NEW BOLIDEN
TARA MINES





# Closure, Restoration and Aftercare Management Plan
# Tara Mines, Navan, County Meath

## Review 2009

March 2009



TOBIN CONSULTING ENGINEERS

TOBIN
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# REPORT

**PROJECT:** **Tara Mines Closure, Restoration and Aftercare Management Plan**

**CLIENT:** **Boliden Tara Mines Ltd.**
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Navan
County Meath

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## TABLE OF CONTENTS

TABLES & APPENDICES



FIGURES



APPENDICES

## EXECUTIVE SUMMARY

The preparation of the closure plan for Boliden Tara Mines Limited (Tara Mines) has been completed as two separate volumes namely:

- Volume 1 Mine Site Closure, Restoration and Aftercare Management Plan
- Volume 2 Reclamation and Closure Plan for the Randalstown Tailings facility

Volume 1 describes the requirements and costings for the closure of the Tara Mines Site Knockumber, Navan, County Meath.

Volume 2 describes the requirements and costings for the closure of the tailings facility at Randalstown, Navan, County Meath

Volume 1 includes a summary of the Financial Provision, which includes both the Mine site and the Tailings facility. (Ref. Section 11)

Tara Mines operates under an Integrated Pollution Prevention Control (IPPC) Licence (Ref. No. P0516-01) issued by the Environmental Protection Agency (EPA) in 2001 and amended in 2006. The CRAMP prepared for the Tara Mines site, including underground working and the surface processing site, can be divided into three distinct stages:

1) Post-closure, the first stage will involve the decommissioning and restoration of the underground working and the surface infrastructure. Structures and infrastructure will be reduced to grade level and the underground workings will be backfilled, with all opening, decline and conduits from the surface to the underground working backfilled.

2) Following the decommissioning and restoration stage, the period of active aftercare monitoring and management will be undertaken. This active monitoring and management will continue in the short to medium term following closure to determine the impact of closure and to assess when stabilisation and equilibrium conditions have been achieved.

3) Following the active monitoring and aftercare stage when stabilisation and equilibrium conditions have been achieved, the final stage will involve long-term monitoring.
   This monitoring is considered validation monitoring to ensure that there is no significant deviation from the stabilisation and equilibrium conditions determined at the completion of Stage 2.

A financing mechanism to cover the cost of the aftercare monitoring described above will be secured and at this stage Tara Mines will seek to surrender its IPPC Licence. This document, entitled Site '*Closure, Restoration and Aftercare Management Plan*' (CRAMP) is prepared to accord with the EPA guidance (for known liabilities at closure). It refers to information contained in the original Site Closure and Decommissioning Plan (2002) and highlights changes in operational practice or processing where

applicable. For completeness, this report also reassesses the ELRA, prepared in 2002 by Knight Piéshold, to determine that adequate insurance cover is in place for unknown, but possible/plausible contamination events during operation (i.e. unknown Liabilities).

In 2006 the EPA published a document entitled "Guidance on Environmental Liability Risk Assessment, Residuals Management Plans and Financial Provisions". The document presented a systematic approach for the preparation of Environmental Liabilities Risk Assessment (ELRA), Residual Management Plans (RMP), Closure, Restoration and Aftercare Management Plans (CRAMP) and Financial Provision. This systematic approach was used in the compilation of this document and it's evolution from the preceding closure plan as mentioned above.

The objective of this CRAMP is to achieve a situation of minimal residual impacts and for the ownership of the site not to be encumbered by planning permission, IPPC licence or mining lease obligations. The assessment of the Financial Provision is to allow for implementation of the closure plan in a controlled manner that is fully financed.

It is the intention to integrate lands, disturbed by construction, operational and decommissioning activities, into the surrounding landscape and that post closure and restoration, the lands will be utilised in the most beneficial manner, taking account of the socio-economic requirements of Navan town and the surrounding hinterlands of County Meath. It is anticipated that the closure and restoration process for the mine site will be completed within five years of the date of commencement.

The environmental liabilities of the Tara Mines site are sub-divided into two categories, which are the 'unknown liabilities' and the 'known liabilities'.

- The **unknown liabilities** are defined as the risk of environmental liabilities occurring due to unexpected events. This may occur from leakages of chemicals to ground, emissions of fumes to air, etc. The unknown liabilities are quantified by means of an Environmental Liabilities Risk Assessment.
- The **known liabilities** are defined as the planned or anticipated liabilities associated with closure, restoration and aftercare management of the site. The known liabilities are quantified by means of a Closure, Restoration and Aftercare Management Plan.
- The financial provision for unknown and known liabilities is detailed in the CRAMP for the Processing Area and Underground Working for the Tara Mines site.

As detailed above, the Closure, Restoration and Aftercare Management Plan details three distinct stages:

1. Post-closure, the first stage will involve the decommissioning and restoration of the underground working and the surface infrastructure. Structures and infrastructure will be reduced to grade level and the underground workings will be backfilled, with all opening, decline and conduits from the surface to the underground working backfilled. At the end of this stage, Tara Mines will provide certification of completion of Decommissioning and Site Restoration to the EPA and will seek 'Non Clean Closure' Status for the site. This change of status to 'Non Clean Closure' will allow Tara Mines to reorganise the financial provision and move to the Active Aftercare Monitoring and Management Stage.

2. Following the decommissioning and restoration stage and the change of status to Non Clean Closure, the period of active aftercare monitoring and management will be undertaken. This active monitoring and management will continue in the short to medium term following closure to determine the impact of closure and to assess when stabilisation and equilibrium conditions have been achieved. At the end of this stage, and when the monitoring demonstrates that stabilisation and equilibrium conditions have been achieved, Tara Mines will provide certification of completion of the Active Aftercare Monitoring and Management Stage to the EPA and will seek 'Clean Closure' status for the site. This change in status to Clean Closure will allow Tara Mines to reorganise the financial provision and move to the Passive Aftercare Monitoring and Management Stage

3. Following the active monitoring and aftercare stage when stabilisation and equilibrium conditions have been achieved, the final stage will involve long-term monitoring.
   This monitoring is considered validation monitoring to ensure that there is no significant deviation from the stabilisation and equilibrium conditions determined at the completion of Stage 2. This stage is essentially a demonstration that the closure of the mine no longer poses a risk to the environment.

The estimated costs associated with each of these stages has been explored in this document and can be summarised below



Table 1: Costs summary

| Item | Period (years) | Costings (€) |
|---|---|---|
| Closure/Decommissioning | 0-2 | 3,120,000 |
| Restoration | 0-2 | 813,738.[1] |
| Aftercare Monitoring (incl. Lab costs) | 0-10 | 1,340,000 (134,000 p.a) |
| Total | | €5,273,738 |

* Average of 3 afteruse options costed in section 9.6.1

[1] Average of 3 after use options costed in section 9.6.1

# 1 INTRODUCTION

## 1.1 BACKGROUND TO REVIEW

Boliden Tara Mines Limited (Tara Mines) operates its mining operation at Knockumber, Navan, County Meath under an Integrated Pollution Prevention Control (IPPC) Licence (Ref. No. P0516-01), issued by the Environmental Protection Agency (EPA) in 2001 and amended in 2006.

Since 1977, Tara Mines has exploited Zinc and Lead mineralisation from within the bedrock beneath the ground in the Navan area (Drawing no. 3064-1000 in Appendix 1 refers). Tara Mines was developed approximately 2km west of Navan in County Meath. Up to the end of 2007 approximately 68 million tonnes (Mt) of ore (at 8.5% Zn and 2.1% Pb) has been mined. Ore production is currently at 2.7Mt per annum.

TOBIN Consulting Engineers (TOBIN) was engaged by Tara Mines to undertake review and revise, as required, the existing '*Site Closure and Decommissioning Plan*' for the Tara Mines site. This Site Closure and Decommissioning Plan were submitted to the EPA in November 2002. TOBIN has also reviewed the existing Environmental Liabilities Risk Assessment (ELRA), prepared by Knight Piésold Ltd., for the mine site, in May 2002.

Both the Site Closure and Decommissioning Plan and the ELRA were prepared and submitted to the EPA to fulfil the requirements of Condition 13.3 and Condition 14.2 of the IPPC Licence.

The EPA, in correspondence dated 14th July 2008, requested that of a number of aspects detailed in the *Site Closure and Decommissioning Plan*, regarding the underground mine and the processing area, be addressed and/or clarified. A number of issues regarding the '*Tailings Management Facility Reclamation and Closure Plan*' were also raised. Issues relating to the tailings management facility are addressed in a separate report, prepared by Golder Associates.

In further correspondence, dated 27th August 2008, the EPA highlighted the publication and availability of an EPA document entitled '*Guidance on Environmental Liability Risk Assessment, Residual Management Plans and Financial Provision*' (June 2006). This document was published to assist IPPC Licensees in assessing environmental risk and provided a systematic approach to the assessment and management of environmental liabilities in order to comply with IPPC conditions. The EPA indicated in this correspondence that all environmental risk assessments issued prior to the publication of the EPA document should be re-assessed against the EPA guidance document, to fulfil licence requirements.

This document, entitled Site '*Closure, Restoration and Aftercare Management Plan*' (CRAMP) is prepared to accord with the EPA guidance (for known liabilities at closure). It refers to information contained in the original Site Closure and Decommissioning Plan (2002) and highlights changes in operational practice or processing where applicable. For completeness, this report also reassesses the ELRA, prepared in 2002 by Knight Piéshold, to determine whether adequate insurance cover is in place for unknown, but possible/plausible contamination events during operation i.e. unknown Liabilities.

The CRAMP prepared for the Tara Mines site, including underground working and the surface processing site, can be divided into three distinct stages:

1. Post-closure, the first stage will involve the decommissioning and restoration of the underground working and the surface infrastructure. Structures and infrastructure will be reduced to grade level and the underground workings will be backfilled, with all opening, decline and conduits from the surface to the underground working backfilled.

2. Following the decommissioning and restoration stage, the period of active aftercare monitoring and management will be undertaken. This active monitoring and management will continue in the short to medium term following closure to determine the impact of closure and to assess when stabilisation and equilibrium conditions have been achieved.

3. Following the active monitoring and aftercare stage when stabilisation and equilibrium conditions have been achieved, the final stage will involve long-term (perpetual) monitoring. This monitoring is considered validation monitoring to ensure that there is no significant deviation from the stabilisation and equilibrium conditions determined at the completion of Stage 2.

As required in the IPPC Licence Condition 13.4, a validation report, to include a certificate of completion, will be issued to the EPA on completion of Stage 1 and Stage 2. Following the completion of Stage 2, it is proposed that Tara Mines and the EPA, together with the Local Authority and other key stakeholders, will enter into an agreement as to the extent of the perpetual aftercare monitoring (Stage 3). A financing mechanism to cover the cost of the perpetual monitoring will be secured and at this stage Tara Mines will seek to surrender its IPPC Licence.

## 1.2 PLANNING HISTORY, LICENSED ACTIVITIES AND CLOSURE / FINANCIAL PROVISION REQUIREMENTS

The development and mining of Scheduled Minerals is regulated under the Mineral Development Acts (1940 to 1999). All mines exploiting Scheduled Minerals require a Mining Leases and Licences, issued by the Minister responsible for the Natural Resources portfolio in Government. Planning permission, under the Planning and Development Act 2000 and an Integrated Pollution Prevention and Control Licence, under the Waste Management Acts 1992 and 2003 must also be obtained from the respective Local Authority and the Environmental Protection Agency.



Tara Mines was issued notification of grant of planning permission by Meath County Council in 1973, with the planning subsequently upheld by AN Bord Pleanála in 1974 (Planning Ref. P73/125). Condition 21 of this Planning Permission related to the closure, restoration and financial provision for the Mine. This condition is reproduced in full below.

| | |
|---|---|
| *21.* | *Insofar as it shall not conflict with the obligations of the Developers under any State Mining Leases:* |
| *a)* | *If and when the mine becomes disused, and has in the opinion of the planning authority permanently ceased to function as a mine, the Developers shall, to the extent required by the planning authority, take down and remove all or specified plant, equipment, installations, buildings and stored material and shall reinstate the site above and below ground visually and hydrologically (so as to ensure a natural self regulating terrain) to a condition fit for agricultural use or for such other use or uses for which planning permission may be granted.* |
| *b)* | *The Developers, before commencing any part of the development, shall either deposit with the planning authority a sum of two hundred thousand pounds (£200,000) or shall enter into a covenant with the planning authority to pay annually to the said authority a sum equivalent to ten thousand pounds (£10,000) at the monetary value pertaining on the date of first payment and continue such payments until the mine permanently ceases to function as a mine. The first payment to be made on 31st December, 1975, or on the last day of the month in which production of ore concentrate commences, whichever is the earlier.* |
| *c)* | *These capital sums paid to the planning authority shall be invested by the authority with the agreement of the Developers and the interest earned thereby shall be reinvested; and any dispute about such investment or reinvestment shall be referred to the Minister for Local Government for determination.* |
| *d)* | *The capital sums and accrued interest derived from 21(b) and (c) above or any portion thereof shall be available to the planning authority and may be used by them for the purpose of securing the satisfactory carrying out and completion of the reinstatement of the site in accordance with 21(a) above or shall be refunded to the Developers in the event of the planning authority being satisfied that the reinstatement work has otherwise been satisfactorily completed in accordance with the provisions of condition 21(a).* |
| *e)* | *If while the mine is still in operation either the planning authority of the Developers carry out reinstatement work such portion of the capital sum and accrued interest referred to at 21(b) and (c) as may be agreed between the planning authority and the Developers may be applied to that purpose and where any reinstatement work undertaken by the Developers has not in the opinion of the planning authority been satisfactorily completed the said capital sums and accrued interest or portion thereof may be used by the planning authority to secure satisfactory completion of the work.* |

Further planning applications and permissions have been granted since the grant of the original Parent Permission. Certain conditions of these permissions have increased the financial provisions made by Tara Mines for closure and restoration of the facility.

The licensing and control of certain large-scale industrial activities has been incorporated under the remit of the Environmental Protection Agency (EPA), since its establishment in 1994. The EPA granted an Integrated Pollution Control (IPC) Licence to Tara Mines in 2001 (Licence Ref. 516). The Environmental Protection Agency Act of 1992 was amended by the Protection of the Environment Act 2003, which gave effect to the EU Integrated Pollution Prevention Control Directive (EU Council Directive 96/61/EC). The Tara Mines IPC Licence was subject to EPA review and it was determined by the EPA that the IPC Licence could be brought into conformity with the requirements of the IPPC Licence Directive. The IPC Licence was amended in June 2006 to an IPPC Licence, under Section 82(11) of the Environmental Protection Acts, 1992 and 2003).

Tara Mines (IPPC Licence No. P0516-01, 2001 as amended 2006) is to carry out "*the extraction and processing (including size reduction and grading) of minerals within the meaning of the Minerals Development Acts, 1940 and 1979, and the storage of related mineral waste*". The licence is issued subject to 15 No. Conditions. The conditions pertinent to Closure, Restoration and Aftercare Management Plan, together with Financial Provisions for such Plan.

Condition 13 of the IPPCL relates to the Site Closure, Decommissioning and Perpetual Aftercare of the site. The exact wording of this Condition is reproduced below.

Condition 14.2 of the IPPCL related to Financial Provisions and Environmental Liabilities. The exact wording of this Condition is reproduced below.

| **Condition 13** | **Site Closure, Decommissioning and Perpetual Aftercare** |
|---|---|
| **13.1** | Following termination, or planned cessation for a period greater than six months, of use or involvement of all or part of the site, the licensee shall decommission, render safe or remove for disposal/recovery, any soil, subsoil, building, plant or equipment, or any waste, materials or substances or other matter contained therein or thereon, that may result in environmental pollution. |
| **13.2** | Closure and Perpetual Aftercare Plans |
| 13.2.1 | The licensee shall within 18months of date of grant of the licence, submit to the agency for agreement, fully costed plans for the decommissioning or closure and perpetual aftercare of the site or part thereof. |
| 13.2.2 | The plans shall be reviewed annually and proposed amendments thereto notified to the Agency for agreement. No amendments may be implemented without the prior written agreement of the Agency. |
| **13.3** | The Closure and Perpetual Aftercare Plans shall include, as a minimum, the following: |
| 13.3.1 | A scope statement for the plans. |
| 13.3.2 | The criteria which define the successful decommissioning of the activity or part thereof, which ensures minimum impact to the environment. |
| 13.3.3 | A programme to achieve the stated criteria. |
| 13.3.4 | Where relevant, a test programme to demonstrate the successful implementation of the closure/decommissioning plan. |
| 13.3.5 | A programme for perpetual aftercare. |
| **13.4** | A final validation report to include a certificate of completion for the closure plan, for all or part of the site as necessary, shall be submitted to the Agency within three months of execution of the plan. The licensee shall carry out such tests investigations or submit certification, as requested by the Agency, to confirm that there is no continuing risk to the environment. |

| **Condition 14 Financial Provisions** | |
|---|---|
| **14.2** | Environmental Liabilities |
| 14.2.1 | The licensee shall arrange for the completion, by an independent and appropriately qualified consultant, of a comprehensive and fully costed Environmental Liabilities Risk Assessment for the whole site which will address liabilities from past and present activities. A report on this assessment to be submitted to the Agency for agreement within twelve months of date of grant of this licence. |
| 14.2.2 | Within eighteen months of the date of grant of this licence, the licensee shall make financial provision in a form acceptable to the Agency to cover any liabilities incurred by the licensee, as a consequence of environmental pollution arising on the site. The amount of indemnity must always be capable of covering the liabilities identified in Condition 14.2.1. |
| 14.2.3 | The amount of indemnity, held under Condition 14.2.2 shall be reviewed and revised as necessary, but at least annually. |
| 14.2.4 | The licensee shall within two weeks of purchase, renewal or revision of the financial indemnity required under Condition 14.2.2, forward to the Agency written proof of such indemnity. |

This report is intended to comply with the requirements of Condition 13.2.2 for review of the Closure, Restoration and Aftercare Management Plan and Condition 14.2.3 for review of financial provision for Environmental Liability.

## 1.3 GUIDANCE AND TERMS OF REFERENCE

The IPPC Licence, issued through the EPA, aims to prevent and reduce emissions to air, water and land, reduce waste and use energy and resources efficiently. The IPPC also addresses environmental management of the licensed facility.

The EPA in 2006 published a document entitled "Guidance on Environmental Liability Risk Assessment, Residuals Management Plans and Financial Provisions". The document presented a systematic approach for the preparation of Environmental Liabilities Risk Assessment (ELRA), Residual Management Plans (RMP), Closure, Restoration and Aftercare Management Plans (CRAMP) and Financial Provision (FP). This systematic approach was used in the review of the existing Site Closure and Decommissioning Plan for Tara Mines.



The benefits of a detailed ELRA, CRAMP and FP planning include:

- The reduction in the potential for environmental damage as a result of accidents;
- The minimisation of residual/long term impacts from processing and waste management activities upon closure;
- Forward Financial Planning for environmental liabilities;
- Reduction in the Financial Provision required through progressive decommissioning and restoration during operations;
- Minimisation of potential financial risk to the operator through continuous improvements in operation and management.

## 1.4 OBJECTIVE OF CLOSURE PLAN AND FINANCIAL PROVISION

The objective of this CRAMP is to achieve a situation of minimal residual impact and for the ownership of the site not to be encumbered by planning permission, IPPC licence or mining lease obligations. The assessment of the Financial Provision is to allow for implementation of the closure plan in a controlled manner that is fully financed.

It is the intention to integrate lands, disturbed by construction, operational and decommissioning activities, into the surrounding landscape and that post closure and restoration the lands will be utilised in the most beneficial manner, taking account of the socio-economic requirements of Navan town and the surrounding hinterlands of County Meath.

The objective of the Closure and Restoration Plan includes:

- Protect public health and safety during the closure, decommissioning and aftercare monitoring period;
- Alleviate or eliminate environmental damage, and in monitoring conditions in the short to medium term (active care) following decommissioning to achieve stabilisation or equilibrium conditions;
- To provide a mechanism and funding for the perpetual aftercare monitoring (passive care) to ensure surface stability measures remain successful;
- To restore the surface site to productive use, taking account of the socio-economic needs of Navan and the wider hinterland of County Meath;
- To restore the site to a condition visually acceptable to the local community;

The EPA Guidance on Environmental Liability Risk Assessment, Residuals Management Plans and Financial Provisions has been used as the template for interrogating and quantifying the potential liabilities to the common datum required by the EPA to provide an objective assessment.

This will ensure an environmentally responsible approach by Tara Mines to the closure of the facility, with due consideration to the surrounding environment, the local amenity and the facilitation of future re-use of the mine site, in order to benefit the local environment, amenity and economy.

The closure of the tailings storage facility located to the north of the mine is subject to a separate Closure Plan by Golder Associates, which will also be submitted to the EPA.



The environmental liabilities of the Tara Mines site are sub-divided into two categories, which are the 'unknown liabilities' and the 'known liabilities'.

- The **unknown liabilities** are defined as the risk of environmental liabilities occurring due to unexpected events. This may occur from leakages of chemicals to ground, emissions of fumes to air, etc. The unknown liabilities are quantified by means of an Environmental Liabilities Risk Assessment.
- The **known liabilities** are defined as the planned or anticipated liabilities associated with closure, restoration and aftercare management of the site. The known liabilities are quantified by means of a Closure, Restoration and Aftercare Management Plan.

- The financial provision for unknown and known liabilities is detailed herein for the Processing Area and Underground Working for the Tara Mines site.

## 1.5 SCENARIO FOR IMPLEMENTATION OF THE CRAMP

Condition 13.1 of IPPC Licence requires that the CRAMP address circumstances following termination, or planned cessation for a period greater than six months.

The CRAMP is prepared based on final termination of use of the site. This termination of use could occur at any timeframe for economic and technical issues. The site could also fall into planned temporary cessation for contributing factors. These hypothetical scenarios are detailed below:

- Low global commodity prices making the mine uneconomical to operate;
- Surplus mine rock;
- Smaller than anticipated reserves;
- Increased production costs;
- Technical problems; and
- Industrial relations problems.

In the event that the mine is placed in planned temporary disuse for a period exceeding six months, the site will not be decommissioned. The EPA will be informed that the cessation of works is not on a permanent basis and the full extent of the CRAMP will not be implemented. During temporary cessation of works, the mine will operate on a full care and maintenance situation, whereby the mine continues to operate, however it does not undertake ore extraction or produce ore concentrate. In such an event, the financial costs of short term disuse will be met from the normal budget of Tara Mines, without any implications or drawdown on the Financial Provision. This will ensure that the Financial Provision for implementation of the termination CRAMP is always available.

Where the site is deemed to have fully terminated operations at the site, the EPA will again be informed and the full CRAMP will be implemented. The implementation of this Plan will be undertaken in consultation with the EPA, Meath County Council and other key stakeholders. In the implementation of the CRAMP, Tara Mines will seek to draw down on the financial provision made for this event.



## 1.6 GENERAL CONTENT AND FORMAT OF THE CLOSURE, RESTORATION AND AFTERCARE MANAGEMENT PLAN

The EPA Guidance document on CRAMPs and ELRAs provides an overview of what should be contained. This outline, reproduced in Table 1.1 below, was regularly reviewed in the preparation of the CRAMP for Tara Mines. Insofar as possible this report includes all the major headings are included in this report. However, owing to specifics of the Tara Mines site and to allow for ease of comparison with the original Closure and Restoration Plan (2002), this CRAMP has unavoidable resulted in some deviation from the outline table of contents provided by the EPA.

Table 1.1 EPA Guidance document on CRAMPs and ELRAs

| Closure Plan Section | Section Contents |
|---|---|
| 1. Introduction | • Facility and Licence Details<br>• Facility Closure Scenarios Covered in the Plan 2 Site |
| 2 Site Evaluation | • Facility Description & History<br>• Facility Compliance Status<br>• Facility Processes and Activities<br>• Inventory of Site Buildings, Plant, Raw Materials and Wastes |
| 3 Closure Considerations | • Clean or Non Clean Closure Declaration<br>• Plant or Equipment Decontamination Requirements<br>• Plant Disposal or Recovery<br>• Waste Disposal or Recovery<br>• Soil or Spoil Removal |
| 4 Criteria for Successful Closure | • Addressing of Site Environmental Liabilities at Closure. |
| 5 Closure Plan Costing | • Decontamination Costs<br>• Plant & Waste Disposal Costs<br>• On going monitoring<br>• Facility Security and Staffing<br>• Other Costs |
| 6 Closure Plan Update & Review | • Proposed Frequency of Review<br>• Proposed Scope of Review |
| 7 Closure Plan Implementation | • EPA Notification<br>• Local or other Statutory Authority notifications<br>• Test Programmed (If Applicable)<br>• Full or Partial Closure considerations |
| 8 Closure Plan Validation | • Closure Validation Audit<br>• Closure Validation Audit Report<br>• Closure Validation Certificate |

## 1.7 MATTERS OF PUBLIC CONCERN

Issues that have the potential to cause public concern regarding the closure of the facility would include:

- Environmental issues
  - Air pollution
  - Noise pollution
  - Surface water
  - Groundwater
  - Soils
  - Landscape and Visual
  - Stability/Subsidence
  - Mining Heritage

- Financial Issues
  - Financial Provision for monitoring of the above
  - Socio economic impacts

- Safety issues
  - After-use Topography
  - Explosives
  - Residues and spoil heaps
  - Fresh Air Raise and Return Air Raise openings

All of these issues are addressed in the course of the CRAMP and ELRA process, however the aspects of concern from the general public are outlined briefly below.

### *1.7.1 Environmental Issues*



Air Pollution

This is a potential matter for public concern, both in terms of the release of substances managed by the IPPC license for the facility and for the release of dust to the atmosphere from the site. All measures currently in place to maintain compliance with the air quality requirements of the IPPC license for the site shall be maintained throughout the closure period to ensure continued compliance in this regard.

The surface water ponds on the site will be among the last pieces of infrastructure to be decommissioned and dust suppression water spraying of roadways and spoil heaps will be employed during dry periods of the closure process wherever the potential for a dust nuisance occurs.

Noise Pollution

The potential for noise impact during the closure period of the site is a matter for public concern. Noise impact from this process shall be minimised at all times so as to ensure compliance with the acoustic requirements of the IPPC license, and to avoid noise nuisance to the closest sensitive receptors. Where the nature of the closure process at hand necessitates a particularly noise intensive practice, any such activity shall be limited to between 08:00 – 22:00 hours, Monday to Friday and 08:00 to 14:00 hour on Saturday.

Surface Water Pollution

Tara Mines discharges treated water from the site to the River Boyne. The River Boyne is a designated site and is of significant amenity and fishing potential. The impact of these discharges on the water quality and ultimately the amenity value of the water resource is of concern to the general public. Tara Mines currently undertake significant treatment of water prior to discharge and conduct regular monitoring to demonstrate that discharges are not impacting on a deleterious impact on the water quality of the aquatic habitat. This will continue during and post operations at the site.

Groundwater Pollution

Owning to the depth of extraction of ore, Tara Mines dewater inflows of groundwater to maintain a dry and safe working environment underground. All dewatered groundwater is pumped to the surface and subject to treatment prior to discharge. As with surface water, Tara Mines currently undertake significant treatment of water prior to discharge and conduct regular monitoring to demonstrate that discharges are not impacting on a deleterious impact on the water quality. This will continue during and post operations at the site.

Soils

Tara Mines undertake soil and vegetation sampling, soil moisture analysis and engage veterinary specialist to ensure that the operation of the Mine site does not impact or soils or agricultural activity adjacent to the main and in the wider surrounding area. Post-closure and during site decommissioning and restoration, significant works will be focused on ensuring that the mine site is remediated to a level appropriate to its envisaged end use. This will ensure that, regardless of the site after-use, the current activities do not pose a risk to flora, fauna or humans.

Landscape and Visual

There is the potential for public concern arising from the landscape and visual aspect of the closure period of the facility. There may be a requirement during the closure period for the creation of temporary spoil heaps and/or berms to facilitate the closure process. On a more permanent basis however it will be the objective of the CRAMP to return the topography of the site to as close as possible to a pre-operation state, or to a state that would be more beneficial to a specific after-use for the site. Mine shafts, openings and pits shall be in filled and made good, and all buildings, plant, head frames and gantries shall be removed.



Stability and Subsidence

There is potential for public concern relating to ground settlement and subsidence of structures, as a result of current activities and post-closure of the facility. Tara Mines currently undertake significant monitoring of ground settlement and will continue to undertake monitoring and surveys as required. The mine design and extraction techniques used at Tara Mines aim to minimise the potential for ground settlement and subsidence (differential settlement). While regional settlement has been recorded from this monitoring, there has been no recorded incidence of building subsidence due to differential settlement.

Mining Heritage

The proposed conservation of the certain aspects of the Tara Mines site should be considered, in order to maintain an aspect of mining heritage in Navan, upon closure of Tara Mines. The history of operations at the site and employment and economic activity generated by the mine should be recognised. An excellent opportunity exists at the site to view geological information, mining machinery and mining techniques. An opportunity exists for teaching the general public and students of the geology of Navan, mining techniques, mine development and environmental control measures, through the development of an educational centre.

### *1.7.2 Financial Issues*

Funding for Monitoring/Mitigation

There is potential for public concern as to the availability in the longer term for financial provision for the above mentioned environmental issues. The finance to cater for the environmental monitoring and mitigation that may be required to ensure that all relevant criteria are met shall be provided for by means of a surety enabling the appropriate state authority to undertake monitoring in keeping with the EPA requirements. This is further outlined in Section 11.

Loss of Employment

Public concern regarding the loss of employment at the facility stems from the fact that Tara Mines is a major employer in the area, and that the closure will lead to a loss of jobs. Unfortunately, the extractive industry is by its very nature a transient sector, and the mineral reserves of any site are finite. The closure of the facility as pertains to employment will however, be a staged process in which staff numbers will be steadily reduce over a number of years. This will serve to both reduce the impact on the local community and also to provide employees with a longer lead in period in which to seek new employment. The staggered nature of the staff numbers reductions will also serve to avoid a flooding of the local job market. It is unknown at the time of writing if the mine facility will be replaced by an alternate industry which may provide replacement job opportunities in the area.



### *1.7.3 Safety Issues*

After-use Topography

As discussed earlier in the Landscape and visual section, the topography of the site after use will be returned to as close as possible to a pre-operation state, or to a state that would be more beneficial to a specific after-use for the site. Mine shafts, openings and pits shall be in-filled and made good, and all buildings, plant, head frames and gantries shall be removed. All surface openings will be in-filled and all spoil heaps will be removed. Tailings and fresh water Ponds will be in filled (unless required for after use industry) and made safe for the public.

Explosives

All explosives, residues and containers of explosives shall be removed from the site during the closure period. There shall at no time be explosives on site in any area open to public admittance.

Residues and Spoil Heaps

There is the potential for public concern regarding the remnants on site post closure, of residues of mine waste and/or the presence of spoil heaps. All and any such material will be removed from the site during the closure period.

F.A.R and R.A.R Openings

Fresh Air Raise and Return Air Raise openings both on the main mine site and on satellite sites catered for in the closure plan will be closed and in filled to make sure that there is no danger to the public arising from same after the closure of the facility.

# 2 SITE SETTING AND OPERATION HISTORY

## 2.1 GEOGRAPHIC AND GEOLOGICAL SETTING

Tara Mines is located at Knockumber, 2km west of Navan, County Meath. Mine development works commenced in 1973, with the commencement of production occurring in 1977 for the extraction and processing of Zinc and Lead. Up to 2007, approximately 68 million tonnes (Mt) of ore (at 8.5% Zn and 2.1% Pb) has been hoisted. Production at the mines is currently approximately 2.7Mt per annum.

The surface mine facility was originally in a rural area outside of Navan, however the expansion of Navan has resulted in the development of residential areas closer to the mine site. Notwithstanding this development, much of the land surrounding the mine remains in agricultural use at present.

Tara Mines is located within the surface water catchment of the River Boyne. The River Boyne flows in a south to north direction towards Navan. The River Blackwater flows from north to south towards Navan. The confluence of the River Blackwater and River Boyne occurs within Navan town and thereafter the flow is generally in an easterly/north-easterly direction. All lands within and surrounding the Tara Mines site would naturally drain towards these significant waterbodies.

The River Boyne and River Blackwater are designated as a Special Area of Conservation (SAC) (Code 002299). The riverine stretches are designated from alkaline fen and alluvial woodland, both of which are listed in Annex I of the EU Habitats Directive. The SAC is also selected for Atlantic Salmon, Otter and River Lamprey, which are listed in Annex II of the EU Habitats Directive.

Tara Mines has operated and maintained its own Meteorological Station at the mine site since 1977, which is listed within the National network of Climatological Service operated by Met Eireann. The mine area has a mean annual rainfall of 834mm for the monitoring period 1977 to 2001. The mean daily maximum air temperature is 14.8$^{0}$C (July) and the mean daily minimum temperature is 3.8$^{0}$C (January).

The mine site occupies a total area of 72 hectares (ha). The mine site is generally flat lying and where not covered by hardstanding, buildings or other ancillary infrastructure, the site is vegetated or planted with tree stands. There are a number of earth berms across the site, constructed to act as noise attenuation / mitigation structures to ameliorate the impact of surface activities on the surrounding environment.



Below ground, Tara Mines is divided into the following sub-areas for management and planning purposes. The following sub-areas are used:

- The Main Mine was the first area to be mined and underlies the surface facility. The ore in this area has largely been mined.
- The South West Extension (SWEX) is a deep ore body to the southwest of the main site.
- The Nevinstown extension is to the north of the Main Mine. The boundary between the Main Mine and Nevinstown is marked by the River Blackwater
- The Liscarton orebody, which lies to the northwest of the main orebody.

The ore is hosted in limestone and dolomites of Lower Carboniferous area, referred to as the Pale Beds, which are often permeable and with cavities present. The Pale Beds are overlain by Upper Dark Limestones, which usually form a low permeability cap/poor groundwater conduit over the Pale Beds.
The ore zone dips to the southwest, with the thickness of ore body varying from <10m to 80m. Mine extraction is carried out between 50m and 1000m below the surface.

The extent of the orebody is shown on drawing number 3064 - 1000 in the Appendices to this report.

## 2.2 MINE OPERATION

An overview of the operation is presented in the process flow diagram Figure 2.1.

### *2.2.1 Existing Mine Facility Surface Infrastructure*

The surface facility, (i.e. lands within the fenced perimeter) occupies a total of 72 hectares. The site layout is depicted on drawing number 3064-1001 in the Appendices to this report. The following infrastructure is located within the facility:

- Administration and canteen buildings;
- Ore storage shed;
- Process plant;
- Concentrate storage and train loading shed;
- Storage buildings
- Engineering maintenance buildings;
- Laboratory;
- Chemical and oil storage tanks and tank farms;
- Roads and car park areas;
- Explosives magazine;
- Landfill area; and
- Drainage management system including settlement ponds.



### *2.2.2 Mine Workings*

The geometry of the ore body has necessitated the design of an effective ore working system. The varying thickness and depth and lateral extent have influenced an ore handling system based on mobile and trackless equipment, which hauls the excavated material to five underground primary crushers.
The crushed material is then carried, via a conveying system, to one central production hoist. The production hoist is located within the Main Mine facility. The orebody is mined by underground cut and fill excavation methods. The ore is removed in alternate vertical slices, leaving pillars of rock to provide stability. The mined out areas are then backfilled with tailings sand, cement and/or development waste, with the exact composition dependent on location and

adjacent mining plans. When the backfill has consolidated and of sufficient strength to provide stability, the pillars are removed.

The mining method is principally a blast-hole open stoping (Libby et al, 1985), employing foot-wall drifts, driven along the strike of the orebody, to give stope lengths varying from 20-30m and widths varying from 15-30m.

### 2.2.3 Mine Development

Mine development takes place in two phases, main development and exploration in which sections of the orebody are outlined and made accessible for eventual mining and stope development. This involves the drilling, blasting and recovery of the stope and pillar ore. Both forms of development are important sources of ore, contributing approximately 400,000 tonnes/annum to a total production of 2.7Mt/annum (2007 production level).

### 2.2.4 Mine Production

Generally stopes and pillars have been laid out with their long axes parallel to strike. This has reduced the amount of footwall development in waste and facilitated stope access through haulage pillars that are essentially aligned down dip. Stope and pillar dimensions have evolved over time from an initial 12.5m width (for both stope and pillar) to the present less rigid dimensions. Widths for both stope and pillar are currently determined on a case by case basis and controlled by local features such as ore thickness, bedding planes, faults, joints and adjacent openings. Heights are also variable and depend on the thickness of the ore (ranging from <10m to 80m).

Either one or two footwall undercut drifts are driven (depending on stope width) in positions that maximise ore recovery and minimise waste dilution. A hanging wall drift is developed when the ore height exceeds 25m, and a slot raise is then developed from the footwall to the hanging wall contact, either at the end of the stope or centrally located, depending on the mucking accessibility. This slot is widened to full stope width. The footwall drifts are also widened to provide a complete undercut while the main blasthole rings, drilled form the footwall or hanging wall drift, if present, are blasted into this void. The ring drilling fan hole pattern, drilled at right angles to the long axis of the stope, is designed with 2.2m burden between holes, although this can be changed to suit local conditions.



Production blasting occurs at the end of day shift. The broken ore is removed by loader from the stope and taken to the one of the four primary crushing stations, either by loader or truck, depending on the distance of travel. The blasting/mucking sequence continues until the stope is completely mined out, after which it is subsequently backfilled.

Ore from the pillars is extracted in the same manner, once the backfill has sufficiently consolidated and strengthened.

### 2.2.5 Ore Handling

The mucking (handling of blasted rock) of the ore is achieved by a combination of conventional and remotely operated scoop trams, as well as manual operated dump trucks. Ore is transported directly via dump trucks and scoops to ore passes, which interconnect the lower haulage levels. The ore travels by gravity within these ore passes.

Ore is also transported by dump trucks and scoops to the primary crushing stations. The broken ore from both production and development is delivered to one of four of these primary crushing stations, where it is reduced in size to less than 150mm size. The crushing stations can accommodate rates of up to 800 tonnes per hour.

Crushed ore from the primary crushing stations is carried by conveyor to a storage bin of 3600 tonne capacity located adjacent to the base of the production shaft. The ore is fed to the shaft skip loading pockets. The ore hoisting cycle to the surface is automatic, with the control of the ore feeders, transfer conveyors and skip loading being regulated by the hoisting cycle and the weigh cells of each loading pocket.

Ore at the surface is hoisted into two 15.5tonne capacity bottom dump skips running in balance, tipped into a small bin at the headframe and then conveyed to a 35,000 tonne capacity surface storage building, known as a 'tepee'. The shaft, 5.03m inside the concrete lining, is equipped throughout in steel and contains two hoisting compartments, a ladder-way and a service compartment.

### *2.2.6 Backfilling*

Upon completion of excavation mined-out areas are backfilled with sand-fraction mill tailings and cement which flows through an extensive underground pipeline network connected to the existing mine backfilling facilities. Stopes are backfilled through holes drilled down into the roof of the excavation and backfill poured down over an extended period until the stope is filled. There will be no backfilling-related connections to surface outside the main mine site. In addition, and wherever feasible, all waste rock from development will be placed in stopes and ore pillars, prior to backfilling with sand and cement. The recovery of approximately 52% of the mill tailings provides sufficient backfill material to replace the ore mined out.

### *2.2.7 Ventilation*

There are two primary reasons for mine ventilation:

- To provide oxygen rich air for underground operators and machines; and
- To remove and dilute concentrations of noxious gases so as to render them harmless.

The main noxious gases to be removed/diluted are emissions from underground diesel equipment (carbon dioxide, carbon monoxide and nitrogen oxides). There are also gases that are generated as by-products of blasting, namely carbon dioxide, carbon monoxide, sulphur dioxide, hydrogen sulphide (in ore with high pyrite content) and ammonia.

The large lateral extent of the orebody, together with its variations in depth and thickness necessitates a ventilation system that can be adapted to demand, as the active mining locations change.

The extensive use of underground diesel equipment requires large volumes of fresh air to be passed through the mining access routes. Ventilation is by a 'pull' system whereby the fans are on the exhaust end of the system creating a negative air flow. Air intake is through seven openings, the main decline, the production shaft, the development shaft, one 3.66m diameter fresh air raise (FAR) and one parallel FAR consisting of two 3.66m diameter bored raises.

Air is exhausted to the surface using five main fan stations as primary ventilation, three of which are located underground. Two of the underground stations each containing two axial flow fans of 2.24m diameter each and rotating at 735rpm develop a pressure of 1800Pa. The total throughput capacity of the four fans (2 stations) is 472$m^3$/sec at design duty. The third underground station has two axial fans of 1.8m diameter and a capacity of 200$m^3$/sec at design duty. The fourth fan station is located at the surface and comprises two backward inclined centrifugal fans of 2.94m diameter, with a capacity of 236$m^3$/sec at design duty. The total up-cast capacity at design duty from all exhaust stations is 908$m^3$/sec or 1,913,000 c.f.m.

*2.2.8 Mine Dewatering*

All underground water encountered during development and mining is collected locally at underground pumping station and piped back into the existing mine and held in an central underground sump. This water is pumped from underground to surface via a riser in the production shaft. All mine water is subject to treatment. The total pumping capacity in the mine is 21,600 $m^3$/d. There will be no additional water pumping related connections to surface. There is sufficient flexibility and storage in the water management system to accommodate all water collected and pumped from underground.

*2.2.9 Water Treatment/Recirculation System*

There are three sources where water is generated within the Tara Mines facility. These sources are:

- Water inflow to underground mine openings;
- Surface water run-off captured within the site; and
- Water returns from the process plant activity.

Water from these three sources is collected, pumped and treated prior to discharge to the River Boyne.

All water from the process plant is pumped to the tailings management facility (TMF) for treatment. Further to adequate treatment and retention time in the TMF, water is returned to the main mine facility and discharged to the Reclaim Water Pond.

Mine-water and surface run-off, representing a low-risk effluent is treated in the on site water treatment system.

The water treatment system comprises three stages of clarification in sediment-aeration ponds prior to discharge to the River Boyne.

At present, all mine-water is pumped and collected at a central underground pumping station. The water enters a large settling sump where suspended solids settle out. The water is pumped to the surface via rising pipework infrastructure within the production shaft.

The underground water is pumped to a mine-water pond, acting as a primary settlement pond. Overflow from this mine-water pond decants, by controlled overflow, to a secondary stage of settlement/clarification in the Reclaim Water Ponds. Water from the Reclaim Water Pond decants, via a controlled overflow, to a Clear Water Pond (Discharge pond). The discharge from the Clear Water Pond to the River Boyne is via a weir structure, which measures and controls the discharge. The rate of discharge from the Clear Water Pond is dictated by the flow in the River Boyne, as a minimum dilution rate of 100:1 is required under EPA licence conditions.

An automatic hydrometric gauging station has been installed on the River Boyne. This gauging station provides a real time record of water levels and flow in the River Boyne. Discharge from the site is controlled based on monitored River Boyne flows.

*2.2.10 Mill Process Operation*

In the underground mining operations, the ore is crushed in the primary crushing stations before hoisting to the surface and is transferred by a conveyor system to the coarse ore storage building. The ore is extracted from the coarse ore storage building and fed to the processing plant.

Ore processing in the mill is achieved by crushing, grinding, flotation, leaching and dewatering. These unit processes are automated, monitored and controlled by a process control system. The crushing and grinding (comminution) circuits are designed to reduce the ore particle size to less than 120 microns. At this size range, the mineral particles are liberated from other minerals and the host rock.

The finely ground ore slurry is pumped from the grinding circuit to the flotation stage of the process. The flotation process is divided into two distinct sequential stages. Lead minerals are recovered in the first stage followed by recovery of zinc minerals in the second stage two. The flotation circuit consists of a series of tank-like cells in which there is a rotating agitator, which stirs the mixture of ground ore and water. Chemical agents are added, one of which promotes frothing. Other agents alter the surface properties of the mineral particles and cause them to be attracted to bubbles, generated by forcing air through the mixture by the agitators. These bubbles, coated with mineral particles, rise to the top of the mixture as a froth, and overflow the lips of the cells into collection troughs or launders.

Different combinations of reagents are used to selectively remove different minerals. Lead minerals are removed in the lead circuit and the remaining material is transferred to the zinc circuit for the removal of the zinc minerals. Following leaching and re-float, the resultant Pb and Zn concentrates, which have a very high water content, have to be dewatered. The concentrates are dewatered separately using thickening and filtration in *Metso* pressure filters. Following dewatering the residual moisture content is less than 9% for zinc concentrate and for 6% lead concentrate.



The final products produced at the mine are Zinc concentrate (56% Zn by weight) and Lead concentrate (65% Pb by weight). This material is conveyed to a 30,000 tonne capacity storage building, where it is loaded onto 55 tonne wagons for rail transport to Dublin. From Dublin the concentrate is shipped to various smelters in Europe.

### *2.2.11 Environmental Monitoring*

At its instigation, Tara Mines planned and executed an extensive baseline study of existing environmental conditions. The Company has established an Environmental Department, which is charged with ensuring compliance of the operation and emissions of to the receiving environment, in compliance with all permits, licences and permissions.

Extensive environmental monitoring is conducted to comply with IPPC Licence emission limits. This monitoring has provided valuable data over an extended timeframe to establish existing environmental conditions and discern any trends.

The main interest of these studies is to ensure that a database of information of the nature and setting of the receiving environment is available so that post mine closure conditions can returned to (or as close as possible), or qualities re-established to, their pre-existing conditions.

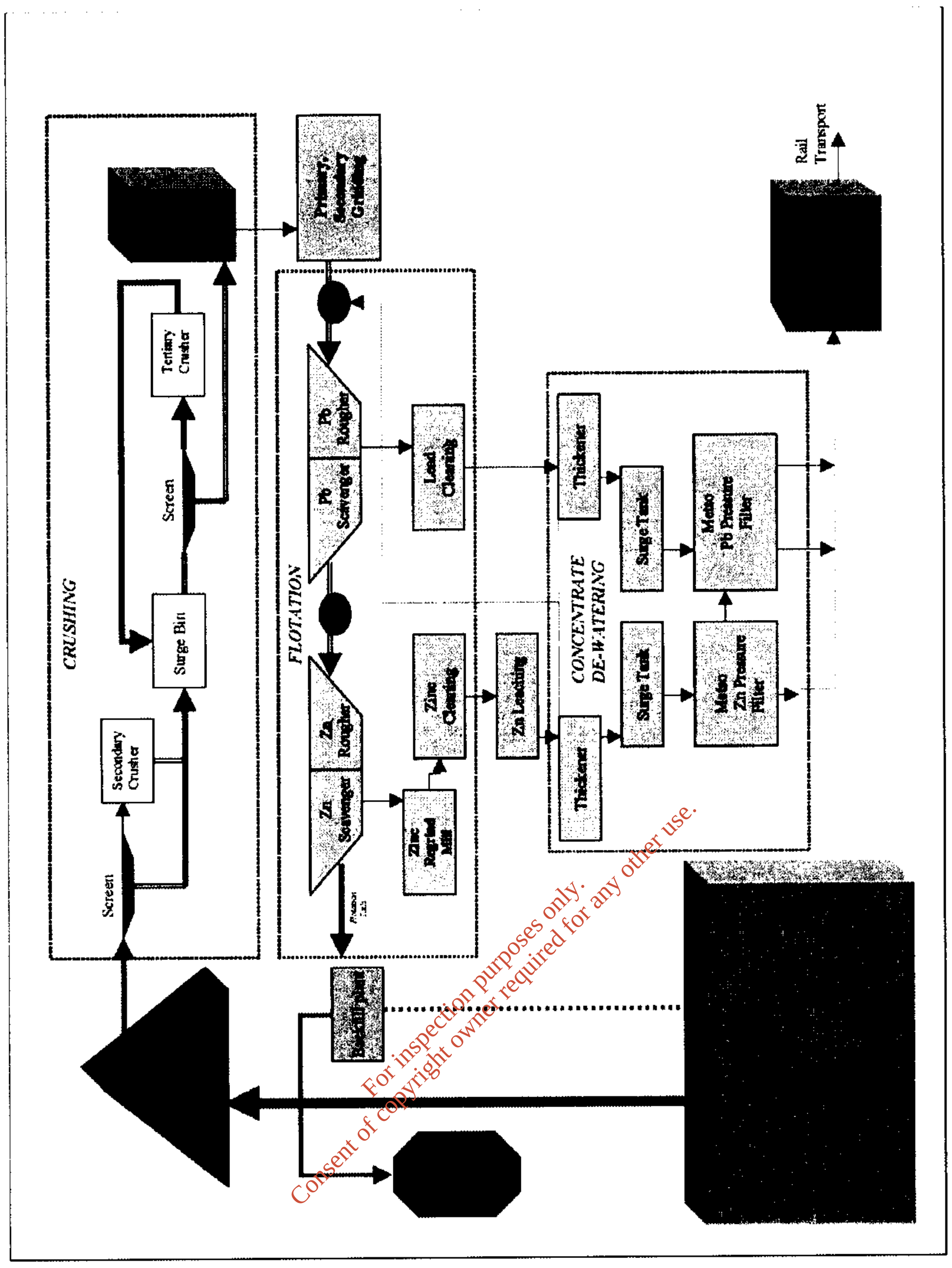
The environmental monitoring consists of continuous or periodic monitoring of the environment consisting of the following:

- Aquatic Environment
  - Physico-chemical surface water quality
  - Biological surface water quality
  - Hydrometic flow gauging
  - Electro-fishing and fish stock surveys
  - Surface water flora and macroinvertebrate fauna
- Geological and Hydrogeological Environment
  - Rock quality and ore testing
  - Underground groundwater inflow gauging
  - Underground groundwater inflow physico-chemical quality assessment
  - Groundwater dewatering assessment
  - Regional groundwater well/borehole surveys
- Atmospheric Environment
  - Climatology
  - Air Quality
- Noise and Vibration

- Agricultural
  - Soil and vegetation sampling
  - Veterinary

- Terrestrial Environment
  - Flora and Fauna assessments
  - Landscaping and visual screening assessments

- Social, Cultural and Socio-Economics
  - Landscaping and visual screening assessments
  - Local Authority Development Plan assessment and contributions


CRUSHING
Screen
Secondary Crusher
Surge Bin
Screen
Tertiary Crusher
Primary, Secondary Crushing
FLOTATION
Pb Scavenger
Pb Rougher
Lead Cleaning
Zn Scavenger
Zn Rougher
Zinc Regrind Mill
Zinc Cleaning
Zn Leaching
CONCENTRATE DE-WATERING
Thickener
Surge Tank
Metso Pb Pressure Filter
Thickener
Surge Tank
Metso Zn Pressure Filter
Rail Transport
Backfill plant

# 3 MINE DEVELOPMENTS AND POST CLOSURE CONSIDERATIONS

## 3.1 GENERAL GEOLOGY OF OREBODY

The geological succession from the surface downwards is described below.

- Approximately 3m to 30m of superficial deposits overlies bedrock in the general area. These superficial deposits consist of glacial till material and alluvial material along depositing watercourses.
- A bedrock unit, referred to as the 'Upper Dark Limestones' (UDL unit), which comprise a series of thinly bedded dark-grey limestones, directly underlies the glacial subsoil.
- A bedrock unit, referred to as the 'Pale Beds' underlies the UDL unit. Approximately 97% of the Navan orebody is hosted in Pale Beds, which is a Courceyan shallow water carbonate bedrock (Ashton et al, 1992). The main Navan orebody comprises a series of several stacked stratiform lenses, the total thickness reaching a maximum of 120m.
- Below the Pale Beds lies a thin muddy limestone unit, which is in turn is underlain by a sequence of laminated siltstones and shales, referred to as the 'Laminated Beds'.
- Below the Laminated Beds are red conglomerates, known as the Red Beds, which are basal Carboniferous lithological units.
- *The Red Beds in unconformable geological contact with Lower Palaeozoic* sedimentary, volcanic and intrusive rocks.

The bulk of the ore occurs as a series of superimposed, generally stratiform to stratabound lenses, which usually dip at gentle angles of 15-20$^0$ to the southwest. The lenses are numbered in ascending order from 5 (lowest) to 1 (highest), with their stratigraphic extent being defined by marker horizons in the enclosing Pale Beds.

The mineral assemblage of the orebody, which is primarily sphalerite and galena (approximately 5:1 – Zn:Pb), with minor amounts of barite, calcite, marcasite, dolomite, pyrite *and rare sulphosalts.*

## 3.2 CURRENT OPERATIONS

Since 1977, Tara Mines has exploited Zinc and Lead mineralisation from within the bedrock beneath the ground in the Navan area. Up to the end of 2007 approxametly 68 million tonnes (Mt) of ore (at 8.5% Zn and 2.1% Pb) has been hoisted. Ore production is currently currently at 2.7Mt per annum.

Mill production for 2008 was 2.41 million tonnes of ore grading 7.76 % Zinc and 1.54 % Lead, with employment of approximately 700 persons in the operation.

The Tara Mine underground mining operations are divided into the following sub-areas, for management and planning purposes:

- The Main Mine was the first area to be mined. The ore in this area has largely been exhausted.
- The Southwest Extension (SWEX) to the southwest of the Main Mine. SWEX is a downdip continuation of the orebody, on the southside of one of the major faults (T fault).
- Nevinstown, to the north of the Main Mine. Nevinstown is the updip section of the orebody on the northeast side of the River Blackwater. The UDL layer is absent, there are indications of karst weathering and cavity formation in the Pale Beds nears the surface.

The delineation of the underground mining sub areas is shown on Drawing 3064 -1002.

SWEX and Nevinstown are currently being developed and mined. Access to both SWEX and Nevinstown is from the Main Mine decline at the Main Mine site. The mining operation is currently being carried out between approximately 50m below ground level (at Nevinstown) to approximately 900m below ground level (to southwest extent of SWEX).



## 3.3 OVERVIEW OF FUTURE OPERATIONS

The further expansion of the mine northwards into the Nevinstown orebody, along with the continuation of the southwest development (SWEX development), will support the capacity and extend the lifespan of the mine.

As of early 2009, the estimated current known Mineral Reserves are 17.1 million tonne grading 7.4% zinc and 1.8% lead. The current estimated Mineral Resources are 13.1 million tonnes of 7.0% zinc and 2.0% lead.

It is envisaged that annual production of approximately 2.7 million tonnes of ore will be maintained, assuring Tara's status as the one of the world's largest zinc mines.

In the future, and dependent on investigation of the orebody, Tara Mines may submit further planning applications and IPPC Licence reviews, to further extend the aerial extent of underground mining. However, it is anticipated at present, in so far as is possible for a hypothetical scenario, that all further underground workings would be accessed from declines within the main mine site. Similar mining technologies, designs and developments would be utilised (or improved techniques in accordance with industry standards) in any future underground development.

The Company is developing a new Autogenous-grinding mill that will replace the current ore grinding system. With this exception all above ground infrastructure is in place at the Main Mine site for storage and processing of ore concentrate. Therefore, into the future, it is not anticipated that the process technique will change significantly.

*It is not anticipated that further expansion and development of the mine will materially alter* the current mine site description. As the Nevinstown orebody and the SWEX development are ancillary to the existing mine all the necessary infrastructure for its operation is in place, including administration, mining and processing facilities, tailings storage capacity, ventilation, effluent discharge facilities and road/rail links to Dublin Port.

# 4 SITE SCREENING, OPERATONAL RISK ASSESSMENT AND SITE EVALUATION

## 4.1 INTRODUCTION

In accordance with the EPA guidance document (Guidance on Environmental Liability Risk Assessment, Residual Management Plans and Financial Provision, EPA 2006), the starting point in the process is an initial screening and risk assessment of the operation. The EPA has developed a relatively simple risk assessment decision matrix to classify site into Risk Categories, which in turn indicate the specific requirements of the Environmental Liabilities Risk Assessment (Unknown Liabilities) and the Closure Restoration and Aftercare Management Plan (Known Liabilities).

The EPA'S Risk Assessment Matrix comprises three components, as follows:

- Complexity; and
- Environmental Sensitivity; and
- Compliance Record.

Complexity

This represents the extent and magnitude of potential hazards present, due to the operation of the facility (e.g. a function of the nature of the activity, the volumes of hazardous materials stored on site, etc). A Complexity Band (G1 least complex to G5 most complex) has been assigned to each class of scheduled activity listed in the Protection of the Environment Act, 2003.

Environmental Sensitivity

This represents the sensitivity of the receiving environment in the vicinity of the facility, with more sensitive locations given a higher score (e.g. the presence of aquifers below the site, groundwater vulnerability, the proximity to surface water bodies and status, the proximity to sensitive human receptors, etc.).

Compliance Record

The compliance history of the facility, in terms of operation management and environmental emission compliance with IPPC Licence requirements are assessed to indicate the performance of the facility.



Each aspect is assessed to give a risk score (or risk metric) and thereby assign the facility into the appropriate risk category. Once this risk screening and risk assessment is complete, the appropriate detail of the Closure, Restoration and Aftercare Management Plan and Financial Provision can been determined.

## 4.2 SITE SPECIFIC SCREENING AND RISK ASSESSMENT

### *4.2.1 Introduction*

In order to determine the extent of the CRAMP for Tara Mines, the EPA has defined a scoping exercise which must be conducted to determine a site specific risk category for each IPPC Licensed facility.

The determination of the Risk Category for the Tara Mines site is outlined below.

### *4.2.2 Complexity Score*

Tara Mines is licensed under Section 83(1) of the Environmental Protection Agency Act (1992) for "*the extraction and processing (including size reduction and grading) of minerals within the meaning of the Minerals Development Acts, 1940 to 1979, and the storage of related mineral waste*".

Under the Protection of the Environment Act, 2003, the Tara Mines activity is considered to be classified under Paragraph 3.4.1 as "*The production, recovery or processing of non-ferrous metals, their compounds or other alloys including antimony, arsenic, beryllium, chromium, lead, magnesium, manganese, phosphorus, selenium, cadmium or mercury, by thermal. chemical or electrolytic means in installations with a batch capacity exceeding 0.5 tonnes, not included in paragraph 3.4.1*".

Under such a classification the Tara Mines activity is assigned a Complexity of G3, under the Office of Environmental Enforcement banding. The Complexity Score for a G3 facility is 3.

### *4.2.3 Environmental Sensitivity Score*

The EPA has developed a sub-matrix for environmental sensitivity. This sub-matrix is reproduced below to include the 6 key potential environmental receptors.

This sub-matrix is completed for the specifics of the Mine site and provides a commentary of justifications for the assigned score. The scoring bands have been developed by the EPA/OEE and with reference to the EP OPRA (Environmental Protection Operator and Pollution Risk Appraisal) Scheme developed by the Environment Agency (UK). This provides a predefined scoring method to produce a environmental sensitivity score (or environmental sensitivity metric) which is objective and common to all licensed facilities, and is shown in Table 4.1.

Table 4.1: Environmental Sensitivity Sub-Matrix

| Environmental Attribute | Attribute Score Range | Site Specific Score | Justification Comment |
|---|---|---|---|
| **Human Occupation**[2] | | | |
| <50m | 5 | | |
| 50-250m | 3 | | |
| 250-1000m | 1 | | No occupied dwellings within |
| >1000m | 0 | 3 | 50m of facility boundary |
| **Groundwater Protection**[34] | | | |
| Regionally Imp. Aquifer | 2 | | |
| Locally Imp. Aquifer | 1 | | |
| Poor Aquifer | 0 | | |
| Extreme Vulnerability | 3 | | Locally Important Aquifer, |
| High Vulnerability | 2 | | generally moderately productive |
| Moderate Vulnerability | 1 | | (Lm) (Score 1) with a general |
| Low Vulnerability | 0 | 1+1= 2 | Moderate Vulnerability (Score 1) |
| **Surface Water Sensitivity**[5] | | | |
| Class A | 3 | | |
| Class B | 2 | | |
| Class C | 1 | | |
| Class D | 0 | | Biotic index of River Blackwater |
| Designated Coastal/Estuarine Waters[6] | 2 | | is Q3-4, therefore assigned to |
| Potential Eutrophic Coastal/Estuarine Waters[7] | 1 | 2 | Quality of Class B |
| **Air Quality and Topography** | | | |
| Complex Terrain[8] | 2 | | |
| Intermediate Terrain[9] | 1 | | |
| Simple Terrain[10] | 0 | 0 | Flat terrain |
| **Protected Ecological Sites and Species**[11] | | | |
| Within or directly bordering species protected site | 2 | | River Blackwater is a Special |
| <1km to protected site | 1 | | Area of Conservation and |



[2] As measured from activity/footprint to public or private occupied building
[3] Groundwater Classifications according to DoELG/EPA/GSI Groundwater Protection Scheme (1999)
[4] Aquifer Classification Score to be added to Groundwater Vulnerability Score
[5] Site located within catchment of EPA Surface Water Classification (1996) or adjacent to transitional water body
[6] Designated as Sensitive Areas UWWT Regulations (2001)
[7] EPA (2002) Water Quality in Ireland (1998-2000)
[8] Generally elevated terrain such as mountain or side of a valley, where receptors are at elevations above the stack tip elevation, US EPA (2000) Meteorological Monitoring Guidance for Regulatory Modelling Applications
[9] Intermediate terrain where the elevations of receptors lie between the stack tip elevation and the plume rise elevation, US EPA (2000) Meteorological Monitoring Guidance for Regulatory Modelling Applications
[10] Relatively flat terrain where the elevations of receptors lie between the stack base and the stack tip elevations, US EPA (2000) Meteorological Monitoring Guidance for Regulatory Modelling Applications.
[11] Distance from activity/footprint to protected areas designated as pNHA (Irish Wildlife Acts, 1976, 2000), cSAC (Habitats Directive, 1992) and/or SPA (Birds Directive 1979)

| | | | |
|---|---|---|---|
| >1km from protected site | 0 | 2 | borders the surface facility |
| **Sensitive Agricultural Receptors**[12]<br>Fruit/Veg/Dairy farm <50m<br>Fruit/Veg/Dairy farm 50-150m<br>Fruit/Veg/Dairy farm >150m | <br>2<br>1<br>0 | <br><br><br>0 | No significant frit, vegetable or dairy farms within 150m of the facility |
| **Total Environmental Attribute Score** | | **9** | |

The environmental sensitivity sub-matrix produces a site-specific environmental attributable score for Tara Mines of 9. Using the Environmental Sensitivity Classification, as reproduced in Table 3.2 below, an Environmental Attributable Score of 9 for the Tara Mines facility equates to an Environmental Sensitivity Classification of 2.

Table 4.2: Environmental Sensitivity Classification (EPA)

| Total Environmental Attribute Score | Environmental Sensitivity Classification |
|---|---|
| Low <7 | 1 |
| Moderate 7-12 | 2 |
| High >12 | 3 |

#### *4.2.4 Compliance Record Score*

The Compliance Record Score is derived from the compliance history of the facility and whether the activities carried on have resulted in contamination or pollution.

Tara Mines has been in production since 1977 and licensed by the EPA since 2001. Tara Mines has established an Environment Department, which is charged with ensuring compliance of operation and emissions with the IPPC Licence. Extensive environmental monitoring is conducted to comply with the IPPCL emission limits. The history of Tara Mines compliance with the IPPC Licence is very high.

The EPA guidance indicates that the EPA Inspector assigned to the facility should be consulted to determine the appropriate score for Licence Compliance. To this end, Mr. Niall Horgan (OEE Inspector) was consulted on the 21st of July 2008. The Tara Mines facility has been assigned a Compliance Record Score of 3.

A compliance record score of 3 is based on the minor emission non-compliances and the fact that the previous activities associated with on-site activities within the Mine site may have resulted in minor soil and groundwater contamination, with the contamination



[12] Distances derived from UK Dept. for Environment, Food and Rural Affairs (2003), Local Air Quality Management – Technical Guidance LAQM.TG(3)

assessed by the OEE as resulting in concentrations above background levels but not posing a risk to the wider environment. The OEE Inspector indicated that all Mines would be assigned a score of no less than 3, with respect to Compliance Record Score.

### *4.2.5 Site Evaluation and Risk Categorisation*

The determination of quantified scores for each of the three risk assessment components allows for the assignment of a site specific Risk Category for the Tara Mines facility

The product of the scores for Complexity, Environmental Sensitivity and Environmental Compliance is used to calculate the total score for the site. With respect to the Tare Mines Site, the total score is 18 ((Complexity Score = 3) x (Env. Sensitivity Score = 2) x (Compliance Score = 3)) The score can be assigned to a Risk Category, which is predefined by the EPA, as defined in the EPA Quantification Table reproduced below.

Table 4.3: Risk Category Determination Table

| Risk Category | Total Screening Score |
|---|---|
| Category 1 | <5 |
| Category 2 | 5-23 |
| Category 3 | >23 |

The Risk Category of the Tara Mines facility, based on the Scoring Rationale provided by the EPA, is a Category 2 (on a risk category scale of 1 to 3).

The EPA indicates that for the majority of Category 2 facilities, a closure plan with exclusively 'Clean Closure' is not achievable. For mining facilities, due to the presence of significant land disturbance/contamination, a process of extensive restoration and aftercare will be required. This is referred to as 'Non-Clean Closure'.

A facility where Clean Closure is not possible requires an Aftercare and Management Plan to address long term issues associated with liabilities and financial provision.

# 5 ENVIRONMENTAL LIABILITIES RISK ASSESSMENT

In accordance with Condition 14.2 of the IPPC Licence, Tara Mines engaged Knight Piésold Ltd. to undertake a comprehensive and fully costed Environmental Liabilities Risk Assessment to address past and current (as of 2002) activities.

This ELRA was issued in May 2002 and submitted to the EPA in accordance with IPPC Licence requirements. A full copy of this ELRA is included in Appendix A of this report.

The ELRA prepared for the Tara Mines site followed the following assessment methodology:

1) Risk Identification; based on the Source-Vector-Receptor Model;

2) Evaluation of Risk, in terms of likelihood, consequence and severity of impact;

3) Assessment of Risk Management and Mitigation;

4) Assessment of existing Financial Provision; and

5) Outline and recommendations for Risk Minimisation.

It is important to note that Tara Mines has adequate insurance cover, to cover public liability exposure. The ELRA focused on the potential and plausible risks at the Tara site, excluding those liabilities associated with the Closure Plan.

The conclusions of the ELRA from 2002 are detailed below:

- No significant liabilities were found associated with emissions to air. The ELRA indicated that further site improvements would occur when the drying of zinc concentrate was phased out. The thermal zinc dryer was replaced with a pressure drying system in 2006, eliminating associated emissions to atmosphere.

- A number of liabilities were identified associated with fuel and chemical storage at the site. The ELRA indicated that the Company's Public Liability Insurance would cover the potential liabilities associated with a catastrophic failure and the policy is sufficient to deal with possible remedial works. However, recommendations for the upgrading of the bunding of the storage tanks were made. These upgrade works have been undertaken to improve site operations and to minimise the potential financial exposure.

- The discharge of treated water to the receiving environment is to one permitted location, at present. The quality of the discharge is high and is generally in compliance with emission limits. A concern was raised in the ELRA regarding the use of Ammonium Nitrate based explosives. It was indicated that it was proposed to phase out the use of this material. Tara Mines now use emulsion-based explosives, which significantly reduces potential for residues and adsorption into the water cycle. Following assessment and study by Tara Mines, naturally occurring concentration of nitrogen and revision of emission limits in the IPPC Licence, discharges are now within permitted levels. The composition of this pipeline has been tested and it is herein confirmed that the pipeline is concrete and not asbestos cement, as previously reported.

- The risk of failure of pipelines between the processing plant site and the tailings management facility were assessed as low. However, the liability exposure of such an occurrence was assessed and the financial liability associated with such an occurrence is covered under the Public Liability Insurance currently held.

The ELRA ultimately concluded that the risk of unknown liabilities associated with past and present (as of 2002) was covered under Public Liability Insurance held by the Company Since the preparation of the Knight Piésold ELRA in 2002, there has been no significant change to operations of mine development at Tara Mines. In fact, the recommendations made in the 2002 ELRA have been acted upon, to minimise risk and financial risk exposure. This has resulted in improved site operations and environmental protection measures.

The reassessment of the site operations and the existing ELRA (2002) has not determined any further financial exposures, which is not addressed in the Closure, Restoration and Aftercare Management Plan. 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 arising from the current operations.

# 6 CLOSURE CONSIDERATIONS

## 6.1 CLOSURE DECLARATION

Owing to the Risk Category of the Tara Mines site (determined as Category 2, Section 4 above), and the requirements of the IPPC Licence , a closure plan with exclusively 'Clean Closure' for Tara Mines is not achievable.

For all mining facilities, due to the presence of significant land disturbance/contamination, a process of extensive restoration and aftercare is required. This is referred to as 'Non-Clean Closure'.

The CRAMP Prepared for Tara Mines is divided into three distinct stages.

1. The decommissioning and restoration of above ground infrastructure within the processing site to grade level and the backfilling of underground mine openings will be undertaken immediately post closure. This will achieve a Non-Clean Closure status, as defined by the EPA;

2. In the short to medium term, aftercare monitoring and management of the site and surrounds will be undertaken to achieve stabilisation and equilibrium conditions. This will achieve a Clean Closure status, as defined by the EPA.

3. Long term to perpetual aftercare monitoring of the site and surrounds will be undertaken after Clean Closure status has been achieved, to ensure no significant deviation from stabilisation and equilibrium conditions. This monitoring is a perpetual validation of Clean Closure.

## 6.2 APPROACH AND OVERVIEW

This section of the Closure, Restoration and Aftercare Management Plan outlines the infrastructure, plant, buildings and other materials that require consideration as part of the closure process.

The mine closure will be undertaken in a cost effective and scheduled manner, which eliminates or minimises potential adverse impacts on the environment, especially public safety, physical ground stability and emissions.

The sequencing of decommissioning and restoration operations for Tara Mines divided between underground decommissioning and surface decommissioning.

Underground workings are progressively backfilled as mine development works advance. Therefore, the extent of post closure decommissioning is relatively limited. However, notwithstanding the limited nature of post-closure underground decommissioning, this is detailed below.

The decommissioning of the surface mine site infrastructure presents the most extensive works required post closure. This decommissioning and scheduling is outlined herein.

Following the decommissioning and restoration, the active and passive monitoring and aftercare management plan stages are outlined.

## 6.3 UNDERGROUND DECOMMISSIONING

During the operational phase, following excavation of the orebody, all underground mine developments are backfilled. The underground mine conduits are backfilled with surplus rock generated in the mine development works. Therefore, the design and ongoing operation of the Mine incorporates progressive decommissioning of works into the mine design, which significantly reduces the requirements of final decommissioning and restoration of underground workings at Tara Mines.

Immediately following closure of the mine, dewatering and ventilation systems will be maintained in operation to permit the completion of all required backfilling of underground development works.

Once the backfilling has been completed, the decommissioning of the underground workings will be completed. Plant and equipment with resale value will be recovered from underground workings. Any plant and equipment deemed appropriate to remain permanently underground will be itemised and rendered safe in environmental terms. All plant and equipment will be drained of fuel, oil and lubricants, they will be cleaned out with detergents and all this material will be recovered to the surface for appropriate disposal. The plant and equipment will be stripped of all rubber components or other materials, as required.

All underground storage tanks (containing fuels, oils, grease and additives) will be all recovered to the surface for appropriate decontamination and decommissioning.

All duct, pipes, cables ladders and landings in declines and shafts will be assessed and removed as appropriate, so as not to obstruct or hinder the permanent sealing of openings and mine opening conduits

When deemed appropriate, the underground ventilation system will be terminated. The termination of the ventilation system may be phased and commensurate with the decommissioning and health and safety requirements of the mine. As Fresh Air Raise and Return Air Raises become defunct, the fans systems will be decommissioned and the surface superstructure removed. A concrete plug will be placed adjacent to the bottom of each of the raises (to conform to recommendations of the Health and Safety Authority and Section 107 of the Mines and Quarries Act 1965) and the vertical conduits / shafts will be backfilled with surplus rock from the mine site (i.e. the surplus rock which has been previously mine out). The raises will be capped at the surface with topsoil and the land contoured to a landform resembling the surrounding landscape.

Within the main mine site, following the removal of all structures and services from the decline, a concrete plug will be installed (to conform to recommendations of the Health and Safety Authority and Section 107 of the Mines and Quarries Act 1965. Following the installation of a concrete plug, the remaining decline void will be sealed with surplus rock. A concrete plug will be constructed within the portal to permanently prevent access to the underground workings.

When all underground decommissioning has been completed, the dewatering system will be terminated at the main mine site and the underground workings will be allowed to re-water with natural groundwater.

## 6.4 GEOTECHNICAL ASSESSMENT OF UNDERGROUND WORKINGS

As detailed in Section 2.2.6 of this report, upon completion of excavations, all mined out areas are backfilled. Underground mine conduits are backfilled with surplus rock generated in the mine development works.

Tara Mines previously commissioned Australian Mining Consultants (UK) Ltd. (AMC) to carry out an independent geotechnical study of the underground workings. While this geotechnical assessment was focused specifically on the Nevinstown extraction area, this is considered to represent the worst case scenario, in terms of surface settlement and ground stability, as the Nevinstown orebody is the shallowest extraction across the entire Tara Mines orebody.
The AMC geotechnical assessment addressed the following issues:

- The potential for surface settlement;
- The stability of the underground mining;
- The stability of strata beneath the River Blackwater;
- Potential for water ingress to mine workings beneath the River Blackwater; and

- Definition of a detailed and long term geotechnical monitoring strategy for Tara Mines.

Tara Mines have been monitoring surface settlement since mining commenced in the late 1970's from an array of approximately 270 surface levelling stations. Over the 30 years of operations at Tara Mines, the data indicates that a maximum of 70mm of surface settlement has occurred, centred over the main mining area. This low order of surface settlement is attributed to the competence and strength of the rocks overlying mine development and extraction, but also reflects the contribution of appropriate mine development design and extraction techniques, including retaining long term rock pillars and the longhole-stoping with backfill mining method.

The AMC modelling, calibrated from historical data, provides a basis for estimating the extent of future settlement. The AMC analysis also demonstrates a generally good agreement between changes in mining activity underground, and consequent changes in surface settlement.

With respect to the Tara Mines underground development, surface settlement is controlled and mitigated principally by two measures:

i. Retaining permanent (yielding) pillars of rock in strategic locations to provide direct support to the hanging wall (roof) rockmass; and
ii. The use of backfill in each mined stope, which is placed as tight as possible against the stope roof to prevent potential for significant long term settlement.

The same strategy as outlined above is used throughout the underground workings. However in sensitive areas (i.e. in areas where there is potential for underground geological instability due to fissuring and faulting) a greater number of permanent pillars are retained in-situ and the backfill material consists of a higher ratio cement backfill.

During the extraction of the ore body at shallowest depth, (i.e. at Nevinstown at depth of 50m below ground level) the predicted settlement is calculated as 200-250mm, with the centre of settlement remaining below the existing Main Mine site and the settlement reducing radially with distance from the underground voids.



Surface settlement will continue to occur post excavation and closure of the mine, although at a gradually reducing rate. The settlement will reduce as the backfill gradually provides increased resistance to the hangingwall relaxation, until equilibrium conditions is achieved. The rebound of groundwater levels to their natural level, following the cessation of dewatering, will also provide further resistance to continued settlement (i.e. water is approximately 1000 time more dense than air, thus provide significant additional support).

The period for achieving equilibrium settlement conditions is difficult to predict, however AMC estimate that equilibrium could be achieved in a 2-3 year timeframe. The continued monitoring from the 270 surface levelling stations over the mine area will allow determination of when this equilibrium has been achieved.

With respect to ground instability as a result of underground mining activity, the AMC geotechnical assessment indicates that minimising the potential for any differential displacement is of primary importance. The geotechnical analysis indicate that differential settlement (as opposed to regional settlement) is only possible where there is displacement in areas of geological structural structures (i.e. faults, etc). Again, mining design and extraction techniques are provided to ensure that the potential for underground settlement in geological sensitive areas are minimised. The historical data and geotechnical assessment indicates that there minor potential for settlement in areas where geological structures are recorded and these structures are predicted to remain stable close to the surface.

Notwithstanding the predictions of minor potential for differential settlement, the AMC geotechnical assessment recommends that public access to buildings in sensitive areas should be prohibited, as a purely precautionary measure, until equilibrium conditions are achieved, whether that be during or post mine operations. There has never been a liability issue with any private development.

The actual maximum radial extent of regional settlement will be smaller that that suggested in the AMC elastic model, owing to the adoption of conservative estimates for model input.

## 6.5 HYDROGEOLOGICAL CONDITIONS AND POST CLOSURE REWATERING

### *6.5.1 General Hydraulic Units*

Tara Mines has retained Water Management Consultants (WMC) to assess on-going hydrogeological studies and to develop predictions for conditions during the post-closure re-watering and flooding of the underground workings.

The solid geology dips to the southwest, whereby the mining voids created by the excavation of the orebody are near surface in the up dip Nevinstown area (approx 50m bgl) and increase in depth to the southwest (approx 900m bgl to southwest extent to SWEX area).

The Pale Beds unit is the principal groundwater bearing unit, which is also the host formation to the orebody. The Pale Beds are dewatered in order to allow underground working of the orebody.

The Upper Dark Limestones (UDL) cover is absent over much of the Nevinstown orebody. Where present, the UDL overlies the Pale beds and increases in thickness over the Pale Beds to the southwest. The UDL displays strong layering, with the hydraulic characteristics displaying evidence of this layering (i.e. the vertical permeability is much lower than the horizontal permeability). Where present, the UDL generally forms a low permeability vertical barrier to groundwater flow from the surface to the Pale Beds. Some groundwater monitoring piezometers in the UDL displayed a response to dewatering in the Main Mine and Nevinstown, indicating some minor leakage from the UDL to the Pale Beds. However notwithstanding this heterogeneity, the UDL has naturally assisted in isolating the underground dewatering from the shallow groundwater levels.

Based on underground monitoring and water chemistry surveys, the amount of groundwater entering the mine voids from the flood plain deposits and river is less than 2% of the total mine inflow.

Groundwater recharge to the Pale Beds occurs mostly as a result of infiltration of precipitation and downward percolation through the superficial glacial deposits into the Pale Beds unit, in areas to the north where the UDL is absent. Virtually all of the district-scale groundwater flow around Tara Mines occurs within the Pale Beds, which is the source of virtually all the groundwater entering Mine Workings. The on-going monitoring results continue to verify the conceptual hydrogeological model described in the Nevinstown Geotechnical Study (Ref. Section 3.4 above).

Pre-mining groundwater heads over the region of the Tara Mine, as measured during a 1975 geotechnical study, were typically between 1 and 3 m below ground level in the area of the flood plain. Measured groundwater level elevations in the Pale Beds ranged from around 39mAOD along the River Blackwater up to 44 mAOD in the vicinity of Nevinstown House (AMC, February 2003).

Except locally around new stoping areas, Pale Beds groundwater levels have been fairly steady since early 2005, responding mostly to seasonal variations in rainfall and groundwater recharge. Below the central part of the Nevinstown orebody, current groundwater levels beneath the river are inferred to be about -130 to -10mOD (representing over 150 m total drawdown). Water levels measured in boreholes in the Pale Beds beneath the river are higher to the southeast, and are currently about -30 to -20 mAOD.



*6.5.2 Source of Groundwater Inflow to the Mine Workings*

Groundwater inflows to Nevinstown and the Main Mine occur mostly in the Pale Beds. District scale lateral groundwater flow in the Pale Beds is the greatest contributor to the mine water inflows. Typically, the inflow rate to underground mine workings has been steady at between 7,855 and 9,165m$^3$/day (1,200 and 1,400 gpm). The rate is steady because of the strongly bounded nature of the Pale Beds groundwater block surrounding the Tara workings. Many of the discrete inflow areas occur in the northwest part of the mining areas, and are often associated with extensions to F1 and F23 fault zone and NW joints. For the purposes of the current closure modelling, it is assumed that the amount of groundwater inflow to the Nevinstown and Main Mine workings immediately on completion of mining will be about 8,510m$^3$/day (1,300 gpm).

A minor amount of inflow occurs due to leakage from the UDL, and an even smaller amount occurs as a result of leakage from the floodplain deposits of the River Blackwater. Over much of its course in the vicinity of the Tara Mine, the Blackwater flows over the relatively low permeability UDL. However, the UDL is absent in the area of Nevinstown to the north of the river. In this area, the floodplain deposits rest on clayey glacial till which reaches thicknesses in excess of 10 m. The low permeability of the clayey till reduces the rate of groundwater flow between the recent alluvium around the River Blackwater and the underlying Pale Beds. As discussed above, it is estimated that inflows derived from the river currently account for less than 2% of the total mine inflows.

The SWEX workings occur down-dip in the Pale Beds and away from the main area of active Pale Beds groundwater circulation. The SWEX workings are overlain by a cover of about 500-800m of UDL. However, above the SWEX area, some significant regional geological structures have been noted, and there are areas where weathering within the UDL has occurred to a significant depth below ground surface (250-400m below ground surface in some areas).

Although there is little active Pale Beds groundwater flow in the area of SWEX, there is an upward connection from the workings through the UDL sequence into the deeper zones of UDL weathering located vertically above the deposit area. The connection has resulted in some downward groundwater flow through the UDL to the SWEX workings. The amount of downward flow has been limited by the underground grouting programme which aims to reduce the amount of groundwater entering SWEX. The recently observed inflow rates to the SWEX workings have generally been within the range 1,965-3,275m$^3$/day (300-500 gpm). For the purposes of the current closure modelling, it is assumed that the amount of groundwater inflow to the SWEX workings immediately on completion of mining will be about 3930m$^3$/day (600 gpm) (although this will depend on future grouting operations that are planned).

### 6.5.3 *Post Closure Groundwater Level Recovery Curve*

On the cessation of pumping from the mine, the residual void space and the mine backfill will begin to re-saturate with groundwater. Water entering the system will initially drain towards the SWEX workings, which is the lowest part of the mine.

When the SWEX workings fill with groundwater, then the Main Mine and the Nevinstown workings will progressively become flooded. As the workings actively fill, they will act as a hydrogeological sink, as is currently the case during operations. During recovery of the groundwater system, all groundwater flow will be inward to the workings.

Water will only start to discharge from the workings once natural hydrogeological conditions are approached and then achieved, where the groundwater heads in the Pale Beds and the flooded workings start to rise very slightly above the groundwater levels in the River Blackwater flood plain deposits towards the lowest (eastern) edge of the site. At that time, the original pre-mining groundwater balance will become re-established and the recovery of water levels will cease (i.e. equilibrium conditions will be re-established). This will occur when the district groundwater recharge to the Pale Beds, and through flow in the flooded workings, becomes balanced by the discharge to the alluvial flood plain deposits.

During the period of active recovery, as the groundwater head in the workings rises, the groundwater inflow rate to SWEX will progressively decrease with time. The bulk of the inflow into the Main Mine and Nevinstown occurs from discrete zones. In the Main Mine, the base of the main inflow zones occurs at around -350m OD. In Nevinstown, most of the inflows are centred at around -200 to -100m OD.

Table 3.1 summarises the maximum inflow rates assigned to each region of the mine in the model. The inflow from these zones will be independent of the rising head until the rising groundwater elevation reaches the elevation of the main inflow zones, thereafter the rate of discharge from the inflow zones will decrease to the steady state equilibrium value attained at full recovery. .



Table 3.1: Maximum inflow rates assigned to regions of the mine.

| Region of mine | Maximum inflow rate $m^3$/day (gpm) |
|---|---|
| Nevinstown | 3600 (550) |
| Main Mine | 4910 (750) |
| SWEX | 3928 (600) |
| **Total** | **12,438 (1,900)** |

Groundwater heads, and water levels in the workings, will continue to recover until equilibrium is achieved. At this point, the rate of district groundwater recharge to the Pale Beds groundwater system will be balanced by the rate of groundwater discharge to the flood plain deposits. This will indicate a return to the natural pre-mining groundwater balance.

The flood plain deposits of the River Blackwater constitute the natural district-scale groundwater discharge zone for the Pale Beds under pre-mining conditions, and also following post-closure recovery. Because of the presence of clays and silts within the flood plain deposits, groundwater heads in the underlying bedrock will rise slightly above the groundwater levels in the flood plain deposits in order to provide the hydraulic gradient to allow groundwater discharge to occur. As per pre-mining conditions, it is expected the post-closure upward head gradient will be small.

Along the line of the river, ground surface elevation is around 71 mAOD at the western limit of the Nevinstown, falling to 64 mAOD in the southeast limit of the mine boundary. The stage of the River Blackwater at Donaghpatrick Bridge to the west of the Nevinstown region of the mine is 40 mAOD and around 38 mAOD in the vicinity of the Nevinstown ore body. To the east of the ore body, the stage drops to around 33 mAOD at Pollboy Bridge (AMC, February 2003). For the current post-closure recovery modelling purposes, a reference stage of 35 mAOD has been applied to represent the River Blackwater in the model. It is expected that bedrock groundwater levels will recover to slightly above this elevation.

Variations in post-stabilisation groundwater will also occur as a result of seasonal changes in groundwater recharge and groundwater levels, and also because of longer term climatic cycles. Based on the current model results and knowledge of the actual groundwater monitoring data to date, it is currently estimated that, within the footprint area of the mine, groundwater levels in the Pale Beds will ultimately recover to an elevation within the range 36-44 mAOD. Because the entire mine footprint area will be interconnected by workings, it is anticipated that water levels will be flat across the entire mined area.

The current model predicts that full recovery of the groundwater system will take within the region of 17-18 years following shut down of the dewatering system and this is described in figure 3.1 below. Once the workings are completely flooded, the mine voids will cease to represent a complete groundwater sink and the pre-mining pattern of groundwater flow and discharge to the flood plain deposits will become re-established. The discharge will occur in a diffuse zone mostly along the axis of the valley to the alluvial underflow system, rather than to bed of the River Blackwater itself. The current model indicates the steady state groundwater discharge from the Pale Beds to the alluvial floodplain underflow system will average about 1,637$m^3$/day (250 gpm).

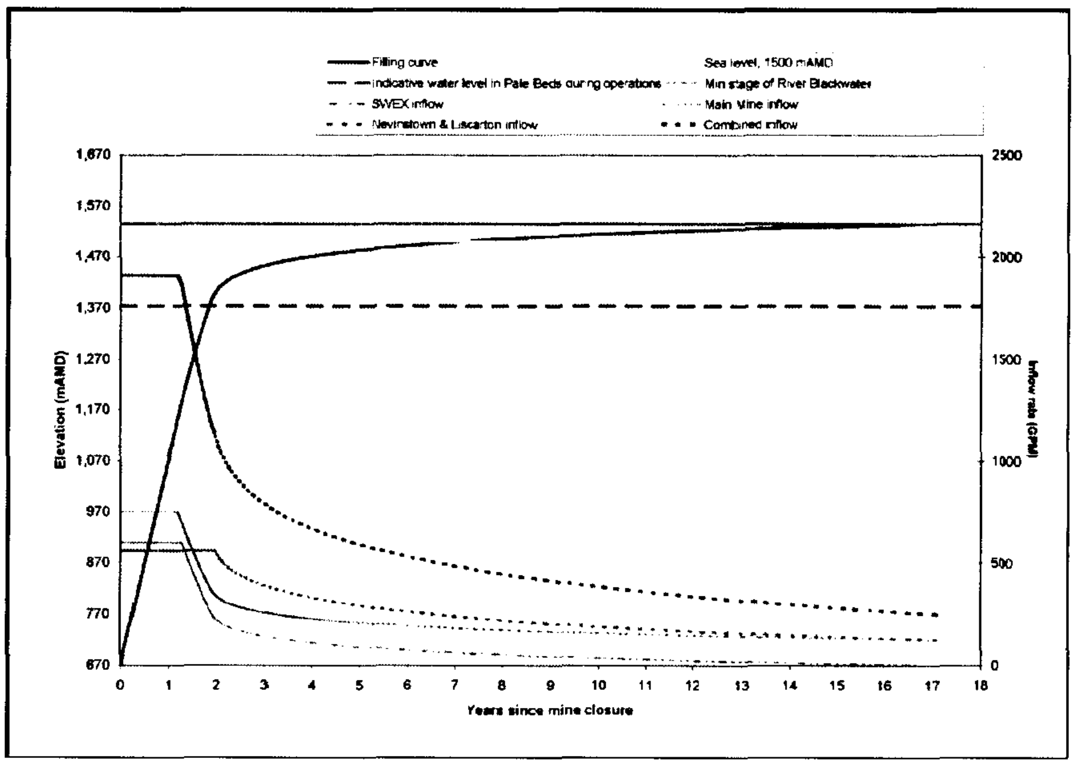



**Figure 3.1: Groundwater recovery curve**

Within the alluvial overburden deposits that form the near surface groundwater system throughout the area of Tara, the post-closure water table will be essentially unchanged relative to pre-mining conditions. No post-closure impacts to the water table are expected in the overburden. Superficial groundwater levels will also be unchanged beneath the flood plain of the River Blackwater. In addition, it is expected that post-closure groundwater levels in the upper horizons of the UDL will also be essentially unchanged relative to pre-mining conditions.

Within the Pale Beds, the post closure groundwater balance will be the same as pre-mining. However, some localized changes to the deeper piezometric levels are expected because of the interconnected nature of the flooded workings. The post-closure piezometric levels in the Pale Beds are expected to be flat over the footprint area of the mine. The implications of this are described in the following paragraphs.

*6.5.4 Hydrochemistry of Post Closure Flooded Workings*

The Tara hydrochemical sampling programme has demonstrated that virtually all of the water makes in the Main Mine and Nevinstown consist of young, calcium-bicarbonate type water flowing within the Pale Beds at relatively shallow depths (-350m OD). Most of the major inflow zones have shown no chemical change with time, and are not expected to show any change between now and the end of the mine life. It is predicted these waters will make up most of the post-closure inflows, both during the active recovery and post-stabilisation phases.

As mining has moved progressively down-dip, the frequency and magnitude of new inflows from the Pale Beds has reduced, and the quality of the water has shown an increasing TDS and salinity. The initial deep Pale Beds groundwater that was encountered in SWEX had high electrical conductivity (EC) values and was considerably older than other Tara groundwaters, having undergone significant ion exchange. The original SWEX water can be exemplified by the sample taken in February 2004 from 700 3UEX. The water had a temperature of almost 31°C, with an EC value of 1,780 us/cm. The sample had a chloride value of 283 mg/l and sulphate of 186 mg/l. Reported calcium was 48 mg/l, magnesium 21 mg/l, sodium 355 mg/l and potassium 5 mg/l. This sample was considered to represent groundwater storage from isolated fractures at or above the level of the ore horizon.

All early SWEX groundwater samples showed a relatively low component of calcium and bicarbonate, indicating little evidence of any connection to surface, and little evidence of any active groundwater circulation. Inflow rates of this poor quality water were low and generally non-sustained, indicating drainage of residual storage, rather than any active groundwater recharge sources.



Higher volume, more sustained inflows to SWEX began to occur in 2004. However, as discussed in Section 3.7 above, it is thought the source of this water is the deeper zones of UDL weathering, located about 250-400 m depth, and vertically above the SWEX deposit area. Again, this water shows a significant influence of more recent calcium bicarbonate waters. EC values are 606-655 us/cm, and temperature values are 26.4-27.0°C. The samples typically have chloride values of 24-40 mg/l, and sulphate values of 11-92 mg/l. Reported calcium is typically 47-73 mg/l, magnesium 20-24 mg/l, sodium 43-72 mg/l, and potassium 3.1-8.1 mg/l. Recorded field parameters (temperature and EC) have shown relatively stable values, indicative of a high storage water source. Again, the water chemistry does not show any significant changes with time, and the current modelling assumes that this water will be typical of the SWEX inflows at the time of eventual mine closure.

When the mine dewatering pumps are switched off, water will quickly accumulate within the SWEX workings. The initial water will be a mixture of the SWEX groundwater inflows (predicted to be initially 3928m$^3$/day (600 gpm – but this will depend on future grouting operations) and groundwater moving down the workings from the Main Mine and Nevinstown (predicted to be initially about 8,510m$^3$/day (1,300 gpm)).

The initial inflow water will enter the bottom of the workings and will dissolve sulphate, zinc and other metals as it enters the mine. Although mineral acidity will be dissolved from the oxidation products that have accumulated in the wall rocks of the workings, the underground sampling work that has been carried out to date indicates that there will be sufficient dissolved alkalinity mass in the inflowing waters that the water in the workings will remain near-neutral. This will be confirmed by additional underground sampling carried out during the course of active mining operations. There will be relatively high levels of iron available in the oxidation products dissolved from the wall rocks which will help co-precipitate and reduce the concentration of the key metals.

It is predicted the cleaner water from the Main Mine and Nevinstown will preferentially flow along channels within the main decline and into the rising water level in the workings as they flood. This water will also dissolve some minor mineral acidity and sulphate from the flow channels, but is expected this will be low. The amount of mineral acidity dissolved will progressively decrease as the workings flood and the oxidation products become removed from the preferential flow paths, such that the water quality will quickly improve with time. Post-closure and during the course of active flooding, periodic skimming of any oils and grease, accumulating on the top of the water will be removed off site by a licensed contractor.

As the workings progressively fill and the water level rises, the inflow rate from the SWEX workings will decrease with time as the head differential decreases. However, the inflow from the Main Mine and Nevinstown will not be subject to the same head control, and therefore the inflow rate from the shallow levels will not decrease until the rising water has recovered to the level of the Main Mine and Nevinstown inflows (above about -350m OD).



Once the lowest levels of the SWEX workings are flooded, the clean water inflow from Nevinstown and the Main Mine will increasingly stratify on top of the water in the bottom of the workings. It is expected there will be a slight density difference between the water in the deeper flooded workings (slightly higher density) and the shallow inflow water (slightly lower density). A chemocline will thus develop in the flooded workings, permanently stratifying the water body.

The pre-mining groundwater flow regime will become re-established following full recovery of groundwater levels. Because of the chemocline, the water in the deeper part of the workings will remain isolated from the environment. Most of the active flow will be above the level of the Main Mine inflows (-350 m OD), and it is expect that all water below this level will be below the level of the active water circulation.

Oxidation of the pyrite minerals will stop as the workings become submerged. Therefore, on-going generation of mineral acidity, sulphate and metals will not occur. Experience at other flooded mines has shown that the water isolated in the deeper part of the workings will become strongly reducing. Depending on the matrix chemistry, there may some precipitation of metal sulphides which would act to improve the chemistry in the flooded workings in the long term.

The exact details of how the workings flood will depend on the final extent of the workings, and on the extent and location of the backfill. More detailed analysis of actual conditions will therefore need to be undertaken nearer to the time of closure when the final mine plan is known with more certainty. The on-going water chemistry sampling plan for the mine will be adapted with time to provide the required empirical data to develop the detailed closure plan. It is expected that all required data for mine closure can be developed by means of on-going sampling and field testing, without the need for theoretical laboratory testing of geochemistry samples.

## 6.6 SURFACE DECOMMISSIONING

Although the extent of the Main Mine site at Knockumber is quite large, the actual ore concentrate processing area is contained in a small area. The remainder of the site is required for the hoisting and storage of the extracted ore, the storage of surplus rock, water storage ponds and other enabling / administration infrastructure.

Surface decommissioning will be undertaken in a scheduled manner. All decommissioning of buildings, structure and tanks will be carried by specialist contractors and in accordance with all relevant Irish and European waste management regulations. The contractor will be required to prepare a Demolition Waste Management Plan for agreement with the EPA in advance of commencement of works.



All warehousing, storage sheds and other defunct buildings, rendered surplus to requirements post-closure will be surveyed and demolished within Year 1 post closure. Demolition materials will be segregated and exported from site, to appropriately licensed or permitted facilities.

Any remaining ore, together with the fines and sludges from the Water Reclaim Ponds will be fed through the mill process. The cleaning of the ponds at Closure stage will reduce the loading of metals accumulating at the base of the reclaim ponds. The cleaned out reclaim ponds will remain in operation until the end of the decommissioning and restoration stage.

Once all material has been processed in the mill, the main processing area can be decommissioned. All fuels, oils, lubricant and other processing liquids will be drained from storage tanks and exported from site, for appropriate treatment. No deoiled, degreased or reagent wastewater will be discharge to the reclaim ponds.

The ESB substation will be assessed and rendered safe by the ESB. All storage tanks will be decontaminated and decommissioned. Any plant and equipment with resale / reuse potential will be exported from the site. All conveyors and feed lines will be decommissioned and the processing building will be surveyed and demolished. All demolition materials will be segregated and exported from site, to appropriately licensed or permitted facilities.

It is anticipated that the main administration building will remain on site for the duration of the decommissioning and restoration stages. The final use or demolition of this building will depend on the agree after use options.

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

A historical disposal area, or approximately 4.5 hectares in extent, was used by Tara Mines in the past. This disposal area was used for storage of reclaim pond sludge and industrial waste. It has been estimated that approximately 12,000m$^3$ of sludge was deposited in this area between 1990 and 1992. The site has not been used since 1992. As part of the post-closure, all surplus rock stored on top of the disposal area will be removed and the disposal area will be capped with a 1m low permeability clay liner. As there is very little putrescible material within the disposal area, there is very low risk of gas venting. The capping of the disposal area is required to reduce the risk of direct or indirect ingestion of heavy metal materials. The capping will also significant reduce the potential for infiltration of rainwater and the generation a metal laden leachate (albeit metals are not highly mobile is soils). The capping of the disposal area will be undertaken in full accordance with the Plan devised by WYG, which was prepared to accord with Condition 7.7.1 of the IPPC Licence.

Any further soil remediation in specific areas of the site will be assessed based on the outcome of specialist investigation undertaken during the decommissioning process.

Following the decommissioning stage, the site will be contoured to a landform compatible with it surrounding environment.

The very final stage of decommissioning will be the infilling of the reclaim ponds. These ponds will be required during the decommissioning and restoration stages to ensure there is not deleterious emissions from the site. As detailed previously the basal sludges from the reclaim ponds will be cleaned out an fed through the mill process prior to the decommissioning of the mill. Therefore the metal concentration within the ponds will be significantly lowered. However, immediately prior to infilling, the ponds will again be cleaned out and the basal materials will be exported to the TMF for permanent storage. The ponds will then be drained and infilled.

The final end use of the site is presently unknown. Significant commercial and retail development is currently occurring to the north and south of the main mine site. In advance of closure, Tara Mines will liaise with the Local Authority, the EPA and other interested parties to devise a mutually acceptable end-use of the site. The site will be decommissioned and restored to a level suitable for that proposed end use of the site.

## 6.7 DECONTAMINATION AND DECOMMISSIONING OF SITE INFRASTRUCTURE

### *6.7.1 Reagents and Chemicals*

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

### *6.7.2 Fuels and Oils*

On closure all stocks of fuels and oils will be collected, compatibly bulked with main stock, and carefully labelled prior to disposal by sale or return under contractual agreement to the supplier. All oils in plant and equipment scheduled for decommissioning and scrapping will be drained to waste oil. Waste oil disposal will be by licensed contractor. All tanks will be decontaminated prior to decommissioning and export off-site. No fuels, oils, or decontamination agents will be discharged on-site.

*6.7.3 Residual Ore and Concentrates*

Ore remaining in the coarse ore store will be fed through the mill process, with the surplus materials returned underground. Remaining sludges will be disposed in the TMF, prior to rehabilitation.

*6.7.4 Miscellaneous Wastes*

All uncontaminated items will be sold to recycling or scrap traders via a contract which will ensure legal and safe disposal.

*6.7.5 Explosives*

Tara Mines contracts out the provision of bulk emulsion explosives to a licensed contractor. Emulsion based explosives are supplied on a needs basis with a quantity stored on surface. A small amount of other explosive product provided by another supplier is stored at the mine. On closure any un-used explosives will be returned to suppliers.

# 7 AFTER-USE OPTIONS

## 7.1 SOCIO ECONOMIC ISSUES

The Tara landbank is located adjacent to the town of Navan in County Meath and is partially located within the town boundaries of Navan Town. In terms of a planning context, Meath is located within the Greater Dublin Region.

### *7.1.1 Regional Planning Guidelines for the Greater Dublin Region 2004-2016*

The Regional Planning Guidelines for the Greater Dublin Region 2004-2016 state that County Meath is located within the hinterland of the Greater Dublin Region. Navan has been identified as a *'Large Growth Town'.*

It is envisaged in these planning guidelines that the,

*'Large Growth Towns are most likely to be successful in attracting a concentration of major employment-generating investment and should have the greatest accessibility/connectivity and will therefore require a location on a main radial/ orbital intersection and high quality rail service. These centres should be economically self-sustaining, with a population, including its catchment, which is able to support facilities such as a high quality secondary education service, a small hospital or polyclinic-type facility of sufficient size to provide non-specialised medical care, and a comparison retail centre'* (Ref Section 7.6).

### *7.1.2 Navan Town Plan 2003-2009*

The current Navan Town Plan is for the period 2003-2009. A Navan Town Plan for the period 2009-2015 is currently being prepared and a draft of this plan is due for publication in late 2009.



#### 7.1.2.1 Landuse Zoning

The current Navan Town Plan 2003-2009 sets out zoning for lands within its town boundary. The objective of zoning is to specify which type of landuse the Council considers appropriate for different area's or zones. Tara landbank partially falls within the town boundary and is therefore zoned.

Lands located within the southern boundary of Tara are currently zoned as E3. This zoning is *'To provide for small and medium sized industries of a local type nature to develop* *and for the displacement of non-compatible town centre commercial uses in accordance with an approved Framework Plan'.*

Lands not within the Tara Landbank but are in close proximity to the site are zoned as follows;

- Lands to the east of Tara have been zoned as A1, *'To protect and enhance the amenity of developed residential communities'.*
- Lands to the northeast of Tara have been zoned as E1, *'To provide for industrial and related uses subject to the provision of necessary physical infrastructure'* and H1, *'To protect the setting, character and environment quality of areas of high natural beauty'.*

As reflected in the current Navan Town Plan 2003-2009, Navan town has been experiencing an unprecedented level of expansion and growth. *'The growth has been reflected in the level of development and building activity and in the demand for developable land'* (Ref Section 1.1). The expansion and growth has seen the population of Navan and its environs rise from 12,810 persons in 2002 to 24,851 as recorded in the 2006 Census of Population (CSO, 2006).

This plan also states that *'The growth and development of Navan over the life of the previous Development Plans has however played a key role in lifting the economic prospects of County Meath and beyond. Continued development is a key determinant of socio economic prosperity and an indicator of the town's growing significance in maintaining and attracting investment'* (Ref Section 1.1).

#### 7.1.2.2 Employment

Tara Mines has been identified in this plan as a major contributor to employment in the town and its environs.

*'Navan has a strong tradition of manufacturing industries, such as furniture and carpet production, in addition to the existence of Tara Mines, the largest single employer in Navan'* (Ref Section 1.2.6.1).

*'Employment and enterprise are provided for within a number of strategically located sites within the context of the balanced development of Navan. Provision for employment and enterprise have been made to the north, east and south of the town, with Tara Mines Ltd. to the west already providing this essential role'* (Ref Section 1.6.8).

## 7.2 POST CLOSURE/AFTERUSE OPTIONS

Afteruse options for the Tara landbank must take into consideration the planning objectives discussed in previous sections and reflect growth that has taken place in Navan in the last number of years.

The aim of the original planning permission was that the Tara landbank be returned to their pre-mining condition namely agricultural grazing land. The end-use potential of the main mine landbank has changed significantly since operations commenced. In light of the growth of Navan an alternative end-use for the Tara landbank may be more appropriate and warrants future consideration by all stakeholders.

A common aim in reclamation and closure planning for mines in the reinstatement of disturbed and degraded land to its pre-mining condition, or an acceptable alternative. This implies that the reclaimed area will be reintegrated appropriately into the surrounding landscape, and will be capable of fulfilling local community needs in an environmentally acceptable manner.

The main potential constraint on land used for mining, and processing is the presence of metals. However as part of the decommissioning and restoration the land can be decontaminated to a level appropriate to a designated end-use. Post closure monitoring will confirm concentrations required to allow agricultural or industrial/commercial land use activities.

Possible land use options are illustrated in Drawing 3064-1003 and are provided in the Appendices of this document. These include;

- Agricultural land,
- Healthcare Campus,
- Commercial Enterprise,
- Industrial Enterprise,
- Retail/Warehouses,
- Urban Residential Use; and
- Amenity Area Use.



The proposals listed above have taken into consideration current zoning objectives listed in the Navan Town Plan 2003-2009. This zoning may alter in any superseding Navan Town Plans and after uses may be updated to reflect these changes. After use proposals have been suggested for areas that are not located in the town boundaries and have not been zoned within the current Town Plan.

Other possible after uses suggested for detailed consideration are;

- Geothermal energy recovery from deep mine water
- Groundwater supplies
- Carbon sequestration

The existing mine activities currently provide large-scale employment in the area. The proposals listed above and illustrated in Drawing 3064-1003 may contribute somewhat to alleviating the employment shortfall once the mine ceases activities. Any future after uses must take this into consideration and also fulfil the needs of the local community.

# 8 POTENTIAL ENVIRONMENTAL IMPACTS FROM CLOSURE ACTIVITIES AND LIABILITIES ARISING

This section addresses the individual impacts of the main demolition and rehabilitation components. It also elaborates on individual, major environmental areas.

## 8.1 MINE AND PLANT SITE CLEARANCE AND REHABILITATION

This includes the cleaning, decontamination, dismantling, removal and disposal of fixed equipment and tanks, together with the removal of designated surface structures, buildings, hardstandings, roads, pipelines, treatment ponds and other surfaces. It requires the sealing and securing of all underground openings. *It also includes the rehabilitation of the main site,* together with ancillary sites to an acceptable beneficial use.

### *8.1.1 Underground Facilities*

Definition

This series of operations includes the removal of saleable plant and infrastructure, their cleaning and the removal of all oils and chemicals from plant, equipment and bulk storage facilities.

*Impact Review and Mitigation*

- **Liquid Effluent** – Liquid effluent generated during cleaning / decontamination of plant and equipment will be collected and exported of site for treatment. There will be no discharge of decontamination or cleaning liquids to the receiving environment. Such decontamination and cleaning will be carried out by specialist contractor and in accordance with applicable waste management regulations. The predicted impact is negligible.

- **Liquid / Solid Waste** – Any mechanical or electrical plant / equipment that will be removed will be disposed of for recycling. Spent oils will be stored within existing tank facilities for disposal by licensed contractors. All chemicals will be removed by specialist contractors. No adverse effects are expected to arise and accordingly the impact will be negligible.

- **Other Impacts** – Removal of equipment and material from the site will generate some heavy traffic over a limited period of time. The impact will be minor.

### *8.1.2 Surface Facilities*

*Definition*

This operation involves the decontamination, cleaning and dismantling of all fixed plant, buildings and water treatment facilities. It also involves the removal of roads and hardstandings and the dismantling / infilling of pipelines as they are phased out of use. It also includes the phased removal of certain facilities and infrastructure on the plant site, all pumphouses and their associated pipelines, the magazine, water discharge systems and bulk storage tanks. The majority of work will take place in the first year of mine closure although some elements will be required during the *Active Care* period of mine closure.

Thereafter, the sites will be landscaped and rehabilitated to beneficial use, as determined by future liaison with stakeholders.

*Impact Review and Mitigation*

- **Gaseous Emissions** – Earthmoving equipment and excavators will generate exhaust emissions but the impact on air quality will be minimal.

- **Particulate Emissions** – The generation of some dust is inevitable. This will be controlled by water spray where necessary. The localised impact on air quality and adjoining property is considered minor.

- **Liquid Effluent** – All drainage from the site will be treated in the mine water treatment pond prior to discharge. Drainage from high risk areas or during particular decontamination and cleansing activities will be controlled and collected for export offsite. The impact of normal surface drainage during the decommissioning phase will be minor.

- **Liquid / Solid Waste** – Residues from all sumps and tanks will be disposed by licensed contractors. Unused ore will be process in the mill and surplus disposed underground. All other solid materials will be disposed by licensed contractor. The impact of waste disposal will be minor.

- **Noise** – Noise generated by decommissioning activity will be different in character to that during operation and therefore probably more apparent to residents. The actual period of disturbance from demolition will be relatively short. With careful planning and programming of equipment operations specified as a contract requirement, it will be possible to minimize the levels of noise generated.

- **Vibration** – Limited demolition blasting may be required for initial foundation breakage. The predicted impact is considered to be minor.

- **Visual** – The removal of unwanted buildings and structures followed by rehabilitation and landscaping to a land form and land use compatible with the surrounding area will be a major beneficial impact.

- **Other Impacts** – Removal of plant, equipment, materials and waste from the site will generate some heavy traffic. This will be short term and the impact is, therefore, rated minor

## 8.2 WATER MANAGEMENT

### *8.2.1 Surface Water*

*Definition*

This involves the cessation of abstraction of water and the subsequent reduction to zero of discharge to the River Boyne.

*Impact Review and Mitigation*

- Liquid Effluent – Discharge to the Boyne will be of comparative quality to that discharged during operations. The resultant impact is therefore considered minimal.

- Other Impacts – The cessation of abstraction of water from the Boyne will have a positive effect on river flow and aquatic biomass.

### *8.2.2 Groundwater Recovery*

*Definition*

This involves the cessation of dewatering to allow flooding of the mine workings and the pumping to ensure that potentially contaminating water is removed and treated. The hydrogeological model predicts that the rewatering of the mine will not result in a negative impact on the surface water quality and it will not result in any deviation in existing water quality of the River Boyne. Monitoring of the rewatering and groundwater recovery will be undertaken as part of the monitoring and aftercare phase.



Following rewatering of the mine, the groundwater levels in wells will be restored to pre-mining conditions. However, there is an existing water supply network system (fed from

Meath County Council's reservoir) around the mine which has provided an alternative to the use of private wells.

*Impact Review and Mitigation*

Following rewatering, the water quality of reactivated wells (following purging) will permit their use if required. A beneficial impact is therefore predicted.

## 8.3 ACID GENERATING POTENTIAL OF MINE WATER POST CLOSURE

A hydrogeological model of the rewatering and groundwater recovery in the mine has been prepared by Water Management Consultancy. This is detailed in Section 6.4. This assessment also addressed the acid generating potential of the mine post closure. Based on the findings of the model, WMC provides the following conclusion.

Oxidation of the pyrite minerals will stop as the workings become submerged. Therefore, on-going generation of mineral acidity, sulphate and metals will not occur. Experience at other flooded mines has shown that the water isolated in the deeper part of the workings will become strongly reducing. Depending on the matrix chemistry, there may some precipitation of metal sulphides which would act to improve the chemistry in the flooded workings in the long term.

The exact details of how the workings flood will depend on the final extent of the workings, and on the extent and location of the backfill. More detailed analysis of actual conditions will therefore need to be undertaken nearer to the time of closure when the final mine plan is known with more certainty. The on-going water chemistry sampling plan for the mine will be adapted with time to provide the required empirical data to develop the detailed closure plan. It is expected that all required data for mine closure can be developed by means of on-going sampling and field testing, without the need for theoretical laboratory testing of geochemistry samples.



## 8.4 FLORA AND FAUNA ASSESSMENT STUDY

A flora and fauna study was carried out in and around the environs of the main Tara Mines site. The study was commissioned to establish the types and significance of habitats on the site in relation to the eventual closure of the mine. The assessment was carried out according to the methodology for Phase 1 Habitat Survey (JNCC). The principal habitats and vegetation types present were recorded and mapped. Habitat classification is according to the number or diversity of species found, the degree to which they represent a natural habitat, and their importance for animals and birds, the system recommended by the

Heritage Council (Fossit 2000). Plant species are named according to Webb, Parnell and Doogue (1996) and a list of the most prevalent and notable plant species made. Direct sightings of bird, mammal and invertebrate species were noted, as well as any other signs of activity, such as droppings or burrows.

Before production commenced at Tara the mine site was landscaped and a variety of shrubs and woodland species planted both native and non-native. Habitats on the mine site vary between semi-natural and highly disturbed and include woodlands, scrub, scattered trees, hedgerows, ornamental/non-native scrub, spoil and bare ground, recolonising bare ground, buildings and artificial surfaces, amenity grassland, dry calcareous and neutral grassland, wet grassland, ponds, streams and rivers and drainage ditches. All of the woodland was planted as part of the landscape plan

Areas of lowest ecological value are comprised of the most disturbed or altered parts of the site with low species diversity, including the hardcore, storage areas and landfill, office buildings and some landscaped areas. Areas of medium ecological value have been or are influenced by human activity, but support a moderate diversity of plant species and most are evolving into semi-natural habitats. They are important for fauna. Included here are planted woodland, scrub, hedgerow, dry neutral grassland, wet grassland, and some ditches and streams. These habitats are of local importance. Areas of high ecological value support the greatest range of species. Two of the habitats identified are considered to be of high ecological value. Namely, areas of species-rich dry calcareous grassland, which support abundant orchids and an area of recolonising bare ground, which supports plants of possible Lesser Centaury (a plant covered by the Flora Protection Order 1999). These habitats are of regional and may be of national and/or international importance.

No animal species of conservation importance occur, nor has been known to in the past, within the main site area. However, the likely presence of species such as Irish hare, fox and common frog and badger is of some note, as these species are protected under the Wildlife Act 1976 (though all are still widespread in distribution).

Flora and fauna follow-up assessments/reviews will be conducted periodically and any changing circumstances will be submitted to the Agency as part of Tara's Annual Environmental Report.

## 8.5 SUBSIDENCE

The issue of ground settlement and subsidence (i.e. differential settlement) is addressed in Section 6.5 above. Due to extensive underground backfilling programme, it is not expected that there will be any subsidence. There are no subsidence implications in regard to mine re-watering.

# 9 QUANTIFICATION OF MATERIALS AT CLOSURE

## 9.1 CLOSURE MEASURES

- Methods for safe plant and infrastructure decontamination, deconstruction and removal – procedures and quality management procedures to be outlined
- Waste handling, storage and removal procedure, regulations and quality management procedures to be outlined.
- Management procedures for documenting (record keeping) of material/waste movement.
- Verification of soil testing to demonstrate no potential for ground contamination
- *Environmental Monitoring during closure*
- Environmental Management System.

In the case of a potential enforced closure, with saleable ore reserves in situ, plant that has a potential for resale will come under the control of the receiver/liquidator and has, therefore, not been considered. Although it is assumed in this report that all plant and demolition material including construction hardcore may be removed from the site, the site may be designated for industrial use and thus many of the services and buildings could be retained. This report has attempted to itemise the materials and costs for various sections and buildings separately, thus allowing for updating as the overall final use of the site becomes clearer.

## 9.2 SCOPE OF CLOSURE WORK

### *9.2.1 Roads*

The areas for roads has been assessed from existing site layout drawings and based on visual surveys of the site. The depth of surfaced materials have been estimated from local knowledge of the site. The internal roads are further divided into (1) roads with bituminous surfacing and spray and chip and (2) roads with compacted hardcore only.

From knowledge from site personnel, it is believed that hardcore for road construction has been imported from outside quarries, or was obtained from the initial development construction of the mine and thus free from any contaminants.

There is a total area of over 50,000m$^2$ *of roads within the site of which* 20,000 *m*$^2$ approximately have been covered with a bituminous surface (Tarmacadam or Asphalt).

For access during decommissioning these roads will be left intact until decommissioning is completed and thus this material will not be used in backfilling of air raises etc.

The quantity of surfaced road material is only 1200$m^3$ and is relatively small. Subject to testing, this material could be processed and recycled . The surfaced material could be removed with the hardcore along with the surface dressed sections. The quantity of hardcore is 55,500 $m^3$ and could be regarded as an asset assuming the material is contaminant free. Tests will be carried out to verify that the material is contaminant free. Material that falls within a specified criteria is classified by the EPA as reusable. Rock not meeting this specified criteria will be processed on site, or backfilled underground. The location, dimensions and quantities of the various materials of the roads are listed in Table 9.1.

*9.2.2 Car Parks, Hardstanding Areas, Storage Bund Areas and Railway Tracks.*

The extent of carpark areas has been measured from site layout drawings and visual assessment of the site, while the depths of hardcore has been evaluated with the assistance of local knowledge. The carpark areas have been divided into (1) areas with bituminous surfacing, (2) spray and chip, (3) concrete bases and (4) hardcore only. It is believed that hardcore in this section has been imported from outside quarries, or was obtained from the initial development construction of the mine and thus free from any contaminants.

Owing to the storage of materials in tanks, surrounding the Concentrator building, the materials in this area will be subjected to further investigation with regard to the presence of contaminants during decommissioning.

There is a total area of 93,600 $m^2$ within this section. As in section 9.2.1, the quantity of surfacing is relatively small (360 $m^3$) and could be removed with the hardcore along with the surfaced dressed areas (12,500 $m^2$). The quantity of reinforced concrete is 3,700 $m^3$. This can be broken up, crushed and recycled with the steel reinforcing removed. The quantity of hardcore is 115,000 $m^3$ and similarly to section 9.2.1 requires verification with regard to being contaminant free. It is estimated that approximately 33,000 $m^3$ of this hardcore is in the vicinity of the concentrator and this material could be used to backfill the ventilation openings and shafts where 58,300 $m^3$ is required.

As above, the voids created by removing hardcore may require backfilling with overburden. It should also be noted that only existing areas of hard standing have been investigated with regard to quantities, it could be the case that other areas contain hardcore with a shallow covering of topsoil. The location, dimensions and quantities of the various materials of this section are listed in Table 9.2.



*9.2.3 Ponds and Screening Berms.*

The main pond areas are to the east of the site where five interlinked ponds are located. The information has been taken from site layout drawings. The quantities for earth material has been divided into quantities of impermeable clay used to make the pond walls and rock slope protection. The Kells road pond is the other pond included in this section.

Screening berms are also located around the site. It is believed that initial screening berms are constructed from topsoil/overburden removed from the initial construction while later internal berms are constructed from surplus rock. The removal of these berms is ongoing and will be completed prior to closure.

There is 57,000 $m^3$ of material within the bund walls of the Reclaim Ponds, consisting of 54,500 $m^3$ clay and 2,500 $m^3$ of rock slope protection. The material within the pond walls can be used to regrade this area to its original elevation. Similarly, the depressions around the ventilation stations at the Kells Road and the Magazine (12,500 $m^3$) will be filled with material from the screening berms. Periphery berms may be retained for landscape and visual mitigation purposes post closure.

The screening berms around the site contain approximately 95,000 $m^3$ of material. It is estimated that 77,000 $m^3$ of overburden/topsoil and 17,000 $m^3$ of mine surplus rock make up these berms. Additional overburden has also been stockpiled to the west and east of the site (approximately 23,000 $m^3$). This overburden material (100,000 $m^3$) can be used for regrading the site on completion of decommissioning. It is assumed the 17,000 $m^3$ of mine-surplus rock will be returned underground or exported to the TMF for capping. The quantities of the various materials in these pond walls, ventilation shaft depressions and berms are listed in Tables 9.3.1, 9.3.2 and 9.3.2 respectively.

### *9.2.4 Buried Pipelines.*

The length, size and type of the various buried pipelines have been evaluated. Pipelines of diameter less than 100mm have been ignored. Many of these pipelines were installed adjacent to each other in the same trench, which will have cost implications if being removed.

There is approximately 30 km of buried pipelines greater or equal to 100mm in diameter throughout the site. This figure also includes for pipelines to Randalstown and to the Boyne River but does not include for pipelines within the various buildings or in the service tunnel. In general, the pipelines within the site itself are ductile iron and range in size from 100mm to 500mm. Many of these pipelines were installed in the same trench at a depth of 2m. The pipelines to and from Randalstown are 630mm and 800mm diameter 6 bar rated HDPE pipes and generally are placed along the Kingscourt railway line.

The discharge pipeline to the Boyne River, which is placed along the railway line, is 2.2km in length with 825mm diameter and is of cement construction and on decommissioning it is proposed that this be left in situ, on agreement with the EPA and Meath County Council. The pipe will either remain open and viable for an alternative end-use or it will be infilled with grout. The end option will depend on whether this pipeline is viewed as an asset for alternative use. Table's 9.4.1 and 9.4.2 show the location, type size, length and weight of the various pipelines.

*9.2.5 Shaft and Ventilation Openings.*

This section has been evaluated to establish the quantities required for backfilling on decommissioning of the mine.

The total voids of openings to underground are 58,300 $m^3$ and surplus material from the decommissioning can be used to fill these voids. Table 9.5 shows the void quantity for the various openings.

*9.2.6 Balancing of overburden requirement and hardcore excavation.*

The summary of the quantities of hardcore excess and overburden requirement listed in the previous sections is listed in Table 9.6. For completeness the hardcore and voids related to the building section are included in this summary although the figures are not double counted.

There appears to be a total of 232,000 $m^3$ of hardcore (inclusive of hardcore below buildings), with an additional 17,000 $m^3$ mine surplus rock to be removed. Assuming hardcore is to be placed underground, the ventilation openings can accommodate 58,000 $m^3$, leaving an excess of 189,000 $m^3$ of hardcore which will require reuse or transport to market. This material will be exported to the TMF for use in the restoration programme.

The total overburden available from berms, pond walls etc. is 163,000 $m^3$ but the void to be filled in the pond areas, the void left by the excavation of the hardcore and building foundations along with the void of the mill basement is 285,000 $m^3$, leaving a shortfall of 113,000 $m^3$ of overburden.

*9.2.7 Buildings and Associated Structures.*

This section has been evaluated using the original Kilborn As Built Drawings. The quantities of the main structural components of each building are listed in Section 9.3.6 and summarised in Table 9.7 of this report. The components have been separated into:

- Reinforced concrete
- Hardcore beneath buildings
- Block work

- Structural Steel and Ancillaries
- Metal Sheet Cladding
- Steel Decking
- Roof Cover and Insulation
- Roof Timbers
- External Windows
- External Doors

Within the above sections there are further breakdowns e.g. Steel Tanks within the steel section and these will be discussed further later in this report.

A summary of all quantities of construction materials and all building quantities per building is listed in Table 9.7. All references to grid lines etc. in the evaluation of these quantities refer to the grid lines on the original Kilborn As Built Drawings.

*9.2.8 Reinforced Concrete*

There is approximately 23,700$m^3$ of reinforced concrete with the individual quantities for each building listed in Table 9.7. This quantity can be further divided into column footings and piers, strip foundations, walls, floors, and plant bases if required.

*9.2.9 Hardcore*

It has been assumed that there is an average depth of 0.4m of hardcore below each building. Hardcore outside the actual building footprint has been included within the hardstanding section of 9.3.2. There is approx. 56,400 $m^3$ of hardcore in this section with 80% (45000 $m^3$) below the Coarse Ore Storage building. Similar to section 9.3.2 it is believed that this material is free from contaminants but this should be verified.

*9.2.10 Block-work*

The total area of block walls is 12,700$m^2$. This section can be divided into hollow or solid block walls. Studded partitions have been ignored for this evaluation.

*9.2.11 Steel*

This section has been subdivided into structural steel, stairs and landings etc, chequered plate and external storage tank steel.



*9.2.12 Structural Steel*

There is approximately 4,100 tonnes of structural steel within the site. This section includes columns, beams, roof trusses and supports, cladding girts and bracings; it also includes the supports for walkways, heavy plant, and conveyor galleries and raised external storage tanks.

*9.2.13 Stairs/Walkways*

Many of the buildings particularly in the Concentrator and Loadout areas have raised steel platforms with steel walkways and stairs. These have been evaluated in linear meters.

*9.2.14 Raised Platform Steel Plate and Gratings*

Generally, the steel plate is 6mm while the platform gratings are 32mm.

*9.2.15 Large External Storage Tanks*

The tanks are constructed from 6mm to 12mm steel plate with ring and/or vertical plate stiffeners. While the steel supports to the tanks have been evaluated in the structural steel section, the actual steel plate and stiffeners of the tanks has been evaluated separately. The 18 no. tanks included in this section are the Fine Ore Bins (2no.), Lime Bins (2no. to be removed pre-closure in next 5 years), Cement Storage Bins(2no.), Sand Tanks (4no.), Sulphuric Acid Tanks (2 no.), Heavy Fuel Oil Tank (to be removed pre-closure in next 5 years), Diesel Oil Storage Tanks (2 no.). The total weight of steel plate is 728 tonnes with an additional 113 tonne of stiffeners etc. An additional 37 tonne has been estimated for the smaller Leach Tanks (4 no.). Thus, the total weight of steel within the tank section is approx. 900 tonnes. Note smaller tanks within the mill building have not been included.

*9.2.16 Metal Sheet Cladding*

There is approx. 35,700 $m^2$ of metal sheet cladding on the site. This can be divided into 16,800 $m^2$of uninsulated cladding and 12,500 $m^2$ of insulated cladding on the buildings and 6,400 $m^2$ of uninsulated cladding on the conveyor galleries. The cladding has been manufactured by *HH Robertsons* and has a BR4 profile. A review of it's specification has shown that that none of this material contains asbestos. This sheeting can be recycled or sold as scrap steel. There is also 2400 linear m of curved edge flashing on the conveyors. Corner flashing and top covers have been ignored for the buildings.



There is also 2,500 $m^2$ of corrugated galvanised sheeting on some of the older ancillary buildings.

*9.2.17 Metal Sheet Decking*

This material is used for roof and raised concrete floor supports. Approximately 25,000 $m^2$ of this material is on the site. In general the decking for the roof is *Robertsons* 38 mm * 0.8mm gauge (18,000 $m^2$) while the steel decking for the raised floors is 64mm*2mm gauge (7,000 $m^2$). This material will be sold as scrap on dismantling.

*9.2.18 Roof Insulation and Cover*

The initial construction of this item was 25mm rigid insulation on a vapour barrier with a build up of felt and gravel. Most of these roofs have since been recovered with 'Repanol' a polyisobutylene membrane manufactured by *Braas* in Germany. There is a total area of 19,000 $m^2$ to be removed. All of this material can be disposed of in any regular licensed landfill.

*9.2.19 Roof Timbers*

There are two buildings with timber roof purlins; the Compressor House and Canteen Building. These timbers can be removed and recycled.

*9.2.20 External Doors*

There are approximately 650 $m^2$ of rigid steel panel or roller steel panel external doors on the buildings. These will be dismantled and sold as scrap metal.

*9.2.21 External Windows*

There are approximately 350$m^3$ of external windows with steel frames. All of this material can be disposed of in a regular licensed landfill although the steel could be recycled as scrap if required.

*9.2.22 Fencing*

There is approximately 6km of security fencing surrounding the compound. The fencing has an overall height of 2.4m, consisting of galvanized woven steel mesh (2.0m wide rolls of rock netting), below 3 strands of galvanized barbed wire. Uprights located at 3m ctrs are 50mm dia. CHS (galvanized) anchored in individual concrete pads, approx. 0.3m square by 0.7m deep. The fence can be dismantled and sold as scrap metal.

*9.2.23 Asbestos Containing Materials*

Based on assessment and testing of materials and pipes, there is no evidence of the presence of asbestos within materials used within the Tara Mines site.



*9.2.24 Chemical and Fuels*

Owing to the operation, there are both chemicals and fuels sorted within the site. All fuels and chemicals are currently contained within bunds to prevent accidental spillage. Fuels and oils are imported as required Chemical including acids and processing additives are stored within tanks.

On closure of the mine, these tanks will be fully drained and decontaminated. All liquids will be exported by an appropriately experienced and permitted haulier to a licensed disposal facility.

*9.2.25 Nuclear Sources*

Tara Mines engaged Rilta Environmental Ltd. to collect and export (to the USA) all radioactive sources surplus to requirements. The collection and export of the radioactive sources, used for exploration and gauging purposes, was fully authorised and verified by the Radiological Protection Institute of Ireland (RPII). By end 2009 there will be only one remaining radioactive source on site. On closure this source will be collected and exported from the site by approved contractor, under the authorisation of the RPII.

*9.2.26 Explosives*

Tara Mines contracts out the provision of bulk emulsion explosives to a licensed contractor Emulsion based explosives are supplied on a needs basis with a quantity stored on surface. A small amount of other explosive product provided by another supplier is stored at the mine. On closure any un-used explosives will be returned to suppliers.

## 9.3 CLOSURE PLAN COSTING

### 9.3.1 Introduction

This section addresses the cost of the work that may be involved in the closure of the Mine Site and to estimate the cost to rehabilitate the site to its initial 'agricultural use' in accordance with Meath County Council Planning Permit P73/125. It is assumed that the present ground profile will be maintained.

The Landfill to the west of the site has not been included in this evaluation but has been addressed in the Land Contamination Assessment / Remediation Report (Section 10). It is assumed that the red brick administration building and Knockumber House will remain.

In the case of an earlier enforced closure, with saleable ore reserves in situ, plant that has a potential for resale will come under the control of the receiver/liquidator and has, therefore, not been considered.

Although it is assumed in this report that all plant and demolition material including construction hardcore may be removed from the site, the site may be designated for industrial use and thus many of the services and buildings could be retained.

This report has maintained the itemisation of the materials contained in the original closure plant and costs revised accordingly based on construction inflation for various sections and buildings separately.

This evaluation has been carried out by the dividing the site into various sections as detailed in sub-section 9.3.2 as follows:

### *9.3.2 Costs*

#### 9.3.2.1 Introduction

There are 3 aspects to rehabilitation costs:

1. The dismantling and storing/stockpiling of the material.
2. Disposal of the material off site.
3. Rehabilitation of the void left by the removal of item 1 above.

The overall cost summary is based on the sections as listed in sections 9.2.1(Roads) to 9.2.7 (Fencing) and is listed in Table 9.8.

The cost to dispose of normal inert builder's rubble in permitted / licensed landfill sites is approximately €9.80/tonne at present day prices. It may be prudent to limit the amount of materials being disposed of in such sites and dispose of material for recycling where possible, thus reduce the overall financial exposure of Tara Mines. It may also be a condition of the EPA to recycle materials where possible. The rates used for dismantling and disposal of particular materials are listed below.

#### 9.3.2.2 Hardcore

If the hardcore is contaminant free the material can be crushed, screened and sold off at a profit of €4.00/tonne. If the material contains low-grade ore it is assumed that this too could be reused off-site, however for the purposes of this report it is proposed to utilise this material for placement underground or at the TMF at a cost of €5.20/tonne. This rate includes €2.00/tonne for excavation/transportation to vent raise/TMF, and €3.20/tonne for transportation/placement underground to allocated stopes.

### *9.3.3 Overburden*

There appears to be a shortfall of this material at the moment. It is assumed that this material will be stockpiled at no cost to Tara over the intervening period from now until decommissioning of the mine. The rate used for transportation from the stockpile and placement of this material is €3.30/ $m^3$.

#### 9.3.3.1 Tarmac/Asphalt

The quantity of this material is small and at this point in time has no residual value. The cost of this material has been included with the hardcore section.



### *9.3.4 Materials Costing*

#### 9.3.4.1 Roads

There is approximately 56,000 $m^3$ (112,000 tonne) of hardcore/bituminous surfacing to be removed. If the material is ore free the material can be crushed, screened and sold off at a profit of €4.00/tonne: €445,000. The cost of filling the void is estimated at €3.30/m$^3$: €184,000. Thus this section will be an asset of €261,000 (€195,000). The quantities and costs concerned are summarized in Tables 9.8 – 9.13.

#### 9.3.4.2 Car parks, Hardstanding areas, Storage Bund areas and Railway tracks.

The quantity of reinforced concrete is 3700 m$^3$ and a disposal rate of €52.50/m$^3$ has been used at a cost of €194,250.

Filling the void with overburden in this section will cost €393,000.

#### 9.3.4.3 Ponds and Screening Berms

There is 57,000 m$^3$ of material (54,500 clay and 2,500 hardcore) within the bund walls of the Reclaim Ponds. As the material will be levelled with a bulldozer a rate of €1.30/m$^3$ has been used. Thus, the cost of re-grading this area is €70,850 with a credit of €20,000 for the slope protection. An additional €10,500 has been allocated to the Kells Road Pond. The depressions of the ventilation openings at the Kells Road (RAR No.3) and Magazine (FAR No.3) will also be filled with material from the surrounding berms costing €16,250.

The cost of spreading the 100,000 m$^3$ of overburden in the screening berms has been included in sections above. The removal of the 17,000 m$^3$ (34,000 tonne) of mine waste to underground will cost €177,000.

The total liability of this section is either €254,000. Table 9.8 shows the quantities and costs involved.

#### 9.3.4.4 Buried Pipelines

There is approximately 30 km of various buried pipelines greater or equal to 100mm diameter throughout the site, to and from Randalstown and to/from the Boyne River. The depth of the pipelines within the mine site varies between 2 and 4 m, the discharge to the Boyne River is 2m below railway track level, while the pipelines to Randalstown are averaged at approx 1.5m in depth. Table 9.10.1 shows the breakdown of the total estimated costs for removal of the various pipelines at €620,700. A possible scrap value for the Ductile Iron and Steel/Alvenius Pipelines of €17,900 is not included in the figure above. As stated previously pipelines within buildings or the mine and mine-service tunnel are not included in this evaluation. It is assumed that the material excavated from the trench can be reused in backfilling. A summary of the costs involved in the removal/disposal of all pipes is listed in Table 9.10.2.

#### 9.3.4.5 Ductile Iron Pipelines

There is 11 km of ductile iron pipes ranging in size from 100mm to 500mm diameter. It is estimated that the cost to remove these pipes and stockpile on the site is €175,000. There may be a resale value attached to these pipes but for this evaluation, only scrappage value of €16,600 has been assumed.

#### 9.3.4.6 High Density Polyethylene Pipelines (HDPE)

There is 14 km of HDPE pipeline on the site. The estimated cost to remove these pipes into 12m lengths and stockpiling at Randalstown and at the mine site is €327,000. There may be a resale value on these pipes but as the pipes are of large diameter, finding an outlet may be difficult. The cost of transporting these pipes back to the manufacturer in Finland may negate any value of the pipes. It is intended to use some of these pipes in the construction of an outfall from the Randalstown facility at close out of the facility. For this evaluation although there is an excavation and stockpiling cost, no residual value has been attached to these pipes as the disposal cost is assumed to negate the residual value.

#### 9.3.4.7 Steel and Alvenius Pipelines

There is 1 km of steel/alvenius pipelines on the site The estimated cost of the removal pipelines is €15,800 with a scrappage value of €1,300.

#### *9.3.4.8* Concrete Pipeline

There is 2.2 km of cement pipeline (diameter 825mm) from the clear water pond to the Boyne. This is placed along the railway track running through Navan. The pipeline is also encased in concrete for 120m where it crosses the Boyne Bridge. Test work carried out on behalf of the Tara Mines that has shown that this pipe is not asbestos containing material. The pipeline is therefore to be treated as normal concrete.

It is proposed to allow this pipeline to remain in situ for future use. If the pipeline has to be removed in this area it will entail removing the southern rail track. It is estimated that the cost of removing this pipeline is €83,000 with an additional €20,000 for removing the Bridge section.

It is proposed to leave the concrete pipeline in situ with the agreement of the EPA and Meath Co. Co. This pipeline could prove a valuable asset to the local authority. IN the event that this pipeline is not considered of beneficial use, the pipeline will be grouted. The cost of grout the pipeline would be completed well within the removal budget of €103,000. There is 1.3km of 1200 mm diameter concrete pipelines. It is assumed that these pipelines will be allowed to remain in situ as it is in the form of a culverted stream, and form part of area drainage. No cost has been allowed in this evaluation.

The total liability for buried pipelines is €840,000.

#### 9.3.4.9 Shaft and Ventilation Openings.

The total voids of openings to underground is 58,300 $m^3$ and surplus material from the decommissioning can be used to fill these voids. Tables 9.9.1 and 9.9.2 show the costs of filling this void.

It has been assumed that all hardcore will be removed and replaced with overburden. It is also assumed that the existing ground level will remain and that overburden material will be brought to site and stockpiled free of charge to augment the present shortfall of overburden. Depending on the hardcore material this section will have either a credit of €336,000 or a liability of €3,900,000. For completeness, this figure includes hardcore below the buildings. Note in the overall summary the hardcore below the buildings and the cost of backfilling with overburden is included in the building section only. The removal of buried pipelines has no significant effect in this section.

### *9.3.5 Buildings Costing.*

The materials within the buildings have been separated into the main building components as listed previously. The estimated costs, both for the individual buildings and type of material are shown in Table 9.11. This Table assumes that the hardcore can be recycled off site.

### *9.3.6 Hardcore*

There is approximately 56,400 $m^3$ of hardcore below the buildings 80% of which is below the Coarse Ore Storage building. This section will be an asset of €451,000.

### *9.3.7 Reinforced Concrete*

The rate for this item will depend on the thickness and location of the reinforced concrete. For example a rate of €42/$m^3$ could be used for all slabs, floors and 300mm thick walls, rising through various rates for buried foundations and thicker walls to €85/$m^3$ for heavy duty plant bases. An average rate of €52.50/$m^3$ has been used in this evaluation. This rate includes for breaking, crushing, screening, segregation of steel reinforcing, and removal of all materials from site.

There is approximately 23,700 $m^3$ of reinforced concrete in this section, this will have a liability of €1,244,000 using an average rate of €52.50/$m^3$.

*9.3.8 Block walls*

A rate of €8.00/m$^2$ has been used and includes for removal, crushing, stockpiling and disposal from the site. There are 12,700 m$^2$ of block walls, which entails a liability of €101,600.

*9.3.9 Steel.*

The asset cost of scrap steel is €26.00/tonne, this rate includes for collection at the site. The dismantling cost of structural steel is also €26.00/tonne. Thus, the asset cost is negated by the dismantling costs.

*9.3.10 Structural Steel*

There is 4,100 tonnes of structural steel within the buildings, 40% of this is within the Concentrator building. It is assumed that the net cost of removal of structural steel will be offset by the residual scrap value.

*9.3.11 Stairs/Walkways etc.*

Although the total quantity has not been completed (Mill), the cost as with structural steel will have a zero rating.

*9.3.12 Large External Storage Tanks and Bins.*

An additional cost of €6,500/tank has been included in this section for decontamination /cutting of the steel plate required in the dismantling costs of each tank.

There are 18 large external tanks at €6,500 and 4 no. smaller tanks at €3,250 to be dismantled. There is approximately 900 tonne of steel plate associated with these tanks. The additional liability of removal of these tanks is €130,000.

*9.3.13 Sheet Metal Cladding*

There is approximately 35,700 m$^2$ of Robertson sheet metal cladding on the buildings and conveyors of the site as previously discussed in section 9.3.7.5. The cost of dismantling/stockpiling of the insulated sheeting is estimated at €16.50/ m$^2$ (€12.50) while the single uninsulated sheet is €6.50/m$^2$, while the total weight of this material is approx 400 tonne. Robertson sheet metal cladding contains small amounts of asbestos and thus removal and disposal will be in accordance with H.S.A and EPA regulations. At the present time disposal of this material requires transportation to Germany at a cost of €790/tonne for transportation and disposal. The estimated cost of dismantling is €357,000 while the transportation/disposal costs are €314,000. Thus, the total liability is €671,000. Table 9.13 lists the costs involved in dismantling and disposal of this material.

A small amount of galvanised corrugated sheeting (2,500 $m^2$) exists on some of the older sheds. This will cost €16,400 to remove and can be sold as scrap.

*9.3.14 Metal Floor and Roof Decking.*

There is approximately 18,500 $m^2$ of 38mm*8 gauge roof decking with 6,000$m^2$ of 64mm/20gauge floor decking. The weights are 158 and 143 tonnes respectively.

The unit rate used for removal and storage of the decking is €8.00/ $m^2$ which gives a total cost of €196,000. Additionally, there will be a residual scrap value of €9,000.

*9.3.15 Roof Covering.*

A rate of €8.00/$m^2$ has been used in the evaluation for removal and disposal of the roof covering. This rate is to include removal separation of the insulation, felt and 'Rhepanol' membrane. The total area of this roofing is approx. 20,000$m^2$ and the removal/disposal of the roof covering is a liability of €160,000.

*9.3.16 Roof Timbers.*

This item only affects the Compressor House and the Canteen and it has been assumed that the recycled value will offset the removal cost.

*9.3.17 External Doors.*

The cost of removal and disposal of the doors has been estimated at €25.00/$m^2$ and a liability of €21,000 has been evaluated.

*9.3.18 External Windows.*

The cost of removal and disposal of the doors has been estimated at €25.00/$m^2$ and a liability of €9,000 has been evaluated.

The total liability of the removal and recycling/disposal of the materials used in the construction of the buildings, depending on the hardcore, is €2,259,510 or €3,297,353.

*9.3.19 Fencing*

The fencing can be dismantled and removed at a rate of €10/m run, giving a total cost of €60,000. The fencing material has minimal scrap value.

## 9.4 SUMMARISED COST ESTIMATES OF SECTION 9.2

| | Dec. 2008 |
|---|---|
| Total Estimated Cost | €3,120,000 |

**Reference Notes**:

1. There is a shortfall of 122,000m$^3$ of overburden to restore the site to its present level on removal of the hardcore and buildings. It is proposed to progressively import this 122,000m$^3$ of topsoil from local development sites in the coming years (i.e. commencing in 2009) and to use this product for restoration (progressive and stockpile for final closure restoration). It is noted that in excess of 120,000m$^3$ of topsoil was imported to the Randalstown TMF in 2008 from local development site for restoration purposes.

   It is assumed that the inert topsoil material will become available free of charge over the next few years. Failing this, the cost of buying in topsoil has been attributed a monetary value of €5/tonne, thereby incurring an additional financial cost €610,000. If the option of having to buy in topsoil is realised, the option of reducing the final elevation of the site can be investigated to reduce the financial burden, without adverse effect in implementing the closure and restoration plan.

2. It has been demonstrated that there is no Asbestos containing materials within the site. This is a significant finding and reduces the financial costs to those calculated in the original closure plan. An estimated cost of €640,800 at 2008 prices is therefore reduced from the closure plan budget.

3. Filling the clear water discharge pipeline with a structurally strong pumped expanding foam or similar may be a cheaper option than removal if agreable with the EPA.

4. The building costs only relate to the actual building materials as discussed and do not include for fixed plant, internal building pipelines, electrical items or studded partitions etc (it is assumed these items can be disposed of at zero cost to Tara Mines ).

Table 9.1 Roads (Assumptions : 1m of hardcore below internal roads . Hardcore on all internal tarmac roads extends 2m on either side of tarmac surfacing).

| Road Number | Road Location | Length (m) | Width (m) | Area ($m^2$) | Tarmac Depth (m) | Tarmac Quantity ($m^3$) | Spray/Chip Area ($m^2$) | Hardcore Depth (m) | Hardcore Quantity ($m^3$) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Entrance Road | 328 | 7.3 | 2394.4 | 0.15 | 359.16 | - | 0.6 | 359.16 |
| 1.1 | Additional for corners etc for 1 above | - | - | 200 | 0.15 | 30 | - | 0.6 | 30 |
| 2 | Security to Portal | 680 | 6 | 4080 | 0.05 | 204 | 1360 | 1 | 6800 |
| 3 | Link from Item 2 to Kells Road | 90 | 6 | 540 | - | - | - | 1 | 900 |
| 4 | Sec. Junc. to Acid tanks to Washbay | 990 | 6 | 5940 | 0.05 | 297 | 3960 | 1 | 9900 |
| 5 | Link Road Laboratory to Loadout | 181 | 6 | 1086 | 0.05 | 54.3 | 724 | 1 | 1810 |
| 6 | Mill Access Road South 1 | - | - | 460 | 0.05 | 23 | - | 1 | 460 |
| 7 | Mill Access Road South 2 | - | - | 340 | 0.05 | 17 | - | 1 | 340 |
| 8 | Mill Access Road South 3 | - | - | 300 | 0.05 | 15 | - | 1 | 300 |
| 9 | Mill Access Road North | - | - | 300 | 0.05 | 15 | - | 1 | 300 |
| 10 | Canteen | 90 | 4 | 360 | 0.05 | 18 | - | 0.5 | 360 |
| 11 | Sec Junct. To Stores | 1150 | 1 | 1150 | 0.05 | 57.5 | - | 1 | 5750 |
| 12 | Fuel Tanks to Tyre Centre | 177 | 6 | 1062 | 0.05 | 53.1 | 531 | 1 | 1770 |
| 13 | Sec. Junct. to Core Shed | 166 | 6 | 996 | 0.05 | 49.8 | 664 | 1 | 1660 |
| 14 | Additional for corners etc for 2 - 13 above | - | - | 500 | 0.05 | 25 | - | 1 | 500 |
| 15 | Magazine Road | 660 | 7.3 | 4818 | - | - | - | 1 | 4818 |
| 16 | Road within Magazine Area | 331 | 6 | 1986 | - | - | - | 0.6 | 1192 |
| 17 | Fresh Air Raise 4 | 270 | 5 | 1350 | - | - | - | 0.5 | 675 |
| 18 | Waste Storage roads | 840 | 6 | 5040 | - | - | - | 1 | 5040 |
| 19 | Portal to RAR No.2 & Reclaim Pond Rd | 420 | 6 | 2520 | - | - | - | 1 | 2520 |
| 20 | Portal to Reclaim Ponds | 790 | 7.3 | 5767 | - | - | - | 1 | 5767 |
| 21 | Kells Road RAR No. 3 | 360 | 6 | 2160 | - | - | - | 0.5 | 1080 |
| 22 | Crest of Mine Water/Reclaim ponds etc. | 1332 | 4 | 5328 | - | - | - | 0.3 | 1598.4 |
| 23 | Kells Road Pond Access | 250 | 4 | 1000 | - | - | - | 0.3 | 300 |
| 24 | Far No. 1 Access (Kells Road) | 150 | 4 | 600 | - | - | - | 0.3 | 180 |
| | **Totals** | | | **50277.4** | | **1217.86** | | | **54409.16** |



## Table 9.2 Carparks and Storage Areas

| | | General Dimensions | | | Tarmac | | | Spray & Chip | Concrete | | | Hardcore | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Length (m) | Width (m) | Area (m$^2$) | Depth (m) | Area (m$^2$) | Quantity (m$^3$) | (m$^2$) | Depth (m) | Area (m$^2$) | Quantity (m$^3$) | Depth (m) | Quantity (m$^3$) |
| | **Carparks** | | | | | | | | | | | | |
| | Main Carpark | | | | | | | | | | | | |
| 1 | Carpark 1 | - | - | 8750 | 0.05 | 2061 | 103 | 6689 | - | - | - | 0.6 | 5250 |
| 2 | Carpark 2 | - | - | 4650 | 0.05 | 798 | 40 | 3852 | - | - | - | 0.6 | 2790 |
| 3 | Carpark 3 | - | - | 920 | 0.05 | 0 | 0 | 920 | - | - | - | 0.6 | 552 |
| 4 | Knockumber House | - | - | 900 | 0.05 | 0 | 0 | 900 | - | - | - | 0.6 | 540 |
| 5 | Toyota parking area at Minedry | - | - | 1735 | 0.05 | 435 | | | 0.2 | 1300 | 260 | 1 | 1735 |
| | **Hardstandings** | | | | | | | 12361 | | | | | |
| 6 | Minedry | - | - | 1896 | 0.05 | 1896 | 95 | - | - | - | - | 1.0 | 1896 |
| 7 | Laboratory | - | - | 950 | - | - | - | - | 0.2 | 90 | 18 | 0.6 | 570 |
| 8 | Stores to Workshops Slab | 62 | 26 | 1612 | - | - | - | - | 0.2 | 1612 | 322 | 1.0 | 1612 |
| 9 | Mobile Workshop Plant Standing Area A | 62 | 30 | 1860 | - | - | - | - | 0.2 | 1860 | 372 | 1.0 | 1860 |
| 10 | Mobile Workshop Plant Standing Area B | - | - | 1490 | - | - | - | - | - | - | - | 1.8 | 2682 |
| 11 | Mill Slab North | - | - | 1070 | - | - | - | - | 0.2 | 1070 | 214 | 1.0 | 1070 |
| 12 | Hard Standing North | - | - | 2800 | - | - | - | - | - | - | - | 1.0 | 2800 |
| 13 | Hard Standing West | - | - | 5670 | - | - | - | - | - | - | - | 1.4 | 7938 |
| 14 | Hard Standing East | - | - | 15100 | - | - | - | - | - | - | - | 1.4 | 21140 |
| 15 | Loadout West | - | - | 560 | 0.05 | 560 | 28 | - | - | - | - | 1.0 | 560 |
| 16 | Loadout East | - | - | 250 | 0.05 | 250 | 13 | - | - | - | - | 1.0 | 250 |
| 17 | Fixed Plant | | | | | | | | | | | | |
| 18 | Hard Standing | - | - | 5650 | - | - | - | - | - | - | - | 1.5 | 8475 |
| 19 | Fixed plant to Railway Line | - | - | 20500 | - | - | - | - | - | - | - | 1.5 | 30750 |
| | ORICA Compound | 35 | 35 | 1225 | - | - | - | - | 0.3 | 1225 | 368 | 0.5 | 612.5 |
| | QME Tent Base | 23 | 40 | 920 | - | - | - | - | 0.3 | 920 | 276 | 0.5 | 460 |
| | QME Batching Plant | 25 | 25 | 625 | - | - | - | - | 0.3 | 625 | 188 | 0.5 | 312.5 |
| | 110kV Substation | 35 | 35 | 1225 | - | - | - | - | 0.45 | 1225 | 551 | 0.5 | 612.5 |
| | **Storage Areas** | | | | | | | | | | | | |
| 20 | Stores Compound | | | | | | | | | | | | |
| 22 | Main Compound | - | - | 5720 | 0.05 | 1650 | 83 | - | 0.15 | 3350 | 503 | 1.0 | 5720 |
| 23 | Sheds | - | - | 880 | - | - | - | - | 0.15 | 880 | 132 | 1.0 | 880 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24 | Direct Charge Compound | - | - | 4900 | - | - | - | - | - | - | - | 1.0 | 4900 |
| 25 | Tyre Centre Storage Area | - | - | 500 | - | - | - | - | - | - | - | 1.0 | 500 |
| | Mill Storage Tent Base | 15 | 20 | 300 | - | - | - | - | 0.3 | 300 | 90 | 0.5 | 150 |
| | AG Storage Tent Base | 23 | 40 | 920 | - | - | - | - | 0.3 | 920 | 276 | 0.5 | 460 |
| | | | | 93578 | | | | | | | | | |
| | **Storage Bund Areas** | | | | | | | | | | | | |
| 26 | Quantities below include for bund walls | | | | | | | | | | | | |
| 27 | Direct Charge Compound (2No.) | 8 | 8 | 128 | - | - | - | - | 0.15 | 128 | 19 | - | - |
| 28 | Chemical Offloading Bund | 9.6 | 4.6 | 44.16 | - | - | - | - | 0.2 | 44 | 9 | - | - |
| 29 | Waste Oil Storage Bund | 30 | 20 | 600 | - | - | - | - | 0.15 | 600 | 90 | - | - |
| 30 | Mine Dry Oil Tank Spill Area | 7 | 7 | 49 | - | - | - | - | 0.15 | 49 | 7 | - | - |
| 31 | Fixed Plant Oil Tank Bund | 4.7 | 4.2 | 19.74 | - | - | - | - | 0.15 | 20 | 3 | - | - |
| 32 | Warehouse Oil Tank Bund | 4.8 | 3.6 | 17.28 | - | - | - | - | 0.2 | 17 | 3 | - | - |
| 33 | Knockumber House Oil Tank Bund | 4 | 3.7 | 14.8 | - | - | - | - | 0.2 | 15 | 3 | - | - |
| | **Railway Track** | 610 | | | | | | | | | | | |
| 34 | Single Track | 50 | 5 | 250 | - | - | - | - | - | - | - | 1.0 | 250 |
| 35 | Double Track | 90 | 10 | 900 | - | - | - | - | - | - | - | 1.0 | 900 |
| 36 | Triple Track | 470 | 15 | 7050 | - | - | - | - | - | - | - | 1.0 | 7050 |
| | **Totals** | | | **102.651** | | | **361** | | | | **3704** | | **115277.5** |

Table 9.3.1 Reclaim Ponds

| | | Pond Elevations (m) A.M.D. | | | Pond Dimensions | | | Quantities | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Average | | | | | |
| | Length (m) | Crest of Pond Wall | Base of Pond Wall | Bottom of Pond | Height Wall | Base Width | Top Width | Total (m³) | Clay/Sand (m³) | Hardcore (m³) |
| Material :- | | | | | | | | | | |
| Impervious Clay with sand drains and | | | | | | | | | | |
| 300mm Minewaste slope protection | | | | | | | | | | |
| Fresh Water Pond | 163 | 1578.35 | 1573.6 | 1573 | 4.75 | 23 | 4 | 10452 | 10037 | 416 |
| Mine Water Pond | 170 | 1578.35 | 1574.6 | 1573 | 3.75 | 19 | 4 | 7331 | 7000 | 332 |
| Reclaim Pond No. 1 | 248 | 1578.35 | 1574.6 | 1573 | 3.75 | 19 | 4 | 10695 | 10211 | 484 |
| Reclaim Pond No. 2 | 342 | 1578.35 | 1574.6 | 1573 | 3.75 | 19 | 4 | 14749 | 14082 | 667 |
| Clear water pond | 326 | 1578.35 | 1574.6 | 1573 | 3.75 | 19 | 4 | 14059 | 13423 | 636 |
| Ponds 1 to 5 Total Quantities | | | | | | | | **57286** | **54753** | **2533** |
| | | | | | | | | | | |
| Kells Road Pond | | | | | | | | | 8000 | |
| | | | | | | | | | **62753** | |

Table 9.3.2 Ventilation Shaft Depressions

| | Ventilation Shaft Depressions | Area (m²) | Depth (m) | Volume (m³) |
|---|---|---|---|---|
| 21 | RAR No. 3 N and S - Kells Road (Estimated) | 2200 | 4 | 8800 |
| 22 | FAR No. 3 - Magazine (Estimated) | 750 | 5 | 3750 |
| | | | | **12550** |

Table 9.3.3 Screening Berms

| | | Material | Length | Elevation | Average Height (m) | Average Base Width (m) | Average Top Width (m) | Average Surface Area (m²) | Berm Quantity (m³) | Quantity Clay (m³) | Quantity Surplus Rock (m³) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Screening Berms** | | | | | | | | | | |
| 1 | Portal to RAR No.2 | Mine Surplus Rock | 355 | 1579.5 | 5.5 | 24 | 4 | | 11360 | 5680 | 5680 |
| 2 | South of RAR No. 2 | | 45 | | 3 | 16 | 4 | | 810 | 810 | |
| 3 | Storage Area at Portal | | 175 | 1577.5 | 3 | 12 | 3 | | 2363 | 2363 | |
| 4 | Portal to Magazine/Washbay Junction | | 340 | 1580.5 | 5.5 | 24 | 4 | | 10880 | 10880 | |
| 5 | Compressor House Pond and Road | | 200 | 1578 | 2.5 | 13 | 2 | | 2100 | 2100 | |
| 6 | Fixed Plant and Compressor House Pond | Mine Surplus Rock | 28 | 1576 | 1.8 | 9 | 2 | | 199 | | 199 |
| 7 | Compressor House and Pond | Mine Surplus Rock | 106 | 1576 | 2.7 | 12 | 1.5 | | 986 | | 986 |
| 8 | Workshop and DC Compound | | 125 | 80.5/81.7 | 5 | 24 | 4.2 | | 3863 | 3863 | |
| 9 | Magazine/Washbay Junction to Tiphead | Mine Surplus Rock | 100 | 1581 | 2.5 | 13 | 4 | | 1450 | | 1450 |
| 10 | Stores Compound and Tiphead | Mine Surplus Rock | 160 | 1581 | 2.5 | 10 | 3 | | 1760 | | 1760 |
| 11 | Magazine Road 1 and Tiphead | | 350 | 1582.5 | 3.2 | 22 | 4.5 | | 8103 | 8103 | |
| 12 | Magazine Road 2 and Tiphead | | 80 | | 2.5 | | | 1060 | 2650 | 2650 | |
| 13 | East side of Tiphead (North) | | 110 | | 2.5 | | | 990 | 2475 | 2475 | |
| 14 | East side of Tiphead (South) | | 180 | | 3 | | | 7780 | 23340 | 23340 | |
| 15 | South side of Tiphead | | 125 | | 1.5 | | | 2400 | 3600 | 3600 | |
| | Screening Berms within Tiphead | | | | | | | | | | |
| 16 | Metal, Timber, Waste Oil etc. | Mine Surplus Rock | 390 | | 1.4 | 5.5 | 0.75 | | 1336 | | 1336 |
| 17 | Barrels | Mine Surplus Rock | 150 | | 1.4 | 5.5 | 0.75 | | 514 | | 514 |
| | Screening Berms around Ventilation Shafts | | | | | | | | | | |
| 18 | Kells Road FAR No. 1 | | 200 | | 2 | 12 | 5 | | 2700 | 2700 | |
| 19 | Kells Road RAR No. 3 (N &S) | Mine Surplus Rock | 265 | | 4.5 | 22 | 7 | | 10335 | 5168 | 5168 |
| | | Material | Length | Elevation | Average Height (m) | Average Base Width (m) | Average Top Width (m) | Average Surface Area (m²) | Berm Quantity (m³) | Quantity Clay (m³) | Quantity Minewaste (m³) |
| 20 | Magazine FAR No.3 | Clay Overburden | 165 | | 3.5 | 14 | 5 | | 3630 | 3630 | |
| | Volume Totals | | | | | | | | **94452** | **77360** | **17092** |
| | Additional stockpiled material not incl. above | | | | | | | | | 22640 | |
| | | | | | | | | | | **100000** | |

Table 9.4.1 Buried Pipelines Note: This schedule does not include for pipelines within buildings or in Mine Service Tunnel

| Pipeline Description. | Location | Type | Size | Length | Comments |
|---|---|---|---|---|---|
| | | | | | |
| Reclaim Process L.P. | Reclaim ponds to Mill | Ductile Iron | 500mm | 705 | |
| | Branch to Service Tunnel | Ductile Iron | 100mm | 175 | |
| Reclaim Process H.P. | Reclaim ponds to Mill | Ductile Iron | 350mm | 760 | |
| (previously Fresh Water) | Branch to Service Tunnel | Ductile Iron | 100mm | 175 | |
| Mine Services Water | Reclaim ponds to Service Tunnel | HDPE | 200mm | 770 | |
| | Branch to Washbay | HDPE | 100mm | 150 | |
| Mine Water | Service Tunnel to Reclaim Ponds | Ductile Iron | 450mm | 730 | |
| | Branch to Mine Water Pond | Ductile Iron | 450mm | 40 | |
| Fire Main | Fresh Water Pond to Ring Main | Ductile Iron | 250mm | 285 | |
| | Link within Ring Main | Ductile Iron | 250mm | 75 | |
| | Branch to Mine Service tunnel | Ductile Iron | 250mm | 90 | |
| | Ring Main | Ductile Iron | 200mm | 1380 | |
| | Branches to Buildings | Ductile Iron | 150mm | 265 | |
| | Branches to Hydrants (12 No. Double) | Ductile Iron | 150mm | 60 | |
| Fresh Water Supply | Boyne Pumphouse to Fresh Water Pond | Ductile Iron | 350mm | 2678 | Railway Track |
| Potable Water | Town Supply to Fresh Water Pumphouse | | | | |
| | Fresh Water Pond to Ring Main | Ductile Iron | 150mm | 285 | |
| | Branch to Service tunnel | Ductile Iron | 150mm | 90 | |
| | Ring Main | Ductile Iron | 150mm | 1380 | |

| | | | | | |
|---|---|---|---|---|---|
| | Branches to Buildings | Ductile Iron | 100mm | 165 | |
| Mine Site Drainage Water | Kells Road Pond to Reclaim Ponds | Ductile Iron | 250mm | 740 | |
| | Branch to Mill | Alvenius | 200mm | 360 | |
| Mine Sludge | Service tunnel to Mill Tailings Pumpbox | Ductile Iron | 100mm | 310 | |
| | Branch to Mine Water Pond | Ductile Iron | 100mm | 475 | Not used |
| Tailings Line | Tailings P'box to R'town Booster Pump | HDPE | 630mm | 3510 | Railway Track |
| | Booster Pump to Stage 3 | HDPE | 630mm | 2000 | |
| | Booster Pump to Stage 4A | HDPE | 630mm | 3520 | Surface |
| Randalstown Flushline | Reclaim Pumps to Booster Pump | HDPE | 315mm | 650 | St 3 Middle Wall |
| | | Steel | 300mm | 600 | Stage 1 Toe |
| Reclaim Line | Randalstown Ponds to Reclaim Pumps | HDPE | 800mm | 4200 | Railway Track (3100) |
| Clear Water Discharge | Clear Water Pond to Boyne | Concrete | 825mm | 2211 | Railway Track |
| | Diffuser pipe in Boyne | Steel | 600mm | 26 | |
| Drainage Streams | | | | | |
| Western Diversion Stream | Computer Building to Kells Road | Concrete | 1200mm | 985 | |
| Eastern Stream | Comprs'r House Pond to Kells Road Pond | Concrete | 1200mm | 280 | |
| | | | | | |
| | | | | | |
| **Overall Total** | | | | **30125** | |

Table 9.4.2 Pipelines By Type

| Size | Type | Length | Weight per Linear m | Weight Tonnes |
|---|---|---|---|---|
| 100mm | Ductile Iron | 1300 | 0.018 | 23.616667 |
| 150mm | Ductile Iron | 2080 | 0.027 | 55.466667 |
| 200mm | Ductile Iron | 1380 | 0.037 | 50.6 |
| 250mm | Ductile Iron | 1190 | 0.049 | 57.913333 |
| 350mm | Ductile Iron | 3438 | 0.080 | 273.321 |
| 450mm | Ductile Iron | 770 | 0.112 | 85.983333 |
| 500mm | Ductile Iron | 705 | 0.129 | 90.945 |
| | | 10863 | | 637.846 |
| 300mm | Steel | 600 | | |
| 600mm | Steel | 26 | | |
| | | 626 | | |
| 100mm | HDPE | 150 | | |
| 200mm | HDPE | 770 | | |
| 315mm | HDPE | 650 | | |
| 630mm | HDPE | 9030 | | |
| 800mm | HDPE | 4200 | | |
| | | 14800 | | |
| 200mm | Alvenius | 360 | | |
| | | | | |
| 825mm | Cement | 2211 | 0.25 | 552.75 |
| | | | | |
| 1200mm | Concrete | 1265 | | |
| | | | | |
| **Total Length** | | **30125** | | |

Table 9.5 Shafts and Ventilation Opes

| | | | Length (m) | Breadth (m) | Width (m) | Volume ($m^3$) |
|---|---|---|---|---|---|---|
| | Portal | | 170 | 4.5 | 3.7 | 2831 |
| Fresh Air Raise | Far No.1 | Kells Road | 220 | 3.7 Dia | 3.7 | 2365 |
| | Far No.2N | Tiphead | 315 | 3.6 Dia | 3.6 | 3206 |
| | Far No.2S | Tiphead | 315 | 3.6 Dia | 3.6 | 3206 |
| | Far No.3 | Magazine | 380 | 3.6 Dia | 3.6 | 3868 |
| | Dev. Shaft | | 325 | 6.3 | 2.5 | 5119 |
| | Decline | Nevinstown | 170 | 4.5 | 3.7 | 2831 |
| | FAR No.4 | SWEX | 837 | 4.0 Dia | 4.0 | 10518 |
| | Total | | | | | 33944 |
| Return Air Raise | RAR No.1 | Mech. Work | 167 | 3.7 Dia | 3.7 | 1796 |
| | RAR No.2 | Backfill | 122 | 3.7 Dia | 3.7 | 1312 |
| | RAR No.3 N | Kells Road | 190 | 3.1 Dia | 3.1 | 1434 |
| | RAR No.3 S | Kells Road | 190 | 3.1 Dia | 3.1 | 1434 |
| | RAR No.4 | Prod. Shaft | 375 | 5.0 Dia | 5.0 | 7363 |
| | RAR No.5 | SWEX | 693 | 4.5 Dia | 4.5 | 11022 |
| | Total | | | | | 24360 |
| **Overall Total** | | | | | | **58304** |

Table 9.6 Hardcore and Overburden Quantity Summary

| Section | Hardcore Quantity ($m^3$) | Surplus Mine Rock Quantity ($m^3$) | Concrete Quantity ($m^3$) | Overburden Available ($m^3$) | Void to be Filled with Overburden | Void to be Filled with Hardcore |
|---|---|---|---|---|---|---|
| 1 . Roads | 55627 | | 0 | | 55627 | 0 |
| 2. Hardstanding | 115639 | | 3704 | | 119343 | 0 |
| 3.A Ponds/Depressions | 2533 | 0 | 0 | 62753 | 62753 | 0 |
| 3.B Screening Berms | | 17092 | | 100000 | | |
| 4. Buried Pipelines | 0 | 0 | 0 | 0 | 0 | 0 |
| 5. Shafts and Opes | | | | | | 58304 |
| 6. Buildings/Basements | 56405 | 0 | 23676 | 0 | 47014 | 0 |
| | | | | | | |
| Totals | **230204** | **17092** | **27380** | **162753** | **284737** | **58304** |
| | | | | | | |
| H'core/M'waste Excess | **188991** | | | | | |
| Overburden Shortage | | | | **121984** | | |
| | | | | | | |

Table 9.7 Buildings Materials Summary

| Building | Area (m²) | Height (m) | Void to be filled | Re-inforced concrete (m3) | Hard core below B'ldg | Solid Block Work (m2) | Hollow Block Work (m2) | Structural Steel Tons | Steel: Stairs Walk ways Linear M | Steel: Ch. Plate 6mm Sq. M | Steel: Tank Steel Plate Tons | Steel: Tank Steel Stiffeners Tons | 32mm Grating Sq. M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Building** | | | | | | | | | | | | | |
| Stores | 1002 | 5.76 | 801 | 240 | 401 | 139 | 273 | 39 | 8 | 0 | 0 | 0 | 0 |
| Eng./Workshops | 2058 | 10.25 | 1647 | 597 | 823 | 176.4 | 1411 | 157 | 20 | 0 | 0 | 0 | 0 |
| Washbay | 398.5 | 9.1 | 598 | 401 | 797 | 0 | 0 | 19 | 0 | 0 | 0 | 0 | 0 |
| Mine Dry | 2150 | 7.4 | 1720 | 722 | 860 | 378 | 1974 | 315 | 37 | 0 | 0 | 0 | 0 |
| Laboratory | 711.5 | 5.2 | 569 | 135 | 285 | 198.3 | 754.6 | 24 | 0 | 0 | 0 | 0 | 0 |
| Compressor House | 645.9 | 11.66 | 517 | 1039 | 258 | 0 | 1830 | 102 | | 0 | 0 | 0 | 0 |
| Headframe Production | 77.02 | 16.91 | 62 | 536 | 54 | 0 | 0 | 109 | 36 | | | | 103 |
| *Service Tunnel* | | | 1563 | 537 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 |
| Dust Collect - Conv. 41001 | 40 | 17 | 32 | 37 | 0 | 0 | 0 | 21 | 40 | 100 | 0 | 0 | 0 |
| Coarse Ore Store | 2124 | 26.7 | 1699 | 260 | 45084 | 0 | 0 | 232 | 0 | 0 | 0 | 0 | 0 |
| Hopper/41002 tunnel etc. | | | 573 | 1322 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Transfer House | 297.7 | 24.8 | 238 | 163 | 119 | 0 | 0 | 98 | | | 0 | 0 | |
| Loadout | 3961 | 18 | 3169 | 1794 | 1585 | 0 | 143.6 | 534 | | 691 | 0 | 0 | |
| Conv. Supports + Gallery | | Varies | 0 | 182.4 | Incl. | 0 | 0 | 96 | | 1573 | 0 | 0 | |
| Conv. Supports + Gallery | | Varies | 0 | 0 | 0 | 0 | 0 | 194 | | | 0 | 0 | |
| Mill | 6840 | 23.3 | 27360 | 6282.2 | 2736 | 2577 | 457.6 | 1614 | | | 0 | 0 | |
| Canteen | 368 | 3 | 294 | 92.0 | 147.2 | 195 | 0 | 0 | | | 0 | 0 | |
| Waste Shed | 900 | 10 | 720 | 270.0 | 360 | 0 | 0 | 50 | | | 0 | 0 | |
| **External Bins and Tanks** | | | | | | | | | | | | | |
| Fine Ore Bins Building | | 33.05 | Incl | 1550.7 | Incl. | 0 | 0 | 102 | 70 | | | | |
| Fine Ore Bins - Steel Bins | | 18.35 | Incl | | Incl. | 0 | 0 | 0 | | | 145 | 28.6 | |
| Lime Bins | 98.00 | 18.55 | Incl | 72.3 | Incl. | 0.0 | 0 | 9 | 0 | | 55.1 | 9.8 | |
| Soda Ash Bin | 49.00 | 20.72 | Incl | 36.1 | Incl. | 0.0 | 0 | 8 | 0 | | 18.9 | 4.7 | |
| Cement Bins | 98.00 | 15.14 | Incl | 123.5 | Incl. | 0.0 | 0 | 19 | | | 54.4 | 16.9 | |
| Sand Tanks | 510.8 | 15.00 | Incl | 1122.1 | Incl. | 0.0 | 0 | 10 | 84 | | 136.3 | 23.9 | |
| Sulphuric Acid Tanks | 450.0 | 8.70 | Incl | 235.3 | Incl. | 62.4 | 0 | 7 | Incl | | 65.0 | 8.0 | |
| *Zinc Thickener* | 660.5 | 6.00 | Incl | 0.0 | Incl. | 0.0 | 0 | 25 | | | 113.0 | 14.1 | |
| Lead Thickener | 148.5 | 4.90 | Incl | 0.0 | Incl. | 0.0 | 0 | 12 | | | 28.3 | 3.5 | |
| Thickener P'house + Tunnel | 45.00 | 4.00 | Incl | 251.0 | Incl. | 0.0 | 0 | 14 | | | | | |
| Bulk Oil Storage | | | | | | | | | | | | | |
| Bunker Oil Tank | 57.76 | 11.00 | 46.21 | 0.0 | Incl. | 0.0 | 0 | 0 | 0 | | 38.8 | 1.2 | |
| Diesel Oil Storage(1) | 57.76 | 5.50 | 46.21 | 0.0 | Incl. | 0.0 | 0 | 0 | 0 | | 22.3 | 1.2 | |

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

| | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Diesel Oil Storage(2) | 134.6 | 12.00 | 107.65 | 43.5 | Incl. | 0.0 | 0 | 0 | 0 | | 50.7 | 1.4 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Oil Pumphouse | 50.41 | 3.00 | 40.33 | 13.1 | Incl. | 32.6 | 0 | 4 | 0 | | 0 | 0 | | 0 | 82 | 0 | 0 | 0 | 50 | 0 | 50 | 0 | 0 | 4 |
| Loadout Sedimentation Tank | 1000 | 3 | 3000 | 1240 | 400 | 0.0 | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Pumphouses & Ancillary Buildings** | | | | | | | | | | | | | | | | | | | | | | | | |
| Fresh Water Pumphouse | 76.8 | 4.7 | 61.4 | 112.6 | 38.4 | 143.6 | | 1.2 | 0.0 | | 0 | 0 | | 0 | 161.1 | 0.0 | 0.0 | 1.4 | 75.0 | 0.0 | 75.0 | 0.0 | 0.0 | 4.8 |
| Reclaim Water Pumphouse | 108.1 | 5.3 | 86.5 | 316.6 | 54.1 | 191.0 | | 2.5 | 0.0 | | 0 | 0 | | 0 | 213.2 | 0.0 | 0.0 | 1.4 | 106.0 | 0.0 | 106.0 | 0.0 | 0.0 | 6.9 |
| Pond Overflow Chambers | | | | 317.8 | 101.3 | 0.0 | | 0.0 | 0.0 | | 0 | 0 | | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Potable Water Dist. P'house | 65.3 | 4.0 | 52.2 | 46.5 | 62.6 | 115.4 | | 1.3 | 0.0 | | 0 | 0 | | 0 | 126.3 | 0.0 | 0.0 | 1.4 | 63.7 | 0.0 | 63.7 | 0.0 | 0.0 | 4.8 |
| Boyne Pumphouse | 65.3 | 4.0 | 52.2 | 234.4 | 52.6 | 160.8 | | 3.7 | Incl | | 0 | 0 | | 0 | 0.0 | 0.0 | 0.0 | 7.0 | 65.3 | 0.0 | 65.3 | 0.0 | 0.0 | 7.0 |
| Transf. Switchgear Rm | 59.2 | 4.1 | 47.3 | 263.8 | 89.6 | 7.4 | | 7.4 | 3.5 | | 0 | 0 | | 0 | 133.6 | 0.0 | 0.0 | 0.0 | 59.2 | 0.0 | 59.2 | 0.0 | 0.0 | 6.7 |
| Estimated Quantities | | | | | | | | | | | | | | | | | | | | | | | | |
| Dev. Shaft Winder + Frame | 400 | | 320.0 | 250 | 160 | 0 | 200 | 60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 900 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mech + Elect Workshop | 500 | | 400.0 | 170 | 200 | 0 | 400 | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 875 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| RAR No 1 and 2 | | | Incl. | 120 | 60 | 0 | 0 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| RAR No. 3 N and S | | | Incl. | 600 | 60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| FAR No. 1 | | | Incl. | 60 | 200 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| FAR No. 2 N & S | | | Incl. | 160 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| FAR No. 3 | | | Incl. | 90 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Leach Tanks | | | Incl. | 400 | Incl | 0 | 0 | 0 | 0 | 0 | 32 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Nevinstown Decline | | | Incl. | 60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mag + Ancillary Bldgs | | | 1192 | 1236 | 1317 | 318 | 556 | 165 | | | | | | | | 725 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Totals** | | | **47014** | **23736** | **56405** | **4695** | **8000** | **4101** | **298** | **2364** | **760** | **118** | **103** | **12449** | **23251** | **2500** | **2332** | **235** | **18506** | **5958** | **20056** | **3198** | **369** | **855** |

Table 9.8 Estimated Costs of Mine site Decommissioning, Demolition and Minesite Rehabilitation

| Item | Summary Costs |
|---|---|
| | Euro |
| **Roads** | -261447 |
| **Hardstanding** | -336822 |
| **Ponds/Depressions** | 77627 |
| **Screening Berms** | 177753 |
| **Buried Pipelines** | 840332 |
| **Shafts and Opes** | 303182 |
| **Buildings** | 2259510 |
| **Fencing** | 60000 |
| **Totals** | **€3,120,135** |

Table 9.9.1 Hardcore and Overburden Costs Summary

| Section | Hardcore | Minewaste | Concrete | Overburden | Void filled | | Section |
|---|---|---|---|---|---|---|---|
| | Credit | Cost | Cost | Available | Cost | | Summary |
| Rate/ (m³). | €8.00 | €10.40 | €52.50 | | €3.30 | | Credit (Neg.) |
| | | | | | €1.30 | for Item3A | |
| | (€4.00/tonne) | (€5.20/tonne) | | | €5.20 | for Item5 | |
| 1 . Roads | -445016 | 0 | 0 | 0 | 183569 | | -261447 |
| 2. Hardstanding | -925106 | 0 | 194455 | 0 | 393829 | | -336822 |
| 3.A Ponds/Depressions | -20267 | 0 | 0 | 0 | 97894 | | 77627 |
| 3.B Screening Berms | 0 | 177753 | 0 | 0 | 0 | | 177753 |
| 4. Buried Pipelines | 0 | 0 | 0 | 0 | 0 | | 0 |
| 5. Shafts and Opes | 0 | 0 | 0 | 0 | 303182 | | 303182 |
| 6. Buildings/Basements | -451236 | 0 | 0 | 0 | 155147 | | -296089 |
| | | | | | | | |
| **Totals** | **-1841625** | **177753** | **194455** | **0** | **1133620** | | **-335797** |
| | | | | | | | |
| **Overall Credit** | **-€335,796.78** | | | | | | |

Table 9.11 Estimated Costs of Minesite Decommissioning, Demolition and Rehabilitation

## Buildings Dismantle and Disposal Costs Summary

| | | | | | | | | | Metal Cladding | | | | | Steel Decking | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Area ($m^2$) | Height | Void to be Filled | Rein forced Concrete (m3) | Hard Core Below Bldg | Solid Block Work (m2) | Hollow Block Work (m2) | Tank Steel Plate Each | HH Robertsons Sheet Insulated ($m^2$) | HH Robertsons Sheet Uninsulated ($m^2$) | Corrugate Galvanise | Circular Corner Flashing | Louvres (m2) | Roof 38mm (m2) | Floor 64mm (m2) | Roof Cover & Insulation | Ext. Window (m2) | Ext. Doors (m2) | Total Building Costs |
| **Dismantle and Disposal Unit Rates in Euros** | | | €3.30 | €52.50 | -€8.00 | €8.00 | €8.00 | €6,500 | €29.90 | €12.80 | €6.50 | €1.30 | €40.00 | €7.80 | €7.40 | €8.00 | €2.50 | €2.50 | Euro |
| **Buildings** | | | | | | | | | | | | | | | | | | | |
| Stores | 1001.9 | 5.76 | 2645 | 12601 | -3206 | 1114 | 2187 | 0 | 23843 | 0 | 0 | 0 | 0 | 7814 | 616 | 8350 | 18.9 | 157.3 | 56140 |
| Eng./Workshops | 2058.4 | 10.25 | 5434 | 31329 | -6587 | 1411 | 11284 | 0 | 46966 | 0 | 0 | 0 | 846 | 16055 | 3241 | 16467 | 108 | 646.8 | 127201 |
| Washbay | 398.5 | 9.1 | 1973 | 21053 | -6376 | 0 | 0 | 0 | 0 | 5408 | 0 | 0 | 0 | 2020 | 0 | 2231 | 0 | 92.6 | 26402 |
| Mine Dry | 2150.3 | 7.4 | 5677 | 37916 | -6881 | 3024 | 15792 | 0 | 36459 | 0 | 0 | 0 | 922 | 18351 | 14171 | 17654 | 465 | 115.5 | 143666 |
| Laboratory | 711.5 | 5.2 | 1878 | 7108 | -2277 | 1586 | 6037 | 0 | 16750 | 0 | 0 | 0 | 0 | 5549 | 0 | 5963 | 132 | 42 | 42768 |
| Compressor House | 645.9 | 11.7 | 1705 | 54562 | -2067 | 0 | 14642 | 0 | 0 | 19127 | 0 | 0 | 1235 | 943 | 0 | 4854 | 9 | 154.3 | 95164 |
| Headframe Production | 77.0 | 36.9 | 203 | 28136 | -435 | 0 | 0 | 0 | 0 | 15392 | 0 | 0 | 2553 | 601 | 0 | 616 | 0 | 14.3 | 47080 |
| Service Tunnel | | | 5156 | 28168 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 33324 |
| Dust Collection Conv. 41001 | 40 | 17 | 106 | 1952 | 0 | 0 | 0 | 0 | 12204 | 0 | 0 | 0 | 0 | 293 | 0 | 300 | 0 | 12 | 14867 |
| Coarse Ore Store | 2123.7 | 26.7 | 5607 | 13665 | -360668 | 0 | 0 | 0 | 87188 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -254208 |
| Hopper/41002 tunnel etc. | | | 1892 | 69413 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 71305 |
| Transfer House | 297.7 | 24.8 | 786 | 8583 | -953 | 0 | 0 | 0 | 22569 | 10031 | 0 | 0 | 0 | 2233 | 0 | 2290 | 0 | 54.4 | 45593 |
| Loadout | 3961.3 | 18 | 10458 | 94198 | -12676 | 0 | 1149 | 0 | 0 | 79857 | 0 | 0 | 0 | 30857 | 465 | 31648 | 0 | 275.2 | 236231 |
| Conveyor Supports & Gallery | | Varies | 0 | 9577 | 0 | 0 | 0 | 0 | 0 | 81262 | 0 | 3032 | 0 | 0 | 0 | 0 | 0 | 0 | 93871 |
| Conveyor Supports & Gallery | | Varies | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mill | 6840 | 23.3 | 90288 | 329814 | -21888 | 20613 | 3661 | 0 | 126248 | 39251 | 0 | 0 | 3402 | 53352 | 25597 | 54720 | 114 | 306.3 | 725478 |
| Canteen | 368 | 3 | 972 | 4830 | -1178 | 1560 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3600 | 75 | 25 | 9884 |
| Waste Shed | 900 | 10 | 2376 | 14175 | -2880 | 0 | 0 | 0 | 0 | 15360 | 0 | 0 | 0 | 0 | 0 | 8000 | 0 | 150 | 37181 |
| **External Bins and Tanks** | | | | | | | | | | | | | | | | | | | |
| Fine Ore Bins Building | | 33.05 | Incl | 81413 | 0 | 0 | 0 | 0 | 0 | 16734 | 0 | 0 | 0 | 2617 | 0 | 0 | 0 | 0 | 100764 |
| Fine Ore Bins - Steel Bins | | 18.35 | Incl | 0 | 0 | 0 | 0 | 13000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13000 |
| Lime Bins | 98.00 | 18.55 | Incl | 3796 | 0 | 0 | 0 | 13000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16796 |
| Soda Ash Bin | 49.00 | 20.72 | Incl | 1893 | 0 | 0 | 0 | 6500 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8393 |
| Cement Bins | 98.00 | 15.14 | Incl | 6484 | 0 | 0 | 0 | 13000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 19484 |
| Sand Tanks | 510.76 | 15.00 | Incl | 58910 | 0 | 0 | 0 | 26000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 84910 |
| Sulphuric Acid Tanks | 450.00 | 8.70 | Incl | 12353 | 0 | 499 | 0 | 13000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 25852 |
| Zinc Thickener | 660.52 | 6.00 | Incl | 0 | 0 | 0 | 0 | 6500 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6500 |
| Lead Thickener | 148.49 | 4.90 | Incl | 0 | 0 | 0 | 0 | 6500 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6500 |
| Thickener Pumphouse & Tunnel | 45.00 | 4.00 | Incl | 13179 | 0 | 0 | 0 | 0 | 0 | 2189 | 0 | 0 | 0 | 385 | 0 | 395 | 0 | 5 | 16153 |
| Bulk Oil Storage | | | | | | | | | | | | | | | | | 0 | 0 | 0 |
| Bunker Oil Tank | 57.76 | 11.00 | 152 | 0 | 0 | 0 | 0 | 6500 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6652 |
| Diesel Oil Storage(1) | 57.76 | 5.50 | 152 | 0 | 0 | 0 | 0 | 6500 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6652 |
| Diesel Oil Storage(2) | 134.56 | 12.00 | 355 | 2283 | 0 | 0 | 0 | 6500 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9138 |

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Oil Pumphouse | 50.41 | 3.00 | 133 | 688 | 0 | 261 | 0 | 0 | 0 | 1044 | 0 | 0 | 0 | 393 | 0 | 403 | 0 | 10.5 | 2933 |
| Loadout Sedimentation Tank | 1000 | 3 | 9900 | 65100 | -3200 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 71800 |
| **Pumphouses & Ancillary Buildings** | | | | | | | | | | | | | | | | | | | |
| Fresh Water Pumphouse | 76.8 | 4.7 | 203 | 5909 | -307 | 1149 | 0 | 0 | 0 | 2062 | 0 | 0 | 43 | 585 | 0 | 600 | 0 | 12 | 10256 |
| Reclaim Water Pumphouse | 108.1 | 5.3 | 285 | 16620 | -432 | 1528 | 0 | 0 | 0 | 2729 | 0 | 0 | 43 | 827 | 0 | 848 | 0 | 17.3 | 22465 |
| Pond Overflow Chambers | | | 0 | 16686 | -811 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15875 |
| Potable Water Distrib. P'house | 65.3 | 4.0 | 172 | 2444 | -501 | 924 | 0 | 0 | 0 | 1616 | 0 | 0 | 43 | 496 | 0 | 509 | 0 | 12 | 5715 |
| Boyne Pumphouse | 65.3 | 4.0 | 172 | 12308 | -421 | 1286 | 0 | 0 | 0 | 0 | 0 | 0 | 211 | 509 | 0 | 522 | 0 | 17.6 | 14605 |
| Main Transf. Switchgear Room | 59.2 | 4.1 | 156 | 13848 | -717 | 59 | 0 | 0 | 0 | 1710 | 0 | 0 | 0 | 461 | 0 | 473 | 0 | 16.8 | 16007 |
| Estimated Quantities | | | | | | | | | | | | | | | | | 0 | 0 | 0 |
| Dev. Shaft Winder +Headframe | 400 | | 1056 | 13125 | -1280 | 0 | 1600 | 0 | 0 | 0 | 5850 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20351 |
| Mech and Electrical Workshop | 500 | | 1320 | 8925 | -1600 | 0 | 3200 | 0 | 0 | 0 | 5688 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 17533 |
| RAR No 1 and 2 | | | Incl | 6300 | -480 | 0 | 0 | 0 | 0 | 3840 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9660 |
| RAR No. 3 N and S | | | Incl | 31500 | -480 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 31020 |
| FAR No. 1 | | | Incl | 3150 | -1600 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1550 |
| FAR No. 2 N & S | | | Incl | 8400 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8400 |
| FAR No. 3 | | | Incl | 4725 | -800 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3925 |
| Leach Tanks | | | Incl | 21000 | Incl | 0 | 0 | 13000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 34000 |
| Nevinstown Decline | | | Incl | 3150 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3150 |
| Magazine and Ancillary Bldgs | | | 3934 | 64890 | -10536 | 2544 | 4448 | 0 | 0 | 0 | 4713 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 69993 |
| | | | | | | | | | | | | | | | | | | 0 | 0 |
| **Totals** | | | **155147** | **1246157** | **-451236** | **37558** | **64001** | **130000** | **372227** | **297613** | **16250** | **3032** | **9298** | **144344** | **44090** | **160445** | **921.9** | **2136.9** | **2231979** |

Table 9.13 Summary Costs of Metal Cladding and Decking

| | Item | Uninsulated | | Insulated | Section | Total Costs |
|---|---|---|---|---|---|---|
| | | Cladding Conveyors | Cladding Buildings | Cladding Buildings | Costs | Dismantle/ Disposal |
| 1 | Dismantle | | | | | |
| | Area Sq. m | 12587 | 10664 | 12449 | | |
| | Dismantle Rate (Euro) | 6.5 | 6.5 | 16.5 | | |
| | Dismantle Cost | **€81,818** | **€69,313** | **€205,410** | **€356,541** | |
| 2 | Disposal | | | | | |
| | Unit Weight. | 0.008 | 0.008 | 0.017 | | |
| | Weight tonnes | 101 | 85 | 212 | | |
| | Transport to Germany, €790/T | **€79,553** | **€67,394** | **€167,191** | **€314,137** | **€670,678** |
| | Total Unit Rates/Sq.m | 12.82 | 12.82 | 29.93 | | |
| 2A | Transport within Ireland €165/T | **€16,615** | **€14,076** | **€34,920** | **€65,611** | **€422,152** |
| | | | | | | |

**Cladding Dismantle and Disposal**

| | Item | 38mm Roof Decking | | 64mm Floor Decking | | Total Costs |
|---|---|---|---|---|---|---|
| | | **Area** | **Weight** | **Area** | **Weight** | **Dismantle/** |
| | | **($m^2$)** | **Tonnes** | **($m^2$)** | **Tonnes** | **Disposal** |
| | | **1 ($m^2$)** | **0.0085** | **1 ($m^2$)** | **0.0240** | |
| 1 | Dismantle | | | | | |
| | Area Sq. m | 18506 | 158 | 5958 | 143 | |
| | Dismantle Rate (Euro) | 8 | | 8 | | |
| | Dismantle Cost | **€148,048** | | **€47,664** | | **€195,712** |
| 2 | Disposal/Scrap Value/Tonne | | 26 | | 26 | |
| | Disposal/Scrap Value (Credit) | | **€4,109** | | **€3,723** | **-€7,832** |
| | Total Unit Costs | 7.78 | | 7.38 | | |
| | | | | | | **€187,880** |
| | | | | | | |

**Decking Dismantle and Disposal Costs**

## 9.5 SITE RESTORATION, INCLUDING LAND CONTAMINATION ASSESSMENT, REMEDIATION COSTING FOR MINE SITE

Knight Piésold Limited (KPL) was commissioned in 2000 by Tara Mines Limited (TML) to carry out a Contaminated Land Assessment at their mine site at Navan, County Meath. Intrusive investigations provided data on the extent of ground contamination resulting from historical and on-going mining related activities and to assess Closure and Perpetual Aftercare costs for the site as required under Clause 13 of the mines IPC Licence (Licence Register Number 516).

The mine site (including a landfill for disposal of certain wastes produced on site) was divided into nine discrete areas (A-I) for the purposes of the investigation. A combination of trial pitting and window sampling was carried out across the whole of the mine site and was targeted at locations such as fuel storage sites considered to constitute a potential source of contamination. The site works at the landfill included the installation of piezometers to monitor any landfill gas produced as a result of the anaerobic breakdown of biodegradable wastes. Two of the sites settling ponds were also investigated by recovery of silt samples from the inflow and outflow of the two ponds.

Based on activities undertaken at the site this investigation focussed on potential contamination by the metals arsenic, antimony, cadmium, lead and zinc, petroleum hydrocarbons (TPH's) and soluble sulphate and pH.

### *9.5.1 Site Investigation Results*

<u>Metals</u>

Elevated concentrations of Lead, Zinc, Antimony and Arsenic were found at the site. Highest concentrations of heavy metals appear to correspond with the gangue (host/non-ore rock) material and the mining process at the site. Concentrations of all metals were highest in Areas A, C, E, G and the settling ponds 1 & 2. Soil sampling results are included in Appendix 10.1

<u>Hydrocarbons</u>

Due to the large area to be assessed, targeted sampling was used to identify any potential areas of concern within the site. The concentration of total petroleum hydrocarbons (TPH's) was considered to be elevated in areas corresponding to where fuel is either stored or used. Elevated concentrations were recorded in Area A (landfill), C (fuel farm), G (workshops) and the silt settling ponds. The concentration of TPH's in all other areas was low.



<u>Groundwater Quality</u>

Two groundwater samples were obtained during the site works (TP1 and WS18). The concentrations of arsenic, cadmium, lead and zinc were within the normal ranges in both of the two samples were targeted at areas were small oil spills were evident. Yearly groundwater monitoring results taken at the site as part of the IPPC licence show no indication of elevated TPH concentrations. Groundwater sampling results are included in Appendix 10.1

Piezometer Gas Monitoring

Generally, the concentration of methane in the piezometers was less than the portable monitoring instruments detection limit (<0.25% v/v). The concentrations of volatile hydrocarbons were low in all of the piezometers tested and ranged from less than 1 ppm to 5.4 ppm.

*9.5.2 Risk Assessment*

In the absence of contaminated land soil quality criteria in the Republic of Ireland, the results were assessed in relation to contaminated land guidance provided in the UK: ICRCL 70/90 ("Notes on the restoration and aftercare of metalliferous mining sites for pasture and grazing") together with the CLEA Assessment for industrial/commercial end uses. Where guidance was not provided by these criteria, the Dutch Intervention Values for Contaminated Land were used. This report does not address the closure of the Randalstown tailings management facility (TMF), which is addressed in a separate document.

Based on an agricultural end use, the concentrations of both lead and zinc were greater than their I.C.R.C.L maximum (Action Trigger) Concentrations (ATC's) for both livestock and crop growth end uses in the majority of samples tested from all areas, with the exception of Area B and I. The concentrations of arsenic were less than the ATC's in all of the samples tested for both livestock and crop growth end uses. The concentrations of cadmium exceeded the ATC for livestock in Area A, C, E and Settling Pond 1 and 2 and for crop growth in Areas A, C, E, G and Settling Pond 1.

Based on an industrial/commercial end use, the analytical results indicated that concentrations of lead and zinc were elevated in the majority of samples analysed from all areas, with the exception of B and I. The concentrations of both arsenic and cadmium were less than their CLEA Soil Guideline Values in all of the samples tested.

The concentration of total petroleum hydrocarbons (TPH's) was considered to be elevated above screening guidelines in areas corresponding to where fuel is either stored or used. Elevated concentrations were recorded in Area A (landfill), C (fuel farm), G (workshops) and the silt settling ponds. The concentration of TPH's in all other areas was low.

Two groundwater samples were obtained during the site works. The concentrations of arsenic, cadmium, lead and zinc were less than their respective Dutch Intervention Values in both of the samples tested. However, the concentration of TPH's was elevated in both of the samples. These two samples were targeted at areas were small oil spills were evident. Yearly groundwater monitoring results taken at the site as part of the IPPC licence, show no indication of elevated TPH concentrations.

monitoring results taken at the site as part of the IPPC licence, show no indication of elevated TPH concentrations.

The site in its current state is considered unlikely to be able to be returned to an agricultural/industrial end use without the relocation of some of this underlying Made Ground/Gangue Material (non ore bearing rock). It is considered that crop growth and associated farming methods to cultivate the soil will require a substantial amount of imported subsoil/topsoil if the underlying waste rock is left in its current position. Potential remediation measures are discussed in detail below.

## 9.6 REMEDIATION OPTIONS

The remediation options available are as follows:

**Excavation and Disposal**

This will involve excavation and processing of the gangue material at the site considered to pose a risk to the future end uses. This will essentially expose the underlying boulder clay which, based on the analytical results is considered to be uncontaminated with respect to the proposed end uses of the site. The waste material can then be effectively capped in order to sever the pathways and reduce the risks to future end users and the groundwater beneath the site.

**Capping the site**

In order to sever exposure pathways that exist through which agricultural end users of the site could be exposed to any contamination present, a layer of clean imported materials could be placed over the existing soils. This capping layer would comprise a granular capillary break/marker layer overlain by clean imported sub-soil and topsoil. In addition the landfill area will have to be suitably engineered to comply with the EPA Landfill Manual on Landfill Restoration & Aftercare (1999).

Should the proposed footprints of buildings, areas of hardstanding or car parks fall within areas of the site where elevated concentrations of metals were recorded at shallow depths, the presence of hardstanding would be sufficient to sever the potential pollutant linkages that may exist.

**Bioremediation**

Bioremediation involves the blending of contaminated soils with appropriate microbial cultures and, possibly conditioning material to create optimal conditions with respect to contaminant concentrations, moisture content, oxygen content, temperature etc. The microbes then degrade the contaminants to produce inert substances such as carbon dioxide and water. The degradation rate is dependant of the ambient conditions cited above. Once the contaminant level drops, the microbial activity slows as the microbes become starved of nutrients, the microbes eventually die off.

### *9.6.1 REMEDIATION OPTIONS AND COSTS*

**Agricultural Land Use**

The existing permit is for closure to agriculture purposes. It is therefore considered that processing of the gangue material covering the surface of the site with subsequent coverage of topsoil on the exposed boulder clay to provide a growth medium for crops and vegetation is considered the most viable option. In addition the landfill will have to be suitably engineered in order to reduce infiltration by rainwater and subsequent leachate generation. The costs are presented in the following table 9.14 below.

Table 9.14 Remediation Costs for Agriculture End Use

| Item No. | Item Description | Unit | Rate | Quantity | Amount |
|---|---|---|---|---|---|
| | | | euros | | euros |
| | | | | | |
| 1 | Earthworks - Balanced cut/fill | $m^3$ | 4.22 | 300,000 | 1,264,805 |
| | | | | | |
| 2 | Drainage Geocomposite | $m^2$ | 4.67 | 100,000 | 466,627 |
| | | | | | |
| 3 | Protective geotextile to pond liner | $m^2$ | 2.45 | 100,000 | 245,000 |
| | | | | | |
| 4 | Subsoil Importation (900mm) | $m^3$ | 5 | 160,000 | -800,000 |
| | | | | | |
| 5 | Topsoil (100mm) | $m^3$ | 2 | 40,000 | 200,000 |
| | | | | | |
| | | | | TOTAL | €1,176,432 |

**Bioremediation**

Further Detail Quantitative Risk Assessment for Soil and Groundwater (including speciated TPH analysis) based on the updated CLEA (2008) and RBCA/UK EA guidance will be undertaken in relation to TPH. Where appropriate, organically contaminated soil could be treated ex-situ in an appropriate licensed facility.

Ex-situ bioremediation where the soils are excavated and placed in windrows for the treatment process as it provides an effective control over the remediation process and the microbial activities occur at a faster rate as compared to in-situ bioremediation. The potential costs of Bioremediation are outlined below in Table 9.15.

Table 9.15 Bioremediation Costs

| Item No. | Item Description | Unit | Rate euros | Quantity | Amount euros |
|---|---|---|---|---|---|
| 1 | Bioremediation | $m^3$ | 163.73 | 5000 | 818,644 |
| | | | | TOTAL | €818,644 |

**Industrial/Commercial land use**

It is noted that Navan and the surrounding areas have undergone, and continue to undergo, significant levels of residential and commercial development much of which is focused on greenfield land. Navan has been identified within the Meath County Development plan as a growth area for Industrial/Commercial/Retail development. Some subsoil material would be required for landscaping purposes. Assuming that pad foundations are proposed to be founded within the boulder clay for light industrial units over the whole of the site, and each footing will provide approximately 8 $m^3$ of waste, the costs of remediation of the site are therefore as follows:

Table 9.16 Remediation Costs for Industrial End Use

| Item No. | Item Description | Unit | Rate euros | Quantity | Amount euros |
|---|---|---|---|---|---|
| 1 | Earthworks - Balanced cut/fill | $m^3$ | 4.22 | 7000 | 29,512 |
| 2 | Drainage Geo-composite | $m^2$ | 4.47 | 100,000 | 466,627 |
| 3 | Protective geotextile to pond liner | $m^2$ | 2.45 | 100,000 | 245,000 |
| 4 | Subsoil (500mm) | $m^3$ | 5 | 60,000 | -300,000 |
| 5 | Topsoil (100mm) | $m^3$ | 2 | 40,000 | 200,000 |
| | | | | TOTAL | €446,139 |



The areas adjacent to the mine site to the south and southwest are currently zoned for industrial and commercial uses. The Tara site may be suitably redeveloped as a Brownfield site, reducing development pressure on Greenfield land, to a lower sensitivity end use such as commercial/industrial units. Redevelopment of the Tara site for Industrial/Commercial end use would require less earthworks, subsoil importation etc.

### 9.6.2 SUMMARY OF COSTS

The costings issues associated wit the CRAMP can be broken down into four principal areas, namely:

1. Closure/Decommissioning (0-2 years)
2. Restoration (0-2 years)
3. Aftercare monitoring (0-10 years)

The estimated costs associated with each of these sections has been explored in this document and can be summarised below

Table 9.17: Costs summary

| Item | Period (years) | Costings (€) |
|---|---|---|
| Closure/Decommissioning | 0-2 | 3,120,000 |
| Restoration | 0-2 | 813,738.[13] |
| Aftercare Monitoring (incl. Lab costs) | 0-10 | 1,340,000 (134,000 p.a) |
| Total | | €5,273,738 |

* average of 3 after use options costed in section 9.6.1



[13] Average of 3 after use options costed in section 9.6.1

# 10 ACTIVE AFTERCARE MONITORING AND MANAGEMENT MEASURES (STAGE 2)

This section provides details of the proposed active aftercare monitoring and management measures which will be continued following decommissioning and restoration of the site.

The objective of the Active Aftercare Monitoring and Management is to demonstrate confidence by the relevant Authorities and local people that monitoring information from the rehabilitated site can demonstrate physical, chemical and ecological stability of the mine components, and their potential land uses, and also that they pose no threat to public health and safety.

It is proposed to continue the operational phase monitoring programme into the active aftercare monitoring and management phase. Thereafter, once equilibrium condition and stabilisation has been certified, Tara Mines will seek Clean Closure Status. Thereafter a less onerous monitoring schedule will be undertaken into the perpetual phase.

The monitoring schedule proposed for the active phase of aftercare monitoring will resemble that currently required under the IPPC Licence. Tara Mines will provide annual monitoring reports to the EPA during the active monitoring phase.

Where monitoring indicates that stabilisation and equilibrium conditions have been achieved for certain criteria, Tara Mines will seek a review of the monitoring frequency. The monitoring schedule will only be adjusted in agreement with the EPA.

The environmental monitoring will consist of the following during the aftercare monitoring phase:

- Aquatic Environment
  - Physico-chemical surface water quality
  - Biological surface water quality
  - Hydrometic flow gauging
  - Electro-fishing and fish stock surveys
  - Surface water flora and macroinvertebrate fauna
- Geological and Hydrogeological Environment
  - Assessment of rewatering and groundwater levels into the mine
  - Physico-chemical quality assessment of groundwater
  - Regional groundwater well/borehole surveys
- Atmospheric Environment
  - Climatology
  - Air Quality
- Noise and Vibration

- Noise and vibration monitoring surveys

- Land Settlement and ground stability assessments

- Agricultural
  - Soil and vegetation sampling
  - Soil moisture
  - Veterinary

- Terrestrial Environment
  - Flora and Fauna assessments
  - Landscaping and visual screening assessments

- Social, Cultural and Socio-Economics
  - Landscaping and visual screening assessments
  - Local Authority Development Plan assessment and contributions

The aftercare maintenance programme, will involve assessment of the site restoration works and upkeep and additional works in order to achieve the restoration objectives. This will largely be dependent on the agreed after use of the site, however may include the following:

- Additional Landscaping, vegetation maintenance and remedial ground contouring;
- Drainage works
- Maintenance of any retained structures or infrastructure.

## 10.1 CLOSURE VALIDATION

As detailed above, the Closure, Restoration and Aftercare Management Plan envisages three distinct stages:

1. Post-closure, the first stage will involve the decommissioning and restoration of the underground working and the surface infrastructure. Structures and infrastructure will be reduced to grade level and the underground workings will be backfilled, with all opening, decline and conduits from the surface to the underground working backfilled. At the end of this stage, Tara Mines will provide certification of completion of Decommissioning and Site Restoration to the EPA and will seek 'Non Clean Closure' Status for the site. This change of status to 'Non Clean Closure' will allow Tara Mines to reorganise the financial provision and move to the Active Aftercare Monitoring and Management Stage.

2. Following the decommissioning and restoration stage and the change of change of status to Non Clean Closure, the period of active aftercare monitoring and management will be undertaken. This active monitoring and management will continue in the short to medium term following closure to determine the impact of closure and to assess when stabilisation and equilibrium conditions have been achieved. At the end of this stage, and when the

monitoring demonstrates that stabilisation and equilibrium conditions have been achieved, Tara Mines will provide certification of completion of the Active Aftercare Monitoring and Management Stage to the EPA and will seek 'Clean Closure' status for the site. This change in status to Clean Closure will allow Tara Mines to reorganise the financial provision and move to the Passive Aftercare Monitoring and Management Stage

3. Following the active monitoring and aftercare stage when stabilisation and equilibrium conditions have been achieved, the final stage will involve long-term (perpetual) monitoring. This monitoring is considered validation monitoring to ensure that there is no significant deviation from the stabilisation and equilibrium conditions determined at the completion of Stage 2. This stage is essentially a demonstration that the closure of the mine no longer poses a risk to the environment.

# 11 FINANCIAL PROVISION

## 11.1 INTRODUCTION

The main objective of the Financial Provision is to ensure that sufficient financial resources are available to cover:

- Unknown environmental liabilities that may occur during the aftercare period for the facilities, as determined by the ELRA.
- Known environmental liabilities that will arise, and have been estimated, during the decommissioning and restoration of the site.
- Known environmental costs that will arise and have been estimated during the active aftercare monitoring and management stage.
- Environmental costs that will arise and have been estimated during the passive aftercare monitoring and management stage.

## 11.2 ESTIMATED TOTAL COST FOR IMPLEMENTATION OF THE CRAMP

This section presents a summary of the estimate cost of implementing the CRAMP for the Mine site facilities and the Tailings facility.

The predicted costing for the works described in this document are given in Table 11.1 below. The predicted costs for the works associated with the tailings facility and described in Volume 2 are given in Table 11.2.

Table 11.1: Mine facilities costs summary



| Item | Period (years) | Costings (€) |
|---|---|---|
| Closure/Decommissioning | 0-2 | 3,120,000 |
| Restoration | 0-2 | 813,738.[14] |
| Aftercare Monitoring (incl. Lab costs) | 0-10 | 1,340,000 (134,000 p.a) |
| **Total** | | **€5,273,738** |

[14] Average of 3 after use options costed in section 9.6.1

Table 11.2 Tailings facility cost summary

| Item | Period (years) | Costings (€) |
|---|---|---|
| Closure/Decommissioning | 0-5 | 4,682,370 |
| Revegetation | 0-5 | 1,128,000 |
| Aftercare Monitoring and Maintenance (incl Lab costs) | 0-5 | 735,000 (147,000 p.a) |
| Aftercare Monitoring and Maintenance (incl Lab costs) | 6 -10 | 305,000 (61,000 p.a) |
| Aftercare Monitoring and Maintenance (incl Lab costs) | 11-15 | 160,000 (32,000 p.a) |
| Water treatment system[15] | | 250,000 |
| **Total** | | **€7,260,370** |

Table 11.3 Insurance to cover unknown liabilities post closure

| Item | Period (years) | Comment | Costing (€) |
|---|---|---|---|
| Mine site and TMF | 0- 5 | Mine decommissioned within 2 years | 275,000 (55,000 p.a) |
| TMF *only* | 6 - 10 | | 137,500 (27,500 p.a) |
| TMF *only* | 11 - 15 | | 70,000 (14,000 p.a) |
| **Total** | | | **€ 482,500** |

Both of the above tables have been sourced from "RECLAMATION AND CLOSURE PLAN FOR THE RANDALSTOWN TAILINGS FACILITY FOLLOWING THE STAGE 5 RAISE". This document was prepared by Golder Associates (UK) Limited, 2009.

**Total Cost of CRAMP**

| | |
|---|---|
| Mine and surface site facilities | € 5,273,738 |
| Tailings facility | € 7,260,370 |
| Insurance Premium | € 482,500 |
| Total Financial Liability | € 13,016,608 |



[15] Possible expenditure of €250,000 for refurbishment of passive water treatment system after 15-20 years

## 11.3 FINANCIAL SURETIES

Since the initial development of the Tara Mines site, financial provisions and insurances have been in place to ensure adequate provision is available to rehabilitate, manage and maintain the Mines facilities through Decommissioning, Restoration and Aftercare Management.

In accordance with the original Parent Permission for the mine, a deed of covenant with Meath County Council was entered in June 1979 to provide financial provision for rehabilitation of the site.

Monies to a value of €13,016,608, as outlined above, shall be held as surety. This fund is to be safeguarded for Post Closure Costs.

The existing insurances held by Tara Mines covers potential environmental liabilities during the operational phase of the operation to the value of €25,000,000 per individual event. The existing financial surety is held in cash form by Meath County Council on behalf of the Company. The investment of the money is jointly agreed and managed conservatively. It is currently invested in a short term deposit with Bank of Ireland. The value of fund was €7.80 million as of 31st December 2008.

The EPA guidance document: *Guidance on Environmental Liability Risk Assessment, Residuals Management Plans and Financial Provision* gives examples of combined Financial Instruments that may be of use. It states:

"It is possible, and in some cases even desirable to design a financial provision mechanism, which brings together more than one of the different types of financial provision, specifically where both known and unknown liabilities require different financial instruments. In this way the shortcomings of one mechanism can be offset by the strengths of another. Such combination approaches have been used in the past, both in Ireland and the UK.

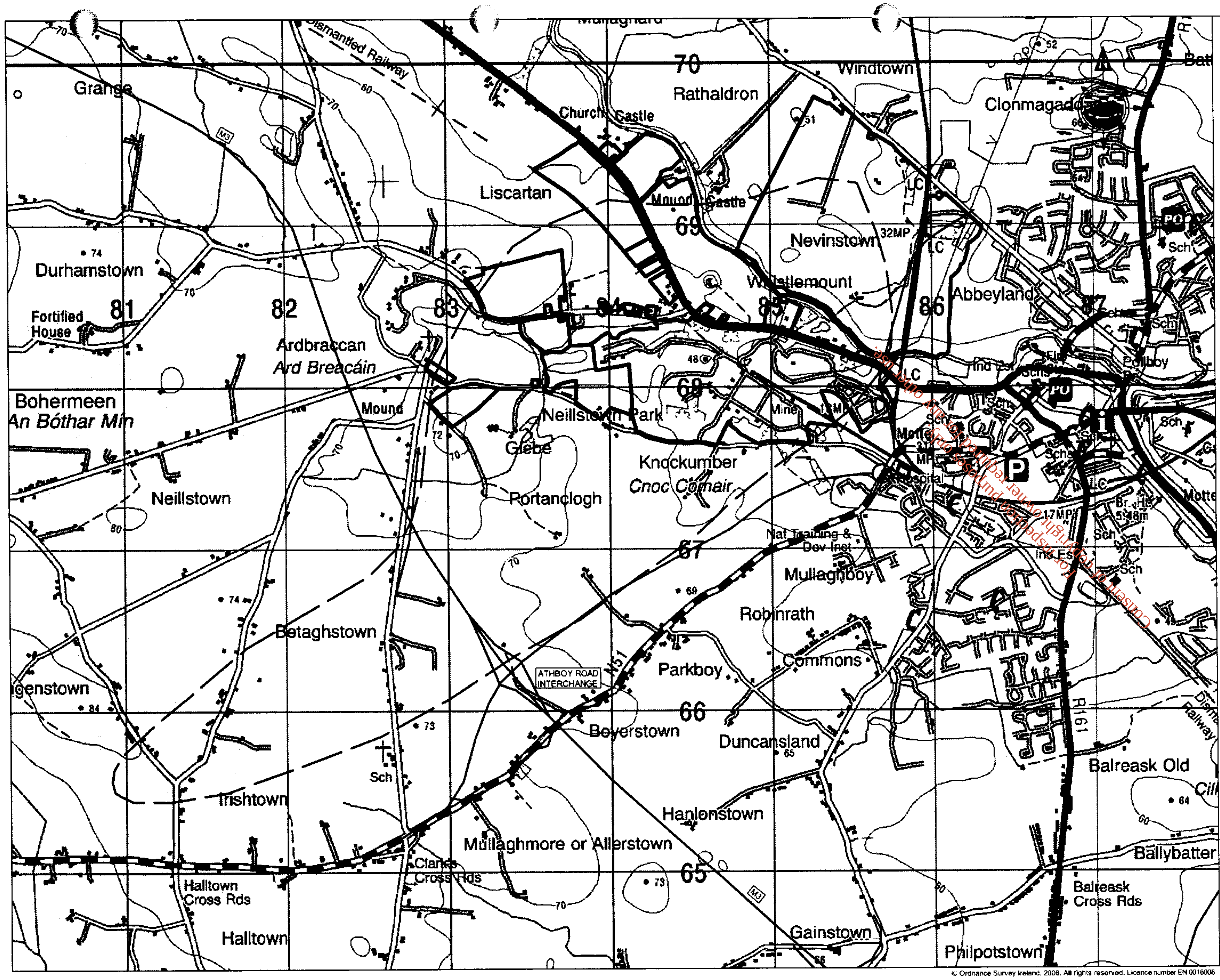
Examples of the combinations that can be used are outlined in Table 11.4

Table 11.4 Combined Financial Instruments Available

| Combined Financial Instrument | Description and Advantages |
|---|---|
| **Insurance backed by Surety Bond** | To satisfy the financial provision requirements of UK waste management law, a mechanism was developed which combined an environmental liability policy and a surety bond *(an unsecured bond, in this case issued by an insurance company in return for a fee).* The environmental liability policy indemnified the landfill operator against specified losses relating to bodily injury and property damage. In the event of the operator's insolvency, the environmental liability policy also indemnified the regulator for the full (i.e. no deductible applying) remediation expenses which it incurred to avoid an environmental emergency.<br><br>In addition, the environmental liability policy was backed by a surety bond. This covered the supervision or revocation of the waste management licence by the regulator. The combined policy and surety bond was available for up to a 5 year period, with a renewal facility. |
| **Cash and Insurance** | The attractions to regulators of cash-based (or equivalent liquid assets, e.g. gilts) have been noted above; in particular, this form of financial provision is readily available to operators and can be "ring-fenced" for the sole purpose of enabling the licence obligations to be met.<br><br>However, there are some shortcomings with cash. It takes time to build up a sum of money sufficient to pay for any major costs that might arise. If these materialise before the fund is adequate to pay for them, the risk is obvious. To address this shortcoming, operators and regulators could, *for instance, use environmental liability insurance* to provide cover for catastrophic losses. The policy can provide protection when the cash deposit is depleted in whole or in part.<br><br>Further refinements to this combination could include:<br>• First, the policy can be modified to allow the regulator to take what is known in the USA as "direct action" (i.e. to recover specified costs regardless of the insured' operator's bankruptcy, fraud or misrepresentations);<br>• Secondly, the policy could take the form of a standardised wording, which has been pre-agreed with the regulator (e.g. which cuts back on the number and scope of the exclusions and reduces the insurer's ability to cancel cover). |
| **Multiple Insurance Policies** | More than one environmental insurance policy, for instance, can be used to achieve a high limit of indemnity (where a second insurer provides cover on an "excess of loss" basis, following the terms of the underlying policy provided by the first insurer). Operators with their own captive insurance company could also use an environmental insurance policy either to sit in excess of the captive or vice versa. |

# APPENDIX 1

**Regional Site Location**




GENERAL LEGEND

LAND OWNERSHIP BOUNDARY

NAVAN BYPASS ALIGNMENT

ORE BODY OUTLINE

NOTES

1. FIGURED DIMENSIONS ONLY TO BE TAKEN FROM THIS DRAWING

2. ALL DRAWINGS TO BE CHECKED BY THE CONTRACTOR ON SITE

3. ENGINEER TO BE INFORMED BY THE CONTRACTOR OF ANY DISCREPANCIES BEFORE ANY WORK COMMENCES

4. ALL LEVELS SHOWN RELATE TO ORDNANCE SURVEY DATUM AT MALIN HEAD

5. OS DISCOVERY SHEET NO'S: N- 2625, 2826, 2624, 2824

210m 0 210m 420m 630m

| Rev | Date | Description | By | Chkd |
|---|---|---|---|---|
| A | 27-03-09 | ISSUED FOR REPORT | MH | BS |

Client: BOLIDEN TARA MINES

Project: TARA MINES CLOSURE PLAN

Title: REGIONAL SITE LOCATION

Scale @ A1: 1:10.560

Prepared by: V.Bonney | Checked: B.Sheridan | Date: Sept 2008

Project Director: S.Finlay

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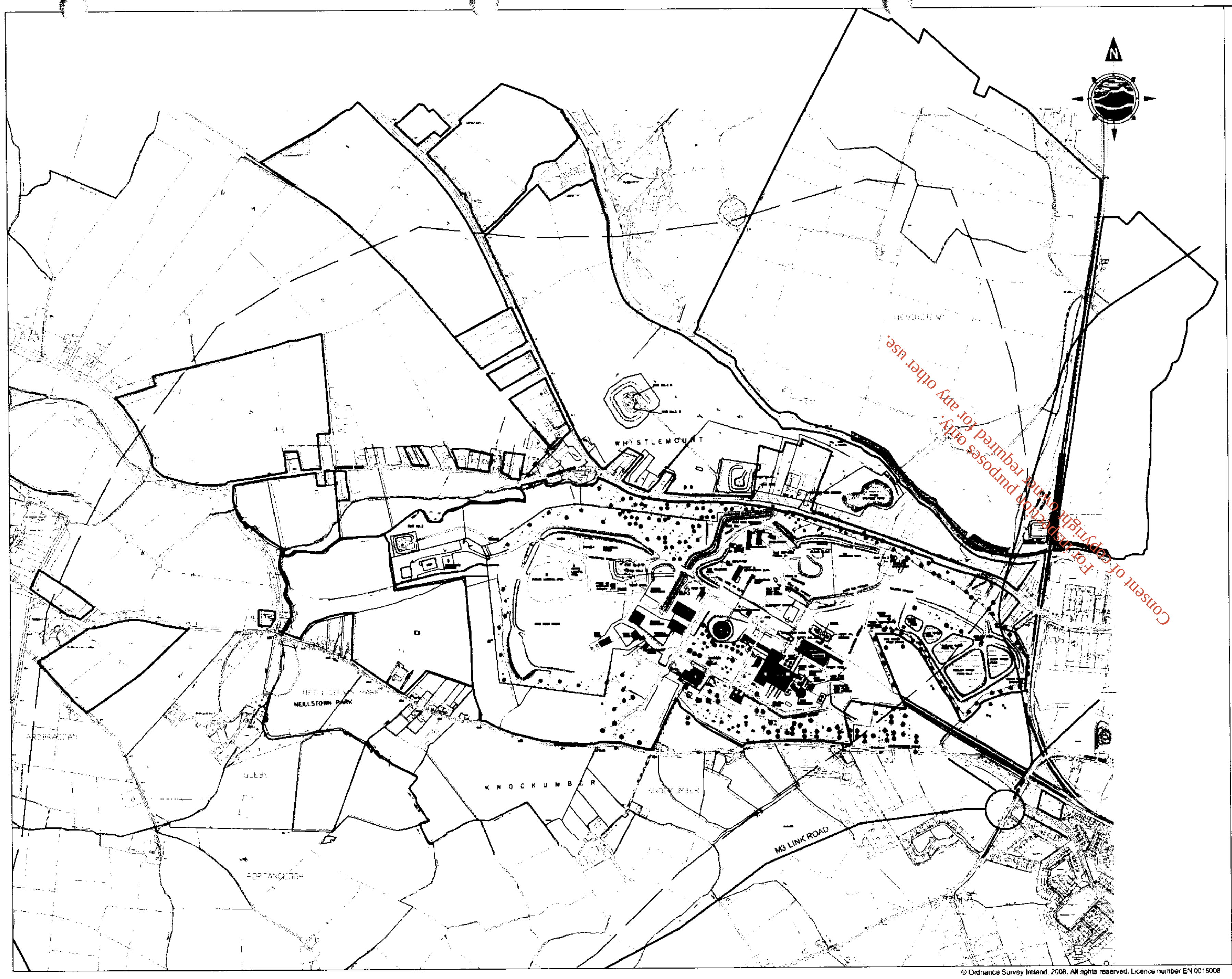
Drawing No: 3064-1000 | Revision: A

# APPENDIX 2

**Site Location Map**






**GENERAL LEGEND**

- LAND OWNERSHIP BOUNDARY
- NAVAN BYPASS ALIGNMENT
- ORE BODY OUTLINE
- CULVERTED STREAM
- TAILINGS LINE
- RECLAIM WATER
- BACK FILL PIPELINE
- FUEL PIPELINE TO UNDERGROUND
- WOODLAND/GRASSLAND
- BERM ACOUSTIC
- BERM
- ROAD (ASPHALT)
- PERIMETER FENCE
- WATER

NOTES

1. FIGURED DIMENSIONS ONLY TO BE TAKEN FROM THIS DRAWING
2. ALL DRAWINGS TO BE CHECKED BY THE CONTRACTOR ON SITE
3. ENGINEER TO BE INFORMED BY THE CONTRACTOR OF ANY DISCREPANCIES BEFORE ANY WORK COMMENCES
4. ALL LEVELS SHOWN RELATE TO ORDNANCE SURVEY DATUM AT MALIN HEAD
5. OS 6" SHEET NO'S: MEATH 25

100m 0 100m 200m 300m

| Rev | Date | Description | By | Chk'd |
|---|---|---|---|---|
| A | [illegible] | ISSUED FOR REPORT | VB | BS |

Client: BOLIDEN TARA MINES

Project: TARA MINES CLOSURE PLAN

Title: SITE LOCATION MAP

Scale @ A1: 1:5,000

| Prepared by: | Checked: | Date: |
|---|---|---|
| V.Bonney | B.Sheridan | Sept 2008 |

Project Director: S.Finlay

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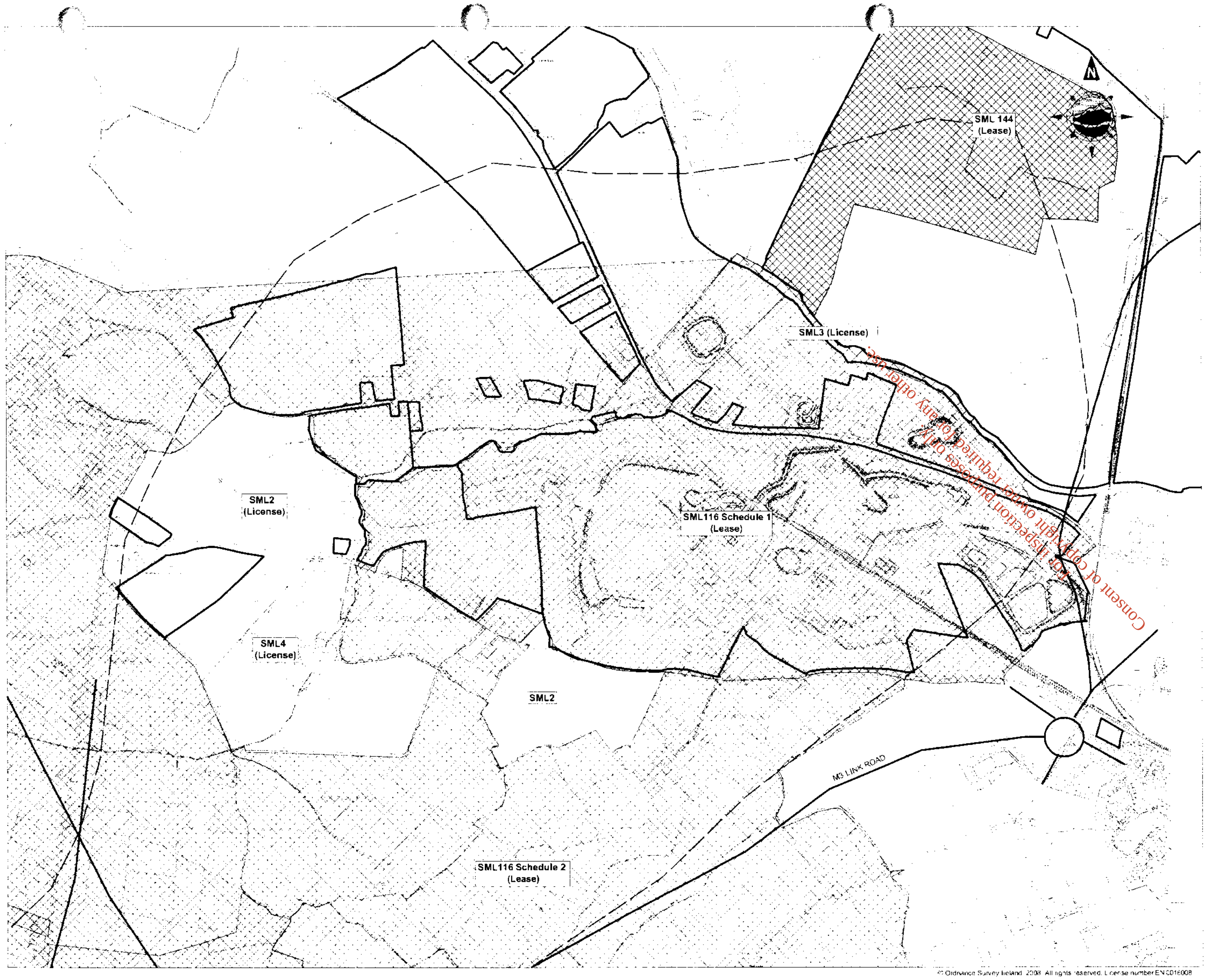
Drawing No.: 3064-1001 Revision: A

# APPENDIX 3

**State Mining Facilities at Navan Mine**






GENERAL LEGEND

NOTES

Client: BOLIDEN TARA MINES

TARA MINES CLOSURE PLAN

STATE MINING FACILITIES AT NAVAN MINE

| | | |
|---|---|---|
| Scale @ A1 | 1:5,000 | |
| Prepared by: V Bannoy | Checked: B.Sheedan | Date: Sept 2008 |
| Project Director: S.Finlay | | |

**TOBIN**

TOBIN Consulting Engineers

Drawing No: 3064-1002 Revision: A

# APPENDIX 4

## Conceptual After Use Map


GENERAL LEGEND
RIVER BLACKWATER SAC
AGRICULTURAL LAND
HEALTHCARE CAMPUS
URBAN RESIDENTIAL AREA
URBAN RESIDENTIAL AREA
INDUSTRIAL AREA
AMENITY AREA
INDUSTRIAL & RELATED USES AREA
INDUSTRIAL AREA
INDUSTRIAL & RELATED USES AREA
RETAIL WAREHOUSES
M3 LINK ROAD
RETAIL WAREHOUSES
AGRICULTURAL LAND
NOTES
BOLIDEN TARA MINES
TARA MINES CLOSURE PLAN
CONCEPTUAL AFTER USE MAP
1:5 000
V Rooney
B Sheridan
Feb 2009
S Finlay
TOBIN
3064-1003
A
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# APPENDIX 5

**Hydrogeological Report**
**Discussion of current modelling results for closure of the workings**



TOBIN

# TECHNICAL MEMORANDUM

WATER MANAGEMENT CONSULTANTS
A Schlumberger Company

| | |
|---|---|
| *To:* | *Ollie Fitzsimons/Brendan O'Reilly* |
| *Company:* | *New Boliden Tara Mines* |
| *Email:* | *Oliver.Fitzsimons@Boliden.com* |
| *Copy to:* | *John Ashton, Eugene Highland, Pat Hanratty* |
| *WMC Ref:* | *1785 Technical Memo December 2008* |
| *From:* | *Geoff Beale/Keith Massey* |
| *Date:* | *12 December 2008* |
| *Pages:* | *14 including this page* |


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**Subject:** **Tara Mines Closure Plan: Discussion of current modelling results for closure of the workings**

## 1. Introduction

As part of the on-going hydrogeology studies for New Boliden Tara Mines, WMC has carried out additional modelling work, and has developed updated predictions for hydrogeological conditions during the eventual flooding of the underground workings.

This memorandum details the results of the post-closure recovery predictions for groundwater levels and hydrochemistry of the flooded workings. It should be noted that the current predictions are based on assumptions of the eventual void volume of the workings and the amount of backfill placed. These will be modified as mining proceeds, and so the current predictions will require updating in detail prior to eventual closure of the workings.

## 2. Principal hydrogeological units at Tara

### *2.1 Pale Beds*

The Pale Beds is the principal groundwater bearing unit within the Carboniferous sequence at Tara. The Pale Beds is also the host formation for the bulk of the economic ore mineralization, and most of the mine void occurs in the Pale Beds formation.

The solid geology dips to the southwest, and consequently the mine void is near surface in the up-dip Nevinstown area, and occurs at an increasing depth moving to the southwest through the Main Mine, SWEX and SWEXB. The upper workings in the final mine void will be about 35 m below ground surface in the area of Nevinstown and more than 800 m below surface in the area of SWEXB.



### *2.2 Upper Dark Limestones*

The Pale Beds and consequently the mine workings are overlain by the Upper Dark Limestones (UDL) unit. The UDL sequence occurs at an increasing thicknesses moving to the southwest. The UDL shows strong geological layering and the sequence is and highly anisotropic. Vertical hydraulic conductivity (Kv) at right angles to the bedding is much lower than lateral hydraulic conductivity (Kh) along the bedding. The UDL cover is absent over much of the Nevinstown orebody to the north of the River Blackwater.


Water Management Consultants Ltd
Registered office: 8th Floor, South Quay Plaza
183 Marsh Hill, London, E14 9SH
Registered Number: 2386601

The UDL generally forms a low permeability vertical barrier to groundwater between the overlying superficial deposits and the underlying dewatered Pale Beds. However, it is known that piezometers in the UDL respond to dewatering of the Main Mine and Nevinstown, so there is some minor vertical leakage from the UDL into the Pale Beds. Between 20 and 70 m of drawdown has been observed in the UDL piezometers. Nonetheless, the UDL has helped isolate the underground workings from the River Blackwater. It is known from underground monitoring and water chemistry surveys that the amount of groundwater entering the workings from the flood plain deposits and the river is currently less than 2% of the total mine inflow.

*2.3 Palaeozoic rocks*

Palaeozoic rocks occur immediately to the east and northeast of the Nevinstown area. The Palaeozoics in this area are in fault contact with the Pale Beds.

Close to the area where significant drawdown has occurred within the Pale Beds, it is expected that some minor drawdown would propagate into the margins of the Palaeozoic rocks. However, because of their low overall permeability, it is not expected that significant drawdown would be observed any distance into the Palaeozoic rocks.

Overall, the Palaeozoic rocks are expected to form a barrier to the spread of drawdown, and the available groundwater monitoring results in the area immediately to the east and northeast of Nevinstown support this (for example piezometer N01765).

*2.4 Superficial deposits*

Superficial alluvial deposits are present over the entire area. These may range from shallow glacial till deposits, typically less than 5 m thick above some parts of Nevinstown where the UDL cover is absent, to palaeochannel deposits over 25 m thick below the flood plain of the River Blackwater.

Field inspections made by WMC on several occasions throughout the course of the mining operation have indicated that shallow groundwater conditions in the superficial deposits in the area of Nevinstown and the Main Mine are largely unchanged as a result of mining. Although there are no superficial monitoring wells overlying the Nevinstown area, there are a number of depressions and pits in which near-surface water can be observed. It is expected that groundwater levels and moisture contents in the superficial deposits have not been significantly altered on a site-wide scale. None of the alluvial monitoring wells above the Main Mine show any trends of declining water levels.

There are isolated locations where natural near surface cavities in the Pale Beds transmit local near-surface groundwater from superficial deposits downwards into the workings. All of the known cavities are natural features that existed before mining began. They are discrete and relatively minor, and occur in areas of extensive jointing and cavity development that have been previously mapped by Tara geologists.



*2.5 Whistlemount Channel*

A palaeochannel feature known as the Whistlemount Channel occurs beneath the area of the Blackwater floodplain. It is mapped and described in detail in the Nevinstown geotechnical report (AMC, February 2003). It is around 1.4 km long, up to 300 m wide and extends to around 27 m below ground level at its deepest point, some 9 m below the surrounding bedrock surface.

Table 1 summarizes the typical fill material for the Whistlemount Channel. A dense to very dense clayey till overlies a dense fluvial silty sand. A basal fluvio-glacial sand and gravel unit of variable thickness underlies the fluvial sand. This unit is thickest along the long axis of the channel. The low permeability clay till is currently saturated and will continue to be saturated throughout the life of active mining.

**Table 1 Typical alluvial fill thicknesses in the Whistlemount Channel**

| Unit | Hydraulic character | Representative thickness (m) | Typical minimum thickness (m) | Maximum thickness (m) |
|---|---|---|---|---|
| Brown and grey clayey till | Aquiclude | 15 | 10 | 15 |
| Dense silty sand to sandy silt | Aquitard to poor aquifer | 5 | 0 | 5 |
| Basal sand and gravel | Aquifer | 5 | 0 | 5 |

The Nevinstown geotechnical study (AMC 2003) includes a long section of Whistlemount Channel, which indicates:

- The ground surface elevation along the Whistlemount Channel is up to around 1,574 mAMD.
- The bed of the River Blackwater in the vicinity of the Whistlemount Channel is around 1,562 mAMD.
- The silty sand and sand and gravel units are of variable thickness. The upper surface of both reaches a maximum elevation around 1,560 mAMD.

The Whistlemount Channel is largely excavated into the hydraulically tight UDL. It only penetrates the more transmissive Pale Beds close to where the course of the River Blackwater turns east towards the railway as it flows on towards Navan and its confluence with the River Boyne.

The River Blackwater crosses the northwest limit of the Whistlemount Channel where the river flows southeast at the southeast limit of Liscartan. Ground elevation is around 1,564 mAMD at this location and the channel deposits are subject to a significant degree of hydraulic isolation from the surface waters of the river by the thick (ca 15 m) fill of stiff clayey till which overlies them.

The Whistlemount Channel was of concern for dewatering of the Nevinstown orebody. However, monitoring has shown than the sands in the lower part of the channel have become dewatered and are not significantly recharged because of the overlying clays and silts.

The monitoring data from piezometer N01675 show that the permeable sand and gravel layers within the base of the Whistlemount Channel (to the south of the river) have become fully dewatered. The piezometer became completely dry shortly after Nevinstown exploration headings were driven in that area.

The Nevinstown North Exploration Decline passes directly below the Whistlemount Channel (1500 NDEX2). The underground observations confirm the readings in the piezometer. The initial inflow when the decline was driven beneath the lowest part of the channel was about 5-8 gpm (in 2003). However, the inflow zone had dried up by early 2006.

Lower permeability silts and clays above the Whistlemount Channel are recharged directly by the river. Near-surface groundwater conditions in these shallow deposits have been unchanged by mining. Thus, the situation exists where a shallow groundwater table occurs in the superficial deposits overlying the channel, but the more permeable alluvial deposits deeper in the channel have become dewatered as a result of downward leakage.

**3. Discussion of the groundwater system**

*3.1 Groundwater recharge*

Groundwater recharge to the Pale Beds occurs mostly as a result of infiltration of precipitation and downward percolation through the superficial glacial deposits into the Pale Beds unit. Virtually all of the district-scale groundwater flow around Tara occurs within the Pale Beds, which is the source of virtually all the groundwater entering Nevinstown and the Main Mine. The on-going monitoring results continue to verify the conceptual hydrogeological model described in the Nevinstown Geotechnical Study (AMC, February 2003).

The recharge to the Pale Beds occurs mostly in the up-dip areas where the UDL cover is thinnest. Thus, most of the active groundwater circulation occurs at relatively shallow levels close to the up-dip area. Moving down-dip, the Pale Beds groundwater has an increasingly greater residence time. This is confirmed by the observations in SWEX, where there is little inflow to the workings from the Pale Beds unit itself, and the Pale Beds groundwater has a higher Total Dissolved Solids (TDS) content and a different chemical signature to the water entering the Nevinstown and Main Mine sectors of the workings (see Section 6.1 below).

*3.2 Pre-mining groundwater levels*

Pre-mining groundwater heads over the Nevinstown region of the Tara Mine, as measured during a 1975 geotechnical study, were typically between 1 and 3 m below ground level in the area of the flood plain. Measured groundwater level elevations in the Pale Beds ranged from around 1,539 mAMD along the River Blackwater up to 1,544 mAMD in the vicinity of Nevinstown House (AMC, February 2003).

*3.3 Current operational groundwater levels*

Except locally around new stoping areas, Pale Beds groundwater levels have been fairly steady since early 2005, responding mostly to seasonal variations in rainfall and groundwater recharge. Below the central part of the Nevinstown orebody, current groundwater levels beneath the river are inferred to be about 1,370-1,490 mAMD (representing over 150 m total drawdown). Water levels measured in boreholes in the Pale Beds beneath the river are higher to the southeast, and are currently about 1,470-1,480 mAMD to the southeast of the A fault.

To the north of the river, the groundwater levels rise fairly rapidly in the un-mined area. At a location about 900 m northeast of the river, water level elevations are currently about 1,530-1,540 mAMD. About 5-15 m total drawdown is observed to date in this area.

*3.4 Groundwater discharge*

Under pre-mining conditions, the groundwater in the Pale Beds moved slowly from the recharge areas towards the flood plain of the River Blackwater. The groundwater discharged by upward leakage through the alluvial deposits to the lower part of the Blackwater flood plain area, in the area where the where the surface topography is lowest. It is expected that most of the active groundwater circulation would have occurred in the upper 150 m of the outcrop area of the Pale Beds, with the groundwater becoming increasingly static down-dip.

Since active dewatering operations for the underground workings began, the flow paths have changed, and all Pale Beds groundwater currently discharges to the underground workings, where it is managed as part of the mine dewatering system. However, some minor groundwater flow still occurs within the overlying superficial glacial deposits towards the flood plain sediments.

*3.5 Discussion of the groundwater flow system*

The regional groundwater flow system within the Pale Beds is fault bounded. As a result, the area of high drawdown associated with the mine is limited to the local area. To the south and southeast, the area of high drawdown is bounded by the D fault zone. To the northeast and north, the area of high drawdown is limited by the presence of the Palaeozoic rocks. To the northwest, the presence of the Liscarton fault and other NE trending structural zones limits the spread of drawdown within the Pale Beds in this direction. To the southwest, the Pale Beds occur at increasing depths below the UDL.

If it is assumed the recharge to the Pale Beds occurs over an outcrop area of about 13 $km^2$, and recharge is about 20-25% mean annual precipitation. Based on this, it can be estimated that aerial recharge to the Pale Beds over the outcrop area contributes about 975-1,200 gpm to the total Tara inflows. This is more than 85% of the current flow rate to the Main Mine and Nevinstown.

Overall, groundwater conditions have remained very stable since the Nevinstown extension was first opened up. Although "new" water continues to be encountered in Nevinstown, there is a resulting decrease in the inflow to the Main Mine further down-dip. The overall combined groundwater inflow rate to Nevinstown and the Main Mine has increased by less than 10% as a result of mining the Nevinstown expansion. There has been no significant increase in the overall total inflow rate since 2004. District groundwater conditions have not significantly altered as a result of mining to date at Nevinstown.

As a result of the leakage from the UDL downward into the Pale Beds, a vadose zone (unsaturated zone) has opened up within the upper part of the UDL, often beneath saturated superficial deposits. The vadose zone initially opened up shortly after the commencement of the dewatering of the Main Mine. The incremental local bedrock drawdown due to Nevinstown has slightly increased the local thickness of the vadose zone.

The vadose zone is present in most areas where till and/or other glacial alluvial deposits are present directly above the dewatered Pale Beds or UDL. When incremental drawdown has occurred within the Pale Beds as a result mining the Nevinstown expansion, the downward leakage from the alluvium has not significantly increased because of the presence of the vadose zone.

*3.6 Source of groundwater inflow to the mine workings*

Groundwater inflows to Nevinstown and the Main Mine occur mostly in the Pale Beds. District-scale lateral groundwater flow in the Pale Beds is the greatest contributor to the mine water inflows. Typically, the inflow rate has been steady at between 1,200 and 1,400 gpm. The rate is steady because of the strongly bounded nature of the Pale Beds groundwater block surrounding the Tara workings. Many of the discrete inflow areas occur in the northwest part of the mining areas, and are often associated with extensions to F1 and F23 fault zone and NW joints. For the purposes of the current closure modelling, it is assumed that the amount of groundwater inflow to the Nevinstown and Main Mine workings immediately on completion of mining will be about 1,300 gpm (see Section 4.1 below).

A minor amount of inflow occurs due to leakage from the UDL, and an even smaller amount occurs as a result of leakage from the floodplain deposits of the River Blackwater. Over much of its course in the vicinity of the Tara Mine, the Blackwater flows over the relatively low permeability UDL. However, the UDL is absent in the area of Nevinstown to the north of the river. In this area, the floodplain deposits rest on clayey glacial till which reaches thicknesses in excess of 10 m. The low permeability of the clayey till reduces the rate of groundwater flow between the recent alluvium around the River Blackwater and the underlying Pale Beds. As discussed above, it is estimated that inflows derived from the river currently account for less than 2% of the total mine inflows.

*3.7 Groundwater conditions in SWEX*

The SWEX workings occur down-dip in the Pale Beds and away from the main area of active Pale Beds groundwater circulation. The SWEX workings are overlain by a cover of about 500-800 m of UDL. However, above the SWEX area, some significant regional geological structures have been noted, and there are areas where weathering within the UDL has occurred to a significant depth below ground surface (250-400 m below ground surface in some areas).

Although there is little active Pale Beds groundwater flow in the area of SWEX, there is an upward connection from the workings through the UDL sequence into the deeper zones of UDL weathering located vertically above the deposit area. The connection has resulted in some downward groundwater flow through the UDL to the SWEX workings. The amount of downward flow has been limited by the underground grouting programme which aims to reduce the amount of groundwater entering SWEX. The recently observed inflow rates to the SWEX workings have generally been within the range 300-500 gpm. For the purposes of the current closure modelling, it is assumed that the amount of groundwater inflow to the SWEX workings immediately on completion of mining will be about 600 gpm (although this will depend on future grouting operations that are planned).

**4. Post-closure recovery curve**

*4.1 Active recovery phase (pre-stabilisation)*

On the cessation of pumping from the mine, the residual void space and the mine backfill will begin to re-saturate with groundwater. Water entering the system will initially drain towards the SWEX workings, which is the lowest part of the mine.

The SWEX workings fill with groundwater, and then the Main Mine and the Nevinstown workings will progressively become flooded. As the workings actively fill, they will act as a hydrogeological sink, as is currently the case during operations. During recovery of the groundwater system, all groundwater flow will be inward to the workings.

Water will only start to discharge from the workings once groundwater heads in the Pale Beds and the flooded workings start to rise very slightly above the groundwater levels in the River Blackwater flood plain deposits towards the lowest (eastern) edge of the site. At that time, the original pre-mining groundwater balance will become re-established and the recovery of water levels will cease. This will occur when the district groundwater recharge to the Pale Beds, and through flow in the flooded workings, becomes balanced by the discharge to the alluvial flood plain deposits.

During the period of active recovery, as the groundwater head in the workings rises, the groundwater inflow rate to SWEX will progressively decrease with time. The bulk of the inflow into the Main Mine and Nevinstown occurs from discrete zones. In the Main Mine, the base of the main inflow zones occurs at around 1,150 m AMD. In Nevinstown, most of the inflows are centred at around 1,300-1,400 mAMD.

Table 2 summarizes the maximum inflow rates assigned to each region of the mine in the model. The inflow from these zones will be independent of the rising head until the rising groundwater elevation reaches the elevation of the main inflow zones, whereafter the rate of discharge from the inflow zones will decrease to the steady state equilibrium value attained at full recovery. Figure 1 shows the predicted decrease in groundwater inflow rates from each zone during the active recovery period. Figure 1 also shows the predicted filling curve for the mine, given the currently assumed final void and backfill volumes.

**Table 2 Maximum inflow rates assigned to regions of the mine**

| Region of mine | Maximum inflow rate (gpm) |
|---|---|
| Nevinstown | 550 |
| Main Mine | 750 |
| SWEX | 600 |
| **Total** | **1,900** |

*4.2 Long term post-closure water levels (post-stabilisation)*

Groundwater heads, and water levels in the workings, will continue to recover until equilibrium is achieved. At this point, the rate of district groundwater recharge to the Pale Beds groundwater system will be balanced by the rate of groundwater discharge to the flood plain deposits. This will indicate a return to the natural pre-mining groundwater balance.

The flood plain deposits of the River Blackwater constitute the natural district-scale groundwater discharge zone for the Pale Beds under pre-mining conditions, and also following post-closure recovery. Because of the presence of clays and silts within the flood plain deposits, groundwater heads in the underlying bedrock will rise slightly above the groundwater levels in the flood plain deposits in order to provide the hydraulic gradient to allow groundwater discharge to occur. As per pre-mining conditions, it is expected the post-closure upward head gradient will be small.

Along the line of the river, ground surface elevation is around 1,571 mAMD, (71 masl) at the western limit of the Nevinstown, falling to 1,564 mAMD in the southeast limit of the mine boundary. The stage of the River Blackwater at Donaghpatrick Bridge to the west of the Nevinstown region of the mine is 1,540 mAMD and around 1,538 mAMD in the vicinity of the Nevinstown orebody. To the east of the orebody, the stage drops to around 1,533 mAMD at Pollboy Bridge (AMC, February 2003). For the current post-closure recovery modelling purposes, a reference stage of 1,535 mAMD has been applied to represent the River Blackwater in the model. It is expected that bedrock groundwater levels will recover to slightly above this elevation.

*4.3 Discussion of model results*



The key input parameters to the recovery model are summarized in Appendix A. The recovery curve is show in Figure1. The final post-stabilisation groundwater levels in the Pale Bed are simulated as 1,537 mAMD. When interpreting the results, the preliminary nature of the current model needs to be appreciated. The actual recovery curve will be strongly dependent on the final mined void and the amount of placed backfill, which will only be known with certainty once the mine approaches the end of its planned life.

Variations in post-stabilisation groundwater will also occur as a result of seasonal changes in groundwater recharge and groundwater levels, and also because of longer term climatic cycles. Based on the current model results and knowledge of the actual groundwater monitoring data to date, it is currently estimated that, within the footprint area of the mine, groundwater levels in the Pale Beds will ultimately recover to an elevation within the range 1,536-1,544 mAMD. Because the entire mine footpint area will be interconnected by workings, it is anticipated that water levels will be flat across the entire mined area.

The current model predicts that full recovery of the groundwater system will take within the region of 17-18 years following shut down of the dewatering system. Once the workings are completely flooded, the mine voids will cease to represent a complete groundwater sink and the pre-mining pattern of groundwater flow and discharge to the flood plain deposits will become re-established. The discharge will occur in a diffuse zone mostly along the axis of the valley to the alluvial underflow system, rather than to bed of the River Blackwater itself. The current model indicates the steady state groundwater discharge from the Pale Beds to the alluvial floodplain underflow system will average about 250 gpm.

Sensitivity of the current model to several of the input parameters has been investigated. The basic model runs assume an effective backfill porosity of 0.03. This may change depending on the ambient moisture content of the material during operations. Recovery has also been simulated for a run considering a backfill porosity of 0.05. However, with the current assumptions, this only marginally increases the recovery time (less than one year difference). The sensitivity of the model to the porosity of the mine backfill is low since the bulk of the groundwater storage to refill occurs within the dewatered district Pale Beds groundwater block. In the base case model, the specific yield (drainable porosity) of the Pale Beds was set at 0.02. Increasing this value to 0.03 would increase the recovery time by 3-4 years.

Although water will discharge from the Pale Beds and the mine void to the alluvial flood plain deposits, it is anticipated that the piezometric surface within the flooded area will remain lower than other district bedrock groundwater blocks. Therefore, it is anticipated that a slight inward hydraulic gradient will remain between the surrounding bedrock groundwater blocks and the Pale Beds groundwater block that contains the flooded workings. This will minimise the potential for any groundwater to migrate away from the flooded workings in the long term.

*4.4 Modelling of the Whistlemount channel*

Groundwater levels in the Whistlemount Channel will recover fully. Depending on the actual vertical permeability of the silts and clays in the upper part of the channel, it is expected that alluvial water levels in the channel will recover in advance of the recovering bedrock.

Section 2.5 above discusses that the channel deposits yielded an estimated 5-8 gpm into the decline. Since the decline was driven below the lowest part of the channel, this dewatering rate may be considered indicative of the maximum recharge rate, arising via vertical infiltration through the till to the silty sand and sand and gravel units in the base of the Whistlemount Channel.

Figure 2 shows the modelled recovery curves for the permeable sediments at the base of the Whistlemount Channel for recharge rates of 5-8 gpm, and using the channel geometry described in Section 2.5 above. At 5 gpm, water levels take about 12-14 years to recover in the channel. At 8 gpm, recovery would be achieved in 8-10 years. Thus, given the preliminary model results, and with reference to Figure 1, it can be estimated that alluvial deposits of the Whistlemount Channel will recover ahead of the rising groundwater levels in the underlying bedrock units.

**5. Discussion of post-mining groundwater levels**

Within the alluvial overburden deposits that form the near surface groundwater system throughout the area of Tara, the post-closure water table will be essentially unchanged relative to pre-mining conditions. No post-closure impacts to the water table are expected in the overburden. Superficial groundwater levels will also be unchanged beneath the flood plain of the River Blackwater. In addition, it is expected that post-closure groundwater levels in the upper horizons of the UDL will also be essentially unchanged relative to pre-mining conditions.

Within the Pale Beds, the post closure groundwater balance will be the same as pre-mining. However, some localized changes to the deeper piezometric levels are expected because of the interconnected nature of the flooded workings. The post-closure piezometric levels in the Pale Beds are expected to be flat over the footprint area of the mine. The implications of this are described in the following paragraphs.

At the east end of the mine footprint, in the vicinity of the River Blackwater, there will be no residual drawdown. It is predicted that Pale Beds piezometric levels in this area will be marginally higher than pre-mining, and there will be a slight upward hydraulic gradient from the Pale Beds below the flood plain towards the river, as a result of the groundwater discharge to the river.

On the southwest and west side of the mine footprint area (including SWEX), deeper piezometric levels will show residual drawdown compared with pre-mining conditions. The amount of residual piezometric drawdown in the Pale Beds at the mining horizon will be greater than 10 m in some areas (depending on surface topography). However, it should be appreciated that this is representative of conditions 800 m below surface, and not near surface conditions. There will be a downward hydraulic gradient developed between the upper weathered zone of the UDL and the Pale Beds at depth. It should be noted that all existing domestic wells in this area are drilled either in superficial alluvial deposits or shallow weathered UDL materials, a long way above the horizon where the residual drawdown is predicted to occur in the underlying Pale Beds. The pre-mining Pale Beds in this area had no active groundwater circulation, and consequently pre-mining TDS levels were elevated and groundwater quality was much poorer than in the upgradient areas closer to the flood plain.

In the area of the Nevinstown workings, it is expected there will be minor (1-5 m) of residual drawdown in the piezometric surface, and a slight downward hydraulic gradient. The pre-mining hydraulic gradient in this area was also downward between the shallow water table and the deeper Pale Beds piezometric surface.

Moving regionally away from the mine footprint area, it is expected there will be a small amount of residual drawdown in the Pale Beds groundwater block. However, there are no pre-mining boreholes installed to be able to assess this with any reliability.

## 6. Hydrochemistry of the flooded workings

*6.1 Post-closure groundwater inflow chemistry*

The Tara hydrochemical sampling programme has demonstrated that virtually all of the water makes in the Main Mine and Nevinstown consist of young, calcium-bicarbonate type water flowing within the Pale Beds at relatively shallow depths (above 1,150 mAMD). Most of the major inflow zones have shown no chemical change with time, and are not expected to show any change between now and the end of the mine life. It is predicted these waters will make up most of the post-closure inflows, both during the active recovery and post-stabilisation phases.

As mining has moved progressively down-dip, the frequency and magnitude of new inflows from the Pale Beds has reduced, and the quality of the water has shown an increasing TDS and salinity. The initial deep Pale Beds groundwater that was encountered in SWEX had high electrical conductivity (EC) values and was considerably older than other Tara groundwaters, having undergone significant ion exchange. The original SWEX water can be exemplified by the sample taken in February 2004 from 700 3UEX. The water had a temperature of almost 31°C, with an EC value of 1,780 µs/cm. The sample had a chloride value of 283 mg/l and sulphate of 186 mg/l. Reported calcium was 48 mg/l, magnesium 21 mg/l, sodium 355 mg/l and potassium 5 mg/l. This sample was considered to represent groundwater storage from isolated fractures at or above the level of the ore horizon.



All early SWEX groundwater samples showed a relatively low component of calcium and bicarbonate, indicating little evidence of any connection to surface, and little evidence of any active groundwater circulation. Inflow rates of this poor quality water were low and generally non-sustained, indicating drainage of residual storage, rather than any active groundwater recharge sources.

Higher volume, more sustained inflows to SWEX began to occur in 2004. However, as discussed in Section 3.7 above, it is thought the source of this water is the deeper zones of UDL weathering, located about 250-400 m depth, and vertically above the SWEX deposit area. Again, this water shows a significant influence of more recent calcium bicarbonate waters. EC values are 606-655 μs/cm, and temperature values are 26.4-27.0°C. The samples typically have chloride values of 24-40 mg/l, and sulphate values of 11-92 mg/l. Reported calcium is typically 47-73 mg/l, magnesium 20-24 mg/l, sodium 43-72 mg/l, and potassium 3.1-8.1 mg/l. Recorded field parameters (temperature and EC) have shown relatively stable values, indicative of a high storage water source. Again, the water chemistry does not show any significant changes with time, and the current modelling assumes that this water will be typical of the SWEX inflows at the time of eventual mine closure.

*6.2 Chemical conditions in the workings*

When the mine dewatering pumps are switched off, water will quickly accumulate within the SWEX workings. The initial water will be a mixture of the SWEX groundwater inflows (predicted to be initially 600 gpm – but this will depend on future grouting operations) and groundwater moving down the workings from the Main Mine and Nevinstown (predicted to be initially about 1,300 gpm).

The initial inflow water will enter the bottom of the workings and will dissolve sulphate, zinc and other metals as it enters the mine. Although mineral acidity will be dissolved from the oxidation products that have accumulated in the wall rocks of the workings, the underground sampling work that has been carried out to date indicates that there will be sufficient dissolved alkalinity mass in the inflowing waters that the water in the workings will remain near-neutral. This will need to be confirmed by additional underground sampling carried out during the course of active mining operations. There will be relatively high levels of iron available in the oxidation products dissolved from the wall rocks which will help co-precipitate and reduce the concentration of the key metals.

It is predicted the cleaner water from the Main Mine and Nevinstown will preferentially flow along channels within the main decline and into the rising water level in the workings as they flood. This water will also dissolve some minor mineral acidity and sulphate from the flow channels, but is expected this will be low. The amount of mineral acidity dissolved will progressively decrease as the workings flood and the oxidation products become removed from the preferential flow paths, such that the water quality will quickly improve with time. During the course of active flooding, it will be necessary to periodically skim any oils and grease from the top of the water rising in the decline.

As the workings progressively fill and the water level rises, the inflow rate from the SWEX workings will decrease with time as the head differential decreases (see Figure 1). However, the inflow from the Main Mine and Nevinstown will not be subject to the same head control, and therefore the inflow rate from the shallow levels will not decrease until the rising water has recovered to the level of the Main Mine and Nevinstown inflows (above about 1,150 mAMD).

Once the lowest levels of the SWEX workings are flooded, the clean water inflow from Nevinstown and the Main Mine will increasingly stratify on top of the water in the bottom of the workings. It is expected there will be a slight density difference between the water in the deeper flooded workings (slightly higher density) and the shallow inflow water (slightly lower density). A chemocline will thus develop in the flooded workings, permanently stratifying the water body.

The pre-mining groundwater flow regime will become re-established following full recovery of groundwater levels. Because of the chemocline, the water in the deeper part of the workings will remain isolated from the environment. Most of the active flow will be above the level of the Main Mine inflows (above 1,150 mAMD), and it is expect that all water below this level will be below the level of the active water circulation.

Oxidation of the pyrite minerals will stop as the workings become submerged. Therefore, on-going generation of mineral acidity, sulfate and metals will not occur. Experience at other flooded mines has shown that the water isolated in the deeper part of the workings will become strongly reducing. Depending on the matrix chemistry, there may some precipitation of metal sulphides which would act to improve the chemistry in the flooded workings in the long term.

The exact details of how the workings flood will depend on the final extent of the workings, and on the extent and location of the backfill. More detailed analysis of actual conditions will therefore need to be undertaken nearer to the time of closure when the final mine plan is known with more certainty. The on-going water chemistry sampling plan for the mine will be adapted with time to provide the required empirical data to develop the detailed closure plan. It is expected that all required data for mine closure can be developed by means of on-going sampling and field testing, without the need for theoretical laboratory testing of geochemistry samples.

Recent hydrochemical data from the Nevinstown and Main Mine have been used to make a preliminary prediction of the water that will circulate at shallow levels within the flooded workings, and that will discharge to the alluvial underflow of the Blackwater floodplain. The preliminary chemistry mixing model predicts sulphate values within the range 60-110 mg/l, zinc of about 0.02-0.13 mg/l, lead of about 0.01-0.04 mg/l, and manganese of 0.03-0.4 mg/l.

As the water from the Pale Beds discharges upwards into the underflow system of the flood plan deposits, the clay minerals in the till and clayey-silty sands of the alluvium will help promote the attenuation of any residual dissolved metal concentrations in the groundwater as a result of sorption processes. Metal concentrations in groundwater that eventually discharges to the surface water of the River Blackwater should therefore be within the currently observed ranges for the river system.

**7. References**

Australian Mining Consultants. April 2003. Nevinstown Geotechnical Study. Report Produced for Tara Mines Limited.

Water Management Consultants Ltd. April 2007. Assessment of the hydrogeology of the Liscartan application area.

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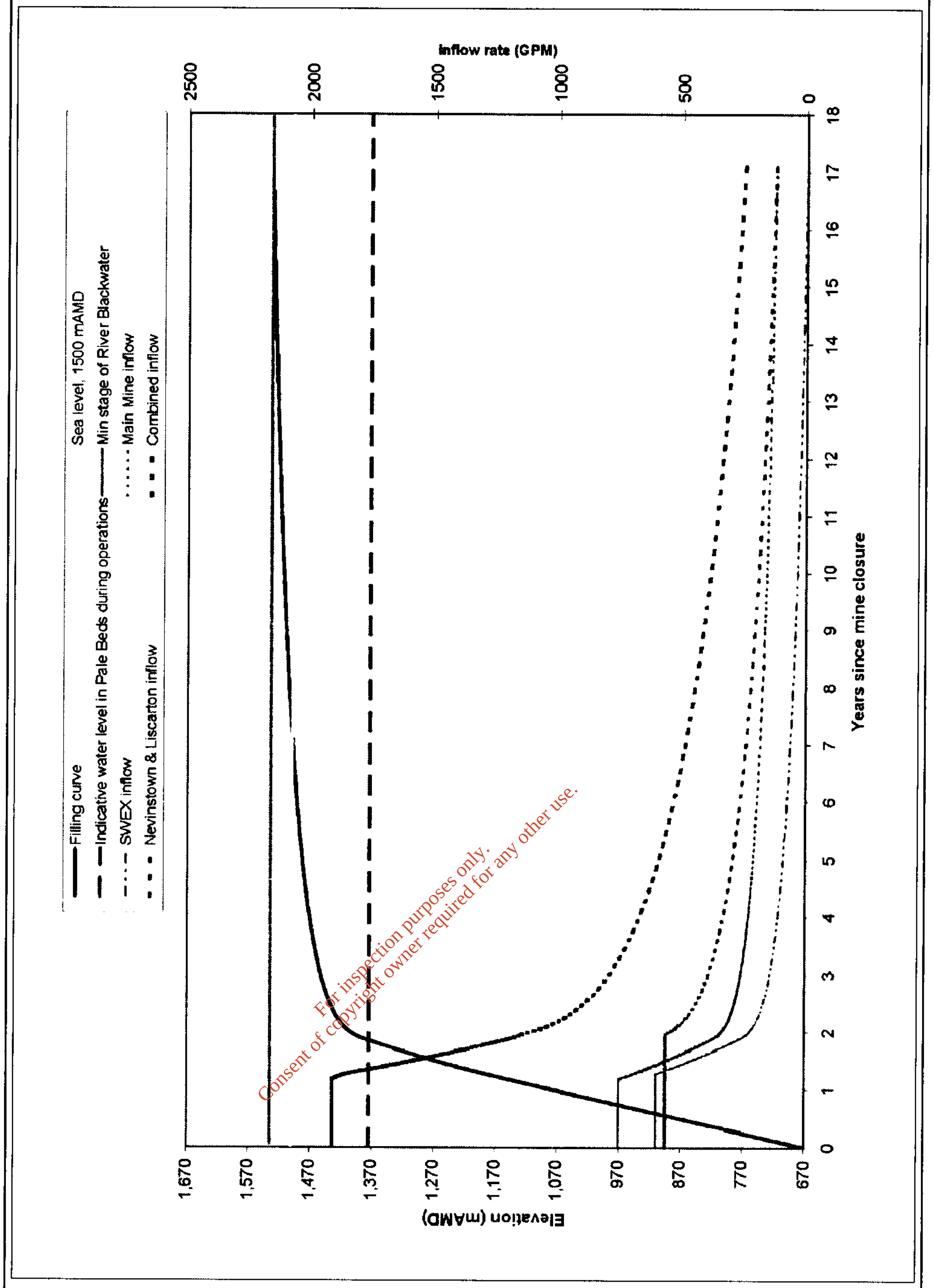
# Figure 1 Recovery curve for Tara workings



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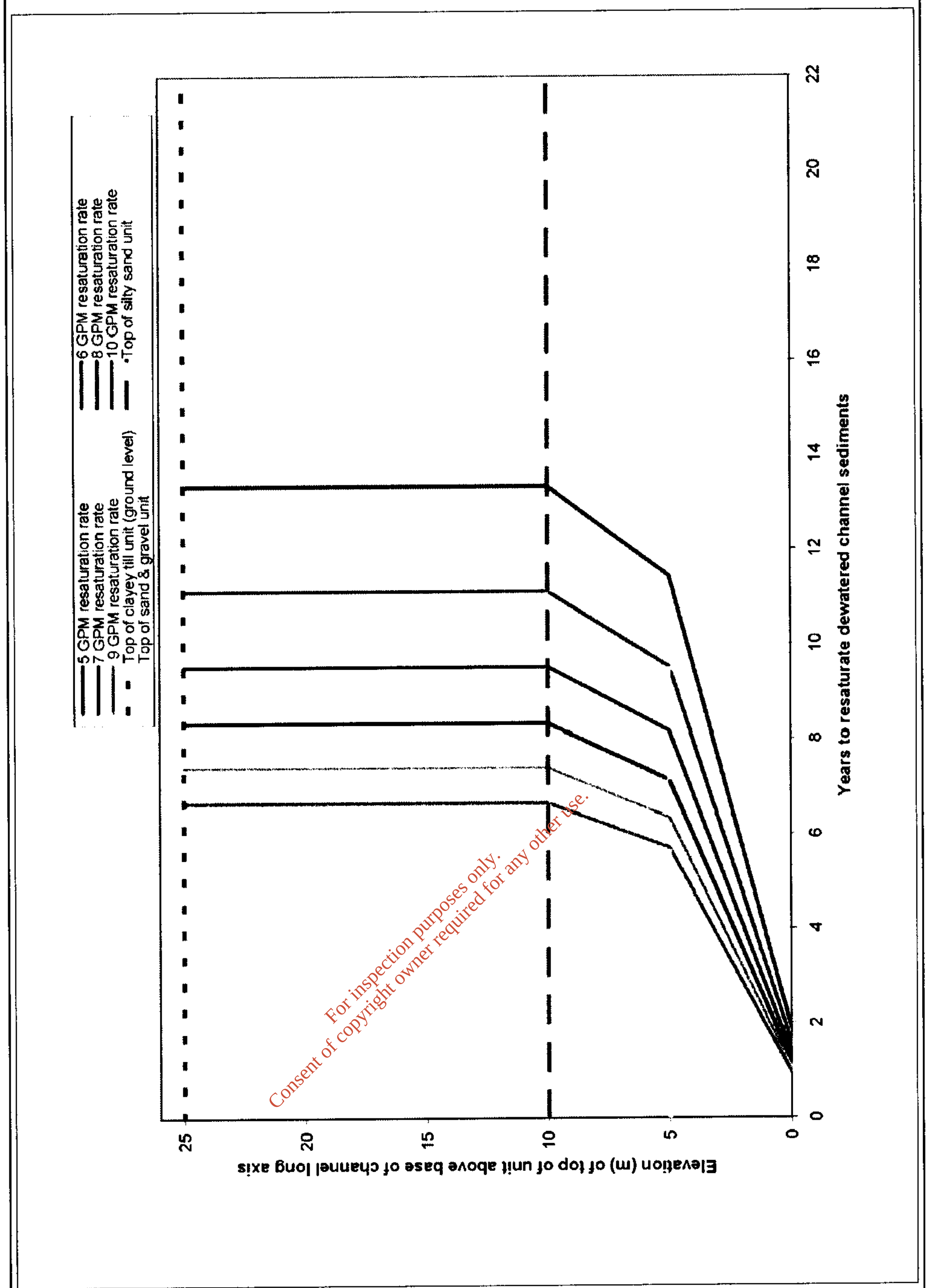
# Figure 2 Recovery of dewatered Whistlemount Channel Sediments



**APPENDIX A**

# Tara Mine post-closure recovery model input summary

## Porosity

| | |
|---|---|
| Backfill porosity | 3% |
| Specific yield (drainable porosity) of Pale Beds | 2% |

## Tonnages mined

| | | |
|---|---|---|
| Final tonnage from Nevinstown | 17 | Mt |
| Final tonnage from Main Mine | 45 | Mt |
| Final tonnage from SWEX | 30 | Mt |
| Total final tonnage | 92 | Mt |

## Mean specific gravity of rock at Tara

| | | |
|---|---|---|
| Mean specific gravity of rock at Tara | 2.90 | $t/m^3$ |

## Volumes mined

| | | |
|---|---|---|
| Nevinstown | 5,862,069 | $m^3$ |
| Main Mine | 15,517,241 | $m^3$ |
| SWEX | 10,344,828 | $m^3$ |
| Total | 31,724,138 | $m^3$ |

## Maximum inflow rates to workings

| | | |
|---|---|---|
| Nevinstown | 550 | GPM |
| Main Mine | 750 | GPM |
| SWEX | 600 | GPM |
| Total | 1,900 | GPM |

## Estimated surface area of dewatered Pale Beds at mine closure

| | | |
|---|---|---|
| Estimated surface area of dewatered Pale Beds at mine closure | 11 | $km^2$ |



## Steady state recharge to Pale Beds at mine closure

| | | |
|---|---|---|
| LTA mean annual rainfall at Tara | 850 | mm/a |
| Steady state recharge | 85 | mm/a |
| | 250 | GPM |

## Percentage of mine void backfilled and non-backfilled

| | |
|---|---|
| Percentage of mine void that is non-backfilled development | 20% |
| Overall percentage of mine void that is not backfilled | 28% |
| Overall percentage of mine void that is backfilled | 72% |

## Reference stage level on River Blackwater

| | | |
|---|---|---|
| Estimated lowest stage elevation of River Blackwater to the east of Nevinstown (head control point for groundwater discharge from mine system at full recovery) | 1,535 | mAMD |

# APPENDIX 6

**Soil Sampling Results**

## SUMMARY OF GROUND CONDITIONS

Table 1 provides a summary of the ground conditions encountered during intrusive site investigation.

Table 1: Summary of ground conditions encountered during site investigation.

| Areas | Thickness of Made Ground | Thickness of friable, Grey/green Clay | Thickness of brown Sandy Gravelly Clay |
|---|---|---|---|
| A | Over 3 m (base not proven) | | |
| B | 0.5 to 1 m | 0.4 to 1.5 m | 0.5 to 2.8 m |
| C | 1.5 to 1.8 m | 1.0 m | 1.0 to 2.0 m |
| | | | |
| D | 0.5 to 1.0 m | 1.0 m | 2.0 m |
| E | 0 to 1.8 m | 0.4 to 2.0 m | 1.0 to 2.5 m |
| F | 0.7 m (Deeper areas not excavated) | 0.5 to 1.0 m | 1.0 to 3.2 m |
| G | 0.6 to 1.8 m | 0.3 to 1.5 m | 0.5 to 2.6 m |
| H | WS32 not drilled | | |
| I | 0.5 m (Topsoil) | 1.0 m | 1.1 m |

Table 2: Contamination analysis results for Area A.

| | CLEA SGV (mg/kg) | ICRCL 70/90 Threshold Trigger Concentration | ICRCL 70/90 Maximum (Action Trigger) Concentration | | Samples | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | For Grazing Livestock | For Crop Growth (risk of phytotoxicity) | TP1 0.3 m | TP2 1.5 m | WS3 0.5-0.8 m | TP4 2.0 m | TP5 2.0 m | TP6 3.0 m | TP7 2.0 m | TP8B 2.2 m | TP8B 3.0 m |
| Total Arsenic (mg/kg) | 500 | 50 | 500 | 1000 | 80 | 120 | 96 | 93 | 13 | 90 | 110 | 110 | 93 |
| Total Cadmium (mg/kg) | 1400 | 3 | 30 | 50 | 39 | 25 | 77 | 49 | 1 | 57 | 40 | 104 | 84 |
| Total Lead (mg/kg) | 750 | 300 | 1000 | - | 2500 | 2500 | 7900 | 6600 | 55 | 6600 | 3700 | 11000 | 10000 |
| Total Zinc (mg/kg) | - | 1000 | 3000 | 1000 | 13000 | 8200 | 26000 | 17000 | 220 | 19000 | 15000 | 35000 | 31000 |
| Total Antimony (mg/kg)** | - | - | - | - | <30 A | 35 B | 195 D | 130 D | <30 A | 80 C | 90 C | 130 D | 190 D |
| pH (unit) | - | - | - | - | 8.0 | 8.1 | 7.8 | 7.8 | 7.9 | 7.6 | 7.1 | 7.7 | 7.7 |
| Soluble Sulphate (g/l) | - | - | - | - | <0.5 | <0.5 | 1.58 | 1.52 | <0.5 | 1.35 | 1.49 | 1.57 | 1.57 |
| TPH (mg/kg) | 5000* | - | - | - | 59 | 56 | 379 | <20 | <20 | 759 | 42 | 5802 | 827 |

Notes: *relates to commonly used value for TPH concentrations

*** Antimony concentrations are compared to Kelly's Table. For ease of comparison, contamination classes have been added into the table.*

Table 3: Contamination analysis results for Area B.

| Parameters | CLEA SGV Industrial/Commercial (mg/kg) | ICRCL 70/90 Threshold Trigger Concentration | ICRCL 70/90 Maximum (Action Trigger) Concentration | | Samples | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | For Grazing Livestock | For Crop Growth (risk of phytotoxicity) | WS9 0.6-1.0 m | WS10 0.1-1.0 m | WS10 1.7-2.0 m | WS11 0.5-1.0 m | WS12 0.3-0.6 m |
| Total Arsenic (mg/kg) | 500 | 50 | 500 | 1000 | <5 | 23 | <5 | 9.8 | 5 |
| Total Cadmium (mg/kg) | 1400 | 3 | 30 | 50 | <1 | 5 | <1 | 1.2 | 1.9 |
| Total Lead (mg/kg) | 750 | 300 | 1000 | - | 59 | 260 | <30 | 33 | 38 |
| Total Zinc (mg/kg) | - | 1000 | 3000 | 1000 | 270 | 1300 | 82 | 150 | 150 |
| Total Antimony (mg/kg)** | - | - | - | - | 1635 E | <30 A | <30 A | <30 A | <30 A |
| pH (unit) | - | - | - | - | 7.3 | 8.0 | 8.2 | 8.4 | 7.7 |
| Soluble Sulphate (g/l) | - | - | - | - | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| TPH (mg/kg) | 5000* | - | - | - | <20 | 147 | 43 | <20 | <20 |

Notes: *relates to commonly used value for TPH concentrations

*** Antimony concentrations are compared to Kelly's Table. For ease of comparison, contamination classes have been added into the table.*

Table 4: Contamination analysis results for Area C.

| Parameters | CLEA SGV Industrial /Commercial (mg/kg) | ICRCL 70/90 Threshold Trigger Concentration | ICRCL 70/90 Maximum (Action Trigger) Concentration: For Grazing Livestock | ICRCL 70/90 Maximum (Action Trigger) Concentration: For Crop Growth (risk of phytotoxicity) | Samples: WS14 0.4 m | WS14 1.5 m | WS15 0.6 m | WS15 2.3-2.6 m | WS16 0-0.6 m | WS16 1.7-2.1 m | WS17 0.6-1.4 m | WS17 1.8 m |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Arsenic (mg/kg) | 500 | 50 | 500 | 1000 | 62 | 130 | 45 | 7.3 | 69 | 9.8 | 63 | <5.0 |
| Total Cadmium (mg/kg) | 1400 | 3 | 30 | 50 | 43 | 12 | 12 | 3.3 | 127 | 1.8 | 68 | 2.3 |
| Total Lead (mg/kg) | 750 | 300 | 1000 | - | 6600 | 2400 | 550 | <30 | 8400 | 160 | 4700 | 51 |
| Total Zinc (mg/kg) | - | 1000 | 3000 | 1000 | 24000 | 8900 | 4000 | 130 | 31000 | 510 | 230 | 180 |
| Total Antimony (mg/kg)** | - | - | - | - | 160 D | 13 A | 35 B | 50 B | 180 D | 50 B | 95 C | 65 C |
| pH (unit) | - | - | - | - | 8.3 | 8.3 | 7.6 | 8.5 | 8.5 | 8.0 | 8.1 | 7.3 |
| Soluble Sulphate (g/l) | - | - | - | - | <0.5 | <0.5 | 0.73 | <0.5 | <0.5 | <0.5 | 0.56 | <0.5 |
| TPH (mg/kg) | 5000* | - | - | - | 3193 | 1394 | 95 | 4349 | 6023 | <20 | 6360 | <20 |

Notes: *relates to commonly used value for TPH concentrations

*** Antimony concentrations are compared to Kelly's Table. For ease of comparison, contamination classes have been added into the table.*

Table 5: Contamination analysis results for Area D.

| Parameters | CLEA SGV Industrial /Commercial (mg/kg) | ICRCL 70/90 Threshold Trigger Concentration | ICRCL 70/90 Maximum (Action Trigger) Concentration | | Samples | | |
|---|---|---|---|---|---|---|---|
| | | | For Grazing Livestock | For Crop Growth (risk of phytotoxicity) | WS18 0-0.4 m | WS18 2.5-3.0 m | WS20 1.5 m |
| Total Arsenic (mg/kg) | 500 | 50 | 500 | 1000 | 6 | <5 | <5 |
| Total Cadmium (mg/kg) | 1400 | 3 | 30 | 50 | 1.6 | <1 | <1 |
| Total Lead (mg/kg) | 750 | 300 | 1000 | - | 70 | <30 | <30 |
| Total Zinc (mg/kg) | | 1000 | 3000 | 1000 | 290 | 85 | 120 |
| Total Antimony (mg/kg)** | - | - | - | - | <30 A | <30 A | <30 A |
| pH (unit) | - | - | - | - | 7.5 | 8.5 | 8.3 |
| Soluble Sulphate (g/l) | - | - | - | - | <0.5 | <0.5 | <0.5 |
| TPH (mg/kg) | 5000* | - | - | - | <20 | 96 | <20 |

Notes: *relates to commonly used value for TPH concentrations

*** Antimony concentrations are compared to Kellys Table. For ease of comparison, contamination classes have been added into the above.*

Table 6: Contamination analysis results for Area E.

| Parameters | CLEA SGV Industrial /Commercial (mg/kg) | ICRCL 70/90 Threshold Trigger Concentration | ICRCL 70/90 Maximum (Action Trigger) Concentration | | Samples | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | For Grazing Livestock | For Crop Growth (risk of phytotoxicity) | WS1 3 0.3 m | WS1 3 1.4 m | WS1 9 0.4 m | WS2 1 1.3 m | WS2 2 0-1.2m | WS2 2 1.7-2.0m | WS2 3 0-1.4m | WS2 4 0-0.5m |
| Total Arsenic (mg/kg) | 500 | 50 | 500 | 1000 | 120 | 140 | 120 | 160 | 18 | <5 | 53 | <5 |
| Total Cadmium (mg/kg) | 1400 | 3 | 30 | 50 | 77 | 59 | 41 | 28 | <1 | 1.4 | 47 | 1.4 |
| Total Lead (mg/kg) | 750 | 300 | 1000 | - | 15000 | 7200 | 2700 | 2600 | 53 | <30 | 3300 | 75 |
| Total Zinc (mg/kg) | - | 1000 | 3000 | 1000 | 26000 | 19000 | 14000 | 18000 | 350 | 61 | 14000 | 330 |
| Total Antimony (mg/kg)** | - | - | - | - | 205 D | 130 D | 45 B | 85 C | <30 A | <30 A | 115 D | <30 A |
| pH (unit) | - | - | - | - | 7.9 | 7.9 | 8.4 | 7.8 | 6.8 | 3.1 | 7.7 | 7.7 |
| Soluble Sulphate (g/l) | - | - | - | - | 0.6 | <0.5 | <0.5 | <0.5 | <0.5 | 0.75 | 0.57 | <0.5 |
| TPH (mg/kg) | 5000* | - | - | - | 173 | 187 | <20 | <20 | <20 | <20 | <20 | <20 |

Notes: *relates to commonly used value for TPH concentrations

*** Antimony concentrations are compared to Kellys Table. For ease of comparison, contamination classes have been added into the table.*

Table 7: Contamination analysis results for Area F.

| Parameters | CLEA SGV Industrial /Commercial (mg/kg) | ICRCL 70/90 Threshold Trigger Concentration | ICRCL 70/90 Maximum (Action Trigger) Concentration | | Samples | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | For Grazing Livestock | For Crop Growth (risk of phytotoxicity) | WS24 0-0.5 m | WS25 0.8-1.1 m | WS26 0.7-1.0 m | WS27 0.7-1.0 m | WS28 0-0.5 m | WS28 1.5-2.0m |
| Total Arsenic (mg/kg) | 500 | 50 | 500 | 1000 | <5 | <5 | <5 | 13 | 58 | <5 |
| Total Cadmium (mg/kg) | 1400 | 3 | 30 | 50 | 1.4 | <1 | 1.8 | 1.3 | 16 | <1 |
| Total Lead (mg/kg) | 750 | 300 | 1000 | - | 75 | 78 | <30 | 95 | 1700 | <30 |
| Total Zinc (mg/kg) | - | 1000 | 3000 | 1000 | 330 | 620 | 92 | 590 | 5600 | 140 |
| Total Antimony (mg/kg)** | - | - | - | - | <30 A | 1640 E | 35 B | 50 B | 65 C | <30 A |
| pH (unit) | - | - | - | - | 7.7 | 8.1 | 7.9 | 8.5 | 8.1 | 7.8 |
| Soluble Sulphate (g/l) | - | - | - | - | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| TPH (mg/kg) | 5000* | - | - | - | <20 | 37 | <20 | <20 | <20 | 250 |

Notes: *relates to commonly used value for TPH concentrations

*** Antimony concentrations are compared to Kellys Table. For ease of comparison, contamination classes have been added into the table.*

Table 8: Contamination analysis results for Area G.

| Parameters | CLEA SGV Industrial /Commercial (mg/kg) | ICRCL 70/90 Threshold Trigger Concentration | ICRCL 70/90 Maximum (Action Trigger) Concentration | | Samples | | |
|---|---|---|---|---|---|---|---|
| | | | For Grazing Livestock | For Crop Growth (risk of phytotoxicity) | WS29 0.8 m | WS30 0.8-0.9 m | WS31 0.4 m |
| Total Arsenic (mg/kg) | 500 | 50 | 500 | 1000 | <5 | 180 | 150 |
| Total Cadmium (mg/kg) | 1400 | 3 | 30 | 50 | 1.7 | 13 | 61 |
| Total Lead (mg/kg) | 750 | 300 | 1000 | - | <30 | 940 | 5100 |
| Total Zinc (mg/kg) | - | 1000 | 3000 | 1000 | 62 | 4000 | 20000 |
| Total Antimony (mg/kg)** | - | - | - | - | <30 A | 50 B | 70 C |
| pH (unit) | - | - | - | - | 7.4 | 8 | 8.3 |
| Soluble Sulphate (g/l) | - | - | - | - | <0.5 | <0.5 | <0.5 |
| TPH (mg/kg) | 5000* | - | - | - | <20 | <20 | 1410 |

Notes: *relates to commonly used value for TPH concentrations

*** Antimony concentrations are compared to Kellys Table. For ease of comparison, contamination classes have been added into the table.*

Table 9: Contamination analysis results for Area I.

| Parameters | CLEA SGV Industrial /Commercial (mg/kg) | ICRCL 70/90 Threshold Trigger Concentration | ICRCL 70/90 Maximum (Action Trigger) Concentration | | Samples |
|---|---|---|---|---|---|
| | | | For Grazing Livestock | For Crop Growth (risk of phytotoxicity) | WS33 0-0.5 m |
| Total Arsenic (mg/kg) | 500 | 50 | 500 | 1000 | 32 |
| Total Cadmium (mg/kg) | 1400 | 3 | 30 | 50 | 2 |
| Total Lead (mg/kg) | 750 | 300 | 1000 | - | 240 |
| Total Zinc (mg/kg) | - | 1000 | 3000 | 1000 | 1000 |
| Total Antimony (mg/kg)** | - | - | - | - | <30 A |
| pH (unit) | - | - | - | - | 8.3 |
| Soluble Sulphate (g/l) | - | - | - | - | <0.5 |
| TPH (mg/kg) | 5000* | - | - | - | <20 |

Notes: *relates to commonly used value for TPH concentrations

*** Antimony concentrations are compared to Kellys Table. For ease of comparison, contamination classes have been added into the table.*

Table 10 Contamination analysis results for Sediment Samples from Settling Ponds

| Parameters | CLEA SGV Industrial /Commercial (mg/kg) | ICRCL 70/90 Threshold Trigger Concentration | ICRCL 70/90 Maximum (Action Trigger) Concentration | | Samples | | | |
|---|---|---|---|---|---|---|---|---|
| | | | For Grazing Livestock | For Crop Growth (risk of phytotoxicity) | S1L1 | S1L2 | S2L1 | S2L2 |
| Total Arsenic (mg/kg) | 500 | 50 | 500 | 1000 | 78 | 97 | 120 | 54 |
| Total Cadmium (mg/kg) | 1400 | 3 | 30 | 50 | 177 | 68 | 37 | 44 |
| Total Lead (mg/kg) | 750 | 300 | 1000 | - | 13000 | 11000 | 8000 | 3400 |
| Total Zinc (mg/kg) | | 1000 | 3000 | 1000 | 57000 | 28000 | 16000 | 16000 |
| Total Antimony (mg/kg)** | - | - | - | - | 155 D | 155 D | 120 D | 80 C |
| pH (unit) | - | - | - | - | 7.9 | 8.1 | 7.9 | 7.9 |
| Soluble Sulphate (g/l) | - | - | - | - | <0.5 | <0.5 | <0.5 | <0.5 |
| TPH (mg/kg) | 5000* | - | - | - | 3067 | 54288 | 510 | 2540 |

Notes: *relates to commonly used value for TPH concentrations

*** Antimony concentrations are compared to Kellys Table. For ease of comparison, contamination classes have been added into the tab*

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