drawing 8 shows the locations of the seepage monitoring points in Stage 4B. Seepage flowing under and through the dam raise is collected in the downstream toe drain and discharged through 5 V-notch flow monitoring weirs shown in Drawing 8, along Stages III dam walls. The collected seepages from these 5 weirs are then discharged to the perimeter interceptor channel along the downstream toe of Stage III.

5.5 Discussion

5.5.1 Interpretation of Piezometric Observations

The majority of the piezometers were installed in the tailings foundation of the Stage 4 dam raise, but a few were installed in the dam fill to measure any construction porewater pressures. Typically each of the six clusters would consist of five Casagrande piezometers and seven vibrating wire piezometers. The piezometric elevations in Stage 4B to December 2010 will be discussed in two groups.

- Stage 4B dam fill; and
- Tailings foundations for the Stage 4B dam raise.

5.5.2 Stage 4B Dam Fill

Vibrating wire piezometers were installed in the fill at Cluster 150, 850, 1300, 1750 and 2200 to measure construction pore pressures. If the fill is partially saturated, then the readings are likely to be erroneous.

The vibrating wire piezometers VW150G, VW150H, VW850H, are non operational. VW 510G is recording a piezometric head below the installation depth at 1583.4 m AMD. VW850G recorded a maximum value of 1585.2 which is slightly above (0.5m) the 2010 reading at the end of 2010. VW1300F recorded a maximum value of 1583.72 m AMD which is only 0.2m above its installation level and the minimum value recorded is below the installation level. VW1750H at an elevation of 1586.5 m AMD is indicating a maximum value of 1587.1 m AMD. VW2200G at an elevation 1584.02 m AMD and VW 2200H at an elevation of 1586.5 m AMD indicated maximum levels in 2011 of 1584.8 m AMD and 1588.0 m AMD respectively. During the 2011 monitoring period, the pond water in Stage 4B has risen from 1586.6 m AMD to 1588.2 m AMD. The piezometric levels recorded in the downstream fill do not reflect the rise in pond water level and indicate the internal drainage system is operating as per the design.

After completion of construction Casagrande standpipe piezometers were installed into the dam fill. The standpipe piezometers installed were SP150D and F; SP850D and F; SP1300D and F; SP1750D and F, and SP2200D and F.

SP150D was dry while SP 150F fluctuated between dry and 1584.6 m AMD. SP500D was dry and SP 500F fluctuated between dry and 1584.0 m AMD. SP850D is effectively dry. SP850F is fluctuating between dry and 1585.8 m AMD and is probably affected by rainfall penetration. SP1300D is dry. SP1300F is fluctuating between dry and 0.7 m above the tip (1584.7 m AMD). SP 1750D and F are dry as are 2200D and F.

The standpipe piezometers are more reliable than the vibrating wire piezometers and indicated that the downstream sector of the dam wall is dry and the internal drainage system is operating in accordance with the design. The majority of standpipe piezometers were installed at about an elevation of 1584 m AMD and based on the results the phreatic surface is below this level. The two highest values recorded in the vibrating wire piezometers were from VW1750 installed at a level of 1586.5 m AMD and VW2200H installed at a level of 1586.5 m AMD. The values were 1587.1 m AMD and 1588.2 m AMD respectively. These values appear onerous compared to the standpipe readings from the same location. This is probably due to the fill being only partially unsaturated at the level the instruments were installed at.

5.5.3 Tailings Foundations and at the Upstream Toe of Stage 4B Dam Raise

The vibrating wire piezometers were installed in the foundation tailings to determine the rise in pore pressure during construction of the raise and have been continued to be monitored to determine the response of the piezometers due to the changes in pond water level. After completion of construction standpipe piezometers were installed into the tailings foundations. The maximum pond water level in Stage 4B in 2011 was 1588.2 m AMD and as the pond water is rising, the vibrating wire and Casagrande standpipe piezometers installed into the foundation tailings are slowly responding.

Monitoring of the vibrating wire piezometers in the tailings foundations is undertaken to ensure that pore pressures are not excessive beneath the downstream toe of the Stage 4B raise caused by a rising pond water level. If the dam was completely impermeable, a rise in the pond water would result in an equal rise in the piezometric level in the foundation tailings. However, neither the dam raise which incorporates a downstream drainage blanket nor the existing Stages III dam walls or basin areas are completely impermeable. Therefore, the actual response and the piezometric elevation are partly dependent on the location of the piezometer in terms of the distance from the upstream toe and hence pond water edge, distance from the drainage blanket and the depth of the piezometers. As a general guide, the piezometers closest to the upstream toe of the Stage 4B dam wall generally give higher piezometric levels reflecting the shorter seepage path from the pond water, further distance from the drainage blanket and the influence of the potentially higher horizontal permeability of the tailings. The horizontal permeability of the tailings is anticipated to be at least ten times greater than the vertical permeability due to stratification during deposition. The deeper the piezometers are located, generally the lower expected values of the vertical permeability of the tailings for a given tailings grain size distribution and the potential effects on the

piezometric level as a result of a downward hydraulic gradient into the foundations although this is considerably variable.

Cluster 150 shows a reasonably narrow range of vibrating wire piezometric values both laterally across the base of the dam wall and vertically into the tailings. The piezometric levels have been rising with the rise in the pond water level. The range in variation of maximum piezometric levels is between 1585.3 m AMD (VW150B) and 1582.4 m AMD (VW150F). Piezometer VW150B is 2.9 m below the pond water level. Piezometer VW150E, located in the downstream tailings foundations is at 1582.9 m AMD or 5.3 m below the pond water level.

The Casagrande standpipe piezometer SP150A indicate a piezometric level of 1584.7 m AMD which has slowly increased and is slightly lower than the vibrating wire piezometers installed in the tailings foundations upstream of the chimney drain. Standpipe piezometer, SP150C, and SP150E indicated maximum piezometric levels of 1583.4 m AMSL and 1583.9 m AMSL respectively. SP150E recorded a maximum piezometric level some 1m higher than that recorded in the vibrating wire piezometers VW150E.

Cluster 500 shows a narrow range of piezometric values both laterally across the base of the dam wall and vertically into the tailings. The piezometric levels have been rising with the rise in the pond water level. The range in variation of maximum piezometric levels is between 1584.1 m AMD (VW510B) and 1583.1 m AMD (VW510D). Piezometer VW510D is 5.1 m below the pond water level. Piezometer VW510E, located in the downstream tailings foundations is at 1583.9 m AMD or 4.3 m below the pond water level.

The Casagrande standpipe piezometer SP510A, B and C are following similar paths, slowly increasing with increasing pond water level and at the end of the year varied between 1583.4 m AMD and 1583.9 m AMD which are similar to the vibrating wire piezometers installed in the tailings foundations upstream of the chimney drain. Standpipe SP510E recorded a maximum piezometric pressure in the downstream tailings foundations of 1583.9 m AMD which is the same as recorded in VW510E.

Cluster 850 shows a relatively narrow range of piezometric values both laterally across the base of the dam wall and vertically into the tailings. The piezometric levels have been rising with the rise in the pond water level. The range in variation of maximum piezometric levels is between 1584.7 m AMD (VW850A) and 1582.6 m AMD (VW850E). Piezometer VW850A is 3.5 m below the pond water level. Piezometer VW850E, located in the downstream tailings foundations is recording a piezometric pressure at 1582.6 m AMD or 5.7 m below the pond water level.

The Casagrande standpipe piezometer SP850A, C and E have been rising with the increase in pond water level. During the year, the maximum piezometric level in SP850A was at an elevation of 1584.1 m AMD, some 4.2 m below the pond water level. SP850C is showing significant fluctuation as in 2010. The maximum and minimum levels recorded in 2011 were 1588.0 m AMD and 1582.6 m AMD and there is therefore a likely problem with the instrument. A typical cause for such fluctuations in a piezometer is infiltration by rainfall. This will need to be checked by the Tara personnel responsible for monitoring the facility and if necessary, the instrument should be replaced. SP850E recorded a maximum piezometric level of 1583.3 m AMD, which is above 0.7 m above VW850E and some 4.9 m below the pond water level.

Cluster 1300 shows a reasonably narrow range of piezometric values both laterally across the base of the dam wall and vertically into the tailings. The piezometric levels have been rising with the rise in the pond water level. The range in variation of maximum piezometric levels is between 1583.5 m AMD (VW1300C) and 1581.6 m AMD (VW1300B). Piezometer 1300C is 4.7 m below the pond water level. Piezometer VW1300E, located in the downstream tailings foundations recorded a piezometric level at 1582.2 m AMD or 6 m below the pond water level.

The Casagrande standpipe piezometers SP1300A, B and C and E indicate a very slow rise in piezometric levels with pond raise. The maximum levels from A, B and C piezometers recorded in 2011 were between 1583.0 m AMD and 1583.3 m AMD. SP1300E recorded 1583.3 m AMD some 4.9 m below the pond water level. This level is 1.1 m higher than recorded in VW1300E.

Cluster 1750 shows a wide range of piezometric values both laterally across the base of the dam wall and vertically into the tailings. The piezometric levels have been rising with the rise in the pond water level. The

range in variation of maximum piezometric levels is between 1582.9 m AMD (VW1750A) and 1580 m AMD (1750VWAD). Piezometer VW1750A is 4.3 m below the pond water level. Piezometer VW1750E is no longer operational.

The Casagrande standpipe piezometer SP1750A, C, and E indicate a very slow rise in piezometric levels with pond raise. The maximum levels from piezometers A and C were between 1581.2 m AMD and 1581.9 m AMD. SP1750E recorded 1581.8 m AMD some 6.4 m below the pond water level.

Cluster 2200 shows a wide range of piezometric values both laterally across the base of the dam wall and vertically into the tailings. The piezometric levels have been rising with the rise in the pond water level. The range in variation of maximum piezometric levels is between 1584.9 m AMD (VW2200A) and 1580.8 m AMD (VW2200F). Piezometer VW2200A is 3.3 m below the pond water level. Piezometer VW2200E, located in the downstream tailings foundations recorded a maximum piezometric level at 1582.5 m AMD or 5.7 m below the pond water level.

The Casagrande standpipe piezometer SP2200A B, C and E indicate a steady rise in piezometric levels with pond raise. The maximum levels recorded from piezometers A, B and C were between 1583.9 m AMD and 1583.3 m AMD. SP2200E recorded a maximum level of 1584.3 m AMD although this seems out of place compared to the general trend of progressive rising. The last reading indicated a piezometric level of 1583.0 m AMD which appears more appropriate. This value is 0.5 m greater than the level recorded in VW2200E. The difference in the maximum and minimum values in SP2200E is 3.7 m and the lower values may be in error. Similar low readings on the same dates were obtained SP 2000B and 2000C.

The piezometric levels in the downstream tailings foundation of the dam wall will affect the long term stability of the dam wall except for the dividing wall between Stages 4A and 4B. The stability analysis indicates that as the piezometric level in the downstream sector of the foundation tailings increases, the factor of safety decreases as illustrated below.

Table 7: Piezometric Elv. vs FoS

Piezometric Elv.mAMD	Factor of Safety (Static)
1588.0	1.08
1587.5	1.20
1587.0	1.31
1586.5	1.40
1586.0	1.78
1584.0	2.00
1583.5	2.25

It is clear that the piezometric elevation in the tailings foundation on the downstream side of the dam wall should not exceed 1587 m or approximately 1.5 m below the maximum permissible pond water level. The pond water level in Stage 4B is at a maximum of approximately 1588.2 m AMD. The piezometric levels recorded in the series E standpipe piezometers in the downstream tailing foundations are variable and between 1581.8 m AMD and 1583.9 m AMD or 6.4 m and 4.3 m below the pond water level at the time of measurement. From the vibrating wire piezometers, the variation in piezometric level was between 1582.2 m AMD and 1583.8 m AMD.

From Table 7, the factor of safety would be about 2 which is satisfactory.

5.5.4 Selected Piezometers

A number of piezometers are currently monitored along the upstream toe section of the dam wall which were installed to monitor construction pore pressures and include: 78A; 84B; 89C; 100A and B; 263.5AD; 264A and B; 340A; 344B; 420A and B; 452AD; 525AD; 580A and B; 675A and B; 760A and B; 770CD; 980A and B; 1054.5A and B; 1200B; 1201A; 1201CD; 1390A and B; 1480A and B; 1570A and B; 1670A, B and CD; 1840A and B; 1930A and B; 2020A, B and CD; 2110A and B; 2290A and B; 2380A and B.

All of these piezometers are located in the tailings foundation, located on the upstream side of the dam raise wall and as such do not impact on the stability of the dam wall. Reading from these instruments should cease until Stage 5B is in operation.

5.5.5 Interpretation of Foundation Tailings and Dam Movement Observations

As indicated earlier, horizontal movements are monitored by inclinometers and vertical movements are monitored by extensometers and settlement plates.

Monitoring stations were also installed during construction of Stage 4B in 2004/5 and the chainage and post construction elevation (2007) are tabulated below.

Table 8: Monitoring Point Chainage and Elv.

Chainage South Wall	Elevation	Chainage North Wall	Elevation
1750B	1590.457	150B	1590.423
2200B	1590.497	500B	1590.460
West Wall			
850B	1590.381		
1300B	1590.468		

There were some serious issues with the inclinometer probe which ceased to operate during 2010 and the last readings measured were in August 2010. All the inclinometers have been recalibrated using an inclinometer probe from another manufacturer which was not completely compatible with the previous probe. Six readings have been obtained since a new probe was used for monitoring.

Where heave has occurred from the data, this is possibly a result of survey error.

- Horizontal movements recorded by inclinometers: Over the monitoring period, the inclinometers have indicated very small effective movements which are generally between 5 mm and 10 mm.
- Vertical movements monitored by extensometers: Over the monitoring period, only marginal vertical settlements (up to 10 mm) have been recorded by the majority of the extensometers. However, 500C indicated movements of approximately 100 mm. The majority of movement was between readings taken between February and March 2012 and therefore is likely an error in the March readings. These will be checked. The extensometer at 150B indicated a settlement of 50 mm between December 2010 and February 2012 and because the settlement is similar for each point it is assumed to be erroneous. This will also be checked.
- Vertical movements monitored by the new monitoring points: Over the monitoring period, no discernible vertical settlement trends have been recorded by these points.

The movements discussed above have no impact on the integrity of the structure. To be of concern there would need to be a rapid change in movement over the six monthly monitoring periods or a gradual trend over a period of years. Once commenced, movement needs to be continuous and increasing over the monthly period. A trigger in terms of magnitude of movement would be 25 mm to 50 mm horizontally and 20 mm to 30 mm vertically over a six monthly period.

5.5.6 Interpretation of Seepage Observations

The seepage data from the five monitoring points in Stage 4B (MH44-Weir 1, MH48-Weir 2, MH52-Weir 3, MH56-Weir 4 and MH60-Weir 5 indicate an increase in flow rate from the previous monitoring period. Maximum flow rates were between 0.07 l/s and 0.2l/s and minimum flow rates were between 0.0 l/s and 0.05 l/s. The trend of the data follows the rise in water level in the pond and the peaks could be attributed to

high rainfall events. The flow rates should be assessed over a long dry period to accurately determine seepage from the pond.

Monitoring of pH indicates values ranging from 7.5 and 7.9 and sulphates from a lower bound value of 1156 mg/l to a maximum of 2002 mg/l. The average sulphate value measured The sulphate values are fluctuating due to seasonal affects and have slightly increased compared to 2010. The results for the various periods are tabulated below.

Table 9: pH and Sulphate Readings

	Feb-11		Jun-11		Aug-11		Nov-11	
	pH	Sulphate	pH	Sulphate	pH	Sulphate	pH	Sulphate
Average	7.6	1242	7.7	1588	7.6	1663	7.8	1390
Maximum	7.7	1402	7.8	1795	7.6	2002	7.9	1390
Minimum	7.5	1156	7.7	1371	7.5	1422	7.7	1390

The average values increase during the summer period as expected and decrease in winter due to the increase rainfall.

6.0 SUMMARY AND RECOMMENDATIONS

6.1 Dam Condition and Performance

The dam wall is in very good conditions showing no signs of distress. Vegetation both on the dam walls and perimeter interceptor channel needs to be managed to allow for visual inspection in the former case and to allow unhindered flow in the latter case. Areas of heavy gorse should be thinned to the extent that the wall can be readily viewed from the perimeter access road. Areas of moss on the dam wall should be treated and removed otherwise the plant will displace the grass.

The instrumentation results obtained are within the normal range based on the design criteria and these together, with observations made during the site inspection, indicate that the inactive dams and the active dam are in good operational condition.

There is reasonable correlation between the piezometric levels obtained by the vibrating wire piezometers and the Casagrande piezometers installed in the foundation tailings.

The piezometric levels in the downstream sectors of the Stage I, II, III, 4A and 4B dam walls are low or dry indicating that the internal drainage systems are working satisfactory. This also indicates that the factor of safety against dam wall stability failure of these structures is greater than 1.5 which is satisfactory. The piezometric levels in the glacial materials forming the foundations beneath the downstream shoulder of Stages I, II and III are low and indicate factors of safety against stability failure of these structures greater than 1.5 which is satisfactory. The piezometric levels in the foundation tailings beneath the downstream shoulders of Stages 4A and 4B indicate factors of safety against stability failure of these structures greater than 2 which is satisfactory.

6.2 Instrumentation Monitoring Programme

Recommendations are given regarding the frequency of monitoring and other actions which must conform to Schedule (iv) of the IPPC licence.

6.2.1 Stages I and II

- All standpipe piezometers should be monitored on a monthly basis due to the ongoing construction activity.

- Piezometer 62 needs to be made operational or replaced.
- All settlement monitoring points on the dam crest should be read quarterly for changes of elevation.
- The monitoring points on the dam slope between chainage 525 to 700 should be measured quarterly for lateral and vertical movements.
- The weirs in the eastern perimeter interceptor channel should be checked for leakage and sediment and vegetation removed from the base.
- Seepage from weir monitoring points in the eastern perimeter interceptor channel should be measured on a monthly basis together with pH and sulphates. Additional chemical analyses should be read quarterly and include conductivity, suspended solids, lead, zinc, pH and sulphates.

6.2.2 Stages 4A

- Vibrating wire piezometers in the clusters should be monitored on a monthly basis due to the ongoing construction activity.
- A number of vibrating wire piezometers are currently monitored along the upstream toe section of the dam wall (non cluster) which were installed to monitor construction pore pressures and include: 120A; 340A; 1480A; 1670A and D; 1740A; 1820A, C, and D; 1920A; 1965A, C, and D; 2060A; 2850A; 2880A and B, and 3160A. The monitoring of these piezometers should cease until the Stage 5A is operational.
- All standpipe piezometers should be monitored on a monthly basis due to the construction activity.
- New standpipe piezometers should be installed in the downstream tailings foundations of Stage 4A at chainages 0, 200, 400, 600, 800, 1000 1200, 1400, 1600 1800, 2000, 2200 and 2400. A total of 13 standpipes piezometers and they should be installed adjacent to the D series of Standpipe piezometers and 2.5 m into the tailings and which is approximately 2.5 m below the blanket drain.
- The inclinometers/extensometers should continue to be read at least monthly due to the construction activity.
- All settlement monitoring points on the dam crest should be read quarterly for changes of elevation.
- Seepage from weir monitoring points should continue to be measured on a monthly basis. The chemical analyses should be read quarterly and include conductivity, suspended solids, lead, zinc, pH and sulphates.
- The weirs should be checked for any leakage.
- Stage 4A pond level, rainfall, pH, conductivity and sulphate level should continue to be monitored on a quarterly basis.

6.2.3 Stage III

- All standpipe piezometers should be monitored on a monthly basis.
- A new piezometer should be installed adjacent to 3/1/3.
- All settlement monitoring points on the dam crest should be read quarterly for changes of elevation.
- The weirs in the western perimeter interceptor channel should be checked for leakage and sediment and vegetation removed from the base.
- Seepage from weir monitoring points in the western perimeter interceptor channel should be measured on a monthly basis together with pH and sulphates. Additional chemical analyses should be read quarterly and include conductivity, suspended solids, lead, zinc, pH and sulphates.

6.2.4 Stage 4B

- The vibrating wire piezometers in the clusters should be read on a quarterly basis.
- A number of piezometers are currently monitored along the upstream toe section of the dam wall which were installed (non cluster) to monitor construction pore pressures and include: 78A; 84B; 89C; 100A and B; 263.5AD; 264A and B; 340A; 344B; 420A and B; 452AD; 525AD; 580A and B; 675A and B; 760A and B; 770CD; 980A and B; 1054.5A and B; 1200B; 1201A; 1201CD; 1390A and B; 1480A and B; 1570A and B; 1670A, B and CD; 1840A and B; 1930A and B; 2020A, B and CD; 2110A and B; 2290A and B; 2380A and B. The monitoring of these piezometers should cease until the Stage 5B is operational.
- All standpipe piezometers should be read on a monthly basis.
- The inclinometers/extensometers should be read quarterly.
- All settlement monitoring points on the dam crest should be read quarterly for changes in elevation.
- Seepage from weir monitoring points should continue to be measured on a monthly basis. The chemical analyses should be measured quarterly and include conductivity, suspended solids, lead, zinc, pH and sulphates.
- The weirs should be checked for any leakage.
- Stage 4B pond level, rainfall, pH, conductivity and sulphate level should continue to be monitored on a quarterly basis.

7.0 REFERENCES

1) Boliden Tara Mines: Record of Instrumentation Monitoring Results, Stages, I, II, III, 4A and 4B Tailings Dams, for the Period up to the end of December 2011.

Report Signature Page

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APPENDIX A

Drawings

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Figure 9c	Cross-Section of Instrument Cluster 850
Figure 9d	Cross-Section of Instrument Cluster 1300
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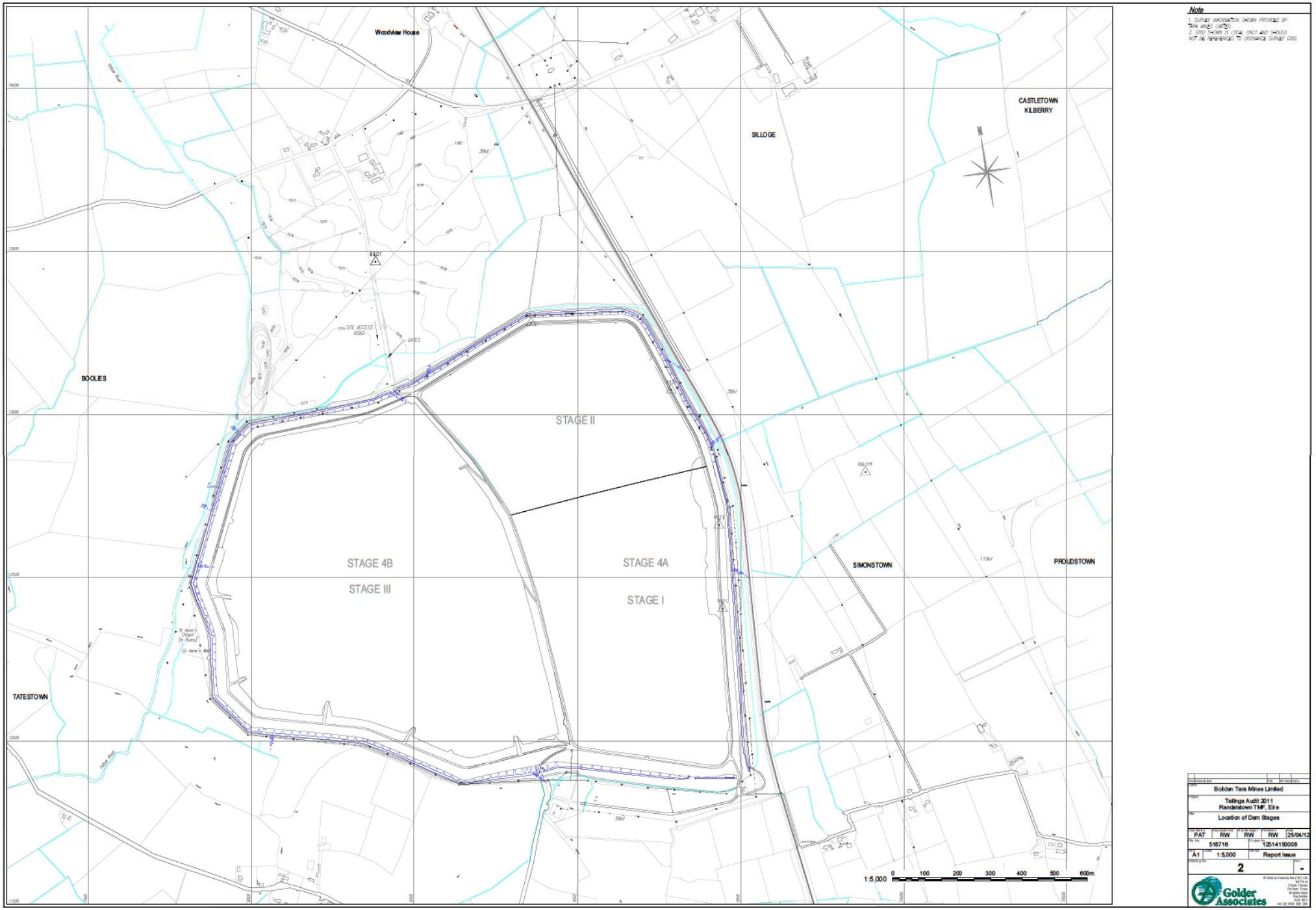
Figure 10	Casagrande Piezometer Section
Figure 11	Location of Stage 4B Ground Movement Monitoring Instruments

Client	Boliden Tara Mines Limited	Created by: PAT	Requested by: RW	Proj Manager: RW	Reviewer: RW	Date: 25/04/12
Project	Tailings Audit 2010 Randalstown TMF, Eire	File No.: 518741		Project No.: 12514150008		
		Size: A4	Scale: Not to scale	Status: Report Issue		
Title	Site Location Plan	Drawing No.: 1				Rev: -

Golder Associates



Note

1. SURVEY INFORMATION SHOWN PROVIDED BY TARA MINES LIMITED.
2. GRID SHOWN IS LOCAL ONLY AND SHOULD NOT BE REFERENCED TO ORDNANCE SURVEY GRID.

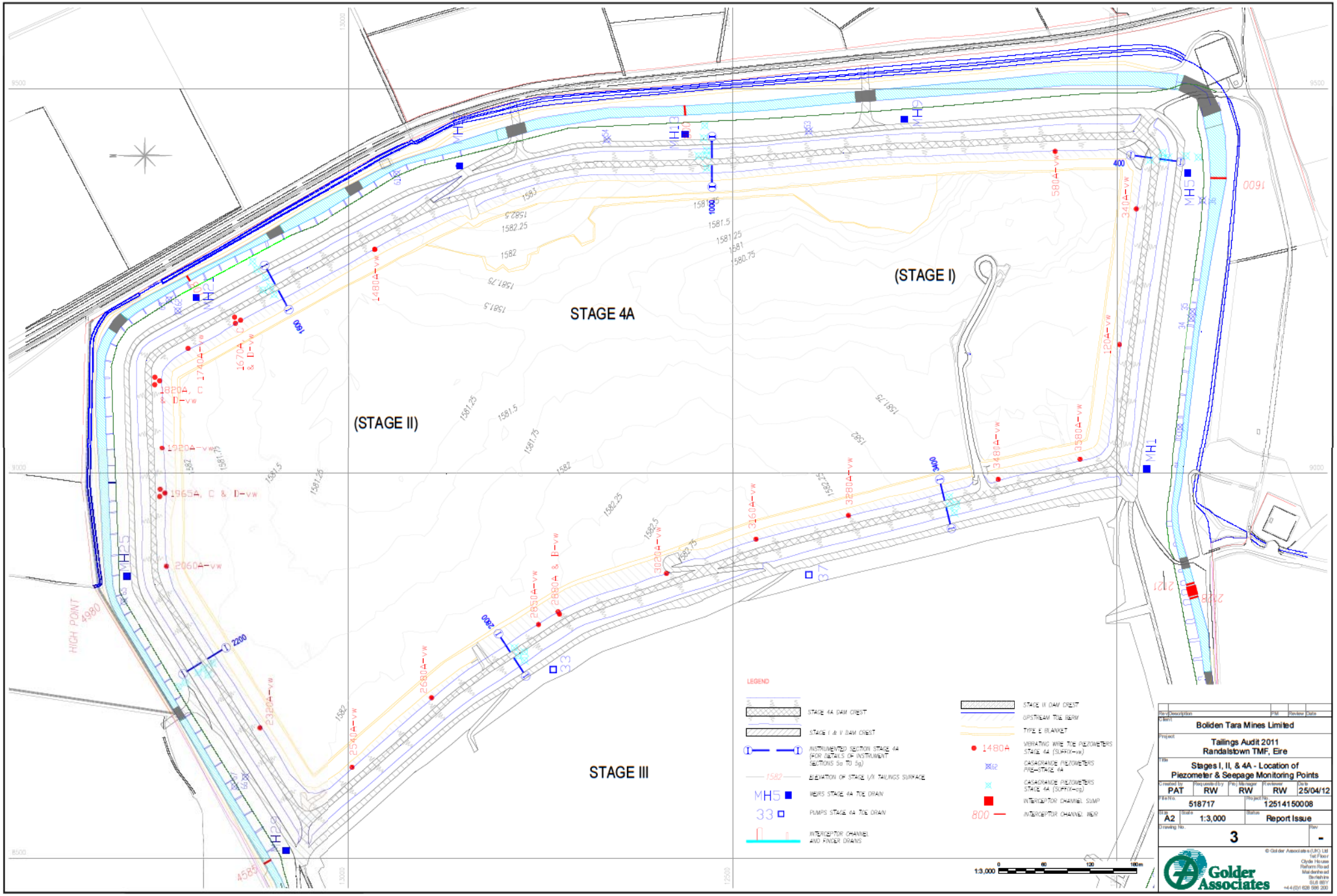
Bolden Tara Mines Limited

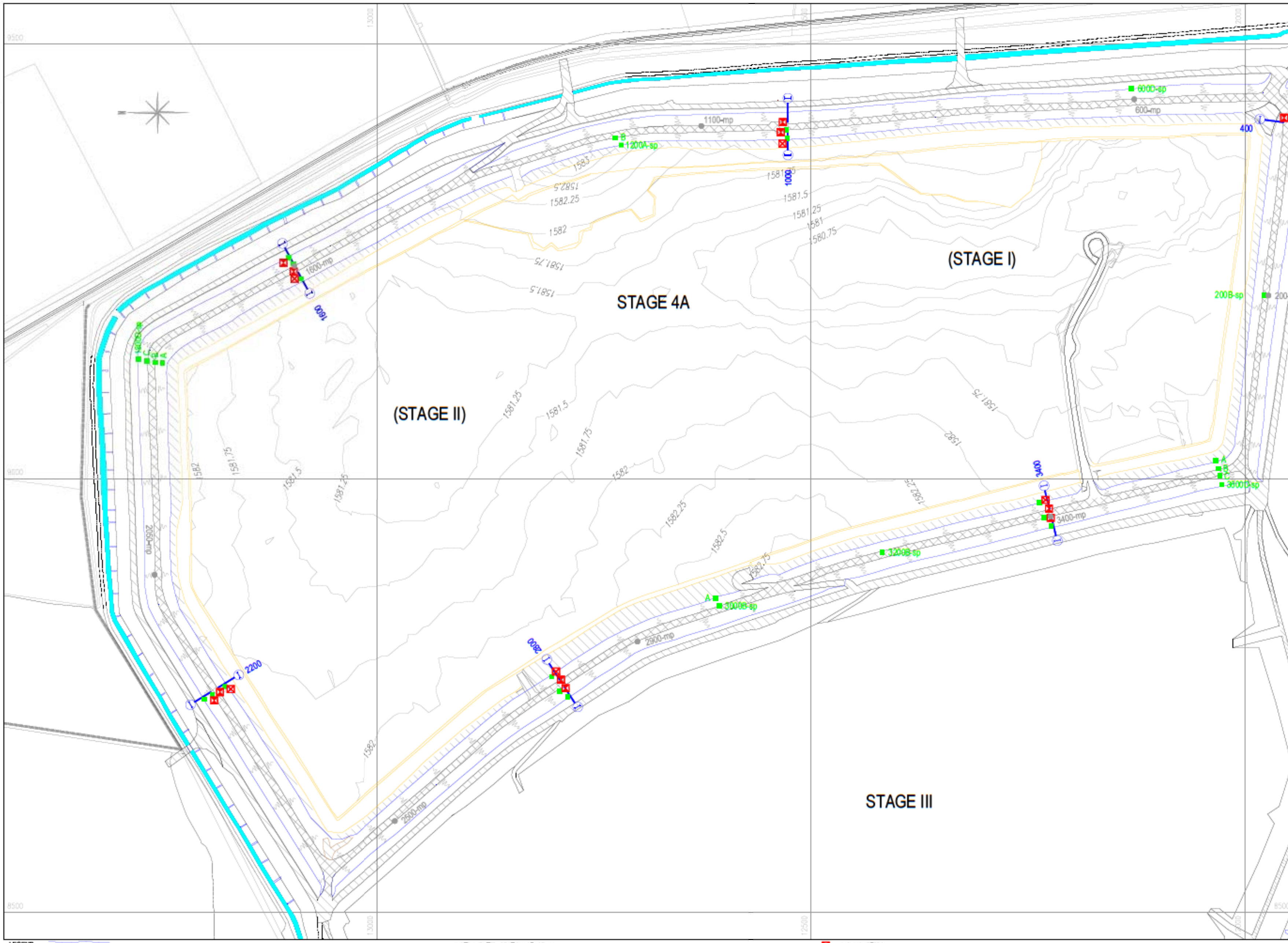
Tailings Audit 2011
Randalstown TMF, Eire

Location of Dam Stages

PAT	RW	RW	25/04/12
518716		1251415008	
A1	1:5,000	Report Issue	
2		-	

Golder Associates


STAGE 4A
(STAGE I)
(STAGE II)
STAGE III
MH1
MH2
MH5
MH25
HIGH POINT 4980
LEGEND
STAGE 4A DAM CREST
STAGE I & V DAM CREST
INSTRUMENTED SECTION STAGE 4A (FOR DETAILS OF INSTRUMENT SECTIONS 5a TO 5g)
ELEVATION OF STAGE I/V TAILINGS SURFACE
WEIRS STAGE 4A TOE DRAIN
PUMPS STAGE 4A TOE DRAIN
INTERCEPTOR CHANNEL AND FINGER DRAINS
UPSTREAM TOE BERM
TYPE E BLANKET
VERTICAL WIRE TOE PIEZOMETERS STAGE 4A (SUFFIX –vw)
CASAGRANDE PIEZOMETERS PRE-STAGE 4A
CASAGRANDE PIEZOMETERS STAGE 4A (SUFFIX –cg)
INTERCEPTOR CHANNEL SUMP
INTERCEPTOR CHANNEL WEIR
1:3,000
Boliden Tara Mines Limited
Tailings Audit 2011
Randalstown TMF, Eire
Stages I, II, & 4A - Location of Piezometer & Seepage Monitoring Points
Created by PAT
Req'd/Edit'd by RW
Proj. Manager RW
Reviewed RW
Date 25/04/12
File No. 518717
Project No. 12514150008
Size A2
Scale 1:3,000
Status Report Issue
Drawing No. 3
Rev -
Golder Associates



LEGEND

Symbol	Description
	STAGE 4A DAM CREST
	STAGE I & II DAM CREST
	STAGE III DAM CREST
	UPSTREAM TOE BERM
	TYPE E BLANKET
	INSTRUMENTED SECTION STAGE 4A (FOR DETAILS OF INSTRUMENT SECTIONS SEE FIGURES 5a TO 5g)
	INTERCEPTOR CHANNEL AND FINGER DRAINS
200-mp	MONITORING PEGS APRIL 2005(SUFFIX—mp)
1582	ELEVATION OF STAGE I/II TAILINGS SURFACE
1200A-sp	SETTLEMENT PLATES (SUFFIX—sp)
	INCLINOMETERS
	INCLINOMETERS / EXTENSOMETERS

NOTE: OBSOLETE INSTRUMENTS NOT SHOWN ON THIS FIGURE

1:3,000 — 0, 60, 120, 180m

Rev	Description	PM	Review	Date

Client: Boliden Tara Mines Limited

Project: Tailings Audit 2011, Randalstown TMF, Eire

Title: Location of Stage 4A Ground Movement Monitoring Instruments

Created by	Requested by	Proj Manager	Reviewer	Date
PAT	RW	RW	RW	25/04/12

File No.	Project No.
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Size	Scale	Status
A2	1:3,000	Report Issue

Drawing No.	Rev
4	-

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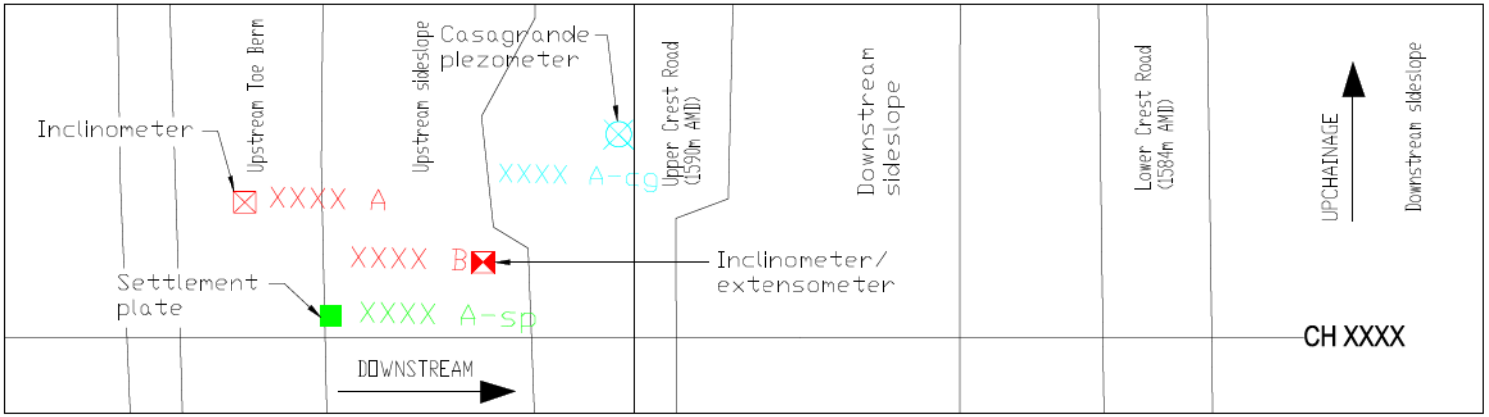
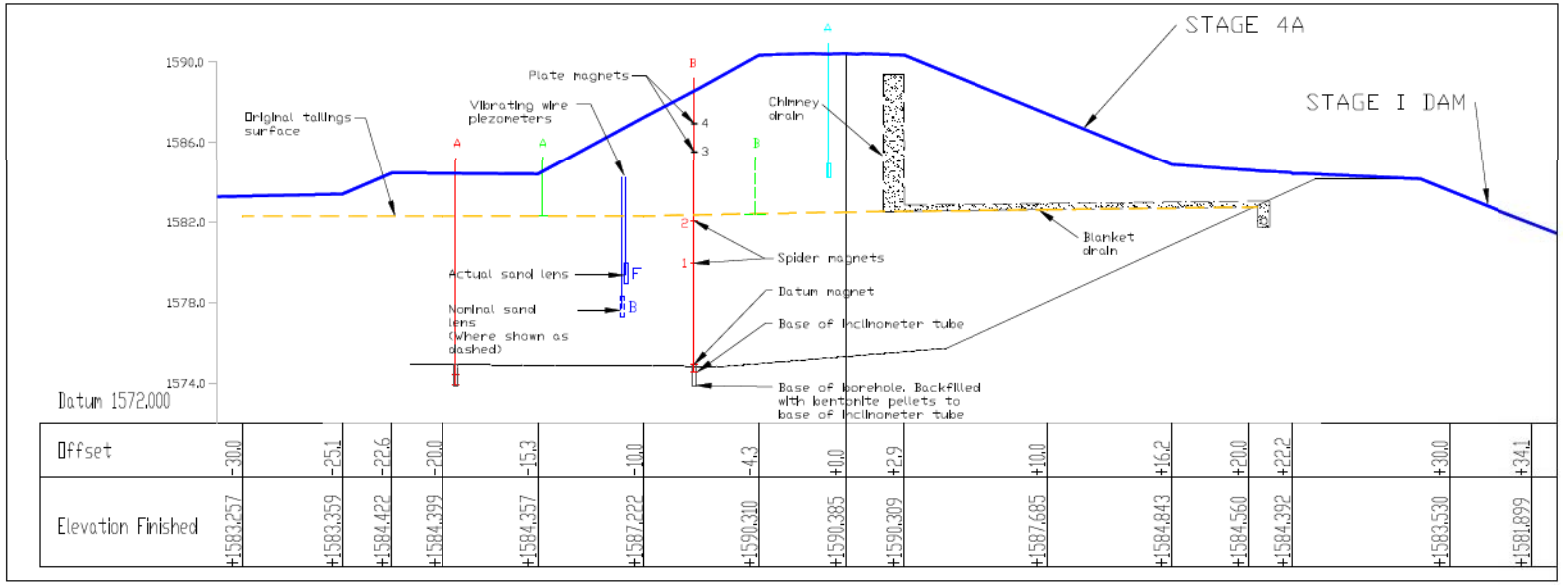


PLAN



SECTION

NOTE:

Instruments shown as dashed are obsolete (damaged or buried). Location is schematic.

1:250 0 5 10 15m

Rev	Description	PM	Review	Date

Client: Boliden Tara Mines Limited

Project: Tailings Audit 2011
Randalstown TMF, Eire

Title: Typical Cross Section, Stage 4A
Legend For Instrument Clusters (DWG. 5b - 5g)

Created by	Requested by	Proj Manager	Reviewer	Date
PAT	RW	RW	RW	25/04/12

File No.	Project No.
518719	12514150008

Size	Scale	Status
A3	1:250	Report Issue

Drawing No.: 5a

Rev: -

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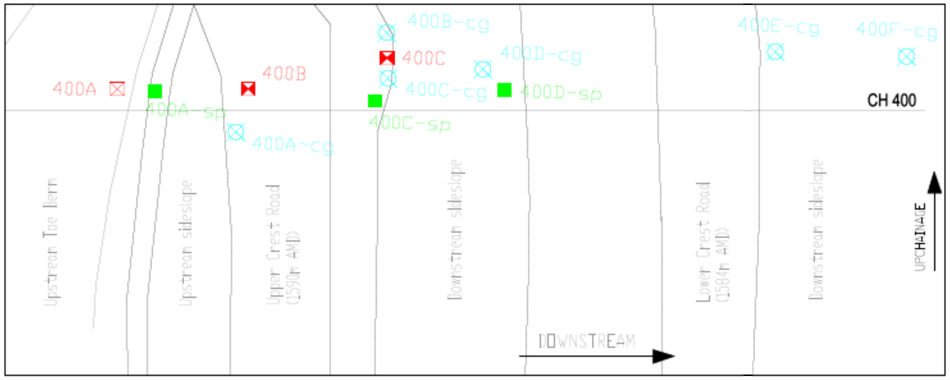
+44 (0)1628 586 200

NOTES

1. Instruments shown as dashed are absolete (damaged or buried). Location is schematic.
2. For legend see Figure 5a.



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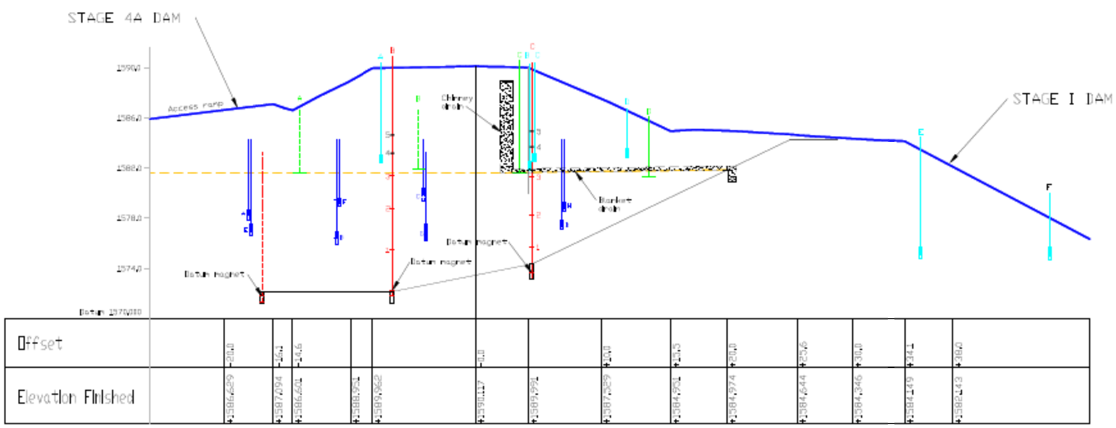

SECTION

Chainage 400				
Instrument ID	Type	Initial Elevation at		Elevation at top
400 A	inclinometer (obsolete)	1571.36	inclo tube base	buried
400 B	inclinometer/extensometer	1572.88	datum magnet	1590.94
400 C	inclinometer/extensometer	1573.67	datum magnet	1590.38
400 A -vw	vibrating wire piezometer	1578.24	piezometer tip	cable to terminal box
400 B -vw	vibrating wire piezometer	1576.39	piezometer tip	cable to terminal box
400 C -vw	vibrating wire piezometer	1579.80	piezometer tip	cable to terminal box
400 D -vw	vibrating wire piezometer	1576.57	piezometer tip	cable to terminal box
400 E -vw	vibrating wire piezometer	1576.96	piezometer tip	cable to terminal box
400 F -vw	vibrating wire piezometer	1579.20	piezometer tip	cable to terminal box
400 G -vw	vibrating wire piezometer	1576.35	piezometer tip	cable to terminal box
400 H -vw	vibrating wire piezometer	1576.80	piezometer tip	cable to terminal box
400 A -sp	settlement plate (buried)	1581.59	plate	
400 B -sp	settlement plate (buried)	1581.89	plate	
400 C -sp	settlement plate	1581.64	plate	
400 D -sp	settlement plate	1581.32	plate	
400 A -cg	casagrande piezometer	1582.39	piezometer tip	1590.41
400 B -cg	casagrande piezometer	1581.83	piezometer tip	1590.31
400 C -cg	casagrande piezometer	1582.49	piezometer tip	1590.38
400 D -cg	casagrande piezometer	1582.84	piezometer tip	1586.70
400 E -cg	casagrande piezometer	1575.05	piezometer tip	1584.46
400 F -cg	casagrande piezometer	1575.00	piezometer tip	1580.04

INSTRUMENT CLUSTER TABLE

1:200 0 4 8 12 16 20 24m

Boliden Tara Mines Limited

Tailings Audit 2011
Randalstown TMF, Eire

Cross Section, Stage 4A, South Dam
Instrument Cluster 400

PAT	RW	RW	RW	25/04/12
518720		12514150008		
A1	1:200	Report Issue		
5b			-	

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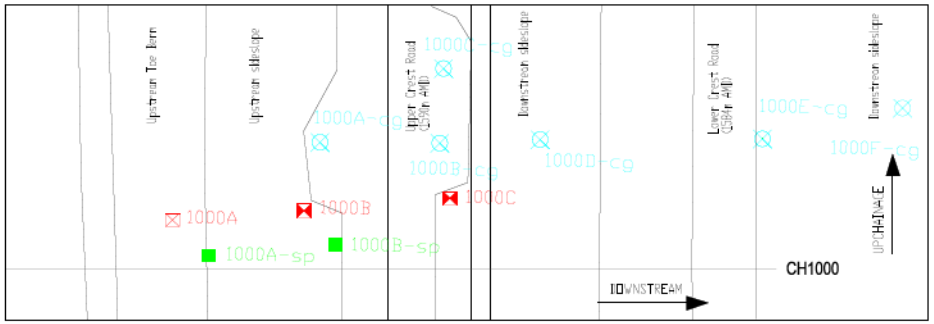
NOTES

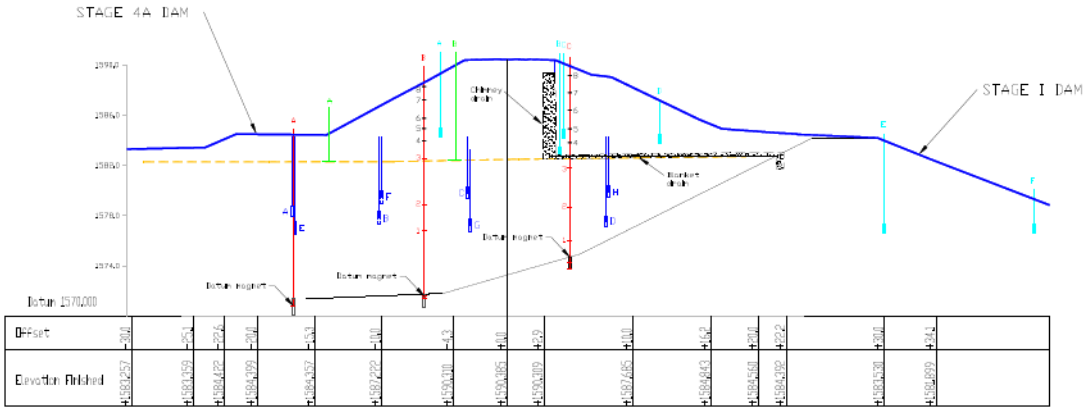
1. Instruments shown as dashed are obsolete (damaged or buried). Location is schematic.
2. For legend see Figure 5a.



PLAN

Chainage 1000				
Instrument ID	Type	Initial Elevation at		Elevation at top
1000 A	inclinometer	1570.83	inclo tube base	1584.83
1000 B	inclinometer/extensometer	1571.61	datum magnet	1589.77
1000 C	inclinometer/extensometer	1574.24	datum magnet	1590.51
1000 A -vw	vibrating wire piezometer	1579.57	piezometer tip	cable to terminal box
1000 B -vw	vibrating wire piezometer	1577.78	piezometer tip	cable to terminal box
1000 C -vw	vibrating wire piezometer	1579.78	piezometer tip	cable to terminal box
1000 D -vw	vibrating wire piezometer	1577.49	piezometer tip	cable to terminal box
1000 E -vw	vibrating wire piezometer	1576.98	piezometer tip	cable to terminal box
1000 F -vw	vibrating wire piezometer	1579.48	piezometer tip	cable to terminal box
1000 G -vw	vibrating wire piezometer	1577.22	piezometer tip	cable to terminal box
1000 H -vw	vibrating wire piezometer	1579.88	piezometer tip	cable to terminal box
1000 A -sp	settlement plate	1582.14	plate	
1000 B -sp	settlement plate	1582.080	plate	
1000 A -cg	casagrande piezometer	1584.20	piezometer tip	1590.90
1000 B -cg	casagrande piezometer	1582.65	piezometer tip	1590.85
1000 C -cg	casagrande piezometer	1584.12	piezometer tip	1590.80
1000 D -cg	casagrande piezometer	1583.69	piezometer tip	1587.13
1000 E -cg	casagrande piezometer	1576.55	piezometer tip	1584.41
1000 F -cg	casagrande piezometer	1576.51	piezometer tip	1579.96

CLUSTER SUMMARY TABLE



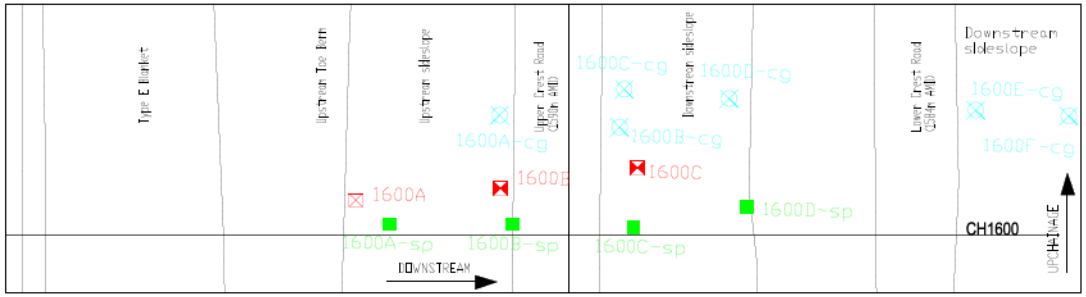
SECTION

1:200 0 4 8 12 16 20 24m

Bolden Tara Mines Limited
Tailings Audit 2011
Randelstown TMF, Eire
Cross Section, Stage 4A, East Dam
Instrument Cluster 1000
PAT RW RW RW 25/04/12
518721 1251415008
A1 1:200 Report Issue
5c -
Golder Associates

NOTES

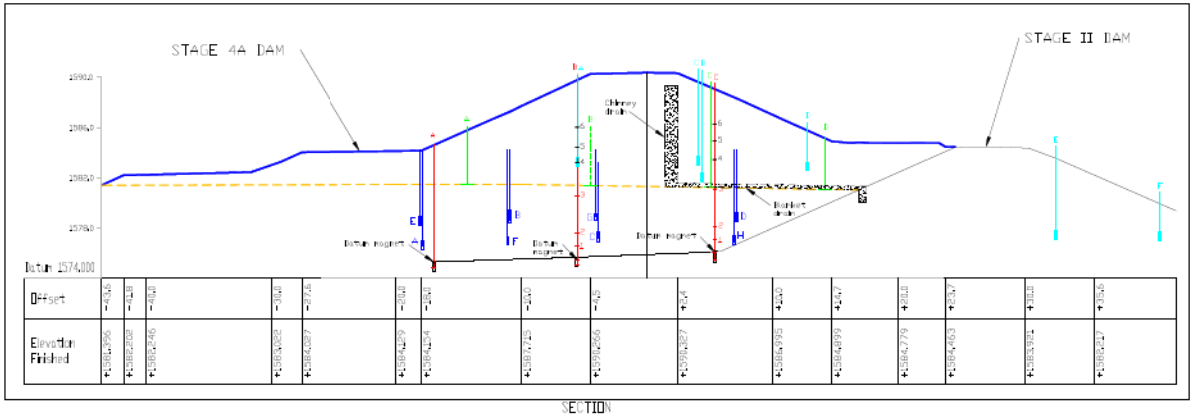
1. Instruments shown as dashed are obsolete (damaged or buried). Location is schematic.
2. For legend see Figure 5a.



PLAN

Chainage 1600				
Instrument ID	Type	Initial Elevation at		Elevation at top
1600 A	inclinometer	1574.87	incllo tube base	1594.57
1600 B	inclinometer/extensometer	1575.47	datum magnet	1590.32
1600 C	inclinometer/extensometer	1575.96	datum magnet	1589.51
1600 A -vw	vibrating wire piezometer	1576.61	piezometer tip	cable to terminal box
1600 B -vw	vibrating wire piezometer	1578.64	piezometer tip	cable to terminal box
1600 C -vw	vibrating wire piezometer	1577.17	piezometer tip	cable to terminal box
1600 D -vw	vibrating wire piezometer	1578.67	piezometer tip	cable to terminal box
1600 E -vw	vibrating wire piezometer	1578.44	piezometer tip	cable to terminal box
1600 F -vw	vibrating wire piezometer	1576.88	piezometer tip	cable to terminal box
1600 G -vw	vibrating wire piezometer	1578.88	piezometer tip	cable to terminal box
1600 H -vw	vibrating wire piezometer	1576.92	piezometer tip	cable to terminal box
1600 A -sp	settlement plate	1580.65	plate	
1600 B -sp	settlement plate (buried)	1581.56	plate	
1600 C -sp	settlement plate	1581.50	plate	
1600 D -sp	settlement plate	1581.60	plate	
1600 A -cg	casagrande piezometer	1582.95	piezometer tip	1590.13
1600 B -cg	casagrande piezometer	1581.71	piezometer tip	1590.82
1600 C -cg	casagrande piezometer	1583.02	piezometer tip	1590.54
1600 D -cg	casagrande piezometer	1582.56	piezometer tip	1586.33
1600 E -cg	casagrande piezometer	1577.13	piezometer tip	1584.96
1600 F -cg	casagrande piezometer	1577.02	piezometer tip	1580.92

CLUSTER SUMMARY TABLE



SECTION

1:200 0 4 8 12 16 20 24m

Golder Associates

Bolden Tara Mines Limited

Tailings Audit 2011
Randalstown TMF, Eire

Cross Section, Stage 4A, East Dam
Instrument Cluster 1600

Drawn	Checked	Reviewed	Date
PAT	RW	RW	25/04/12

Project No.	Report No.
518722	1251415008

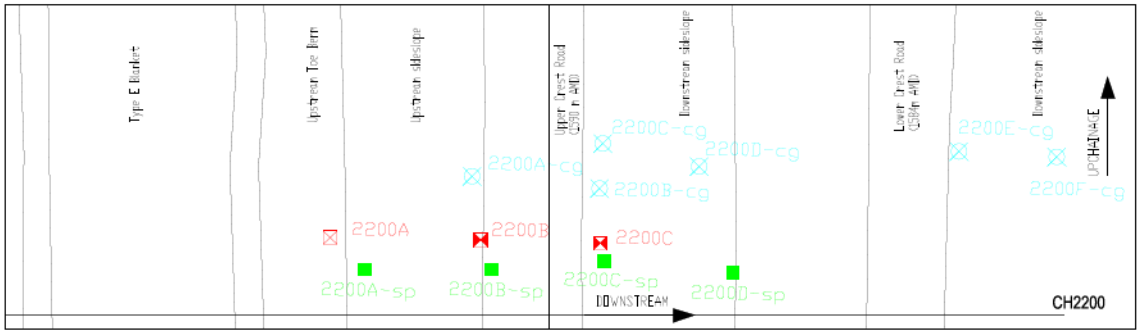
Scale	Status
A1 1:200	Report Issue

Drawing No. 5d

Rev -

NOTES

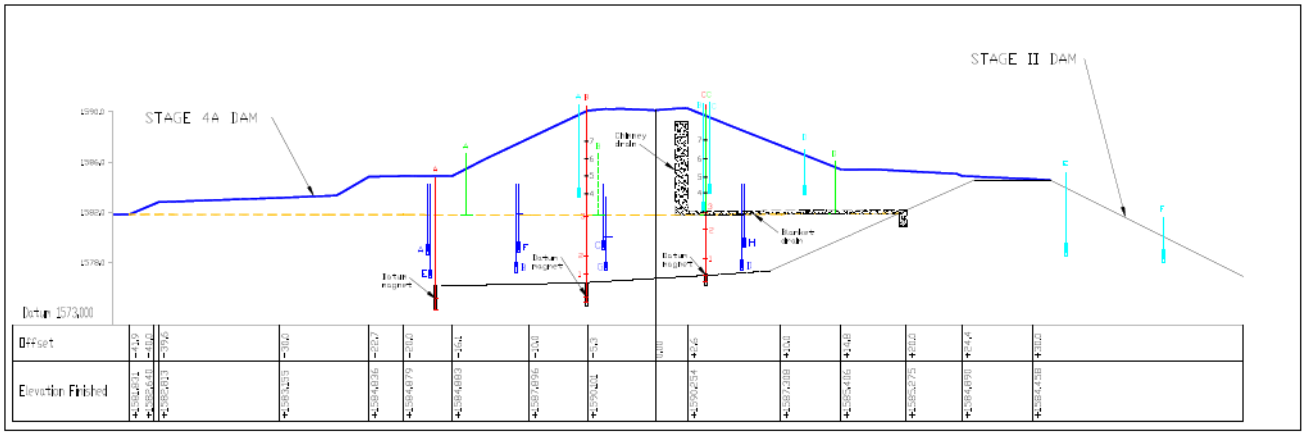
1. Instruments shown as dashed are obsolete (damaged or buried). Location is schematic.
2. For legend see Figure 5a.



PLAN

Chainage 2200				
Instrument ID	Type	Initial Elevation at:		Elevation at top
2200 A	inclinometer	1574.27	inclinometer base	1584.74
2200 B	inclinometer/extensometer	1575.29	datum magnet	1590.30
2200 C	inclinometer/extensometer	1576.99	datum magnet	1590.56
2200 A -ve	vibrating wire piezometer	1578.93	piezometer tip	cable to terminal box
2200 B -ve	vibrating wire piezometer	1577.72	piezometer tip	cable to terminal box
2200 C -ve	vibrating wire piezometer	1579.28	piezometer tip	cable to terminal box
2200 D -ve	vibrating wire piezometer	1577.59	piezometer tip	cable to terminal box
2200 E -ve	vibrating wire piezometer	1576.68	piezometer tip	cable to terminal box
2200 F -ve	vibrating wire piezometer	1578.98	piezometer tip	cable to terminal box
2200 G -ve	vibrating wire piezometer	1577.55	piezometer tip	cable to terminal box
2200 H -ve	vibrating wire piezometer	1579.31	piezometer tip	cable to terminal box
2200 A -sp	settlement plate	1581.85	plate	
2200 B -sp	settlement plate (buried)	1581.85	plate	
2200 C -sp	settlement plate	1581.66	plate	
2200 D -sp	settlement plate	1581.61	plate	
2200 A -cg	casagrande piezometer	1583.22	piezometer tip	1590.51
2200 B -cg	casagrande piezometer	1582.06	piezometer tip	1590.60
2200 C -cg	casagrande piezometer	1583.49	piezometer tip	1590.71
2200 D -cg	casagrande piezometer	1583.43	piezometer tip	1587.02
2200 E -cg	casagrande piezometer	1578.47	piezometer tip	1585.10
2200 F -cg	casagrande piezometer	1578.31	piezometer tip	1581.56

CLUSTER SUMMARY TABLE



SECTION

1:200 0 4 8 12 16 20 24m

Bolden Tara Mines Limited

Tailings Audit 2011
Randalstown TMF, Eire

Cross Section, Stage 4A, North Dam
Instrument Cluster 2200

Drawn	Checked	Reviewed	Date
PAT	RW	RW	25/04/12

Project No.	Phase
518723	1251415008

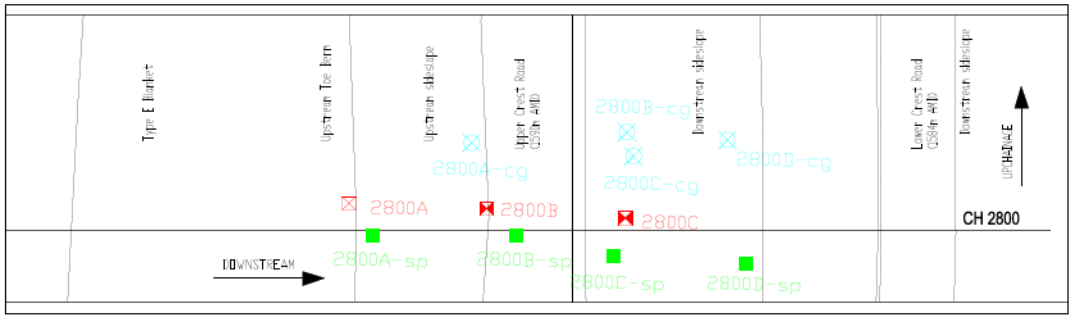
Size	Scale	Revision
A1	1:200	Report Issue

Figure No. 5e

Golder Associates

NOTES

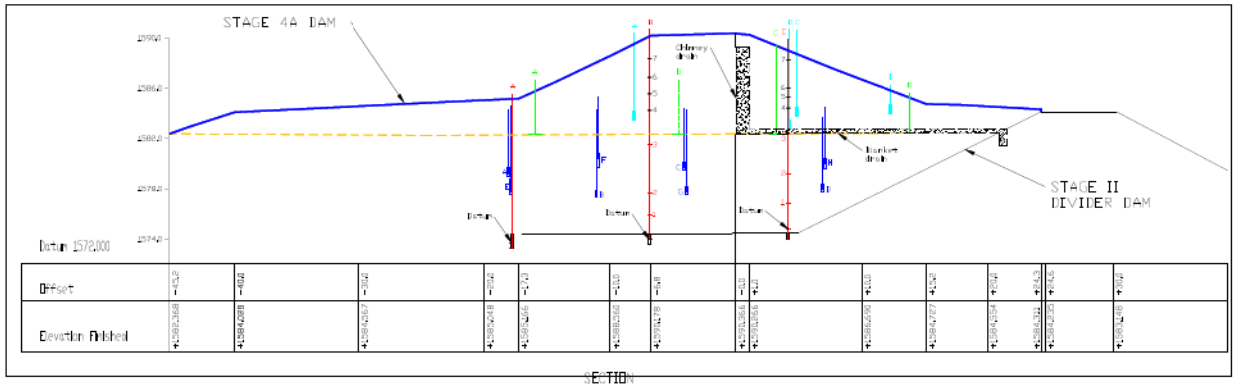
1. Instruments shown as dashed are obsolete (damaged or buried). Location is schematic.
2. For legend see Figure 5a.



PLAN

Chainage 2800				
Instrument ID	Type	Initial Elevation at:		Elevation at top
2800.A	inclinometer	1573.26	inclo tube base	1585.54
2800.B	inclinometer/extensometer	1574.37	datum magnet	1590.69
2800.C	inclinometer/extensometer	1574.77	datum magnet	1589.91
2800.A-vw	vibrating wire piezometer	1578.45	piezometer tip	cable to terminal box
2800.B-vw	vibrating wire piezometer	1577.80	piezometer tip	cable to terminal box
2800.C-vw	vibrating wire piezometer	1578.64	piezometer tip	cable to terminal box
2800.D-vw	vibrating wire piezometer	1577.92	piezometer tip	cable to terminal box
2800.E-vw	vibrating wire piezometer	1577.76	piezometer tip	cable to terminal box
2800.F-vw	vibrating wire piezometer	1580.35	piezometer tip	cable to terminal box
2800.G-vw	vibrating wire piezometer	1577.72	piezometer tip	cable to terminal box
2800.H-vw	vibrating wire piezometer	1580.93	piezometer tip	cable to terminal box
2800.A-sp	settlement plate	1582.41	plate	
2800.B-sp	settlement plate (buried)	1582.15	plate	
2800.C-sp	settlement plate	1582.31	plate	
2800.D-sp	settlement plate	1582.49	plate	
2800.A-cg	casagrande piezometer	1583.54	piezometer tip	1590.43
2800.B-cg	casagrande piezometer	1582.79	piezometer tip	1590.70
2800.C-cg	casagrande piezometer	1583.80	piezometer tip	1590.59
2800.D-cg	casagrande piezometer	1583.89	piezometer tip	1596.30

CLUSTER SUMMARY TABLE



SECTION

1:200 0 4 8 12 16 20 24m

Bolden Tara Mines Limited

Tailings Audit 2011
Randalstown TMF, Eire

Cross Section, Stage 4A, West Dam, Instrument Cluster 2800

Drawn	Checked	Reviewed	Approved	Date
PAT	RW	RW	RW	25/04/12

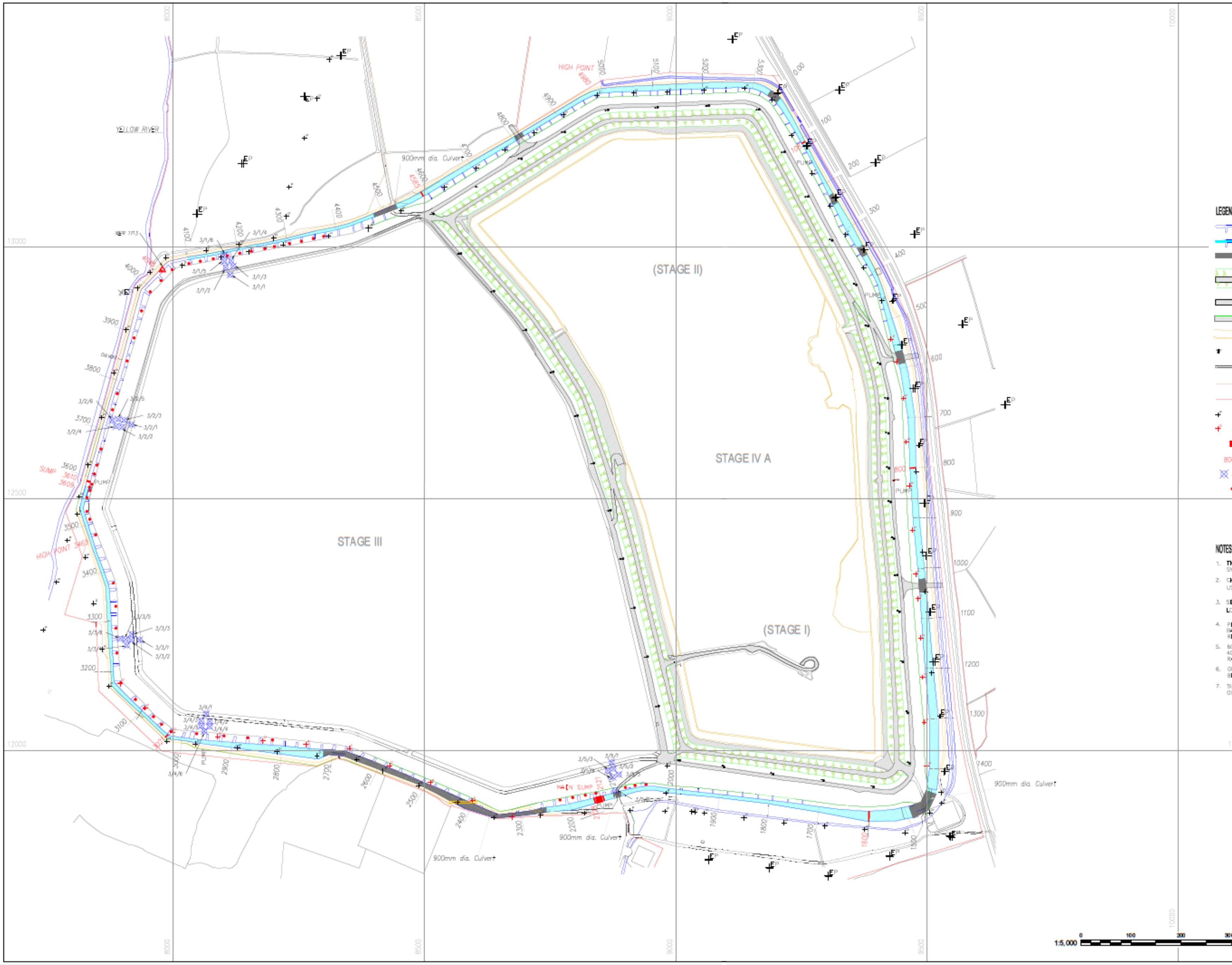
Rev. No.	Project No.
518724	1251415008

Scale	Size	Status
1:200	A1	Report Issue

Figure No. 5f

Rev. -

Golder Associates



LEGEND

- INTERCEPTOR CHANNEL
- INTERCEPTOR CHANNEL REGRADED 1997/1998
- INTERCEPTOR CULVERT (900mm DIA.)
- STAGE 4A DAM WALL
- 7584 and 7590m ACCESS ROADS
- UPSTREAM TOEBERM
- TYPE E BLANKET
- TOE DRAIN COLLECTOR PITS
- ACCESS ROADS
- EXISTING SECURITY FENCE
- SITE BOUNDARY
- EXISTING POWER LINES
- RELOCATED POWER LINES
- INTERCEPTOR CHANNEL SUMP
- 800 — INTERCEPTOR CHANNEL WEIRS
- 3/4/4 CASAGRANDE PIEZOMETER STAGE III
- WELL

NOTES

1. THE CHAINAGE SYSTEM IS INDEPENDENT TO SYSTEM USED FOR STAGE 4A CONSTRUCTION
2. CHAINAGE SHOWN IS DIFFERENT TO THAT USED IN CLOSURE PLAN FIG. 9.7A
3. SEE DRW. 13 FOR INTERCEPTOR CHANNEL LONGITUDINAL PROFILE
4. PIEZOMETER LOCATIONS AND LEVELS BASED ON FIG.1b 2 OF EIS REF. (KPP, REF 11019\R9488\PJS
5. 600mm CULVERT BETWEEN CH. 3770 & 4020m TO BE REMOVED PRIOR TO RAISING CHANNEL TO CLOSURE PROFILE
6. GRID SHOWN IS LOCAL ONLY AND SHOULD NOT BE REFERENCED TO ORDNANCE SURVEY GRID.
7. SURVEY INFORMATION SHOWN PROVIDED BY OUTOKUMPU TARA MINES LIMITED.

Rev	Description	PM	Review	Date

Client	Boliden Tara Mines Limited
Project	Tailings Audit 2011 Randalstown TMF, Eire
Title	Stage III - Location of Piezometer & Seepage Monitoring Points

Created by	Requested by	Proj Manager	Reviewer	Date
PAT	RW	RW	RW	25/04/12

File No.	Project No.
518726	12514150008

Size	Scale	Status
A2	1:5,000	Report Issue

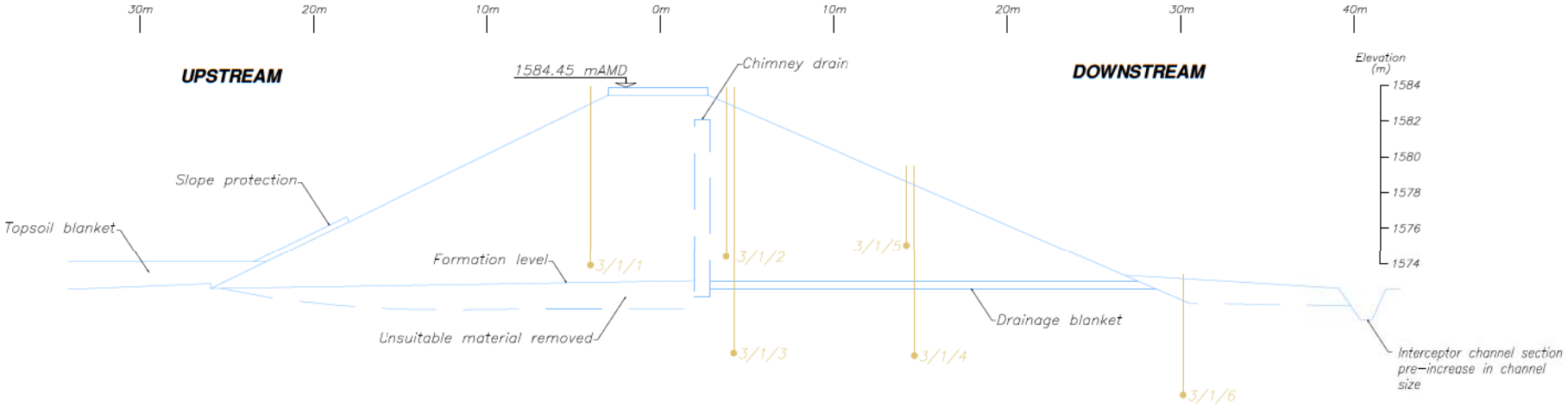
Drawing No.	Rev
6	-

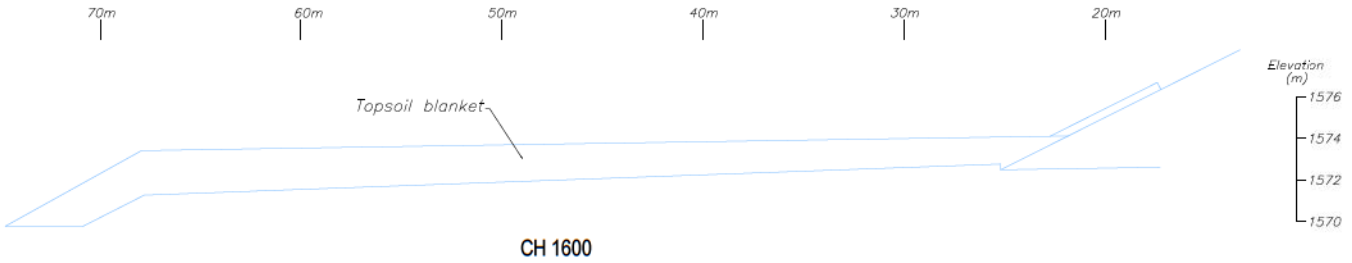
Golder Associates

1st Floor
Clyde House
Reform Road
Maidenhead
Berkshire
SL6 8BY
+44 (0)1 628 586 200

Piezometer number	Sand Filter Thickness	Tip Levels	Standpipe Top Level
3/1/1	2.00	1574.37	1584.24
3/1/2	1.50	1574.69	1584.12
3/1/3	1.60	1569.57	1584.49
3/1/4	2.00	1568.89	1579.19
3/1/5	1.60	1575.00	1578.96
3/1/6	1.50	1566.94	1573.11

Diameter of Borehole: 203mm
I.D. of Standpipe: 19mm





CH 1600

Rev	Description	PM	Review	Date

Client: Boliden Tara Mines Limited

Project: Tailings Audit 2011
Randalstown TMF, Eire

Title: Cross-section, Stage III
North dam, piezometer Stack 1

Created by	Requested by	Proj Manager	Reviewer	Date
PAT	RW	RW	RW	25/04/12

File No.: 518727
Project No.: 12514150008

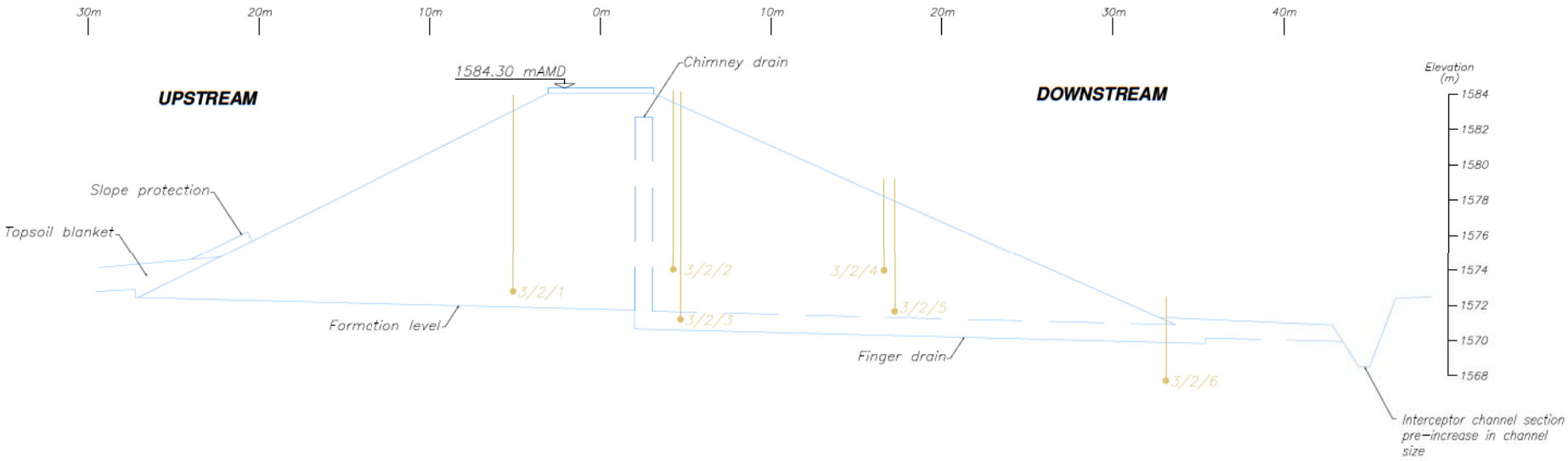
Size: A3
Scale: Not to scale
Status: Report Issue

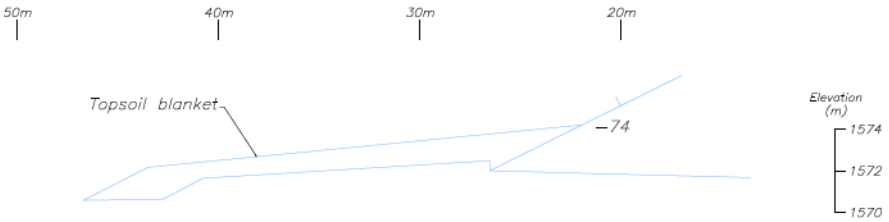
Drawing No.: 7a
Rev: -

1st Floor
Clyde House
Reform Road
Maidenhead
Berkshire
SL6 8BY
+44 (0)1628 586 200

Piezometer number	Sand Filter Thickness	Tip Level	Standpipe Top Level
3/2/1	1.70	1572.58	1583.54
3/2/2	1.70	1573.29	1583.62
3/2/3	1.50	1570.83	1583.67
3/2/4	1.60	1573.18	1578.00
3/2/5	1.50	1571.17	1578.19
3/2/6	1.50	1567.43	1571.65

Diameter of Borehole: 203mm
I.D. of Standpipe: 19mm





CH 2000

Rev	Description	PM	Review	Date

Client: Boliden Tara Mines Limited

Project: Tailings Audit 2011
Randalstown TMF, Eire

Title: Cross-section, Stage III
West dam, piezometer Stack 2

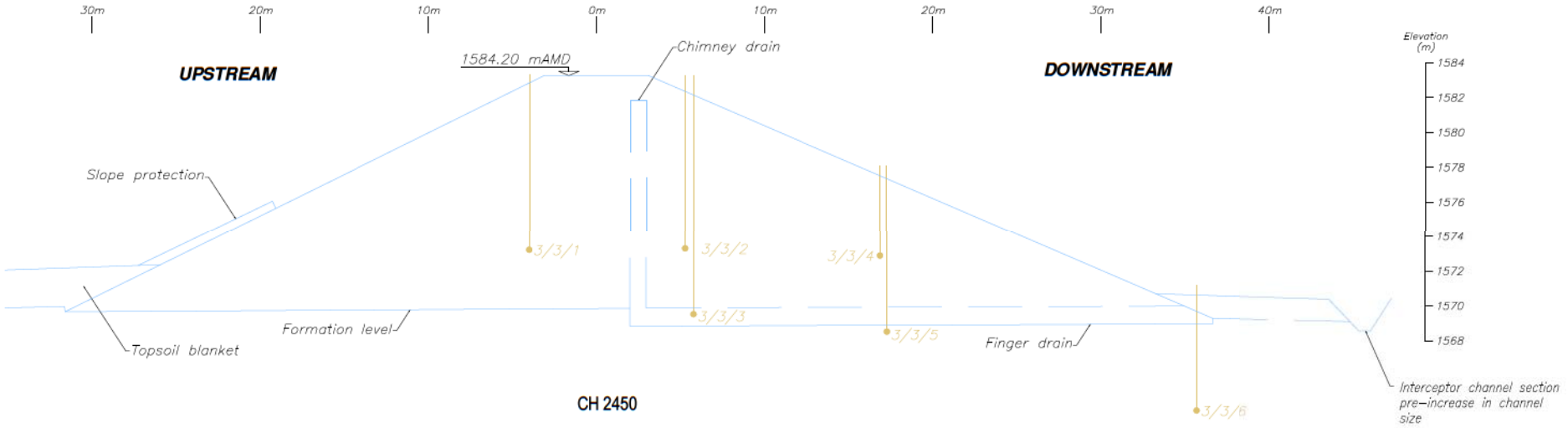
Created by	Requested by	Proj Manager	Reviewer	Date
PAT	RW	RW	RW	25/04/12

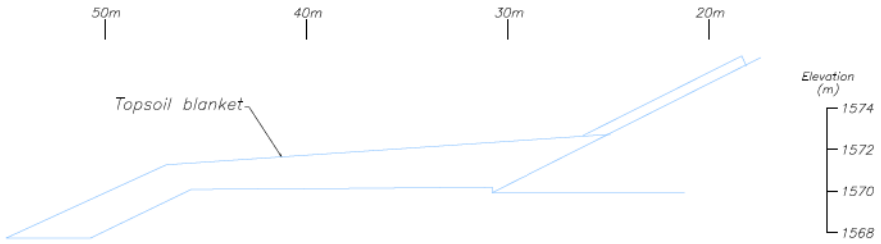
File No.: 518728
Project No.: 12514150008
Size: A3
Scale: Not to scale
Status: Report Issue
Drawing No.: 7b
Rev: -

Golder Associates
1st Floor
Clyde House
Reform Road
Maidenhead
Berkshire
SL6 8BY
+44 (0)1628 586 200

Piezometer number	Sand Filter Thickness	Tip Level	Standpipe Top Level
3/3/1	1.50	1573.70	1583.63
3/3/2	1.50	1573.08	1583.57
3/3/3	1.50	1568.66	1583.52
3/3/4	1.50	1572.51	1578.68
3/3/5	1.50	1567.70	1578.57
3/3/6	1.50	1564.71	1571.35

Diameter of Borehole: 203mm
I.D. of Standpipe: 19mm





Rev	Description	PM	Review	Date

Client: Boliden Tara Mines Limited

Project: Tailings Audit 2011
Randalstown TMF, Eire

Title: Cross-section, Stage III
West dam, piezometer Stack 3

Created by	Requested by	Proj Manager	Reviewer	Date
PAT	RW	RW	RW	25/04/12

File No.: 518729
Project No.: 12514150008

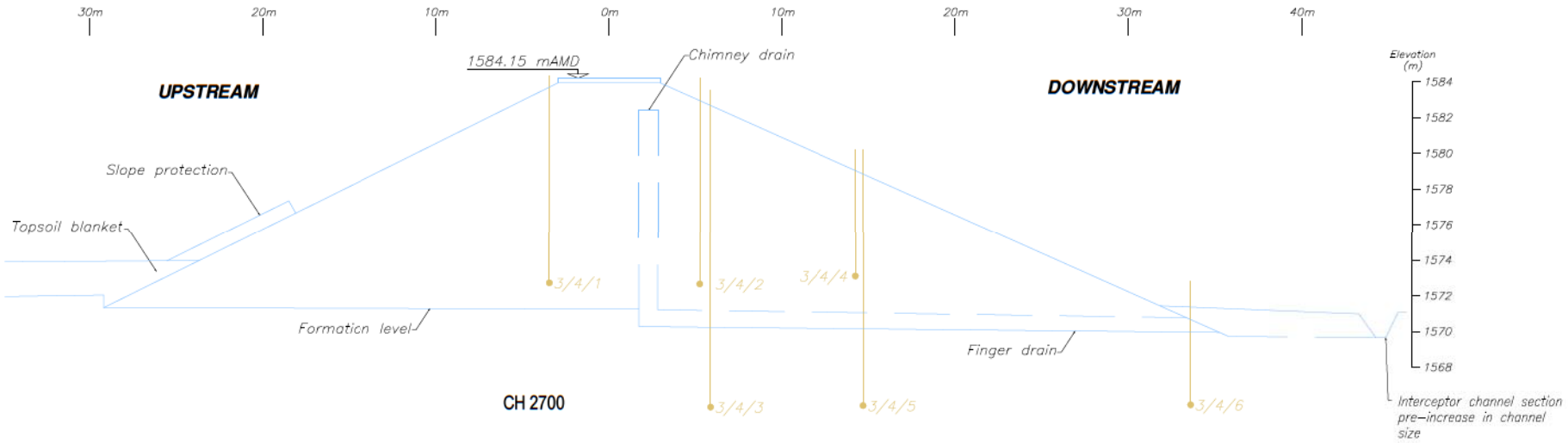
Size: A3
Scale: Not to scale
Status: Report Issue

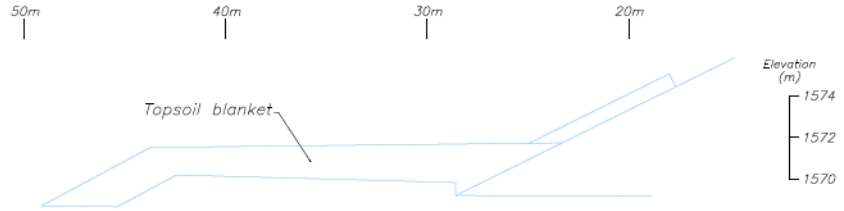
Drawing No.: 7c
Rev: -

1st Floor
Clyde House
Reform Road
Maidenhead
Berkshire
SL6 8BY
+44 (0)1628 586 200

Piezometer number	Sand Filter Thickness	Tip Level	Standpipe Top Level
3/4/1	1.50	1571.51	1584.04
3/4/2	1.50	1571.41	1582.91
3/4/3	1.50	1565.42	1588.28
3/4/4	1.50	1572.09	1579.13
3/4/5	1.50	1564.43	1579.16
3/4/6	1.50	1565.42	1571.56

Diameter of Borehole: 203mm
I.D. of Standpipe: 19mm





Rev	Description	PM	Review	Date

Client: Boliden Tara Mines Limited

Project: Tailings Audit 2011
Randalstown TMF, Eire

Title: Cross-section, Stage III
South dam, piezometer Stack 4

Created by	Requested by	Proj Manager	Reviewer	Date
PAT	RW	RW	RW	25/04/12

File No.: 518730
Project No.: 12514150008

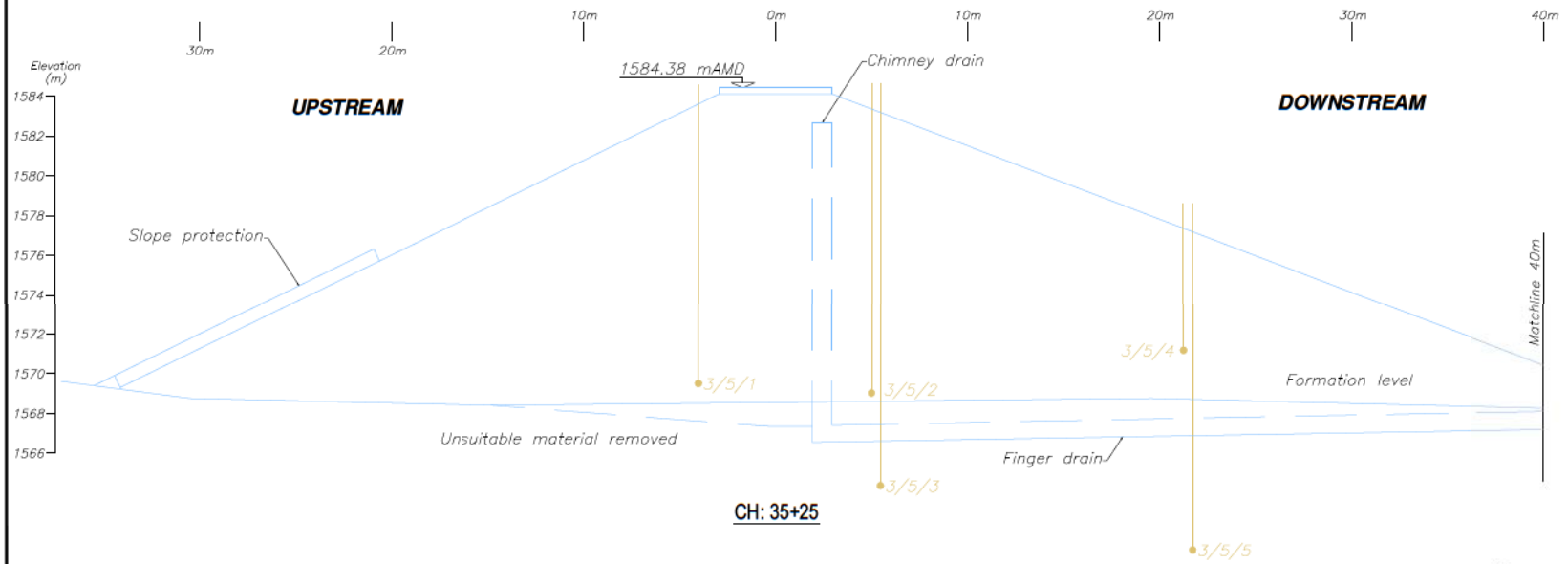
Size: A3
Scale: Not to scale
Status: Report Issue

Drawing No.: 7d
Rev: -

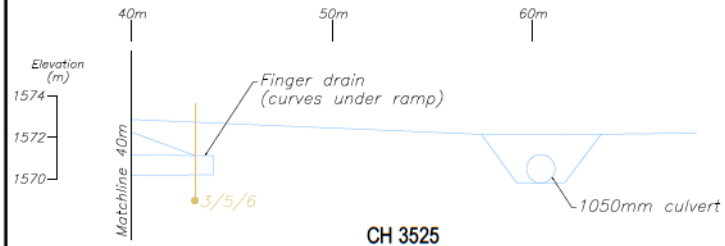
Golder Associates
1st Floor
Clyde House
Reform Road
Maidenhead
Berkshire
SL6 8BY
+44 (0)1628 586 200

Piezometer number	Sand Filter Thickness	Tip Level	Standpipe Top Level
3/5/1	1.50	1568.62	1583.73
3/5/2	1.50	1568.28	1583.50
3/5/3	1.50	1563.60	1583.52
3/5/4	2.00	1570.75	1577.45
3/5/5	1.00	1560.72	1577.56
3/5/6	1.50	1564.72	1569.58

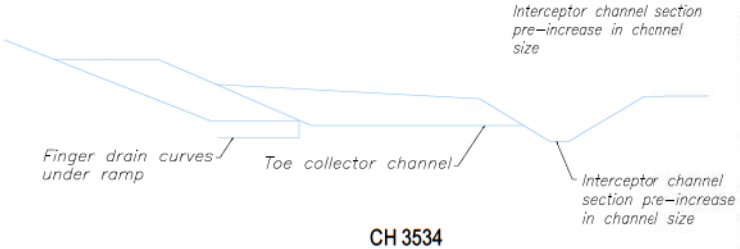
Diameter of Borehole: 203mm
I.D. of Standpipe: 19mm



CH: 35+25



CH 3525
DOWNSTREAM TOE



CH 3534
DOWNSTREAM TOE (FINGER DRAIN EXIT)

Rev	Description	PM	Review	Date

Client: Boliden Tara Mines Limited

Project: Tailings Audit 2011
Randalstown TMF, Eire

Title: Cross-section, Stage III
South dam, piezometer Stack 5

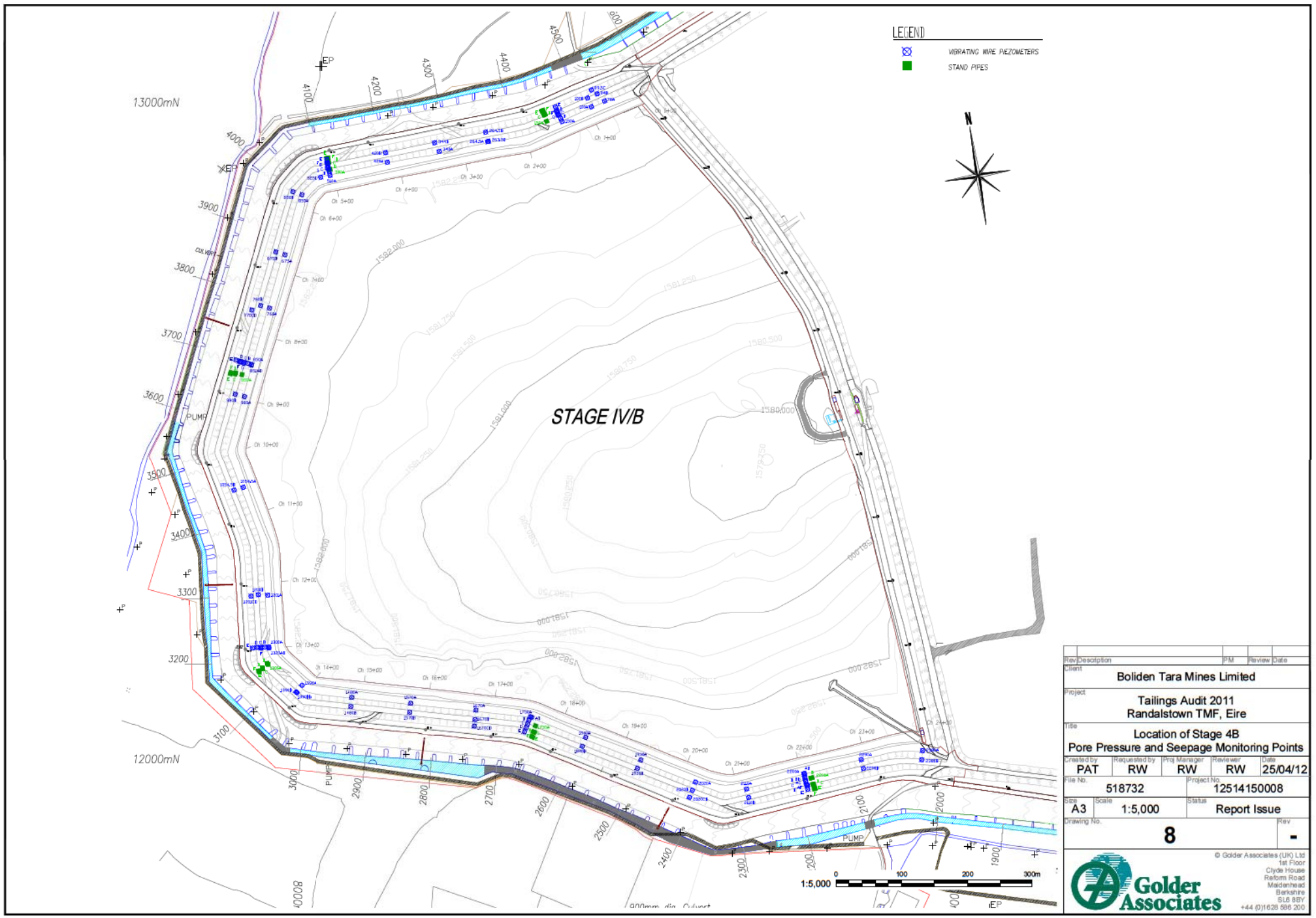
Created by	Requested by	Proj Manager	Reviewer	Date
PAT	RW	RW	RW	25/04/12

File No.: 518731
Project No.: 12514150008

Size: A3
Scale: Not to scale
Status: Report Issue

Drawing No.: 7e
Rev: -

1st Floor
Clyde House
Reform Road
Maidenhead
Berkshire
SL6 8BY
+44 (0)1628 586 200



Rev	Description	PM	Review	Date

Client: Boliden Tara Mines Limited

Project: Tailings Audit 2011
Randalstown TMF, Eire

Title: Location of Stage 4B
Pore Pressure and Seepage Monitoring Points

Created by	Requested by	Proj Manager	Reviewer	Date
PAT	RW	RW	RW	25/04/12

File No.	Project No.
518732	12514150008

Size	Scale	Status
A3	1:5,000	Report Issue

Drawing No.: 8

Rev: -

Golder Associates
1st Floor
Clyde House
Reform Road
Maidenhead
Berkshire
SL6 8BY
+44 (0)1628 586 200

Client: Boliden Tara Mines Limited	Created by: PAT	Requested by: RW	Proj Manager: RW	Reviewer: RW	Date: 25/04/12	
Project: Tailings Audit 2011 Randalstown TMF, Eire	File No.: 518733		Project No.: 12514150008			
Title: Cross Section of Instrument Cluster 150	Size: A4	Scale: Not to scale	Status: Report Issue			
	Drawing No.: 9a				Rev: -	

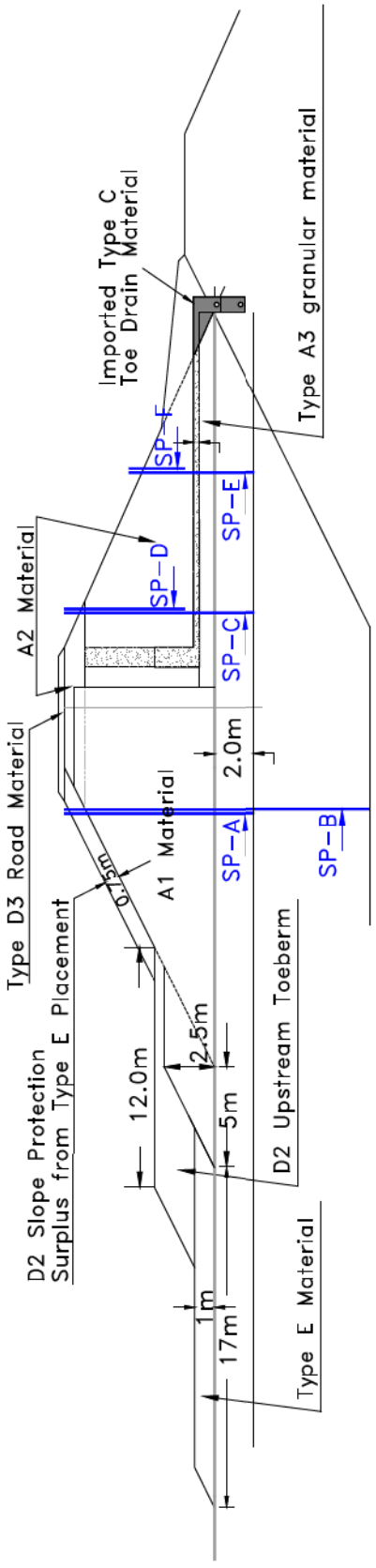
Client: Boliden Tara Mines Limited	Created by: PAT	Requested by: RW	Proj Manager: RW	Reviewer: RW	Date: 25/04/12	
Project: Tailings Audit 2011 Randalstown TMF, Eire	File No.: 518734		Project No.: 12514150008			
Title: Cross Section of Instrument Cluster 500	Size: A4	Scale: Not to scale	Status: Report Issue			
	Drawing No.: 9b				Rev: -	

Golder Associates	Client: Boliden Tara Mines Limited	Created by: PAT	Requested by: RW	Proj Manager: RW	Reviewer: RW	Date: 25/04/12
	Project: Tailings Audit 2011 Randalstown TMF, Eire	File No.: 518735			Project No.: 12514150008	
		Size: A4	Scale: Not to scale		Status: Report Issue	
	Title: Cross Section of Instrument Cluster 850	Drawing No.: 9c				Rev: -

Client: Boliden Tara Mines Limited	Created by: PAT	Requested by: RW	Proj Manager: RW	Reviewer: RW	Date: 25/04/12
Project: Tailings Audit 2011 Randalstown TMF, Eire	File No.: 518736		Project No.: 12514150008		
Title: Cross Section of Instrument Cluster 1300	Size: A4	Scale: Not to scale	Status: Report Issue		
	Drawing No.: 9d				Rev: -

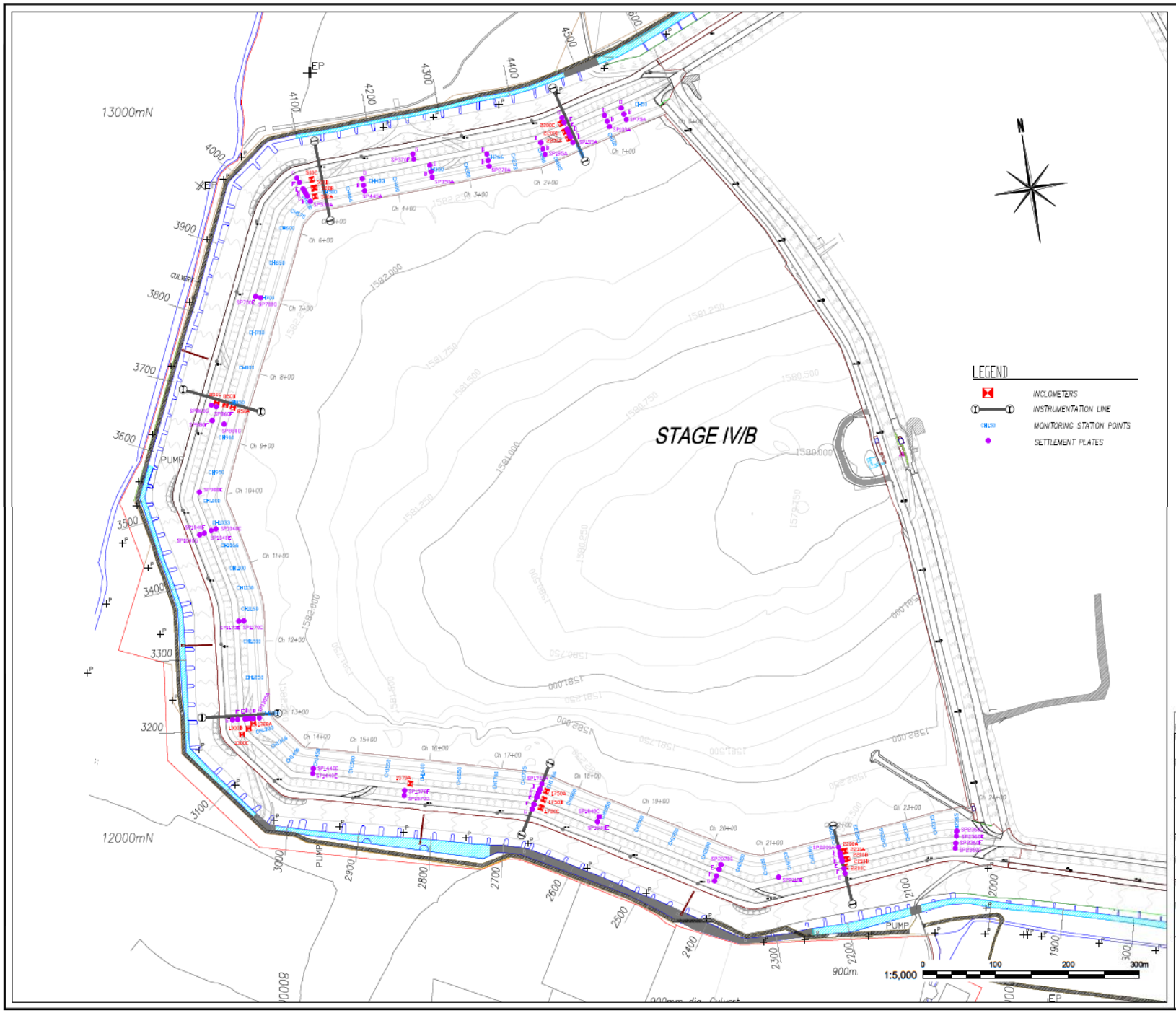
Client: Boliden Tara Mines Limited						
Project: Tailings Audit 2011 Randalstown TMF, Eire						
Title: Cross Section of Instrument Cluster 1750						
Created by: PAT	Requested by: RW	Proj Manager: RW	Reviewer: RW	Date: 25/04/12		
File No.: 518737			Project No.: 12514150008			
Size: A4	Scale: Not to scale		Status: Report Issue			
Drawing No.: 9e					Rev: -	

Golder Associates	Client: Boliden Tara Mines Limited	Created by: PAT	Requested by: RW	Proj Manager: RW	Reviewer: RW	Date: 25/04/12
	Project: Tailings Audit 2011 Randalstown TMF, Eire	File No.: 518738			Project No.: 12514150008	
		Size: A4	Scale: Not to scale		Status: Report Issue	
	Title: Cross Section of Instrument Cluster 2200	Drawing No.: 9f				Rev: -



Typical Casagrande Piezometer Cluster Section

Client: Boliden Tara Mines Limited						
Project: Tailings Audit 2011 Randalstown TMF, Eire						
Title: Casagrande Piezometer Section						
Created by: PAT	Requested by: RW	Proj Manager: RW	Reviewer: RW	Date: 25/04/12		
File No.: 518739			Project No.: 12514150008			
Size: A4	Scale: Not to scale		Status: Report Issue			
Drawing No.: 10					Rev: -	



Rev	Description	PM	Review	Date

Client: Boliden Tara Mines Limited

Project: Tailings Audit 2011
Randalstown TMF, Eire

Title: Location of Stage 4B
Ground Movement Monitoring Instruments

Created by	Requested by	Proj Manager	Reviewer	Date
PAT	RW	RW	RW	25/04/12

File No.: 518740
Project No.: 12514150008
Size: A3
Scale: 1:5,000
Status: Report Issue
Drawing No.: 11
Rev: -

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APPENDIX B

Monitoring Data Presented As Charts.

TMF Instrumentation Numbers

Stage 1 and 2 Casagrande Standpipes

Eastern Perimeter Interceptor Channel Flow Rates

Stage 4A Cluster Casagrande Piezometers

Stage 4A Cluster VW Piezometers

Stage 4A Crest Settlement Points

Stage 4A Inclinometer Results

Stage 4A Extensometer Results

Stage 4A External Drainage Flow Rates

Stage 3 Casagrande Standpipes

Western Perimeter Interceptor Channel Flow Rates

Stage 4B Cluster Casagrande Piezometers

Stage 4B Cluster VW Piezometers

Stage 4B Crest Settlement Points

Stage 4B Inclinometer Results

Stage 4B Extensometer Results

Stage 4B External Drainage Flow Rates

TMF Instrumentation Numbers

*All instruments marked in RED have malfunctioned and are giving spurious/dry readings
**Inclinometers marked in RED have been covered by Tailings and are no longer read

Stage I & II Standpipes

			Dry									
Chainage	23	24	25	26	27	28	29	29-2	30	31	31-2	32
Standpipe Easting	9660.598	9811.178	9888.678	9855.105	9644.761	9434.814	9188.169	9211.669	9276.013	8887.467	8605.414	8987.136
Standpipe Northing	11592.202	11604.89	11604.15	11690.27	11601.31	11642.86	11617.268	11622.101	11230.28	11320.6	11134.49	11246.66
Standpipe base level	1549.369	1571.911	1573.378	1573.16	1568.23	1564.644	1575.91	1583.36	1577.16	1578.32	1564.45	1576.76
Standpipe base level	1566.369	1566.256	1568.078	1565.161	1579.25	1574.58	1573.43	1577.995	1574.38	1574.11	1578.54	1573.548
Standpipe Depth	3.00	5.65	5.5	3.84	11.02	9.65	3.48	5.265	3.72	4.11	5.51	3.215

Stage III Standpipes

Location	37/1	37/2	37/3	37/4	37/5	37/6	37/7	37/8	37/9	37/10	37/11	37/12	37/13	37/14	37/15	37/16	37/17	37/18	37/19	37/20	37/21	37/22	37/23	37/24	37/25	37/26
Standpipe Top level	1584.240	1584.132	1584.879	1575.392	1575.060	1573.102	1568.560	1568.630	1583.670	1578.666	1576.992	1571.490	1568.630	1583.530	1576.680	1578.579	1571.350	1584.640	1582.910	1583.198	1578.110	1575.860	1571.560	1583.760	1582.540	1578.450
Standpipe base level	1574.370	1574.690	1568.370	1568.880	1575.060	1566.960	1570.260	1576.860	1573.180	1571.170	1567.430	1575.760	1573.080	1568.640	1573.580	1567.760	1564.710	1571.530	1575.410	1565.430	1570.060	1564.460	1565.430	1568.680	1568.280	1570.750
Standpipe Depth	9.87	9.43	15.31	10.30	3.96	6.17	10.96	10.33	12.84	4.82	7.03	4.23	5.55	10.49	14.86	6.17	10.87	6.64	12.53	11.50	17.86	7.04	14.73	6.14	15.11	15.22	15.60	6.70	16.98	4.86

Stage 4A Inclinometers

Location	400B	400C	400DA	400DB	400DC	400DA	400EB	400EC	400FA	400FB	400FC	400GA	400GB	400GC	400HB	400HC	400IB	400IC	400JB	400JC	400KB	400KC
Indo Top level	1591.956	1586.410	1586.860	1590.787	1580.458	1584.605	1588.367	1588.483	1584.516	1581.342	1590.106	1585.508	1588.706	1580.931	1585.187	-	1590.199					
Indo Base level	1571.776	1573.490	1575.248	1571.195	1573.724	1574.975	1575.483	1576.853	1574.653	1574.663	1576.195	1572.325	1574.319	1575.148	1568.563	-	1572.353					
Indo depth	20.259	16.933	11.615	19.608	16.734	9.735	15.754	11.795	10.088	15.36	13.558	12.367	13.407	10.54	16.524	-	17.877					

Stage 4A Extensometers

Location	400B	400C	400DA	400DB	400DC	400DA	400EB	400EC	400FA	400FB	400FC	400GA	400GB	400GC	400HB	400HC	400IB	400IC	400JB	400JC	400KB	400KC
Pith				3.6	1.398																	
fourth				5.913	2.892		4.897	3.355		3.718	2.777		3.484	1.724		3.601						
third				5.365	4.178		5.605	4.684		5.118	4.289		5.045	3.374		5.064						
second		5.78		5.906	5.656		7.118	6.146		6.658	5.874		5.463	4.812		5.365	5.137					
first		7		7.013	6.828		8.58	8.533		8.84	6.756		6.823	5.913		6.675	6.42					
B		10.118		9.516	8.968		10.068	11		9.826	8.753		8.4	7.815		8.65	8.178					
C		12.659		12.008	11.892		13.814	13.464		12.913	9.974		11.155	10.864		11.372	11.659					
D		15.847		14.716	14.146		16.519	15.58		14.965	12.239		14.27	13.154		13.648	13.6					
Datum		16.803		19.236	16.328		14.971	13.58		16.43												

Stage 4A Standpipes

			Dry						Dry						Dry						Dry					
Chainage	400 A	400 B	400C	400 D	400E	400 F	1400 A	3000 B	1400 C	3000 D	1400 E	3000 F	1400 A	1600B	1600 C	1400 D	1400 E	1400 F	1800C	1800C	1800C	1845 B	1845 D	2200A	2200 B	2200 C	2200 D	2200 E	2200 F	2350 A	3000 B	2350 C	2350 D	3400 A	3400B	3400 C	3400 D
Standpipe Easting	9408.438	9614.462	9431.106	9610.359	9409.063	9407.313	9198.569	9405.501	9405.621	9417.46	9435.364	9446.236	9230.733	9243.348	9241.472	9240.148	9246.537	9274.469	9078.9	9078.9	8978.7	8973.786	8971.023	8969.926	8745.305	8763.133	8739.648	8737.673	8733.88	8771.988	8763.897	8760.525	8754.947	8965.948	8956.848	8958.583	8948.143
Standpipe Northing	11596.302	11643.16	11642.838	11636.36	11633.59	11642.83	11626.21	11624.65	11642.82	11637.43	11632.97	11642.82	11604.43	11630.53	11618.3	11631.79	11613.385	11628.5	11628.5	11628.5	11624.51	11624.51	11627.53	11579.15	11612.87	11615.45	11602.85	11606.93	11616.67	11778.33	11778.33	11773.05	11723.76	11724.58	11728.83	11731.4
Standpipe top level	1594.431	1596.166	1595.778	1584.76	1584.45	1580.884	1590.849	1590.849	1589.08	1587.193	1584.91	1590.84	1590.14	1588.616	1586.139	1588.559	1580.916	1590.7	1590.7	1590.7	1588.8	1588.411	1586.964	1584.514	1590.69	1590.748	1587.78	1587.051	1585.1	1584.163	1590.464	1588.78	1588.464	1588.164	1586.964	1586.964	1586.964
Standpipe base level	1582.358	1581.826	1582.486	1581.862	1579.651	1574.986	1586.899	1582.653	1584.123	1583.651	1576.597	1576.534	1582.849	1581.748	1582.631	1582.159	1577.119	1577.016	1583.736	1583.736	1583.808	1578.193	1576.694	1583.219	1582.169	1581.496	1582.415	1578.465	1578.311	1583.564	1582.798	1582.795	1583.598	1583.398	1582.151	1582.598	1581.771
Standpipe Depth	8.000	8.490	7.806	5.865	9.430	5.900	6.700	8.195	6.980	5.442	7.865	3.430	7.185	6.885	7.595	5.77	7.63	5.9	6.96	6.96	7.01	11.22	9.26	7.295	8.545	7.22	5.98	6.655	7.25	6.88	7.83	6.795	7.115	6.95	8.66	6.965	5.92	

Stage 4A VW Piezometer Clusters

Cluster at Ch3400 has been covered over by Tailings from stage 5B

Chainage	400 A	400 B	400C	400 D	400E	400 F	400 G	400 H	1400 A	3000 B	1400 C	1400 D	1400 E	1400 F	3000 G	1400 H	1400 A	3000 B	1600C	3000 D	1600E	1400 F	1400 G	1400H	2200 A	2200 B	2200 C	2200 D	2200 E	2200 F	2200 G	2200 H	2350 A	2350 B	3000 C	3000 D	2350 E	2350 F	2350 G	3000 H	3400 A	3400 B	3400 C	3400 D	3400 E	3400 F	3400 G	3400 H
Tailings Level	1581.681	1581.681	1581.681	1581.681	1581.681	1581.681	1581.681	1581.681	1582.338	1581.981	1581.981	1582.338	1582.338	1582.338	1581.981	1582.338	1582.338	1582.338	1581.981	1582.338	1581.981	1581.981	1581.981	1581.981	1581.981	1581.981	1581.981	1581.981	1581.981	1581.981	1581.981	1581.981	1582.338	1582.338	1582.338	1582.338	1582.338	1582.338	1582.338	1582.338	1582.338	1582.338	1582.338	1582.338	1582.338	1582.338	1582.338
Piezo Tip	1579.681	1577.781	1576.956	1575.381	1576.356	1576.156	1576.956	1577.781	1575.781	1577.781	1575.781	1577.781	1576.956	1577.781	1576.956	1577.781	1577.781	1576.956	1577.781	1576.956	1577.781	1576.956	1577.781	1576.956	1577.781	1577.781	1577.781	1576.956	1577.781	1576.956	1577.781	1576.956	1577.781	1576.956	1577.781	1576.956	1577.781	1576.956	1577.781	1576.956	1577.781	1576.956	1577.781	1576.956	1577.781	1576.956	1577.781

STAGE 4A Upstream Toe VW Piezometers

Chainage	400 A	400 B	400C	400 D	400E	1400 A	3000 B	1400 C	3000 D	1400 E	3000 F	1400 A	1600B	1600 C	1400 D	1400 E	1400 F	1800C	1800C	1800C	1845 B	1845 D	2200A	2200 B	2200 C	2200 D	2200 E	2200 F	2350 A	3000 B	2350 C	2350 D	3400 A	3400B	3400 C	3400 D	3400 E	3400 F	3400 G	3400 H
Pad Level	A	A	A	A	E	A	E	A	A	E	D	C	A	A	D	C	A	A	D	C	A	A	A	A	A	E	A	A	B	A	A	A	A	A	A	E	A	A	A	A
Level of Pipe	1581.15	1582.648	1581.235			1581.943		1582.7					1581.36					1583.29				1583.27						1581.256				1583.576	1583.581	1581.592			1583.318	1581.35	1581.095
Pipe above Tailtop	1.15	1.69	1.31			1.31		1.7					1.36					1.29				1.27						1.256				1.576	1.581	1.592			1.318	1.35	1.095
Old Tailings Level	1582.01	1581.81	1580.95	1581.55	1581.55	1580.8	1582.18	1582.18	1581.52	1581.37	1581.37		1581.98					1582.03				1582.15	1581.78	1581.7				1581.77	1581.98	1582.31																				
Tailings Level	1582	1581.59	1581.08			1580.95		1581.67					1581.46	1581.36		1581.86	1581.86	1582.86	1581.81	1581.81	1581.81	1582.05						1581.41	1581.57	1582.056			1581.78	1581.731	1581.367	1582.376	1582.731	1582.443		1582.07	1582	1581.99
Piezo below Pipe/Tip	3.3	3.4	3.4	3.46		3.19		3.43					3.46	3.36				3.48				3.44						3.38	3.46	3.47			3.14	3.38	3.3	3.83	3.37	3.48		3.14	3.3	3.4
Level of Piezo	1580.85	1580.39	1579.79	1579.24	1579.65	1579.75	1579.57	1579.98	1580.28	1579.61	1579.48	1581.75	1581.46	1580.16	1581.81	1582.19	1581.86	1580.36	1580.81	1581.81	1581.81	1581.81	1581.81	1582.37	1580.83	1579.83	1579.96	1580.24	1580.3	1580.786	1579.21	1577.78	1580.62	1580.461	1580.01	1581.25	1580.46	1581.111	1579.24	1577.47	1581.08	1580.85	1580.365

Stage 4B Inclinometers

Location	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
Indo Top level	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550
Indo Base level	1537	1536	1534	1536	1536	1535	1535	1535	1535	1535	1534	1527.5
Depth	13	14	16	12	14	15	12	15	15	15	16	22.5

Stage 4B Extensometers

Location	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
Pith			1.118							0.329	1.345	0.327
fourth	0.935	1.206	2.506	0.897	1.695	0.666	0.376	2.060	0.906	1.646	1.811	1.222
third	1.578	1.983	4.233	1.960	1.964	2.822	1.233	3.851	1.962	2.481	3.693	3.454
second	4.557	4.989	6.111	3.781	3.879	4.825	3.413	5.509	5.110	4.587	5.481	7.438	5.455
first	6.230	6.983	7.989	6.090	6.110	6.184	5.345	7.367	7.305	6.731	7.757	9.430	7.755
B	8.040	9.083	10.000	8.613	7.537	8.118	7.365	8.555	9.387	8.838	10.315		10.454
C	10.031	9.985	11.760	10.530	9.046	10.002	9.575	10.307	12.115	10.857	13.64		13.065
D	13.149	11.063	13.616	11.813	12.856	11.598	11.468	11.957	14.008	12.836	16.68		16.008
Datum		14.447	16.305			15.338	13.693	15.308	17.308	15.353		

Stage 4B Standpipes

			Dry		Dry				Dry					Dry		Dry				Dry							Dry		Dry
Chainage	350 A	350 C	1300 D	350 E	1500F	1500 A	1500 B	5000C	1500 D	1500E	1500	1500 A	850 C	850 D	850 E	1500 F	1500 A	3000 B	1300C	1300E	1300 F	1350 A	1750 C	1750 D	1750 E	1750 F	2150 A	2000 B	2300 C	2150 D	2150 E	2150 F
Standpipe Easting	8851.538	8867.359	8380.359	8863.983	8385.575	8855.964	8842.721	8857.78	8855.759	8856.633	8856.189	7787.670	7798.822	7817.276	7798.560	7810.238	7798.554	7784.947	7788.546	7797.633	7553.235	7552.133	8374.366	8373.010	8371.424	8370.498	8348.848	8778.704	8784.675	8796.356	8802.565	8798.788
Standpipe Northing	11548.696	11562.576	11565.167	11566.376	11568.362	11569.686	11569.686	11615.482	11615.262	11626.964	11617.48	11569.633	11568.373	11555.367	11552.361	11552.361	11552.361	11544.333	11545.881	11543.294	11592.304	11593.154	11546.544	11544.446	11543.963	11541.141	11546.544	11544.446	11543.963	11539.814	11547.692	11549.392
Standpipe base level	1560.358	1556.167	1558.174	1557.168	1556.318	1558.403	1556.403	1556.018	1556.018	1554.018	1556.018	1556.493	1557.493	1556.493	1556.493	1556.493	1556.493	1556.493	1556.478	1556.478	1556.478	1556.335	1556.335	1556.335	1556.335	1556.335	1557.778	1557.845	1558.148	1558.468	1559.168	1558.468
Standpipe base level	1560.158	1560.147	1558.124	1556.068	1554.388	1558.068	1556.318	1555.313	1555.263	1554.308	1555.263	1555.263	1554.313	1554.313	1554.313	1554.313	1554.313	1554.313	1554.178	1554.178	1554.178	1554.035	1554.035	1554.035	1554.035	1554.035	1554.035	1554.035	1554.035	1554.035	1554.035	1554.035
Standpipe Depth	0.20	6.20	7.27	5.3	10.23	14.22	10.11	6.35	7.008	5.7	10.23	5.98	6.2	7.35	5.81	11.2	16.2	10.3	6.1	7.87	3.81	10.15	10.32	6.35	6.806	7.845	10.61	16.92	10.61	6.45	7.36	5.26

Stage 4B VW Piezometer Clusters

Chainage	350 A	350 B	1500C	1500 D	1500E	1500 F	5100 A	5100B	5100 C	5100 D	5100	5100 F	850A	850 B	850 C	850 D	850 E	850F	1300 A	1300 B	1300 C	1300 D	1300 E	1300F	1750 A	1750 B	1750 C	1750 D	1750 E	1750 F	2150 A	2150 B	2150 C	2150 D	2150 E	2150 F
Tailings Level	1560.158	1560.158	1560.158	1560.158	1560.158	1560.158	1560.158	1560.158	1560.158	1560.158	1560.158	1560.158	1560.158	1560.158	1560.158	1560.158	1560.158	1560.158	1560.158	1560.158	1560.158	1560.158	1560.158	1560.158	1560.158	1560.158	1560.158	1560.158	1560.158	1560.158	1560.158	1560.158	1560.158	1560.158	1560.158	1560.158
Piezo Tip	1560.158	1560.158	1558.124	1556.068	1554.388	1558.068	1556.318	1555.313	1555.263	1554.308	1555.263	1555.263	1554.313	1554.313	1554.313	1554.313	1554.313	1554.313	1554.178	1554.178	1554.178	1554.035	1554.035	1554.035	1554.035	1554.035	1554.035	1554.035	1554.035	1554.035	1554.035	1554.035	1554.035	1554.035	1554.035	1554.035

Stage 5A VW Piezometers

Chainage	1B			1BC			2F1			3B1		3B5			4B3			4B5			7B1			8B0			9B1			11B1			11B5			13B1			13B5			15B1			15B5			16B1			16B5			17B1		
Location	A	B	C	A	B	OG Standpipe	A	B	C	D	A	B	B	C	A	B	OG Standpipe	B	C	A	B	A	B	C	A	B	C	A	B	OG Standpipe	A	B	C	A	B	C	A	B	C	OG Standpipe	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Top of Pipe						1548.105											1560.069																									1548.107													
Tailings Level	1550.31	1550.31	1548.26	1550.26	1548.41	1546.28	1548.24	1550.76	1548.54	1546.8	1548.55	1546.78	1548.24	1550.76	1548.54	1546.8	1548.55	1546.78	1550.26	1548.46	1548.46	1550.26	1548.55	1546.78	1550.26	1548.46	1548.46	1550.26	1548.55	1546.78	1550.26	1548.46	1548.46	1550.26	1548.55	1546.78	1550.26	1548.46	1548.46	1550.26	1548.55	1546.78	1550.26	1548.46	1548.46	1550.26	1548.55	1546.78	1550.26	1548.46	1548.46	1550.26	1548.55	1546.78
Install Depth	3.04	3.03	3.01	3.40	3.00	3.99	3.75	3.05	3.00	3.01	3.01	3.78	1.58	3.03	3.01	3.01	3.45	3.00	2.00	1.98	3.01	3.23	1.99	3.00	3.00	3.00	3.48	2.00	3.00	3.03	3.00	3.04	3.04	3.13	3.35	3.33	3.02	3.00	3.04	3.04	3.46	3.00	3.03	3.01	3.03	3.00	3.10	3.20	3.00	3.00	3.00	3.00	3.00	3.00
Piezo Tip	1546.27	1546.29	1546.96	1545.95	1546.41	1546.26	1546.35	1546.76	1546.53	1546.08	1546.37	1546.17	1546.47	1546.45	1546.51	1546.69	1546.39	1546.61	1546.66	1546.48	1546.69	1546.27	1546.38	1546.31	1546.61	1546.35	1546.55	1546.73	1546.54	1546.33	1546.23	1546.31	1546.13	1546.18	1546.06	1546.08	1546.27	1546.31	1546.46	1546.667	1546.41	1546.38	1546.42	1546.38	1546.50	1546.40	1546.38	1546.50	1546.40	1546.38	1546.50	1546.40	1546.38
Chainage	1BB			1BD			2B5			2DB			3B3			3B7			4B4			4B6			7B2			8B2			9B2			11B2			11B6			13B2			13B6			15B2			15B6			16B2			16B6			17B2		
Location	A	B	A	B	C	OG Standpipe	A	B	B	C	B	A	B	C	A	B	OG Standpipe	B	C	A	B	A	B	C	A	B	C	A	B	OG Standpipe	A	B	C	A	B	C	A	B	C	OG Standpipe	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Top of Pipe						1556.327											1568.095																									1556.148													
Tailings Level	1550.06	1550.06	1548.06	1550.06	1548.06	1546.057	1548.06	1550.06	1548.06	1546.8	1548.06	1546.8	1548.06	1550.06	1548.06	1546.8	1548.06	1546.8	1550.06	1548.06	1548.06	1550.06	1548.06	1546.8	1550.06	1548.06	1548.06	1550.06	1548.06	1546.8	1550.06	1548.06	1548.06	1550.06	1548.06	1546.8	1550.06	1548.06	1548.06	1550.06	1548.06	1546.8	1550.06	1548.06	1548.06	1550.06	1548.06	1546.8	1550.06	1548.06	1548.06	1550.06	1548.06	1546.8
Install Depth	3.10	3.10	3.00	2.26	2.20	3.445	3.30	2.30	3.10	3.15	2.00	2.40	3.70	3.00	3.30	3.50	3.00	3.00	2.00	2.00	2.00	3.17	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Piezo Tip	1546.40	1546.40	1546.90	1546.30	1546.10	1546.383	1546.30	1546.40	1546.35	1546.45	1546.10	1545.960	1546.50	1546.50	1546.20	1546.50	1546.50	1546.50	1546.50	1546.50	1546.50	1546.50	1546.50	1546.50	1546.50	1546.50	1546.50	1546.50	1546.50	1546.50	1546.50	1546.50	1546.50	1546.50	1546.50	1546.50	1546.50	1546.50	1546.50	1546.50	1546.50	1546.50	1546.50	1546.50	1546.50	1546.50	1546.50	1546.50	1546.50	1546.50	1546.50	1546.50	1546.50	1546.50

Stage 4 MH V-notch wiers

MH number	1	5	9	13	17	21	25	29	44	48	52	56	60
Location	Stage 4A								Stage 4B				

Stage 5 MH V-notch wiers

MH number	68A	68A	72A	76A	80A	84A	88A	92A
Location	Stage 5A							