# Mine Operations Plan

## Tahmoor Colliery

**2012 – 2019**
**Amendment A**
**October 2015**
**Amendment B**
**December 2017**
**Amendment C**
**February 2018**
**Amendment D**
**March 2018**
**Amendment E**
**March 2018**
**Amendment F**
**August 2018**
**Amendment G**
**May 2019**

Note:
The following convention has been applied to the text.
MOP Original – Black text
Amendment A - Red text
Amendment B – Blue Text
Amendment C – Maroon Text
Amendment D – Purple text
Amendment E – Orange Text
Amendment F – Green Text
Amendment G – Navy Text

# MINE OPERATIONS PLAN

## (MOP) - Amendment G

| | |
|---|---|
| **Name of Mine:** | **Tahmoor Colliery** |
| Name of Leaseholder: | Tahmoor Coal Pty Ltd |
| Name of Mine Operator: | Tahmoor Coal Pty Ltd |
| Titles / Mining Leases: | ML1376, ML1308, ML1539, ML1642 & CCL716 |
| MOP Commencement Date: | 1 October 2012 |
| MOP Completion Date: | 30 September 2019 |
| Mine Manager: | Malcolm Waterfall<br>Manager of Mining Engineering<br>(02) 4640 0100 |
| Environmental Representative: | Ron Bush<br>Manager Environment and Community<br>(02) 4640 0100 |
| Authorisation Holder: | Tahmoor Coal Pty Limited |
| Authorisation Representative: | Peter Vale<br>General Manager<br>(02) 4640 0100 |
| Reporting Officer: | Belinda Clayton<br>Approvals and Community Coordinator<br>(02) 4640 0133 |
| Signature: | ……………………………….. |
| Date: | 1 May 2019 |

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Amendment A Added
Fiona Robinson
Amendment B Added
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Amendment C Added
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Amendment D Added
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Amendment E Added
Fiona Robinson
Amendment F Added
Fiona Robinson/Ron Bush
Amendment G Added
Fiona Robinson/Ron Bush

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# 1 INTRODUCTION

Tahmoor Colliery is located south of the township of Tahmoor approximately 80 km south west of Sydney. Surface facilities are situated to the South of the Bargo River and adjacent to Remembrance Driveway (Old Hume Highway). The Refuse (Reject) Emplacement Area (REA) is located to the East of the main southern railway. The underground workings extend under the town of Tahmoor. Two (2) ventilation shafts are located on the outskirts of the town and one (1) on the mine site.

Construction of the mine was commenced by Clutha Development in 1975. Mining commenced in 1980 and the Tahmoor Washery commissioned in 1981. In the mid 80's, BP Coal acquired the mine from Clutha Development. In 1987 the gas extraction facility was commissioned and longwall mining commenced. CRA acquired BP Coal's interest in Tahmoor Colliery in 1989. In 1997, Austral Coal Limited acquired Tahmoor Colliery from CRA. In 2005, Centennial Coal acquired a majority shareholding in Austral Coal Limited. Tahmoor Colliery is owned by Tahmoor Coal Pty Ltd ("Tahmoor Coal") a fully owned subsidiary of Austral Coal Limited ("Austral"). In October 2007 Xstrata Coal Pty Ltd ("Xstrata Coal") successfully acquired 100% shareholding in Austral, and therefore ownership of Tahmoor Colliery. In 2013, Xstrata merged with Glencore. Tahmoor Colliery is now known as Glencore's Tahmoor Underground. Tahmoor Coal Pty Ltd was acquired on 20 April 2018 the GFG Alliance's SIMEC Mining division, specifically SIMEC (Australia) Mining Pty Ltd, and now operates as Tahmoor Coking Coal Operations (**TCCO**).

The first Mining Operations Plan for Tahmoor Colliery was prepared for the period from June 2002 to April 2008. This plan was accepted in August 2002. The current plan has been amended on a number of occasions and its period of operation extended to 30 September 2012.

This Mining Operations Plan (MOP) has been prepared in accordance the *Interim Mining Operations Plan Guideline (DRE, 2012)*, and covers the period from 1 October 2012 to 30 September 2019

This MOP was approved first approved on the 25 January 2013. At this time Tahmoor Colliery was intending to lodge a development application for the proposed Tahmoor South Project which would have amended the Refuse Emplacement Area substantially.

As this application has not yet been lodged, Tahmoor Colliery has reviewed its current refuse emplacement capacity with the aim of utilising the total approved capacity of the existing REA.

Tahmoor Coal received development consent DA57/93 for the Refuse Emplacement Area in 1994 from the Land and Environment Court.

The current Refuse Emplacement Area was approved to an area of 73 hectares in DA 57/93, and was planned to be progressively extended over time and completed areas concurrently rehabilitated. At the present time approximately 69 hectares has been emplaced and progressively rehabilitated.

Tahmoor Coal now plans to extend the REA to the full approved area. The expansion is planned to occur during the final quarter of 2015.

Tahmoor Coal is seeking to amend the current MOP in October 2015 to incorporate the proposed changes.

Tahmoor Coal has engaged the services of Cardno to review the approved emplacement area and has designed the expansion in accordance with the approval.

A number of drawings have been provided in the appendix including

- Figure 5.1 – DA57/93 Approved Final Shape of the Refuse Emplacement Area – Figure 7.15 from the EIS
- Figure 5.2 – Cardno drawing of the proposed works showing the additional 4 hectares of the REA contained within the existing approval including in Figure 5.1

Tahmoor Coal operates under a number of consents for the REA, and according to legal advice both consents are valid. These include the:

- 1979 Development Consent for the Coal Preparation Plant and Ancillary Washery and Reject Area
- Tahmoor North Consent approved by the Land and Environment Court in 1994

As mentioned above the 1994 consent is approved to an area of 73ha, however the 1979 Consent is approved to an area of 87.4 ha. Tahmoor Coal intends to expand the REA to the full extent approved in the 1979 consent throughout the MOP approval period.

Tahmoor Coal is seeking to amend the current MOP in December 2017 to incorporate the proposed changes.

A number of drawing are included in the appendix including:

- Figure 6.1 – Approved shape of the REA in accordance with the 1979 Consent
- Figure 6.2 – Cardno Drawings of Stage 1 expansion of the REA

In May 2018, TCCO received a Section 240 Notice (Our Ref: DI0680 2018, ACES Ref: 0353-2016, OUT17/48999) from the DPE Resource Regulator. This direction outlined a number of actions, which included incorporation of the Corrective Management Action Plan (CMAP) for the rehabilitation of Myrtle Creek (Revision B, Version 1, dated 16 June 2017 No. TAHUG-2119843053-10). This further addressed in Section 5.5 and a copy of the Myrtle Creek CMAP is included as Appendix 6.

In addition in May 2018, the NSW Resource Regulator conducted an inspection of the REA.

Actions that resulted from this inspection included:

- Stabilisation of the earthern drains at the REA
- Review the topsoil depth checking process

These actions are addressed in Section 6.1 and a copy of correspondence addressing these actions is included as Appendix 8.

The Longwall 32 Subsidence Management Plan Approval dated 14 September 2018 requires that the Environmental Management Plan (EMP) for Longwall 32 be incorporated as an appendix to the Mining Operations Plan. The Longwall 32 EMP is contained within Appendix 9.

## 1.1 CONSENTS, AUTHORISATIONS AND LICENSES

Tahmoor Colliery has been in operation for over 30 years, during which time a number of major and minor changes to planning, development and mining legalisation have occurred. As a result, the consents and approvals for Tahmoor Colliery are large in number, and cover a variety of land areas and successive mine developments.

A summary of Tahmoor Colliery Development Consents is provided in **Table 1.1**.

A summary of Tahmoor Colliery Leases and Exploration Authorisations is provided in **Table 1.2**.

A summary of Tahmoor Colliery licences is provided in **Table 1.3**, including the site Environment Protection Licence (EPL), Water Licences and Dangerous Goods Licence.

Other approvals issued by government agencies include the site's Subsidence Management Plans; a summary of these is provided in **Table 1.4**.

**Table 1.1 Tahmoor Colliery Development Consents**

| Consent Number | Consent Description | Date Granted | Expiry Date |
|---|---|---|---|
| DA 1975 | Underground Mine | 26/03/1975 | No expiry |
| DA 1979 | Coal Preparation Plant Stockpiles and Refuse Emplacement Area | 23/08/1979 | No expiry |
| DA 1979 (Mod 1) | Modification for road haulage of trial coal shipments | 16/09/1985 | No expiry |
| DA 190/85 | Surface Works for Gas Extraction | 16/12/1985 | No expiry |
| DA 1979 (Mod 2) | Modification for Upgrades for Longwall Mining | 05/11/1986 | No expiry |
| DA 1979 (Mod 3) | Modification for Road haulage in Wollondilly Shire and when rail unavailable | 1988 | No expiry |
| DA 57/93 | Tahmoor North Project | 7 /09/1994 | No expiry |
| DA 1979 (Mod 4) | Modification for Road haulage to Corrimal and Coal Cliff Coke Works | 13/12/1994 | No expiry |
| DA 67/98 | Tahmoor North Extension Project | 25/02/1999 | 16/06/2024 |
| DA 67/98 (Mod 1) | Modification for additional areas to be subsided | 26/11/2006 | 16/06/2024 |
| DA 57/93 (Mod 1) | Modification for heritage approval condition | 7/06/2007 | No expiry |
| DA 67/98 (Mod 2) | Modification for Redbank Tunnel Subsidence Management | 8/04/2012 | 16/06/2024 |
| DA 67/98 (Mod 3) | Modification for Redbank Tunnel Subdivision of Land | 18/9/12 | 16/06/2024 |
| DA 67/98 (Mod 4) | Expanded Subsidence Footprint | 15/10/18 | 16/06/2024 |

**Table 1.2 Tahmoor Coal Pty Limited Mining Leases & Exploration Authorisations**

| Title Lease / Authorisation | Lease / Authorisation Description | Date Granted | Expiry Date |
|---|---|---|---|
| Consolidated Coal Lease 716 | Original Tahmoor Leases | 15/06/1990 | 13/03/2021 |
| Mining Lease 1376 | Tahmoor North Lease | 28/08/1995 | 28/08/2016 |
| Mining Lease 1308 | Small Western lease to west of CCL716 | 02/03/2014 | 02/03/2035 |
| Mining Lease 1539 | Tahmoor North Extension Lease | 16/06/2003 | 16/06/2024 |
| Mining Lease 1642 | Surface Freehold Areas | 27/08/2010 | 27/08/2031 |
| Exploration Authorisation 206 | Exploration Authorisation 206 - coincides with CCL 716 (renewal application pending with DRE) | | |
| Exploration Authorisation 410 | Exploration Authorisation 410 - coincides with ML 1376 and ML 1539 (renewal application pending with DRE) | | |

**Table 1.3 Summary of Tahmoor Coal Pty Ltd Licences**

| Licence Title | Date Granted | Expiry Date |
|---|---|---|
| Environment Protection Licence 1389 | 1/05/2012 | 1/01/2013 |
| Water Licence (Line 1) 10BL602333 | 21/05/2008 | 20/05/2013 |
| Water Licence (Line 2) 10BL602336 | 21/05/2008 | 20/05/2013 |
| Water Licence (Line 3) 10BL602337 | 21/05/2008 | 20/05/2013 |
| Dangerous Goods Licence XSTR200005 | 18/01/2012 | 2/02/2017 |

**Table 1.4 SMP Approval Status**

| SMP Approval | Approval Status |
|---|---|
| LW26 Second Workings - extraction | Approved 9/04/2009 |
| LW27 First Workings | Approved 25/05/010 |
| LW28 First Workings | Approved 3/05/012 |
| LW27-30 Second Workings - extraction | 31/10/12 |
| LW31 Second Workings | 3/5/2017 |
| LW32 – Second Workings | 14/9/2018 |

## 1.2 LAND OWNERSHIP

Tahmoor Colliery is owned by Tahmoor Coal Pty Limited, a fully owned subsidiary of Xstrata Coal New South Wales. For the purpose of this document, all references to Tahmoor Colliery, infer Tahmoor Coal Pty Limited. A schedule of land owned by Tahmoor Colliery is provided in **Table 1.5** below.

All properties listed are freehold land and are consistent with Map 1 – Pre-Mining Environment.

**Table 1.5 Schedule of Land Ownership**

| Lot | DP | Physical Address | Tenure Type | Occupancy Description |
|---|---|---|---|---|
| 170 | 751250 | Ashby Close, Bargo | Freehold | Bargo Colliery Site |
| 35 | 751250 | Tylers Rd, Bargo | Freehold | Bargo Colliery Site |
| 1 | 120968 | Remembrance Driveway, Bargo | Freehold | Tahmoor Colliery Mine Site |
| 162 | 1054184 | Remembrance Driveway, Bargo | Freehold | Tahmoor Colliery Mine Site |
| 162 | 1054184 | Remembrance Driveway, Bargo | Freehold | Tahmoor Colliery Mine Site |
| 162 | 1054184 | Remembrance Driveway, Bargo | Freehold | Tahmoor Colliery Mine Site |
| 13 | 3306 | Stratford Rd, Tahmoor | Freehold | Tahmoor Colliery No.1 Shaft |
| 441 | 751270 | 275 Rockford Rd, Tahmoor | Freehold | Tahmoor Colliery No.2 Shaft |
| 11 | 1012641 | 140 Bridge Street, Picton | Freehold | Vacant Land |
| 22 | 734563 | Bridge Street, Picton | Freehold | Tahmoor Colliery No.4 Shaft (approved – no yet constructed) |
| 248 | 751250 | Charlies Point Road, Bargo | Freehold | Refuse Emplacement Area |
| 217 | 751250 | 115 Charlies Point Road, Bargo | Freehold | House occupied by tenant |
| 2232 | 787222 | 225 Charlies Point Road, Bargo | Freehold | Refuse Emplacement Area |
| 21 | 776716 | 80 Innes Street, Thirlmere | Freehold | Tahmoor Colliery No.4 Shaft (proposed site – no yet approved or constructed) |
| 245 | 751250 | 125 Anthony Road, Bargo | Freehold | Agisted land. |
| 132 | 879762 | 4 Hodgson Grove, Tahmoor | Freehold | House occupied by tenant |
| 134 | 879762 | 7 Hodgson Grove, Tahmoor | Freehold | House occupied by tenant |
| 64 | 10669 | 5 Struan St, Tahmoor | Freehold | House unoccupied |

## 1.3 STAKEHOLDER CONSULTATION

Tahmoor Colliery has developed a Social Involvement Plan (SIP) to assist in the process of continually improving and maintaining Tahmoor Colliery's role as a responsible corporate citizen and to assist with the implementation of appropriate communication strategies to promote positive and long-term relationships with our community.
The objectives of this plan include but are not limited to:

- Identify key stakeholders;
- Identify and document key community risks and opportunities including methods to manage them effectively so as to prevent adverse impacts;
- Establish and document consultation strategies;
- Deliver sustainable benefits to the community in which Tahmoor Colliery operates by building local capacity via the community support programs; and
- Comply with the requirements of Xstrata plc SD Standards and Business Principles and also the Xstrata Coal Policies and Standards.

The SIP covers all stakeholder engagement, including neighbouring land holders, community members from the local area and wider region, and engagement with various government agencies. Tahmoor Colliery engages with the Tahmoor Colliery Community Consultation Committee (TCCCC) on matters relating to mine rehabilitation and closure, through quarterly reporting and annual site inspections of the site (including mine rehabilitation areas at the site Refuse Emplacement Area). The TCCCC includes Councillors from Wollondilly Shire Council and representatives of the local community, as well representatives from non-government organisations involved in environmental management.

Stakeholder consultation is an ongoing process that takes place throughout the life of the project. Tahmoor Colliery has established a good working relationship with the local community and seeks to continue this as we continue our operations. A list of the key stakeholders is provided in **Table 1.6**.

**Table 1.6 Tahmoor Colliery Key Stakeholder List**

| Stakeholder | Information requirements and Method of Consultation |
| --- | --- |
| **Local community**<br>• **Stakeholders within 100m buffer of pit top operations**<br>• **Stakeholders in active subsidence zone** | Ongoing consultation with stakeholders within local community before, during and after mining operations will be undertaken by various methods including community information sessions, monthly newsletters, face to face meetings and newspaper articles. They will be informed and provided with the opportunity to provide feedback in relation to mining operations, rehabilitation objectives/criteria and progress throughout the life of the mine and at mine closure. |
| **NSW Department of Trade & Investment, Regional Infrastructure and Services** | Ongoing consultation for management of statutory matters. Liaise for lease relinquishment. Address matters raised in guidelines, policies and project approval before, during and after mining operations. |
| **Office of Environment & Heritage / Environment Protection Authority** | Liaise regularly to attend to licence management matters. Ongoing consultation for management of statutory matters. Liaise for lease relinquishment. Review Closure Decommissioning and Rehabilitation MOP. |
| **NSW Department of Planning & Infrastructure** | Ongoing consultation to manage development consent and planning matters before and during mining operations. Review Closure Decommissioning and Rehabilitation MOP. |
| **NSW Office of Water** | Ongoing consultation to manage water during mining operations including mine dewatering and discharge boreholes sealed as required by. NOW kept informed of developments and process. |
| **Wollondilly Shire Council** | Ongoing consultation with respect to development consent matters and project planning before, during and after mining operations. Review Closure Decommissioning and Rehabilitation MOP. |
| **Mine Subsidence Board (MSB) now known as the Subsidence Advisory NSW** | Ongoing consultation before, during and after mining operations with MSB representatives. Face to face engagement with MSB representative and local residents impacted or potentially impacted by subsidence. |
| **Xstrata Coal / Xstrata Coal NSW now referred to as Glencore Coal Assets Australia (GCAA)** | As per Xstrata and XCN internal communication standards. |
| **Potential final land user** | If identified, the final land user should be consulted (where appropriate) through the detailed mine closure development process in order to maximise potential opportunities to value add to the land. |
| **Aboriginal groups** | Consultation as required pertaining to the management of Aboriginal heritage sites. Where appropriate, consultation will be conducted via site inspections/meetings. |
| **Local business community** | Ongoing updates of mining operations via newsletters, information sessions and newspaper articles. To be consulted regarding any Social Impact Assessments that may be |

| Stakeholder | Information requirements and Method of Consultation |
|---|---|
| | undertaken prior to mine closure. Methods for consultation with businesses will be developed as part of the assessment process. |
| **Community Groups** | Financial and in kind support for local community groups via Xstrata Coal Tahmoor's Corporate Social Involvement community support program. Community support programmes focus on enhancing socio-economic capacity, prosperity and environmental health of stakeholder communities. They are aimed at sustainable enhancements that do not remain dependent on the operation beyond its expected life. |
| **Tahmoor Colliery Employees** | Ongoing communication with Tahmoor Colliery employees regarding current and future mining operations via various forms including tool box talks, newsletters and monthly meetings. Likely timing of mine closure and implications for future employment will be communicated through tool box talks, staff meetings and internal publications (i.e. newsletters). |

# 2 PROPOSED MINING ACTIVITIES

## 2.1 PROJECT DESCRIPTION

Tahmoor Colliery is currently extracting Longwall 26 (LW26). Current mining activities are completed in accordance with the Subsidence Management Plan (SMP) application for LW 24-26. Tahmoor Colliery currently has SMP approval for LW27 first workings, while LW27 extraction approval is expected later in 2012. Progressive SMP first workings and extraction approvals are expected over time for future workings beyond LW30 during the MOP reporting period. The general sequence and staging of longwall extraction for Life of Mine (which includes the MOP period) is provided in **Table 2.1**. Tahmoor's expected Life of Mine currently extends to around 2020 depending on mining extraction rates and resource recovery options. Mine life may extend beyond 2020 during which time smaller remnant coal blocks and main roadway pillars may also be extracted.

**Table 2.1 Proposed longwall mining sequence for Life of Mine**

| Longwall Panel | Proposed Start | Proposed Completion |
|---|---|---|
| Longwall 26 | 30/03/2011 | 02/09/2012 |
| Longwall 27 | 01/10/2012 | 14/09/2013 |
| Longwall 28 | 11/10/2013 | 12/08/2014 |
| Longwall 29 | 08/09/2014 | 20/06/2015 |
| Longwall 30 | 17/07/2015 | 27/04/2016 |
| Longwall 31 | 24/05/2016 | 26/6/2018 |
| Longwall 32 | 24/07/2018 | 19/05/2019 |
| Longwall 33 | 20/06/2019 | 15/04/2020 |
| Longwall 34 | 13/05/2020 | 31/12/2020 |
| Longwall 35 | 28/01/2021 | 17/08/2021 |

Tahmoor Colliery processes Run of Mine (ROM) Coal at an on-site Coal Handling & Preparation Plant (CHPP). The CHPP utilises crushing and screening, primary and secondary cyclones, and a flotation circuit to produce coking and thermal coal product which is stockpiled, before being loaded and transported by rail to Port Kembla Coal Terminal.

Fine reject from the coal washing process is dried using a belt press filter and mixed with coarse reject before being conveyed to the on-site Refuse Emplacement Area (REA). Refuse is emplaced using haul trucks and reshaped by dozers, before being capped with topsoil and progressively rehabilitated.

All coal and reject handling is by a fully enclosed conveyor system, with the exception of the tripper conveyor to the primary product stockpile.

All operations described in this section are expected to remain for the Life of Mine.

## 2.2 ACTIVITIES OVER THE MOP TERM

**Construction Activities**

The following projects are expected to be constructed and complete during the MOP term:

- Upgrade to existing Health, Safety and Training Building;
- Upgrade to Mine Production building;
- New surface car parking facilities;
- Continued construction of services associated with the recently constructed Recycled Water Treatment Plant ( Environment Protection Licence Pollution Reduction Plan - PRP20);
- Waste Water Treatment Plant (PRP22);
- Completion of the Redbank Tunnel Railway Subsidence Management Project;
- Upgrade to coal handling and processing equipment;
- Completion of a coal seam methane gas flaring plant;
- Upgrade to No.3 Shaft winder with man riding capabilities; and
- No.4 Shaft and main ventilation fan construction

Before construction activities commence on the above projects, the necessary consents and approvals will be gained, if not already held, as required.

**Amendment A**

The proposed works comprising the construction of the additional 4 hectares of the REA include:

- Surveying and marking up of the boundary limits of the approved area by a registered surveyor
- Appropriate Colliery supervision to ensure all works are contained to the boundary limits of the existing REA approval and undertaken in accordance with Tahmoor Colliery Ground Disturbance and Excavation Procedures
- Clearing and mulching of remnant vegetation
- Removal and stockpiling of topsoil and subsoil
- Construction of clean and dirty water drainage systems including temporary erosion and sediment control
- Relocation of the access road around the perimeter of the Emplacement
- Emplacement of refuse
- Rehabilitation of the area

In the Environmental Impact Statement included in approval DA 57/93, the REA was described in Section 7.7 and the final shape of the REA is shown in Figure 7.15. The REA was proposed to be progressively enlarged over time, with each completed stage of emplacement rehabilitated and revegetated. The proposed works above comprise the next stage of the approved REA and are in full conformance with the EIS and approved by the Land and Environment Court. No further Department of Planning and Environment consultation or approval is required to undertake the proposed works, as they are already approved.

**Amendment B**

The proposed works include the construction of a total of 14 hectares expansion of the REA. This will be completed in stages with the first stage being approximately 5 hectares. As with previous expansions this will involve:

- Surveying and marking up of the boundary limits of the approved area by a registered surveyor
- Appropriate Colliery supervision to ensure all works are contained to the boundary limits of the existing REA approval and undertaken in accordance with Tahmoor Colliery Ground Disturbance and Excavation Procedures
- Clearing and mulching of remnant vegetation
- Removal and stockpiling of topsoil and subsoil
- Construction of clean and dirty water drainage systems including temporary erosion and sediment control
- Relocation of the access road around the perimeter of the Emplacement
- Emplacement of refuse
- Rehabilitation of the area

**Long term Drainage**

It is envisaged that if the Tahmoor South Project is approved that the drainage of the entire REA will be modified, such that the majority of cleanwater drainage will be transferred in an easterly direction. In the event that the Tahmoor South Project is not approved a review of the long term drainage will be conducted to remove the long term need for the proposed underdrainage. This redesign will be conducted in consultation with the relevant agencies at that time.

**Mine Development & Sequence**

Current mining methods (continuous miners and longwall extraction) will continue for the term of the MOP, and generally in accordance with the sequencing information provided in **Table 2.1**.

**Tailings/Reject Management Operations**

Refuse emplacement activities as described in Section 2.1 will continue over the term of the MOP.

**Overview of Rehabilitation Activities**

Rehabilitation is undertaken in accordance with Tahmoor's *Biodiversity & Land Management Plan*, with the annual program detailed each year in the site *Annual Rehabilitation Plan*. All disturbed areas are rehabilitated once they become available, with rehabilitation activities generally involving the application of topsoil (or other growth media), scarification and/or ripping to encourage drainage and create furrows for seed bed, the application of any required ameliorants or fertilizers, and finally direct seeding or planting with tubestock, depending on the rehabilitation objectives for the area. The majority of rehabilitation completed during the MOP term will be at the REA, as emplaced areas are progressively reshaped, topsoiled and rehabilitated.

**Proposed Exploration**

No surface drilling exploration activities are currently proposed in the Tahmoor North Leases, however drilling may be carried out in the future to further determine or define geological structure, coal quality or for other investigatory or monitoring purposes. Similarly surface seismic or other surface exploration is not currently proposed in the Tahmoor North Leases however it may be undertaken for similar purposes as exploration drilling. Extensive underground exploration is undertaken by in-seam drilling and will continue throughout the MOP period.

**Production & Waste Schedule**

A summary of the expected production and waste schedule is provided in **Table 2.2**.

**Table 2.2 Production & Waste Schedule for the MOP Term**

| Material Production Schedule during MOP Term | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Material** | **Unit** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** |
| **ROM Coal** | t | 2,632,812 | 3,038,996 | 3,048,819 | 2,995,780 | 3,138,411 | 3,162,854 | 2,570,641 | 2,231,340 |
| **Reject** | t | 861,127 | 702,779 | 645,653 | 641,401 | 651,332 | 843,811 | 570,176 | 707,402 |
| **Product Coal (Coking)** | t | 1,718,436 | 2,376,769 | 2,439,431 | 2,378,639 | 2,524,714 | 2,342,549 | 2,024,024 | 1,384,045 |

# 3. ENVIRONMENTAL ISSUES MANAGEMENT

## 3.1 RISK ASSESSMENT

Tahmoor Colliery has developed an Environment & Community Broad Brush Risk Assessment (ECBBRA), which identifies environmental hazards and controls associated with Tahmoor's surface and underground operations. Each year, the ECBBRA is reviewed and updated to capture any changes to internal or external environment. Actions from the ECBBRA are documented in the site action register (XstraSafe), so progress can be tracked by mine management.

The ECBBRA was developed and is reviewed in accordance with AS/NZS ISO 31000:2009 Risk Management – Principles & Guidelines, and the annual ECBBRA review involves a cross section of personnel from Tahmoor Colliery including staff from environment & community, health & safety, coal handling & preparation plant, engineering and mine operations.

The Tahmoor Colliery ECBBRA was undertaken on 4 November 2009, and revised annually as detailed in Table 2.3

**Table 2.3 Tahmoor Colliery E&C BBRA**

| TITLE | VERSION | REVIEW |
|---|---|---|
| Tahmoor Colliery E&C BBRA | 1 | 4/11/2009 |
| Tahmoor Colliery E&C BBRA | 2 | 4/11/2010 |
| Tahmoor Colliery E&C BBRA | 3 | 15/12/2011 |
| Tahmoor Colliery E&C BBRA | 4 | 18/12/2012 |
| Tahmoor Colliery E&C BBRA | 5 | 1/11/2013 |
| Tahmoor Colliery E&C BBRA | 6 | 4/4/2014 |

| | | |
|---|---|---|
| Tahmoor Colliery E&C BBRA | 7 | 17/11/2015 |
| Tahmoor Colliery E&C BBRA | 8 | 7/1/2016 |
| Tahmoor Colliery E&C BBRA | 9 | 19/6/2017 |

## 3.2 ISSUES MANAGEMENT DOCUMENTATION

In accordance with the *Interim Mining Operations Plan Guideline*, a list of environmental issues relevant to Tahmoor and applicable management plans is provided in **Table 3.1**. Tahmoor Colliery management plans are developed to comply with development consent and approval requirements, relevant regulation and legislation, relevant Australian and International standards and guidelines, and internal sustainable development standard requirements

**Table 3.1 Relevant Environmental Issues & Applicable Management Plans**

| Relevant Environment Issues (MOP Guideline) | Tahmoor Colliery Management Plan | Version | Approval Authority or External Agency | Submission or Approval Date |
|---|---|---|---|---|
| Air Quality | Air Quality and Greenhouse Gas Management Plan | 4 | Tahmoor Colliery Environment & Community Manager<br>Department of Planning and Environment | 28/7/17 |
| Erosion & Sedimentation | Soil & Water Management Plan | 1 | Tahmoor Colliery Environment & Community Manager | 29/12/15 |
| Surface Water | Soil & Water Management Plan | 1 | Tahmoor Colliery Environment & Community Manager | 29/12/15 |
| Ground Water | Groundwater Management Plan | 2 | NSW Office of Water | 6/1/16 |
| Contaminated Land | Waste Management Plan | 5 | Tahmoor Colliery Environment & Community Manager | 10/11/15 |
| Flora & Fauna | Biodiversity & Land Management Plan | 6 | Tahmoor Colliery Environment & Community Manager | 29/12/15 |
| Flora & Fauna | Rehabilitation Monitoring Procedure | 4 | Tahmoor Colliery Environment & Community Manager | 6/1/16 |
| Weeds & Pests | Biodiversity & Land Management Plan | 6 | Tahmoor Colliery Environment & Community Manager | 29/12/15 |
| Noise | Noise Management Plan | 7 | NSW Environment Protection Authority<br>Department of Planning and Environment | 26/7/17 |
| Visual & Lighting | Biodiversity & Land Management Plan | 6 | Tahmoor Colliery Environment & Community Manager | 29/12/15 |
| Heritage (Aboriginal & European) | Cultural Heritage Management Plan | 3 | Tahmoor Colliery Environment & Community Manager | 5/1/16 |
| Bushfire | Bushfire Management Plan (draft) | 0 | Tahmoor Colliery Environment & Community Manager | |
| Mine Subsidence | Subsidence Management Plan | - | NSW Department of Trade & Investment | As in table 1.4 |

# Post Mining Land Use

## 4.1 REGULATORY REQUIREMENTS

Tahmoor Colliery has several Development Consent conditions related to mine closure, including some detail on post-mining land use and rehabilitation outcomes. These conditions are detailed in **Table 4.1**.

**Table 4.1 Tahmoor Colliery Development Consent conditions related to Mine Closure**

| Approval Title | Condition |
|---|---|
| DA 1975<br>(26th Mar 1975) | C1 On completion of mining activities the site shall be left safe, clean and tidy to the satisfaction of Council and including the following requirements:<br>(i) where required by Council all buildings shall be either removed or satisfactorily covered;<br>(ii) the site shall be so treated that all batters area at a safe angle of repose;<br>(iii) exclusive only of sealed access roads, the surface area shall be satisfactorily graded, top-dressed to a depth of not less than 6" and established with approved trees and grasses; and<br>(iv) the mine shaft shall be sealed in a substantial manner with adequate provision for drainage of the mine.<br>C2 Where required by Council all buildings shall be either remove or satisfactory covered.<br>C3 The site shall be so treated that all batters are at a safe angle of repose.<br>C4 Exclusive only of sealed access roads, the surface area shall be satisfactorily graded, top-dressed to a depth of not less than 6" (152mm) and established with approved trees and grasses.<br>C5 The mine shaft shall be sealed in a substantial manner with adequate provision for drainage of the mine.<br>C6 *Reference to lease conditions related to shaft sealing and closure*. |
| DA 1979<br>(23rd Aug 1979) | 7) Rehabilitation and re-vegetation of the rejects area to be undertaken to the satisfaction of the Commission. Such satisfaction may be assumed if agreement is reached with the Wollondilly Shire Council and with the Lands Department, the Soil Conservation Service and the National Parks and Wildlife Service to the extent that their jurisdiction applies. |
| DA 1979 (M2)<br>(5th Nov 1986) | (7) Rehabilitation and re-vegetation of the rejects area to be undertaken to the satisfaction of the Commission etc (as per Condition 7 – 23 August 1979). |
| CCL 716 | 21) If so directed by the Minister the lease holder shall rehabilitate to the satisfaction of the Minister any lands within the subject area which may have been disturbed by the lease holder.<br>22) Upon completion of operations on the surface of the subject area or upon the expiry or sooner determination of this authority or any renewal thereof, the lease holder shall remove from such surface such buildings, machinery, plant, equipment, constructions and works as may be directed by the Minister and such surface shall be rehabilitated and left in a clean, tidy and safe condition to the satisfaction of the Minister. |

| Approval Title | Condition |
|---|---|
| | 23) If so directed by the Minister the lease holder shall rehabilitate to the satisfaction of the Minister and within such time as may be allowed by the Minister any lands within the subject area which may have been disturbed by mining or prospecting operations whether such operations were or were not carried out by the lease holder. |
| ML 1642 | 7) Disturbed land must be rehabilitated to a sustainable/agreed end land use to the satisfaction of the Director-General. |

## 4.2 POST MINING LAND USE VISION

There are a number of post mining land use options that may be applicable to the Tahmoor Colliery domains including residential, light industrial or a return to native bushland. Currently, it is considered that the likely final land use option for most all of the Tahmoor Colliery closure domains will be a return to native bushland. However the final land use options will be confirmed in the detailed closure planning process, which involves undertaking a final land use analysis. The detailed closure plan, to be developed within five (5) years of mine closure, will be prepared using the selected final land use at that time.

## 4.3 PROJECT REHABILITATION OBJECTIVES

The general rehabilitation objectives shared by the Tahmoor Colliery closure domains are:

- Remove infrastructure and services;
- Level, re-contour and grade areas to achieve safely battered slopes and surfaces;
- Apply topsoil for rehabilitation where required;
- Establish native bushland vegetation, or other type dependent on selected final land use;
- Develop self-sustaining native bushland which requires minimal ongoing care and maintenance.

More detailed rehabilitation objectives will be included in the detailed mine closure plan. The ultimate goal of achieving these project rehabilitation objectives and final land use goals is to satisfy regulatory requirements for closure and successfully relinquish mining tenements, and return the associated securities. More detailed preliminary closure criteria for each of the domains is provided in Section 5.5.

## 5.1 DOMAIN SELECTION

Tahmoor Colliery has five (5) identified primary closure domains based on operational function and geography. Most of these domains are connected or within close proximity of one another, and will therefore share similar final landforms and rehabilitation objectives. A schedule of these domains, with the rehabilitation status and the start and end of the MOP term, is provided in **Table 5.1**.

**Table 5.1 Tahmoor Colliery Closure Domains**

| Domain | Description | Rehabilitation Status | |
|---|---|---|---|
| | | MOP Commencement | MOP Completion |
| **1** | Tahmoor Main Pit Top Area | - | - |
| **1A** | CHPP | Active Area | Active Area |
| **1B** | Rail Loading Facility | Active Area | Active Area |
| **1C** | Main Workshop and Administration Area | Active Area | Active Area |
| **1D** | No.3 Shaft and Gas Drainage Plant | Active Area | Active Area |
| **1E** | Sewage/Water Treatment Plant | Active Area | Active Area |
| **2** | Product Stockpile Area | Active Area | Active Area |
| **3** | Refuse Emplacement Area | Active Area, Ecosystem Est., & Ecosystem Dev. | Active Area, Ecosystem Est., & Ecosystem Dev. |
| **4** | No.1 Ventilation Shaft | Active Area | Active Area |
| **5** | No.2 Ventilation Shaft | Active Area | Active Area |
| **6** | Off Title Subsidence Area | Active Area | Active Area |

## 5.2 DOMAIN REHABILITATION OBJECTIVES

Rehabilitation objectives for each specific closure domain are provided in **Table 5.2**.

**Table 5.2 Tahmoor Colliery Domain Rehabilitation Objectives**

| Domain | Rehabilitation Objective | Source of Domain Rehabilitation Objectives<br>Link to Project Rehabilitation Objectives & Final Land Use Outcomes |
|---|---|---|
| **1A**<br>**CHPP** | Infrastructure and services will be removed from the CHPP area. | 1979 EIS<br>CCL716 |
| **1B**<br>**Rail Loading Facility** | Infrastructure and services will be removed, and buildings removed or covered to ensure the site is safe, clean and tidy.<br>Landform to be recontoured to achieve safe angle of repose slopes (or flatter).<br>Excavations shall be drained, and any run off from depressions or ponded areas must be managed so it does not cause erosion.<br>Grade surface areas.<br>Apply topsoil for rehabilitation.<br>Establish native bushland rehabilitation.<br>Self-sustaining native bushland rehabilitation. | DA1975<br>CCL716 |
| **1C**<br>**Main Workshop & Admin Area** | Infrastructure and services will be removed, and buildings removed or covered to ensure the site is safe, clean and tidy.<br>Landform to be recontoured to achieve safe angle of repose slopes (or flatter).<br>Excavations shall be drained, and any run off from depressions or ponded areas must be managed so it does not cause erosion.<br>Grade surface areas.<br>Apply topsoil for rehabilitation.<br>Establish native bushland rehabilitation.<br>Self-sustaining native bushland rehabilitation. | DA1975<br>CCL716 |
| **1D** | Mine shaft to be sealed, or fenced depending on DRE requirement. | DA1975<br>CCL716 |

| | | |
|---|---|---|
| **No.3 Shaft & Gas Plant** | Infrastructure and services will be removed, and buildings at the No.3 shaft area removed or covered to ensure the site is safe, clean and tidy.<br>Landform to be recontoured to achieve safe angle of repose slopes (or flatter).<br>Excavations shall be drained, and any run off from depressions or ponded areas must be managed so it does not cause erosion.<br>Grade surface areas.<br>Apply topsoil for rehabilitation.<br>Establish native bushland rehabilitation. | |
| **1E**<br>**Sewage & Water Treatment Plants** | Infrastructure and services will be removed, and buildings removed or covered to ensure the site is safe, clean and tidy.<br>Landform to be recontoured to achieve safe angle of repose slopes (or flatter).<br>Excavations shall be drained, and any run off from depressions or ponded areas must be managed so it does not cause erosion.<br>Grade surface areas.<br>Apply topsoil for rehabilitation.<br>Establish native bushland rehabilitation.<br>Self-sustaining native bushland rehabilitation. | DA1975<br>CCL716 |
| **2**<br>**Product Stockpile Area** | Infrastructure and services will be removed from the CHPP area. | 1979 EIS<br>CCL716 |
| **3**<br>**Refuse Emplacement Area** | Infrastructure and services will be removed from the REA site.<br>Achieve design height and ensure maximum capacity is achieved.<br>Landform established to support native ecosystem.<br>Prevent erosion from stormwater runoff following rehabilitation of external batters.<br>Apply topsoil for rehabilitation.<br>Reduce erosion on slopes, and provide furrows for seed beds. | 1979 EIS<br>1993 EIS<br>CCL716<br>REA Rehabilitation & Water Management Plan |

| | | |
|---|---|---|
| | Establish native bushland rehabilitation.<br>Self-sustaining native bushland rehabilitation. | |
| **4**<br>**No.1 Ventilation Shaft** | Mine shaft to be sealed, or fenced depending on DRE requirement.<br>Infrastructure and services will be removed, and buildings removed or covered to ensure the site is safe, clean and tidy.<br>Landform to be recontoured to achieve safe angle of repose slopes (or flatter).<br>Excavations shall be drained, and any run off from depressions or ponded areas must be managed so it does not cause erosion.<br>Grade surface areas.<br>Apply topsoil for rehabilitation.<br>Establish native bushland rehabilitation.<br>Self-sustaining native bushland rehabilitation. | DA1975<br>CCL716 |
| **5**<br>**No.2 Ventilation Shaft** | Mine shaft to be sealed, or fenced depending on DRE requirement.<br>Infrastructure and services will be removed, and buildings removed or covered to ensure the site is safe, clean and tidy.<br>Landform to be recontoured to achieve safe angle of repose slopes (or flatter).<br>Excavations shall be drained, and any run off from depressions or ponded areas must be managed so it does not cause erosion.<br>Grade surface areas.<br>Apply topsoil for rehabilitation.<br>Establish native bushland rehabilitation.<br>Self-sustaining native bushland rehabilitation. | DA1975<br>CCL716 |
| **6**<br>**Off Title Subsidence Area** | Area to be rehabilitated in line with the 2017 CMAP | ML1376<br>ML1539 |

## 5.3 REHABILITATION PHASES

Tahmoor Colliery has adopted the DRE rehabilitation phases for mine closure in accordance with the *Interim Mining Operations Plan Guideline*. The following rehabilitation phases are used throughout this MOP to describe the status of each closure domain:

- Decommissioning
- Landform Establishment
- Growth Medium Development
- Ecosystem Establishment
- Ecosystem Development.

## 5.4 REHABILITATION INDICATORS & COMPLETION CRITERIA

The preliminary rehabilitation indicators and completion criteria detailed in Section 5.5 have been developed to meet the domain rehabilitation objectives from the site's various consents and approvals. These criteria will continue to be refined throughout the MOP term, following the implementation of rehabilitation and biodiversity monitoring programs, as part of the site's continue improvement process. Closure criteria will be refined for each specific rehabilitation domain in accordance with *XCN SD ANN 0039 – 10.2 Closure Criteria Development and Rehabilitation Monitoring*. For a detailed breakdown of rehabilitation indicators and completion criteria, including link and reference to the relevant source approvals, refer to Section 5.5.

## 5.5 REHABILITATION TABLE

| Domain | Rehabilitation Phase | Regulatory Requirement | Domain Objective | Indicator | Completion Criteria | Justification/Source | Complete (Yes/No) |
|---|---|---|---|---|---|---|---|
| **Domain 1A:**<br><br>**Coal Handling & Preparation Plant (CHPP)** | Decommissioning | Plant will be eliminated when operations cease at the completion of mine life.<br><br>1979 EIS Section 5.4 | Infrastructure and services will be removed from the CHPP area. | All services to be removed from CHPP area. | Yes | 1979 EIS<br><br>CCL716 | No |
| | | …the lease holder shall remove…such buildings, machinery, plant, equipment, constructions and works as may be directed by the Minister and such surface shall be rehabilitated and left in a clean, tidy and safe condition to the satisfaction of the Minister.<br><br>CCL716 Condition 22 | | CHPP buildings, offices and infrastructure to be removed. | | | |
| | | | | Underground reagent storage tanks to be removed. | | | |
| | | | | Written approval from the Minister or delegate from the Department of Resources & Energy to confirm satisfaction. | | | |
| | Landform establishment | No specific regulatory requirement. | *Rehabilitation to be consistent with Domains 1B, 1C, 1D & 1E.*<br><br>Landform to be recontoured to achieve safe angle of repose slopes (or flatter). | Maximum slope on final landform. | Yes - angle of repose slopes on recontoured landform. | DA1975<br><br>(not applicable to CHPP but consistent rehabilitation approach adopted) | No |
| | | | Excavations shall be drained, and any run off from depressions or ponded areas must be managed so it does not cause erosion. | Water to be drained (where practical) from excavations.<br><br>Drainage from depressions or ponds should not cause erosion. | Yes | DA1975<br><br>(not applicable to CHPP but consistent rehabilitation approach adopted) | No |
| | | | Grade surface areas. | Surface hardstand, workshops and administration building areas to be graded. | Yes – surface area graded. | (not applicable to CHPP but consistent rehabilitation approach adopted) | No |

| Domain | Rehabilitation Phase | Regulatory Requirement | Domain Objective | Indicator | Completion Criteria | Justification/Source | Complete (Yes/No) |
|---|---|---|---|---|---|---|---|
| | Growth medium development | No specific regulatory requirement. | Apply topsoil for rehabilitation. | Topsoil placement depth. | >152mm | DA1975<br><br>(not applicable to CHPP but consistent rehabilitation approach adopted) | No |
| | Ecosystem establishment | No specific regulatory requirement. | Establish native bushland rehabilitation. | Conduct seeding and/or planting. | Yes – seeding and/or planting completed. | DA1975<br><br>(not applicable to CHPP but consistent rehabilitation approach adopted) | No |
| | Ecosystem development | No specific regulatory requirement. | Self-sustaining native bushland rehabilitation. | Presence of weeds in monitoring transects (%). | <10% | Analogue sites 1 & 2 | No |
| | | | | Evidence of second generation flora germination in monitoring transects. | Yes | Analogue sites 1 & 2 | No |
| | | | | Rehabilitation monitoring transects contain flora species and structural characteristics similar to the desired vegetation communities at the analogue sites. | Yes | Analogue sites 1 & 2 | No |

| Domain | Rehabilitation Phase | Regulatory Requirement | Domain Objective | Indicator | Completion Criteria | Justification/Source | Complete (Yes/No) |
|---|---|---|---|---|---|---|---|
| **Domain 1B:**<br><br>**Rail Loading Facility (rail spur)** | Decommissioning | Site shall be left safe, clean and tidy to the satisfaction of Council.<br><br>DA1975 Condition (C1) | Infrastructure and services will be removed, and buildings removed or covered to ensure the site is safe, clean and tidy. | All services, track and associated infrastructure to be removed. | Yes | DA1975 | No |
| | | Where required by council all buildings will be either removed or satisfactorily covered.<br><br>DA1975 Condition (C2)(i)<br><br>…the lease holder shall remove…such buildings, machinery, plant, equipment, constructions and works as may be directed by the Minister and such surface shall be rehabilitated and left in a clean, tidy and safe condition to the satisfaction of the Minister.<br><br>CCL716 Condition 22 | | Written approval from Council, and the Minister or delegate from the Department of Resources & Energy, to confirm satisfaction. | Yes | DA1975<br><br>CCL716 | No |
| | Landform establishment | The site shall be so treated that all batters are at a safe angle of repose.<br><br>DA1975 Condition (C3)(ii)<br><br>Upon abandonment of operations on any site, the holder shall batter the sides of each excavation… to a safe low angle…<br><br>DA1975 Condition (C6)(18)(xi) | Landform to be recontoured to achieve safe angle of repose slopes (or flatter). | Maximum slope on final landform. | Yes - angle of repose slopes on recontoured landform. | DA1975 | No |

| Domain | Rehabilitation Phase | Regulatory Requirement | Domain Objective | Indicator | Completion Criteria | Justification/Source | Complete (Yes/No) |
|---|---|---|---|---|---|---|---|
| | | Upon abandonment of operations on any site… excavations shall be effectively drained to the satisfaction of the Minister for Mines.<br><br>DA1975 Condition (C6)(18)(xi) | Excavations shall be drained, and any run off from depressions or ponded areas must be managed so it does not cause erosion. | Water to be drained (where practical) from excavations.<br><br>Drainage from depressions or ponds should not cause erosion. | Yes | DA1975 | No |
| | | Ensure run off from any disturbed area including the overflow from any depression or ponded area is discharged in such a manner that it will not cause erosion.<br><br>DA1975 Condition (C6)(18)(xi) | | | | | |
| | | Exclusive only of sealed access roads, the surface area shall be satisfactorily graded…<br><br>DA1975 Condition (C4)(iii) | Grade surface areas. | Surface hardstand, workshops and administration building areas to be graded. | Yes – surface area graded. | DA1975 | No |
| | Growth medium development | Exclusive only of sealed access roads, the surface area shall be… top-dressed to a depth of not less than 6" (152mm)…"<br><br>DA1975 Condition (C4)(iii) | Apply topsoil for rehabilitation. | Topsoil placement depth. | >152mm | DA1975 | No |
| | Ecosystem establishment | Exclusive only of sealed access roads, the surface area shall be… established with approved trees and grasses.<br><br>DA1975 Condition (C4)(iii) | Establish native bushland rehabilitation. | Conduct seeding and/or planting. | Yes – seeding and/or planting completed. | DA1975 | No |

| Domain | Rehabilitation Phase | Regulatory Requirement | Domain Objective | Indicator | Completion Criteria | Justification/Source | Complete (Yes/No) |
|---|---|---|---|---|---|---|---|
| | Ecosystem development | No specific regulatory requirement | Self-sustaining native bushland rehabilitation. | Presence of weeds in monitoring transects (%). | <10% | Analogue sites 1 & 2 | No |
| | | | | Evidence of second generation flora germination in monitoring transects. | Yes | Analogue sites 1 & 2 | No |
| | | | | Rehabilitation monitoring transects contain flora species and structural characteristics similar to the desired vegetation communities at the analogue sites. | Yes | Analogue sites 1 & 2 | No |
| **Domain 1C:**<br><br>**Workshops & Administration** | Decommissioning | Site shall be left safe, clean and tidy to the satisfaction of Council.<br><br>DA1975 Condition (C1) | Infrastructure and services will be removed, and buildings removed or covered to ensure the site is safe, clean and tidy. | All services to be removed from main administration, and from the workshop areas. | Yes | DA1975 | No |
| | | Where required by council all buildings will be either removed or satisfactorily covered.<br><br>DA1975 Condition (C2)(i) | | Workshop buildings removed or covered. | Yes | DA1975 | No |
| | | …the lease holder shall remove…such buildings, machinery, plant, equipment, constructions and works as may be directed by the Minister and such surface shall be rehabilitated and left in a clean, tidy and safe condition to the satisfaction of the Minister.<br><br>CCL716 Condition 22 | | Administration building removed or covered. | Yes | DA1975 | No |
| | | | | Written approval from Council, and the Minister or delegate from the Department of Resources & Energy, to confirm satisfaction. | Yes | DA1975<br><br>CCL716 | No |

| Domain | Rehabilitation Phase | Regulatory Requirement | Domain Objective | Indicator | Completion Criteria | Justification/Source | Complete (Yes/No) |
|---|---|---|---|---|---|---|---|
| | Landform establishment | The site shall be so treated that all batters are at a safe angle of repose.<br><br>DA1975 Condition (C3)(ii)<br><br>Upon abandonment of operations on any site, the holder shall batter the sides of each excavation… to a safe low angle…<br><br>DA1975 Condition (C6)(18)(xi) | Landform to be recontoured to achieve safe angle of repose slopes (or flatter). | Maximum slope on final landform. | Yes - angle of repose slopes on recontoured landform. | DA1975 | No |
| | | Upon abandonment of operations on any site… excavations shall be effectively drained to the satisfaction of the Minister for Mines.<br><br>DA1975 Condition (C6)(18)(xi)<br><br>Ensure run off from any disturbed area including the overflow from any depression or ponded area is discharged in such a manner that it will not cause erosion.<br><br>DA1975 Condition (C6)(18)(xi) | Excavations shall be drained, and any run off from depressions or ponded areas must be managed so it does not cause erosion. | Water to be drained (where practical) from excavations.<br><br>Drainage from depressions or ponds should not cause erosion. | Yes | DA1975 | No |
| | | Exclusive only of sealed access roads, the surface area shall be satisfactorily graded…<br><br>DA1975 Condition (C4)(iii) | Grade surface areas. | Surface hardstand, workshops and administration building areas to be graded. | Yes – surface area graded. | DA1975 | No |

| Domain | Rehabilitation Phase | Regulatory Requirement | Domain Objective | Indicator | Completion Criteria | Justification/Source | Complete (Yes/No) |
|---|---|---|---|---|---|---|---|
| | Growth medium development | Exclusive only of sealed access roads, the surface area shall be… top-dressed to a depth of not less than 6" (152mm)…"<br><br>DA1975 Condition (C4)(iii) | Apply topsoil for rehabilitation. | Topsoil placement depth. | >152mm | DA1975 | No |
| | Ecosystem establishment | Exclusive only of sealed access roads, the surface area shall be… established with approved trees and grasses.<br><br>DA1975 Condition (C4)(iii) | Establish native bushland rehabilitation. | Conduct seeding and/or planting. | Yes – seeding and/or planting completed. | DA1975 | No |
| | Ecosystem development | No specific regulatory requirement | Self-sustaining native bushland rehabilitation. | Presence of weeds in monitoring transects (%). | <10% | Analogue sites 1 & 2 | No |
| | | | | Evidence of second generation flora germination in monitoring transects. | Yes | Analogue sites 1 & 2 | No |
| | | | | Rehabilitation monitoring transects contain flora species and structural characteristics similar to the desired vegetation communities at the analogue sites. | Yes | Analogue sites 1 & 2 | No |

| Domain | Rehabilitation Phase | Regulatory Requirement | Domain Objective | Indicator | Completion Criteria | Justification/Source | Complete (Yes/No) |
|---|---|---|---|---|---|---|---|
| **Domain 1D:**<br><br>**No.3 Shaft & Gas Extraction Plant** | Decommissioning | The mine shaft shall be sealed in a substantial manner with adequate provision for drainage of the mine.<br><br>DA1975 Condition (C5)(iv)<br><br>Upon abandonment of operations on the subject area… the holder shall cause the top of every shaft to be sealed to the satisfaction of the Minister for Mines.<br><br>Provided however that the Minister may, in circumstances he considers appropriate, require any shaft to be fenced in lieu of being sealed.<br><br>DA1975 Condition (C6) | Mine shaft to be sealed, or fenced depending on DRE requirement. | No.3 Ventilation Shaft sealed in accordance with applicable DRE guideline, or fenced in accordance with DRE instruction. | Yes | DA1975 | No |

| Domain | Rehabilitation Phase | Regulatory Requirement | Domain Objective | Indicator | Completion Criteria | Justification/Source | Complete (Yes/No) |
|---|---|---|---|---|---|---|---|
| | | Site shall be left safe, clean and tidy to the satisfaction of Council.<br><br>DA1975 Condition (C1) | Infrastructure and services will be removed, and buildings at the No.3 shaft area removed or covered to ensure the site is safe, clean and tidy. | All services and any buildings at the No.3 shaft area to be removed. | Yes | DA1975 | No |
| | | Where required by council all buildings will be either removed or satisfactorily covered.<br><br>DA1975 Condition (C2)(i) | | Written approval from Council, and the Minister or delegate from the Department of Resources & Energy, to confirm satisfaction. | Yes | DA1975<br><br>CCL716 | No |
| | | …the lease holder shall remove…such buildings, machinery, plant, equipment, constructions and works as may be directed by the Minister and such surface shall be rehabilitated and left in a clean, tidy and safe condition to the satisfaction of the Minister.<br><br>CCL716 Condition 22 | | | | | |
| | Landform establishment | The site shall be so treated that all batters are at a safe angle of repose.<br><br>DA1975 Condition (C3)(ii) | Landform to be recontoured to achieve safe angle of repose slopes (or flatter). | Maximum slope on final landform. | Yes - angle of repose slopes on recontoured landform. | DA1975 | No |
| | | Upon abandonment of operations on any site, the holder shall batter the sides of each excavation… to a safe low angle…<br><br>DA1975 Condition (C6)(18)(xi) | | | | | |

| Domain | Rehabilitation Phase | Regulatory Requirement | Domain Objective | Indicator | Completion Criteria | Justification/Source | Complete (Yes/No) |
|---|---|---|---|---|---|---|---|
| | | Upon abandonment of operations on any site… excavations shall be effectively drained to the satisfaction of the Minister for Mines.<br><br>DA1975 Condition (C6)(18)(xi)<br><br>Ensure run off from any disturbed area including the overflow from any depression or ponded area is discharged in such a manner that it will not cause erosion.<br><br>DA1975 Condition (C6)(18)(xi) | Excavations shall be drained, and any run off from depressions or ponded areas must be managed so it does not cause erosion. | Water to be drained (where practical) from excavations.<br><br>Drainage from depressions or ponds should not cause erosion. | Yes | DA1975 | No |
| | | Exclusive only of sealed access roads, the surface area shall be satisfactorily graded…<br><br>DA1975 Condition (C4)(iii) | Grade surface areas. | No.3 shaft unsealed areas to be graded. | Yes – surface area graded. | DA1975 | No |
| | Growth medium development | Exclusive only of sealed access roads, the surface area shall be… top-dressed to a depth of not less than 6" (152mm)…"<br><br>DA1975 Condition (C4)(iii) | Apply topsoil for rehabilitation. | Topsoil placement depth. | >152mm | DA1975 | No |
| | Ecosystem establishment | Exclusive only of sealed access roads, the surface area shall be… established with approved trees and grasses.<br><br>DA1975 Condition (C4)(iii) | Establish native bushland rehabilitation. | Conduct seeding and/or planting. | Yes – seeding and/or planting completed. | DA1975 | No |

| Domain | Rehabilitation Phase | Regulatory Requirement | Domain Objective | Indicator | Completion Criteria | Justification/Source | Complete (Yes/No) |
|---|---|---|---|---|---|---|---|
| | Ecosystem development | No specific regulatory requirement | Self-sustaining native bushland rehabilitation. | Presence of weeds in monitoring transects (%). | <10% | Analogue sites 1 & 2 | No |
| | | | | Evidence of second generation flora germination in monitoring transects. | Yes | Analogue sites 1 & 2 | No |
| | | | | Rehabilitation monitoring transects contain flora species and structural characteristics similar to the desired vegetation communities at the analogue sites. | Yes | Analogue sites 1 & 2 | No |
| **Domain 1E:** **Sewage & Water Treatment Facilities** | Decommissioning | Site shall be left safe, clean and tidy to the satisfaction of Council. DA1975 Condition (C1) | Infrastructure and services will be removed, and buildings removed or covered to ensure the site is safe, clean and tidy. | All services and infrastructure associated with the sewage and water treatment facilities to be removed. | Yes | DA1975 | No |
| | | Where required by council all buildings will be either removed or satisfactorily covered. DA1975 Condition (C2)(i) | | Written approval from Council, and the Minister or delegate from the Department of Resources & Energy, to confirm satisfaction. | Yes | DA1975 CCL716 | No |
| | | …the lease holder shall remove…such buildings, machinery, plant, equipment, constructions and works as may be directed by the Minister and such surface shall be rehabilitated and left in a clean, tidy and safe condition to the satisfaction of the Minister. CCL716 Condition 22 | | | | | |

| Domain | Rehabilitation Phase | Regulatory Requirement | Domain Objective | Indicator | Completion Criteria | Justification/Source | Complete (Yes/No) |
|---|---|---|---|---|---|---|---|
| | Landform establishment | The site shall be so treated that all batters are at a safe angle of repose.<br><br>DA1975 Condition (C3)(ii)<br><br>Upon abandonment of operations on any site, the holder shall batter the sides of each excavation… to a safe low angle…<br><br>DA1975 Condition (C6)(18)(xi) | Landform to be recontoured to achieve safe angle of repose slopes (or flatter). | Maximum slope on final landform. | Yes - angle of repose slopes on recontoured landform. | DA1975 | No |
| | | Upon abandonment of operations on any site… excavations shall be effectively drained to the satisfaction of the Minister for Mines.<br><br>DA1975 Condition (C6)(18)(xi)<br><br>Ensure run off from any disturbed area including the overflow from any depression or ponded area is discharged in such a manner that it will not cause erosion.<br><br>DA1975 Condition (C6)(18)(xi) | Excavations shall be drained, and any run off from depressions or ponded areas must be managed so it does not cause erosion. | Water to be drained (where practical) from excavations.<br><br>Drainage from depressions or ponds should not cause erosion. | Yes | DA1975 | No |

| Domain | Rehabilitation Phase | Regulatory Requirement | Domain Objective | Indicator | Completion Criteria | Justification/Source | Complete (Yes/No) |
|---|---|---|---|---|---|---|---|
| | | Exclusive only of sealed access roads, the surface area shall be satisfactorily graded…<br><br>DA1975 Condition (C4)(iii) | Grade surface areas. | No.3 shaft unsealed areas to be graded. | Yes – surface area graded. | DA1975 | No |
| | Growth medium development | Exclusive only of sealed access roads, the surface area shall be… top-dressed to a depth of not less than 6" (152mm)…"<br><br>DA1975 Condition (C4)(iii) | Apply topsoil for rehabilitation. | Topsoil placement depth. | >152mm | DA1975 | No |
| | Ecosystem establishment | Exclusive only of sealed access roads, the surface area shall be… established with approved trees and grasses.<br><br>DA1975 Condition (C4)(iii) | Establish native bushland rehabilitation. | Conduct seeding and/or planting. | Yes – seeding and/or planting completed. | DA1975 | No |
| | Ecosystem development | No specific regulatory requirement. | Self-sustaining native bushland rehabilitation. | Presence of weeds in monitoring transects (%). | <10% | Analogue sites 1 & 2 | No |
| | | | | Evidence of second generation flora germination in monitoring transects. | Yes | Analogue sites 1 & 2 | No |
| | | | | Rehabilitation monitoring transects contain flora species and structural characteristics similar to the desired vegetation communities at the analogue sites. | Yes | Analogue sites 1 & 2 | No |

| Domain | Rehabilitation Phase | Regulatory Requirement | Domain Objective | Indicator | Completion Criteria | Justification/Source | Complete (Yes/No) |
|---|---|---|---|---|---|---|---|
| **Domain 2:**<br><br>**Product Coal Stockpile Area** | Decommissioning | Plant will be eliminated when operations cease at the completion of mine life.<br><br>1979 EIS Section 5.4 | Infrastructure and services will be removed from the CHPP area. | All services to be removed from CHPP area. | Yes | 1979 EIS | No |
| | | …the lease holder shall remove…such buildings, machinery, plant, equipment, constructions and works as may be directed by the Minister and such surface shall be rehabilitated and left in a clean, tidy and safe condition to the satisfaction of the Minister.<br><br>CCL716 Condition 22 | | CHPP buildings, offices and infrastructure to be removed. | Yes | | |
| | | | | Written approval from the Minister or delegate from the Department of Resources & Energy, to confirm satisfaction. | Yes | CCL716 | |
| | Landform establishment | No specific regulatory requirement. | Rehabilitation to be consistent with Domains 1B, 1C, 1D & 1E.<br><br>Landform to be recontoured to achieve safe angle of repose slopes (or flatter). | Maximum slope on final landform. | Yes - angle of repose slopes on recontoured landform. | DA1975<br><br>(not applicable to CHPP but consistent rehabilitation approach adopted) | No |
| | | | Excavations shall be drained, and any run off from depressions or ponded areas must be managed so it does not cause erosion. | Water to be drained (where practical) from excavations.<br><br>Drainage from depressions or ponds should not cause erosion. | Yes | DA1975<br><br>(not applicable to CHPP but consistent rehabilitation approach adopted) | No |
| | | | Grade surface areas. | Surface hardstand, workshops and administration building areas to be graded. | Yes – surface area graded. | (not applicable to CHPP but consistent rehabilitation approach adopted) | No |

| Domain | Rehabilitation Phase | Regulatory Requirement | Domain Objective | Indicator | Completion Criteria | Justification/Source | Complete (Yes/No) |
|---|---|---|---|---|---|---|---|
| | Growth medium development | No specific regulatory requirement. | Apply topsoil for rehabilitation. | Topsoil placement depth. | >152mm | DA1975<br><br>(not applicable to CHPP but consistent rehabilitation approach adopted) | No |
| | Ecosystem establishment | No specific regulatory requirement. | Establish native bushland rehabilitation. | Conduct seeding and/or planting. | Yes – seeding and/or planting completed. | DA1975<br><br>(not applicable to CHPP but consistent rehabilitation approach adopted) | No |
| | Ecosystem development | No specific regulatory requirement. | Self-sustaining native bushland rehabilitation. | Presence of weeds in monitoring transects (%). | <10% | Analogue sites 1 & 2 | No |
| | | | | Evidence of second generation flora germination in monitoring transects. | Yes | Analogue sites 1 & 2 | No |
| | | | | Rehabilitation monitoring transects contain flora species and structural characteristics similar to the desired vegetation communities at the analogue sites. | Yes | Analogue sites 1 & 2 | No |

<table>
<tr><th>Domain</th><th>Rehabilitation Phase</th><th>Regulatory Requirement</th><th>Domain Objective</th><th>Indicator</th><th>Completion Criteria</th><th>Justification/Source</th><th>Complete (Yes/No)</th></tr>
<tr><td rowspan="7">Domain 3:<br><br>Refuse Emplacement Area</td><td rowspan="4">Decommissioning</td><td>Plant will be eliminated when operations cease at the completion of mine life.<br><br>1979 EIS Section 5.4</td><td rowspan="4">Infrastructure and services will be removed from the REA site.</td><td>All services related to refuse emplacement activities to be removed from the REA.</td><td rowspan="4">Yes</td><td rowspan="4">1979 EIS<br><br>CCL716<br><br>OUT 18/3606</td><td rowspan="4">No</td></tr>
<tr><td>…the lease holder shall remove…such buildings, machinery, plant, equipment, constructions and works as may be directed by the Minister and such surface shall be rehabilitated and left in a clean, tidy and safe condition to the satisfaction of the Minister.<br><br>CCL716 Condition 22</td><td>REA site offices and any other infrastructure to be removed (note 3R conveyor and reject bin is captured by Domain 1A).</td></tr>
<tr><td rowspan="2">Requirement to have a diversion drain (or equivalent) around the REA to mitigate the risk of failure of the concrete pipes under the REA in the future<br><br>DRG Requirement OUT 18/3606</td><td>Written approval from the Minister or delegate from the Department of Resources & Energy, to confirm satisfaction.</td></tr>
<tr><td>No clean  water diversions pipelines in service beneath the REA at time of closure</td></tr>
<tr><td rowspan="3">Landform establishment</td><td rowspan="3">No specific regulatory requirement</td><td>Achieve design height and ensure maximum capacity is achieved.</td><td>Average depth of fill (height of refuse emplacement) will be 12m.</td><td>12m</td><td>REA Rehabilitation & Water Management Plan / 1993 EIS</td><td>No</td></tr>
<tr><td>Landform established to support native ecosystem.</td><td>Maximum slope on final landform external batters will be 1:4 (generally will be 1:8).</td><td>1:4</td><td>REA Rehabilitation & Water Management Plan / 1993 EIS</td><td>No</td></tr>
<tr><td>Prevent erosion from stormwater runoff following rehabilitation of external batters.</td><td>External batters should have gently sloping contour drains, reporting to water storage dams.</td><td>Yes</td><td>REA Rehabilitation & Water Management Plan / 1993 EIS</td><td>No</td></tr>
</table>

| Domain | Rehabilitation Phase | Regulatory Requirement | Domain Objective | Indicator | Completion Criteria | Justification/Source | Complete (Yes/No) |
|---|---|---|---|---|---|---|---|
| | Growth medium development | No specific regulatory requirement | Apply topsoil for rehabilitation. | Topsoil placement depth. | >200mm | REA Rehabilitation & Water Management Plan / 1993 EIS | No |
| | | | Reduce erosion on slopes, and provide furrows for seed beds. | All final landform slopes to be contour ploughed. | Yes | REA Rehabilitation & Water Management Plan / 1993 EIS | No |
| | Ecosystem establishment | No specific regulatory requirement | Establish native bushland rehabilitation. | Conduct seeding and/or planting. | Yes – seeding and/or planting completed. | REA Rehabilitation & Water Management Plan / 1993 EIS | No |
| | Ecosystem development | No specific regulatory requirement. | Self-sustaining native bushland rehabilitation (REA Rehabilitation & Water Management Plan). | Presence of weeds in monitoring transects (%). | <10% | Analogue sites 1 & 2 | No |
| | | | | Evidence of second generation flora germination in monitoring transects. | Yes | Analogue sites 1 & 2 | No |
| | | | | Rehabilitation monitoring transects contain flora species and structural characteristics similar to the desired vegetation communities at the analogue sites. | Yes | Analogue sites 1 & 2 | No |
| **Domain 4:**<br>**No.1 Ventilation Shaft** | Decommissioning | The mine shaft shall be sealed in a substantial manner with adequate provision for drainage of the mine.<br>DA1975 Condition (C5)(iv) | Mine shaft to be sealed, or fenced depending on DRE requirement. | No.1 Ventilation Shaft sealed in accordance with applicable DRE guideline, or fenced in accordance with DRE instruction. | Yes | DA1975 | No |

<table>
<tr><th>Domain</th><th>Rehabilitation Phase</th><th>Regulatory Requirement</th><th>Domain Objective</th><th>Indicator</th><th>Completion Criteria</th><th>Justification/Source</th><th>Complete (Yes/No)</th></tr>
<tr><td rowspan="4"></td><td rowspan="4"></td><td>Upon abandonment of operations on the subject area… the holder shall cause the top of every shaft to be sealed to the satisfaction of the Minister for Mines.<br><br>Provided however that the Minister may, in circumstances he considers appropriate, require any shaft to be fenced in lieu of being sealed.<br><br>DA1975 Condition (C6)</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Site shall be left safe, clean and tidy to the satisfaction of Council.<br><br>DA1975 Condition (C1)</td><td rowspan="3">Infrastructure will be removed, and buildings removed or covered to ensure the site is safe, clean and tidy.</td><td>All services and any buildings at the No.1 shaft site to be removed.</td><td>Yes</td><td>DA1975</td><td>No</td></tr>
<tr><td>Where required by council all buildings will be either removed or satisfactorily covered.<br><br>DA1975 Condition (C2)(i)</td><td rowspan="2">Written approval from Council, and the Minister or delegate from the Department of Resources & Energy, to confirm satisfaction.</td><td rowspan="2">Yes</td><td rowspan="2">DA1975<br><br>CCL716</td><td rowspan="2">No</td></tr>
<tr><td>…the lease holder shall remove…such buildings, machinery, plant, equipment, constructions and works as may be directed by the Minister and such surface shall be rehabilitated and left in a clean, tidy and safe condition to the satisfaction of the Minister.</td></tr>
</table>

| Domain | Rehabilitation Phase | Regulatory Requirement | Domain Objective | Indicator | Completion Criteria | Justification/Source | Complete (Yes/No) |
|---|---|---|---|---|---|---|---|
| | | CCL716 Condition 22 | | | | | |
| | Landform establishment | The site shall be so treated that all batters are at a safe angle of repose.<br><br>DA1975 Condition (C3)(ii) | Landform to be recontoured to achieve safe angle of repose slopes (or flatter). | Maximum slope on final landform. | Yes - angle of repose slopes on recontoured landform. | DA1975 | No |
| | | Upon abandonment of operations on any site, the holder shall batter the sides of each excavation… to a safe low angle…<br>DA1975 Condition (C6)(18)(xi) | | | | | |
| | | Upon abandonment of operations on any site… excavations shall be effectively drained to the satisfaction of the Minister for Mines.<br><br>DA1975 Condition (C6)(18)(xi) | Excavations shall be drained, and any run off from depressions or ponded areas must be managed so it does not cause erosion. | Water to be drained (where practical) from excavations.<br><br>Drainage from depressions or ponds should not cause erosion. | Yes | DA1975 | No |
| | | Ensure run off from any disturbed area including the overflow from any depression or ponded area is discharged in such a manner that it will not cause erosion.<br><br>DA1975 Condition (C6)(18)(xi) | | | | | |

| Domain | Rehabilitation Phase | Regulatory Requirement | Domain Objective | Indicator | Completion Criteria | Justification/Source | Complete (Yes/No) |
|---|---|---|---|---|---|---|---|
| | | Exclusive only of sealed access roads, the surface area shall be satisfactorily graded…<br><br>DA1975 Condition (C4)(iii) | Grade surface areas. | Surface hardstand, workshops and administration building areas to be graded. | Yes – surface area graded. | DA1975 | No |
| | Growth medium development | Exclusive only of sealed access roads, the surface area shall be… top-dressed to a depth of not less than 6" (152mm)…"<br><br>DA1975 Condition (C4)(iii) | Apply topsoil for rehabilitation. | Topsoil placement depth. | >152mm | DA1975 | No |
| | Ecosystem establishment | Exclusive only of sealed access roads, the surface area shall be… established with approved trees and grasses.<br><br>DA1975 Condition (C4)(iii) | Establish native bushland rehabilitation. | Conduct seeding and/or planting. | Yes – seeding and/or planting completed. | DA1975 | No |
| | Ecosystem development | No specific regulatory requirement. | Self-sustaining native bushland rehabilitation (REA Rehabilitation & Water Management Plan). | Presence of weeds in monitoring transects (%). | <10% | Analogue sites 1 & 2 | No |

| Domain | Rehabilitation Phase | Regulatory Requirement | Domain Objective | Indicator | Completion Criteria | Justification/Source | Complete (Yes/No) |
|---|---|---|---|---|---|---|---|
| | | | | Evidence of second generation flora germination in monitoring transects. | Yes | Analogue sites 1 & 2 | No |
| | | | | Rehabilitation monitoring transects contain flora species and structural characteristics similar to the desired vegetation communities at the analogue sites. | Yes | Analogue sites 1 & 2 | No |
| **Domain 5:**<br><br>**No.2 Ventilation Shaft** | Decommissioning | The mine shaft shall be sealed in a substantial manner with adequate provision for drainage of the mine.<br><br>DA1975 Condition (C5)(iv) | Mine shaft to be sealed, or fenced depending on DRE requirement. | No.2 Ventilation Shaft sealed in accordance with applicable DRE guideline, or fenced in accordance with DRE instruction. | Yes | DA1975 | No |

<table>
<tr><th>Domain</th><th>Rehabilitation Phase</th><th>Regulatory Requirement</th><th>Domain Objective</th><th>Indicator</th><th>Completion Criteria</th><th>Justification/Source</th><th>Complete (Yes/No)</th></tr>
<tr><td rowspan="4"></td><td rowspan="4"></td><td>Upon abandonment of operations on the subject area… the holder shall cause the top of every shaft to be sealed to the satisfaction of the Minister for Mines.<br><br>Provided however that the Minister may, in circumstances he considers appropriate, require any shaft to be fenced in lieu of being sealed.<br><br>DA1975 Condition (C6)</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Site shall be left safe, clean and tidy to the satisfaction of Council.<br><br>DA1975 Condition (C1)</td><td rowspan="3">Infrastructure will be removed, and buildings removed or covered to ensure the site is safe, clean and tidy.</td><td>All services and any buildings at the No.2 shaft site to be removed.</td><td rowspan="3">Yes</td><td rowspan="3">DA1975<br><br>CCL716</td><td rowspan="3">No</td></tr>
<tr><td>Where required by council all buildings will be either removed or satisfactorily covered.<br><br>DA1975 Condition (C2)(i)</td><td rowspan="2">Written approval from Council, and the Minister or delegate from the Department of Resources & Energy, to confirm satisfaction.</td></tr>
<tr><td>…the lease holder shall remove…such buildings, machinery, plant, equipment, constructions</td></tr>
</table>

| Domain | Rehabilitation Phase | Regulatory Requirement | Domain Objective | Indicator | Completion Criteria | Justification/Source | Complete (Yes/No) |
|---|---|---|---|---|---|---|---|
| | | and works as may be directed by the Minister and such surface shall be rehabilitated and left in a clean, tidy and safe condition to the satisfaction of the Minister.<br><br>CCL716 Condition 22 | | | | | |
| | Landform establishment | The site shall be so treated that all batters are at a safe angle of repose.<br><br>DA1975 Condition (C3)(ii)<br><br>Upon abandonment of operations on any site, the holder shall batter the sides of each excavation… to a safe low angle…<br><br>DA1975 Condition (C6)(18)(xi) | Landform to be recontoured to achieve safe angle of repose slopes (or flatter). | Maximum slope on final landform. | Yes - angle of repose slopes on recontoured landform. | DA1975 | No |
| | | Upon abandonment of operations on any site… excavations shall be effectively drained to the satisfaction of the Minister for Mines.<br><br>DA1975 Condition (C6)(18)(xi)<br><br>Ensure run off from any disturbed area including the overflow from any depression or ponded area is discharged in such a manner that it will not cause erosion.<br><br>DA1975 Condition (C6)(18)(xi) | Excavations shall be drained, and any run off from depressions or ponded areas must be managed so it does not cause erosion. | Water to be drained (where practical) from excavations.<br><br>Drainage from depressions or ponds should not cause erosion. | Yes | DA1975 | No |

| Domain | Rehabilitation Phase | Regulatory Requirement | Domain Objective | Indicator | Completion Criteria | Justification/Source | Complete (Yes/No) |
|---|---|---|---|---|---|---|---|
| | | Exclusive only of sealed access roads, the surface area shall be satisfactorily graded…<br><br>DA1975 Condition (C4)(iii) | Grade surface areas. | Surface hardstand, workshops and administration building areas to be graded. | Yes – surface area graded. | DA1975 | No |
| | Growth medium development | Exclusive only of sealed access roads, the surface area shall be… top-dressed to a depth of not less than 6" (152mm)…"<br><br>DA1975 Condition (C4)(iii) | Apply topsoil for rehabilitation. | Topsoil placement depth. | >152mm | DA1975 | No |
| | Ecosystem establishment | Exclusive only of sealed access roads, the surface area shall be… established with approved trees and grasses.<br><br>DA1975 Condition (C4)(iii) | Establish native bushland rehabilitation. | Conduct seeding and/or planting. | Yes – seeding and/or planting completed. | DA1975 | No |
| | Ecosystem development | No specific regulatory requirement. | Self-sustaining native bushland rehabilitation (REA Rehabilitation & Water Management Plan). | Presence of weeds in monitoring transects (%). | <10% | Analogue sites 1 & 2 | No |
| | | | | Evidence of second generation flora germination in monitoring transects. | Yes | Analogue sites 1 & 2 | No |
| | | | | Rehabilitation monitoring transects contain flora species and structural characteristics similar to the desired vegetation communities at the analogue sites. | Yes | Analogue sites 1 & 2 | No |
| **Domain 6 Off Title Subsidence Area** | | Myrtle Creek CMAP | Rehabilitate in accordance with Myrtle Creek CMAP. Myrtle Creek CMAP Schedule is included in Appendix 7. | | | ML1642 ML1539 CCL 716 | NO |

# 5 Rehabilitation Implementation

## 6.1 STATUS AT MOP COMMENCEMENT

A summary of the status of each closure domain at the commencement of the MOP is provided below, including the activities which have occurred in each domain up to this stage:

**Domain 1A – CHPP**
Domain 1A is in the active phase at the commencement of this MOP, and is yet to be rehabilitated.

**Domain 1B – Rail Loading Facility**
Domain 1B is in the active phase at the commencement of this MOP, and is yet to be rehabilitated.

**Domain 1C – Main Workshop & Administration Area**
Domain 1C is in the active phase at the commencement of this MOP, and is yet to be rehabilitated.

**Domain 1D – No.3 Shaft & Gas Drainage Plant**
Domain 1D is in the active phase at the commencement of this MOP, and is yet to be rehabilitated.

**Domain 1E – Sewage & Water Treatment Plants**
Domain 1E is in the active phase at the commencement of this MOP, and is yet to be rehabilitated.

**Domain 2 – Product Stockpile Area**
Domain 2 is in the active phase at the commencement of this MOP, and is yet to be rehabilitated.

**Domain 3 – Refuse Emplacement Area**
Rehabilitation within Domain 3 has commenced, with several parts of the Refuse Emplacement Area (REA) progressing through the nominated rehabilitation phases (see Section 6.3 for area detail). The rehabilitation phases at the REA at the commencement of this MOP are Active Area, Ecosystem Establishment and Ecosystem Development.
The Active area is composed of the active refuse emplacement area including haul roads and infrastructure. Ecosystem Establishment describes rehabilitation that is less than 12 months old, and Ecosystem Development describes the previously rehabilitated areas which continue to develop over time.
All Rehabilitation will occur in line with Rehabilitation and Topsoil Management Procedure TAH SD PRO 0009 (Appendix 4).

*Physical & Chemical Characteristics of Reject*
Refuse (also known as reject) is the waste rock from the coal washing process. The raw coal produced at the mine consists of coal from the full seam, diluted with a proportion of shale and claystone from the roof and floor. This refuse emplaced at the REA consists mostly of the dilution material with a small proportion of carbonaceous material from the seam. The percentage of carbon in the refuse is dependent upon the thickness and quality of the seam being mined, the mining techniques being used and the quality requirements of the coal product. The refuse material is generally sized at <35mm, dark grey to black in colour and is inert.

*Method of Landform Establishment*

Refuse is transported by haul truck from the reject loading bin to the emplacement area. Dumped reject is shaped using a dozer to achieve the final landform profile generally in accordance with the Tahmoor North Environmental Impact Statement (1993).

*Final Landform Profile & Slopes*

Final landform profile is a battered refuse emplacement, approximately 12m high with external batters ranging from 1:4 to 1:8 (maximum design slope is 1:4), generally in accordance with the Tahmoor North Environmental Impact Statement (1993).

*Characteristics of Cover Material*

A review of the *Soil Landscapes of the Wollongong – Port Hacking 1:100 000 Sheet* identified the soils occurring at the Tahmoor Colliery and REA as part of the Lucas Heights Soil Landscape and occurring adjacent to the Gymea Soil Landscape.

The Lucas Heights Soil Landscape is a residual soil landscape characterised by gently undulating crest, ridges and plateau surfaces of the Mittagong Formation. The landscape has been extensively to completely cleared, with natural vegetation existing as a dry sclerophyll low open forest and low woodland. Soils of the Lucas Heights Soil Landscape include:

- Shallow to moderately deep Yellow Podzolic Soils and Yellow Soloths (strong texture contrast with light textured surface soils overlying tough hard and dense B Horizons on ridges and plateau surfaces;
- Lateritic Podzolic Soils on crests
- Yellow Earths (massive, porous earthy materials and gradual increase in clay with depth) on shoulders of plateau and ridges; and
- Earthy Sands (deep uniform sand texture) in valley flats.

Soil limitations of the landscape include stoniness, hard setting surfaces and low soil fertility. Erosion on the landscape is generally low. Where possible, deeper soil horizons are reserved for subsoil and capping material, while the top soil horizons with the highest organic content is reserved to rehabilitation and direct seeding/planting. This process is detailed in Tahmoor's *Soil Survey & Materials Management Plan* (Version 1 - 2010).

*Thickness of Cover Layers & Methods of Laying*

Topsoiled is applied at the REA to a nominal depth of 300mm by scraper and spread by dozer generally in accordance with the Tahmoor North Environmental Impact Statement (1993).

The procedure for ensuring the topsoil depth is the correct thickness is detailed in Rehabilitation and Topsoil Management Procedure (Appendix 4).

*Drainage & Erosion Control Methods*

Erosion and sediment control measures are incorporated into all stages of the REA operation. Features such as sedimentation and retention ponds, clean and contaminated water table and diversion drains, scour protection and sediment fencing along with other basic sediment controls are used across the REA. Contour drains are installed as required to design intervals on slopes to prevent downslope flow and erosion generally in accordance with the Tahmoor North Environmental Impact Statement (1993).

All drains that have been constructed at the southern end of the REA that are not rock lined will be hydromulched by November 2018. This will ensure the landform is stable.

*Vegetation Species & Establishment Techniques*
A combination of sterile cover crops and native grass, shrub and tree seed mixes are used at the REA to achieve the rehabilitation objective of native bushland. A species list has been developed and refined based on the Tahmoor North Environmental Impact Statement (1993), accompanying REA Management, Rehabilitation and Water Monitoring Plan (1995), and more recent rehabilitation monitoring of both rehabilitation and analogue sites, to determine the most appropriate seed mix. In 2011, the seed mix selected for rehabilitation included the following species:

- *Acacia decurrens*
- *Acacia longifolia*
- *Acacia falcata*
- *Acacia suaveolens*
- *Acacia terminalis*
- *Eucalyptus globoidea*
- *Eucalyptus eugenoides*
- *Eucalyptus punctata*
- *Eucalyptus scerophylla*
- *Eucalyptus moluccana*
- *Eucalyptus tereticornis*
- *Eucalyptus rossii*
- *Angophora floribunda*
- *Allocasuarina littoralis*
- *Banksia spinulosa*
- *Dodonaea cuneata*
- *Leptospermum flavescens*
- *Leptospermum juniperinum*
- *Hakea dactyloides*
- *Hakea sericea*
- *Kunzea ambiqua*
- *Hardenbergia violaceae*
- *Kennedia rubicunda*
- *Lomandra longifolia*
- *Lomandra obliqua*
- *Dianella revoluta*
- *Cassinia aculeata*
- Sterile cover crop (Japanese Millet) and light pasture mix for stabilisation.

This species list and seed mix will continue to be refined based on the survival rates and success of these species in rehabilitated areas. The rehabilitation monitoring program detailed in this MOP (Section 7.1) will monitor this success over time, and trigger adjustments as necessary.

*Habitat Establishment Techniques*
Hollow bearing trees and timber logs from clearing activities at the REA have been salvaged and stockpiled for use throughout rehabilitation areas. Logs and hollows are spread throughout rehabilitation areas where access permits, to provide structure and encourage colonisation by fauna.

*Maintenance Activities*
Care and maintenance activities include basic earthwork repairs to erosion as required, and maintenance of sediment controls such as drainage lines, ponds and sediment fencing. Further information on care & maintenance is provided in Section 7.2.

**Domain 4 – No.1 Ventilation Shaft**
Domain 4 is in the active phase at the commencement of this MOP, and is yet to be rehabilitated.

**Domain 5 – No.2 Ventilation Shaft**
Domain 5 is in the active phase at the commencement of this MOP, and is yet to be rehabilitated.

**Domain 6 – Off Title Subsidence Area**
Domain 6 is in the active phase at the commencement of this MOP, and will not be rehabilitated until the Myrtle Creek CMAP submitted is approved. Once the CMAP is approved rehabilitation of natural features will occur.

## 6.2 PROPOSED REHABILITATION ACTIVITIES THIS MOP PERIOD

A summary of the planned rehabilitation activities that are proposed to be implemented over the MOP term (2012 – 2019) for each domain is provided below:

**Domain 1A – CHPP**
Nil – Domain 1A remains in the active phase and is not available during the MOP term for rehabilitation.

**Domain 1B – Rail Loading Facility**
Nil – Domain 1B remains in the active phase and is not available during the MOP term for rehabilitation.

**Domain 1C – Main Workshop & Administration Area**
Nil – Domain 1C remains in the active phase and is not available during the MOP term for rehabilitation.

**Domain 1D – No.3 Shaft & Gas Drainage Plant**
Nil – Domain 1D remains in the active phase and is not available during the MOP term for rehabilitation.

**Domain 1E – Sewage & Water Treatment Plants**
Nil – Domain 1E remains in the active phase and is not available during the MOP term for rehabilitation.

**Domain 2 – Product Stockpile Area**
Nil – Domain 2 remains in the active phase and is not available during the MOP term for rehabilitation.

**Domain 3 – Refuse Emplacement Area**
Progressive rehabilitation of the remaining active areas at the REA will continue throughout the MOP reporting period (in approximate order stages 14, 15, 16, 11, 8, 17, 6 & 9). Note that this sequencing may change due to refuse production rates, or other factors. Rehabilitation methodology will be completed as described in Section 6.1 of this MOP, and generally in accordance with the Tahmoor North Environmental Impact Statement (1993). No changes will occur to this.

The clearing for the expansion of the refuse emplacement is planned to be complete in August 2018. The area is expected to be filled by 2022. Due to the expected nature of filling in layers in this area, with the requirement for flexibility in dumping, rehabilitation will occur in one phase in 2022. However, Tahmoor Colliery is committed to rehabilitating areas as they become available, so if possible they will be rehabilitated sooner. Tahmoor also will commit to completing a Topsoil Management Procedure within the first year of the expansion. This will include the regular turning and maintenance of the topsoil stockpiles. In the Appendix Figure 3G displays the area that is to be cleared in 2018 for the expansion of the REA.

Controls to outside of the new haul road include:
- Sediment fencing around the northern edge of the clean water drain see plan *30012098-401*
- Outside batter to be hydromulched to prevent erosion
- Rock lined diversion chute for the clean water diversion
- Slopes are 1 in 3 for the clean water diversion channel

All management of clearing of vegetation will occur as per the directions in a site specific report completed by qualified ecologist. See Appendix - *3956_Tahmoor_REA_Pre-clearing_Inspection_D1_20180129.*

**Domain 4 – No.1 Ventilation Shaft**
Nil – Domain 4 remains in the active phase and is not available during the MOP term for rehabilitation.

**Domain 5 – No.2 Ventilation Shaft**
Nil – Domain 5 remains in the active phase and is not available during the MOP term for rehabilitation.

**Domain 6 – Off Title Subsidence Area**
Subsidence will occur as per the approved Myrtle Creek CMAP.

## 6.3 REHABILITATION SUMMARY TABLE

In accordance with the *Interim Mining Operations Plan Guideline*, a summary of the rehabilitation status for each domain including area in hectares for the MOP term is provided in **Table 6.3**.

**Table 6.3 Tahmoor Colliery Rehabilitation Summary Table**

| Domain Label | Domain Name | Rehabilitation Phase | Total Domain Area | |
|---|---|---|---|---|
| | | | MOP Commencement | MOP Completion |
| 1A | CHPP | Active Area | 0.44 | 0.44 |
| | | Decommissioning | 0 | 0 |
| | | Landform Establishment | 0 | 0 |
| | | Growth Medium Development | 0 | 0 |
| | | Ecosystem Establishment | 0 | 0 |
| | | Ecosystem Development | 0 | 0 |
| | | Rehabilitation Complete | 0 | 0 |
| 1B | Rail Loading Facility | Active Area | 0.02 | 0.02 |
| | | Decommissioning | 0 | 0 |
| | | Landform Establishment | 0 | 0 |
| | | Growth Medium Development | 0 | 0 |
| | | Ecosystem Establishment | 0 | 0 |
| | | Ecosystem Development | 0 | 0 |
| | | Rehabilitation Complete | 0 | 0 |
| 1C | Main Workshop & Admin Area | Active Area | 0.43 | 0.43 |
| | | Decommissioning | 0 | 0 |
| | | Landform Establishment | 0 | 0 |
| | | Growth Medium Development | 0 | 0 |
| | | Ecosystem Establishment | 0 | 0 |
| | | Ecosystem Development | 0 | 0 |
| | | Rehabilitation Complete | 0 | 0 |
| 1D | No.3 Shaft & Gas Drainage Plant | Active Area | 0.07 | 0.07 |
| | | Decommissioning | 0 | 0 |
| | | Landform Establishment | 0 | 0 |
| | | Growth Medium Development | 0 | 0 |
| | | Ecosystem Establishment | 0 | 0 |
| | | Ecosystem Development | 0 | 0 |
| | | Rehabilitation Complete | 0 | 0 |
| 1E | | Active Area | 0.04 | 0.04 |

| | | | | |
|---|---|---|---|---|
| | **Sewage & Water Treatment Plant** | Decommissioning | 0 | 0 |
| | | Landform Establishment | 0 | 0 |
| | | Growth Medium Development | 0 | 0 |
| | | Ecosystem Establishment | 0 | 0 |
| | | Ecosystem Development | 0 | 0 |
| | | Rehabilitation Complete | 0 | 0 |
| **2** | **Product Stockpile Area** | Active Area | 16.40 | 16.40 |
| | | Decommissioning | 0 | 0 |
| | | Landform Establishment | 0 | 0 |
| | | Growth Medium Development | 0 | 0 |
| | | Ecosystem Establishment | 0 | 0 |
| | | Ecosystem Development | 0 | 0 |
| | | Rehabilitation Complete | 0 | 0 |
| **3** | **Refuse Emplacement Area** | Active Area | 27.74 | 17.5 |
| | | Decommissioning | 0 | 0 |
| | | Landform Establishment | 0 | 0 |
| | | Growth Medium Development | 0 | 0 |
| | | Ecosystem Establishment | 4.75 | 0 |
| | | Ecosystem Development | 50.51 | 70 |
| | | Rehabilitation Complete | 0 | 0 |
| **4** | **No.1 Ventilation Shaft** | Active Area | 0.70 | 0.70 |
| | | Decommissioning | 0 | 0 |
| | | Landform Establishment | 0 | 0 |
| | | Growth Medium Development | 0 | 0 |
| | | Ecosystem Establishment | 0 | 0 |
| | | Ecosystem Development | 0 | 0 |
| | | Rehabilitation Complete | 0 | 0 |
| **5** | **No.2 Ventilation Shaft** | Active Area | 2.90 | 2.90 |
| | | Decommissioning | 0 | 0 |
| | | Landform Establishment | 0 | 0 |
| | | Growth Medium Development | 0 | 0 |
| | | Ecosystem Establishment | 0 | 0 |
| | | Ecosystem Development | 0 | 0 |
| | | Rehabilitation Complete | 0 | 0 |
| 6 | **Off Title Subsidence Area** | | 0 | As per approved Myrtle Creek CMAP |

| | | | | |
|---|---|---|---|---|
| | | | | Schedule included in Appendix 7. |

# 6 Rehabilitation Monitoring & Ongoing Maintenance

## 7.1 REHABILITATION MONITORING

Tahmoor Colliery has developed and implemented an annual rehabilitation monitoring program in accordance with our internal company annexure (*XCN SD ANN 0039 – 10.2 Completion Criteria Development & Rehabilitation Monitoring*), which has been developed based on various Australian government guidelines for mine closure and rehabilitation, and various scientific research papers on soil science and rehabilitation.

The annual rehabilitation program consists of two main parts:

- Annual Rehabilitation Inspection (assessment of rehabilitated areas in general to confirm trajectory towards completion criteria).
- Long-term Rehabilitation Monitoring Sites (detailed evaluation of permanent monitoring transects located throughout rehabilitated areas to monitor progress over time towards achieving completion criteria).

The intent of Tahmoor's rehabilitation monitoring program is to measure the success of rehabilitation, using consistent methods year to year, so results are comparable and improvement actions can be tracked over time. Rehabilitation monitoring is conducted over all phases of rehabilitation, with the greatest emphasis on the Ecosystem Development stage of the MOP rehabilitation phase.

Outcomes of the annual rehabilitation monitoring inspections are recorded and compiled into a report, with improvement actions that are identified as part of the inspection entered into the site action database XstraSafe for tracking and implementation. Improvement actions include care and maintenance activities such as additional seeding or fertilizer, weed management, and erosion repair to improve the quality of rehabilitation areas where deficiencies are identified during the annual monitoring. Improvement actions may also trigger changes to rehabilitation procedures, so rehabilitation methods and standards can be continually improved.

The Annual Rehabilitation Inspection includes an assessment of the following broad indicators:

- Evidence of soil profile development;
- Visual assessment of surface materials;
- Evidence of erosion;
- Stability and function of erosion and sediment control structures;
- Growth rates;
- Evidence of plant mortality or dieback;
- Species diversity, including both native and weed species;
- Presence of overstorey, midstorey and understorey species;
- Evidence of reproductive potential;
- Evidence of biological nutrient cycling;
- Occurrence of potholing or slumping;
- Evidence of spontaneous combustion; and
- Evidence of contamination or other limitations to vegetative establishment.

The Long-term Rehabilitation Monitoring includes an assessment of the following indicators at permanently established monitoring transects each year:

- General site description of vegetation;
- Assessment of reproductive potential of the existing vegetation and soils (soil sampling and lab analysis);
- Number of plants of all species (excluding grasses);
- Measure live vegetation cover for under storey and grasses (separately) using a line intercept method;
- Record details of ground cover (leaf litter, logs and rocks);
- Tag and measure DBH of trees >1.6 m tall, to a maximum of 10 for any one species
- Record canopy cover over 20 m centreline (when trees are tall enough);
- Subjectively describe tree health, by species if relevant, noting signs of drought stress, nutrient deficiencies, disease and severe insect attack as percentage;
- Record any new plant species not present in the smaller plots, including any problem and declared noxious weeds;
- Record the location, number and dimension of all gullies, rill and slope wash features; and
- Photographic monitoring of all sites and repair to permanent transect markers (star pickets) as required.

## 7.2 CARE & MAINTENANCE ACTIVITIES

Maintenance of rehabilitated areas potentially includes fertilising, sediment and erosion control and re-planting or re-seeding as required. The intensity of these activities will be highest over a likely period of two (2) years following Ecosystem Establishment, however depending on the success of rehabilitation, care and maintenance may be required beyond this period to achieve the identified completion criteria for Ecosystem Development for each closure domain.

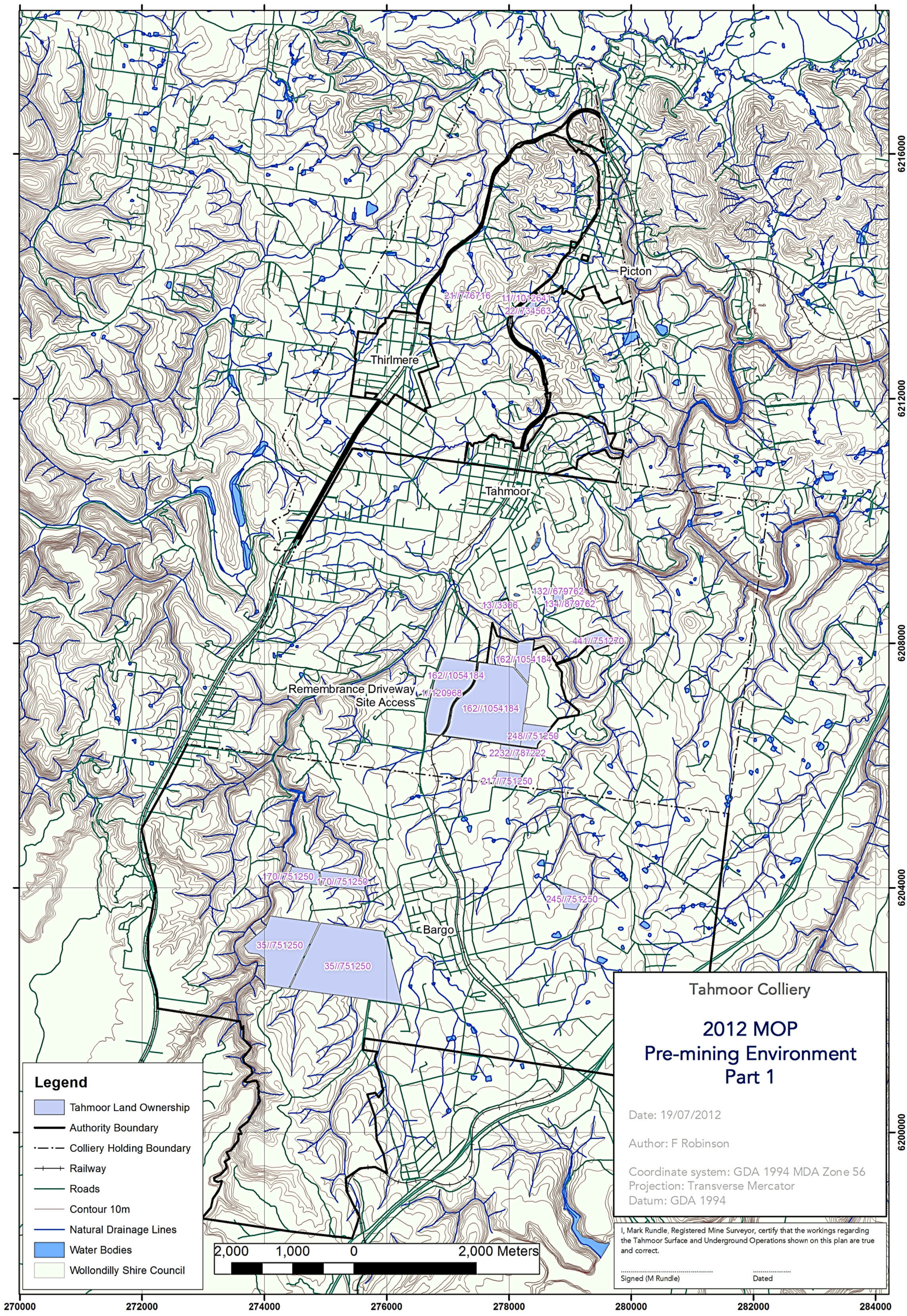
## 7.3 TRIGGER ACTION RESPONSE PLAN (TARP)

A Trigger Action Response Plan (TARP) has been developed to manage unexpected variations in rehabilitation outcomes, in accordance with the *Interim Mining Operations Plan Guideline*. Tahmoor's Rehabilitation Monitoring TARP is provided in **Table 7.1** below.

**Table 7.1 Tahmoor Colliery Rehabilitation TARP**

| ROLES & RESPONSIBILITIES | MINIMUM REQUIREMENTS | LEVEL 1 – NORMAL<br>Rehabilitation Monitoring & Inspections indicate compliance with rehabilitation objectives and completion criteria | LEVEL 2 - ELEVATED<br>Rehabilitation Monitoring & Inspections indicate minor, non-urgent variance from rehabilitation objectives and completion criteria<br><br>(e.g. additional seeding, or fertilizer application required within 12 months) | LEVEL 3 - CRITICAL<br>Rehabilitation Monitoring & Inspections indicate significant or urgent variance from rehabilitation objectives and completion criteria<br><br>(e.g. significant erosion or civil repairs required to prevent within 3 months) |
|---|---|---|---|---|
| **TAHMOOR COLLIERY<br>REHABILITATION MONITORING TARP** | | | | |
| Reject Supervisor<br><br>CHPP Production Coordinator | Understand this TARP. Provide feedback to Environment Coordinator as required. | Conduct operations in accordance with work instructions and landform design criteria. | Report identified issues through to Environment Coordinator in timely manner. | Immediately report identified issues through to Environment Coordinator for action. |
| Rehabilitation Monitoring Consultant | Understand this TARP. Report improvement actions following rehabilitation monitoring. | Conduct operations in accordance with rehabilitation monitoring procedure and XCN requirements. | Report identified issues through to Environment Coordinator in timely manner. | Immediately report identified issues through to Environment Coordinator for action. |
| Environment Coordinator | Coordinate rehabilitation activities in accordance with rehabilitation objectives towards achieving completion criteria. | Implement improvement actions beyond compliance as appropriate. | Coordinate improvement works as part of care & maintenance program detailed in the Annual Rehabilitation Plan. | Coordinate immediate repairs and improvement works as required. |

# Appendix 1 - Rehabilitation Maps



Tahmoor Colliery
2012 MOP
Pre-mining Environment
Part 1
Date: 19/07/2012
Author: F Robinson
Coordinate system: GDA 1994 MGA Zone 56
Projection: Transverse Mercator
Datum: GDA 1994
I, Mark Rundle, Registered Mine Surveyor, certify that the workings regarding the Tahmoor Surface and Underground Operations shown on this plan are true and correct.
Signed (M Rundle)
Dated
Legend
Tahmoor Land Ownership
Authority Boundary
Colliery Holding Boundary
Railway
Roads
Contour 10m
Natural Drainage Lines
Water Bodies
Wollondilly Shire Council
2,000 1,000 0 2,000 Meters
Picton
Thirlmere
Tahmoor
Bargo
Remembrance Driveway
Site Access
21//776716
11//1042641
22//734563
132//679762
134//879762
13//3306
441//751270
162//1054184
162//1054184
1//120968
162//1054184
248//751250
2232//787222
217//751250
170//751250
170//751250
245//751250
35//751250
35//751250
270000
272000
274000
276000
278000
280000
282000
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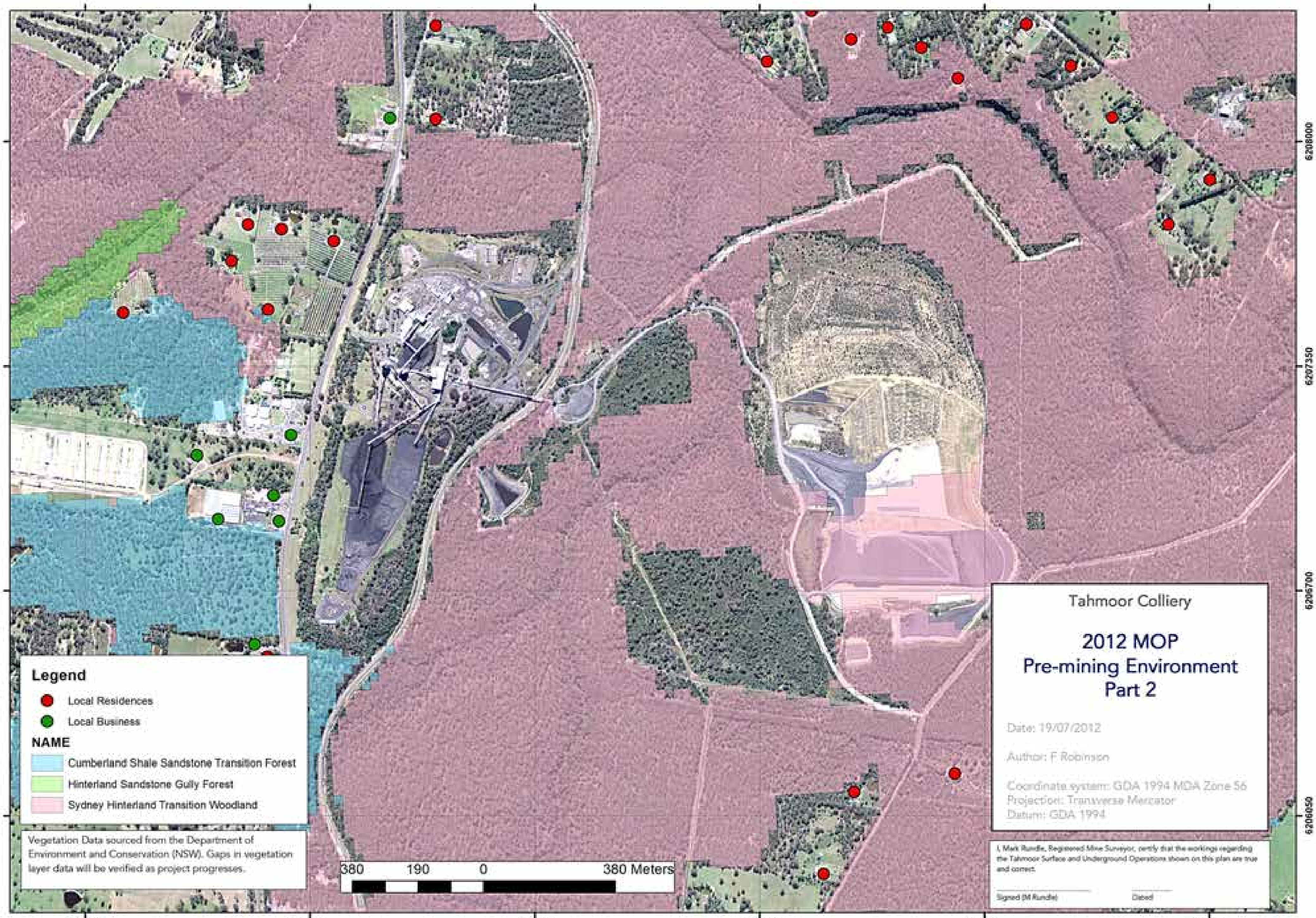
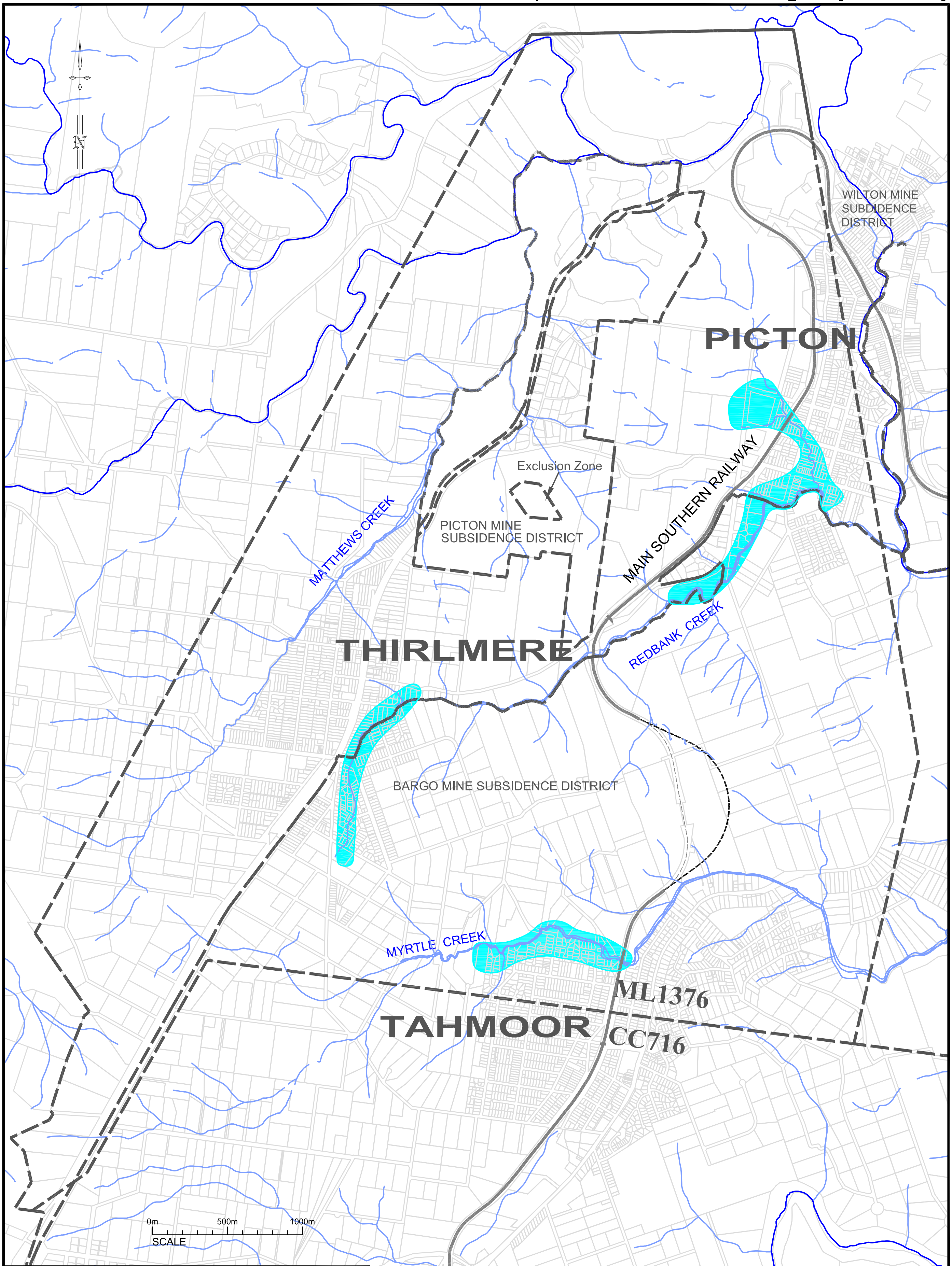
6216000
6212000
6208000
6204000
6200000


Tahmoor Colliery
2012 MOP
Pre-mining Environment
Part 2
Date: 19/07/2012
Author: F Robinson
Coordinate system: GDA 1994 MGA Zone 56
Projection: Transverse Mercator
Datum: GDA 1994
I, Mark Rundle, Registered Mine Surveyor, certify that the workings regarding the Tahmoor Surface and Underground Operations shown on this plan are true and correct.
Signed (M Rundle)
Dated
Legend
Local Residences
Local Business
NAME
Cumberland Shale Sandstone Transition Forest
Hinterland Sandstone Gully Forest
Sydney Hinterland Transition Woodland
Vegetation Data sourced from the Department of Environment and Conservation (NSW). Gaps in vegetation layer data will be verified as project progresses.
380 190 0 380 Meters
276050
276700
277350
278000
278650
279300
6298000
6297350
6296700
6296050

I:\Projects\Tahmoor\MSEC355\AcadData\120731_Flooding&Innundation.dwg



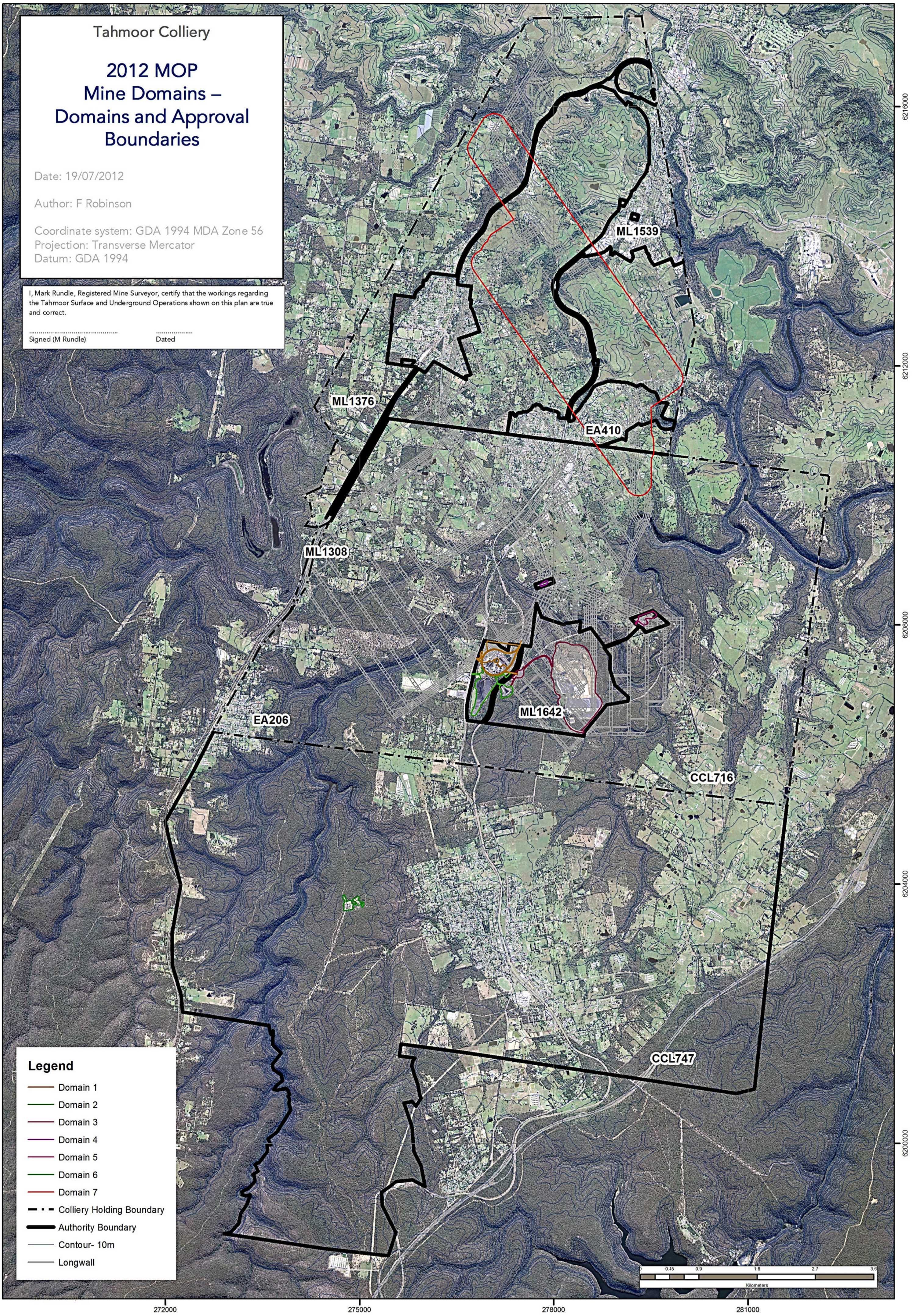

msec mine subsidence ENGINEERING CONSULTANTS
Level 1, 228 Victoria Ave, Chatswood NSW 2067
PO Box 3047, Willoughby North NSW 2068
Tel +61 2 9413 3777 Fax +61 2 9413 3822
www.minesubsidence.com

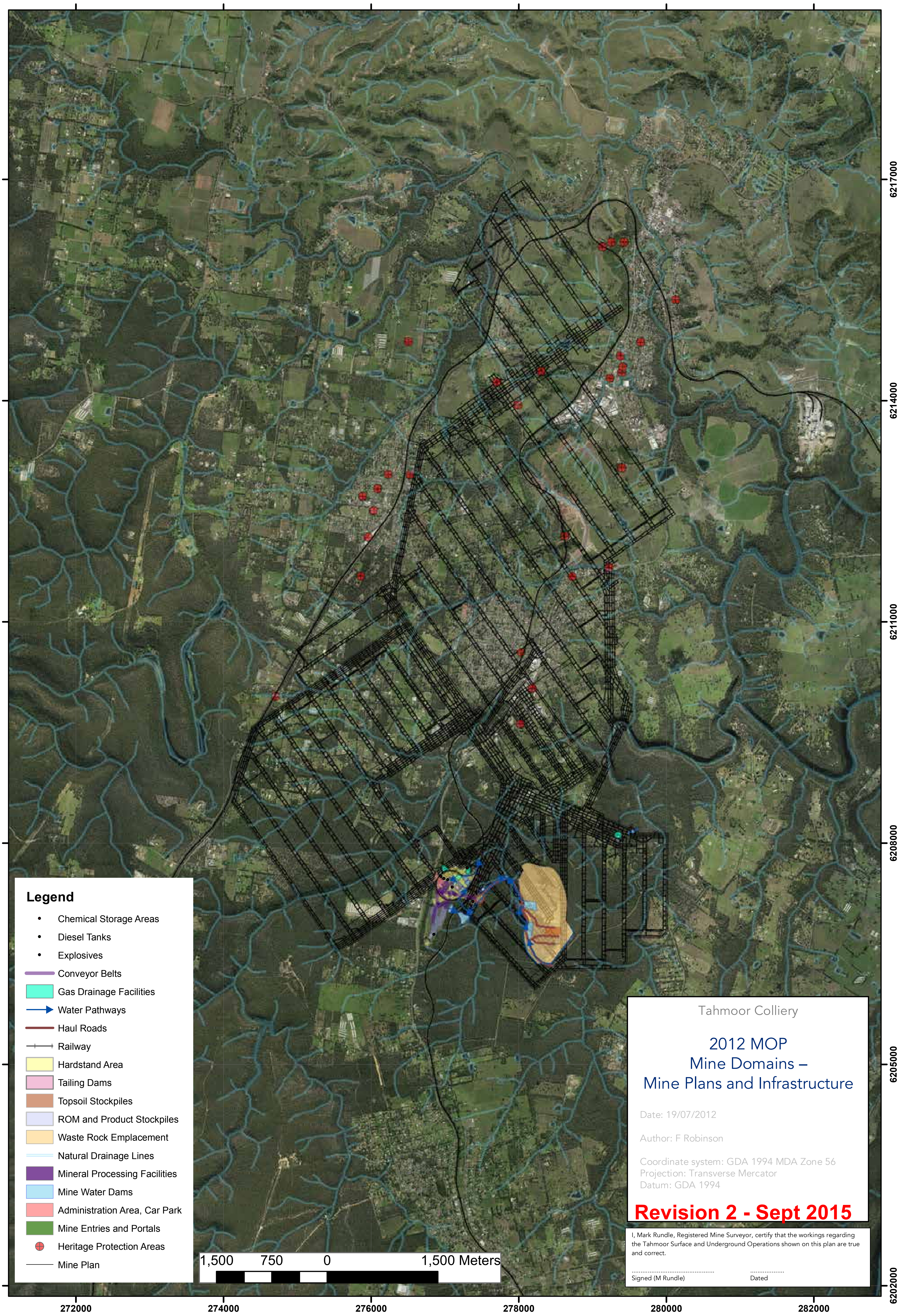
xstrata coal

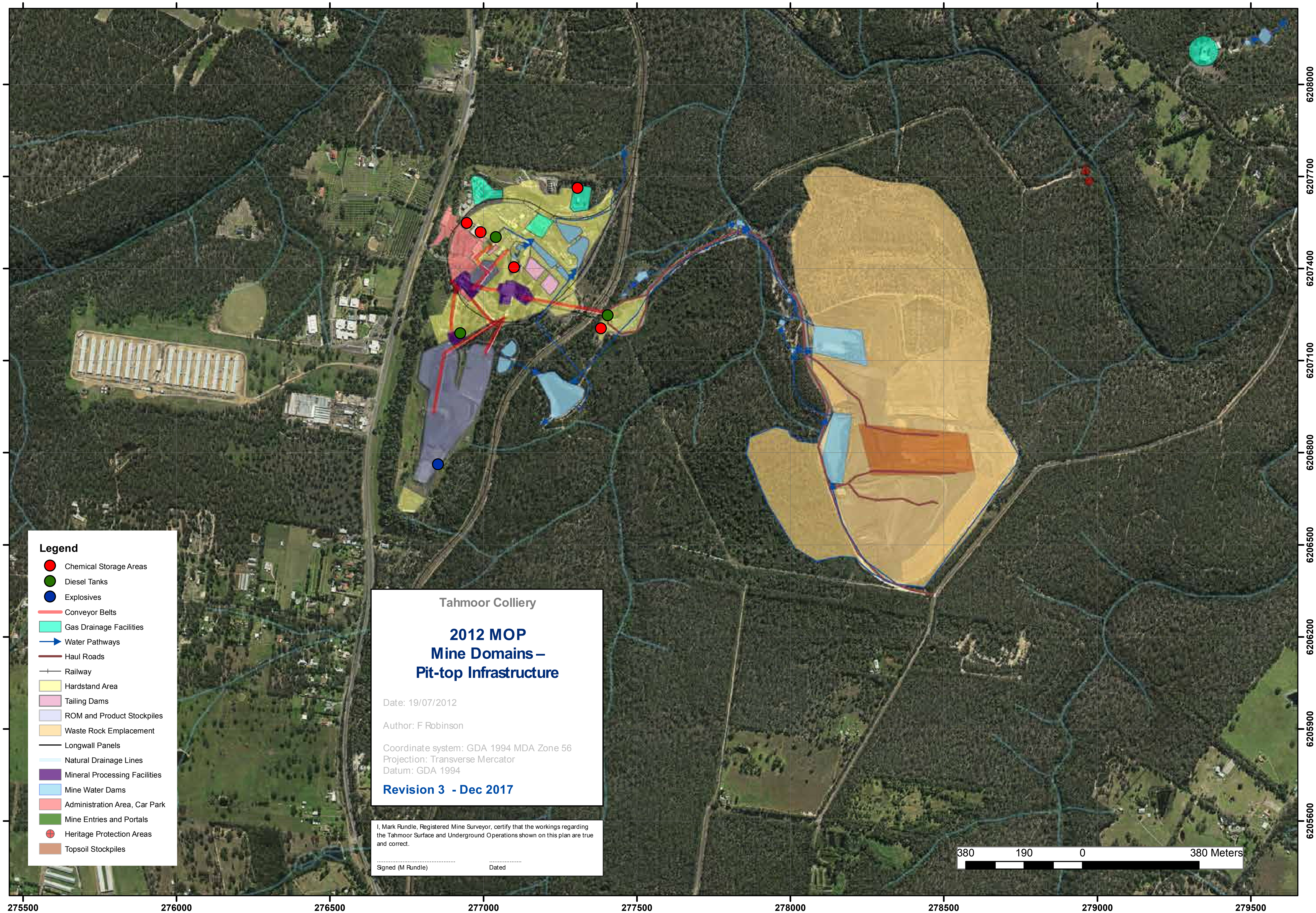
TAHMOOR COLLIERY

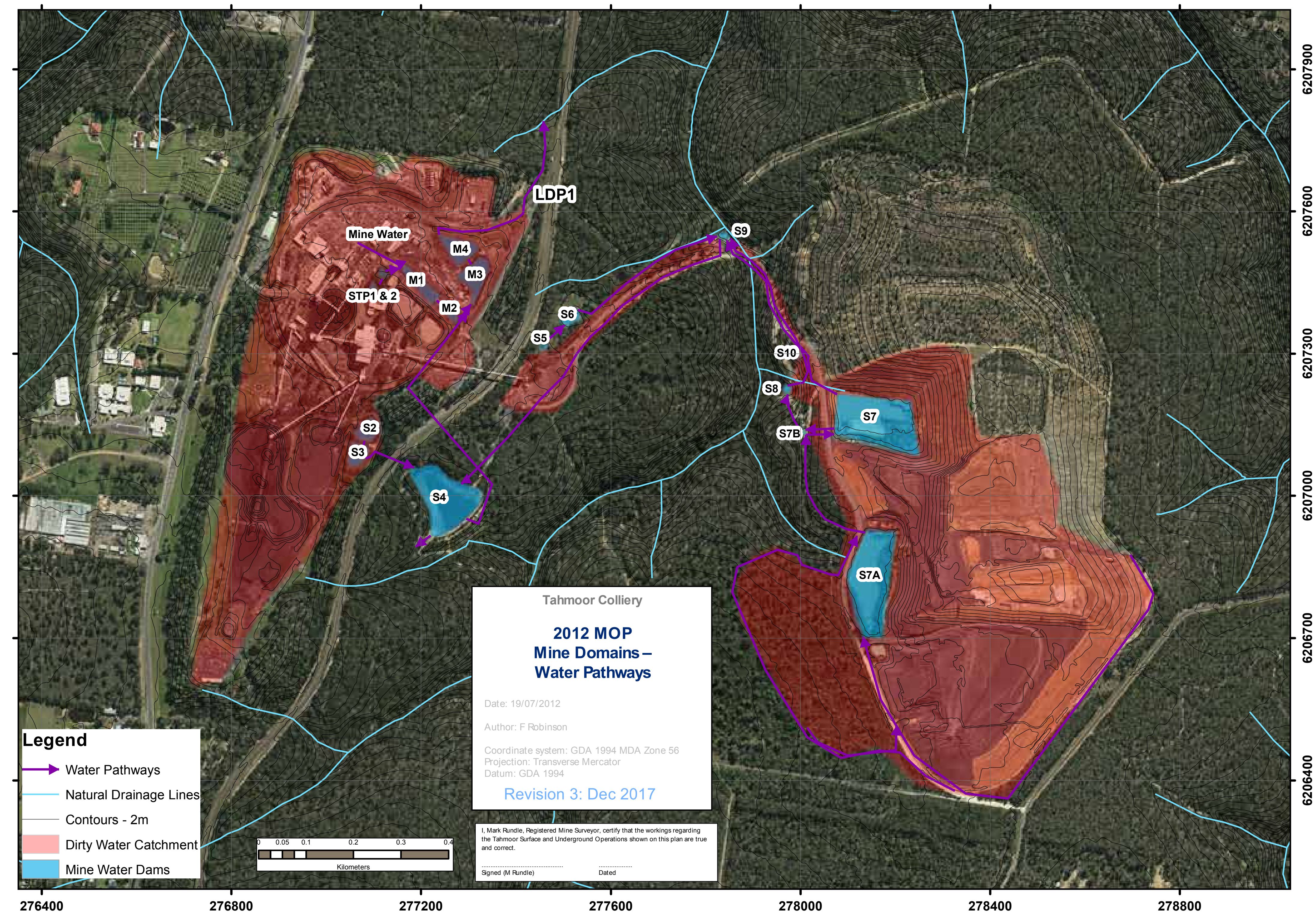
FLOODING & INNUNDATION

| DATE: | SCALE: | DRAWING No: | Rev No |
|---|---|---|---|
| 31-July-2012 | as shown | MSEC355 | 01 |

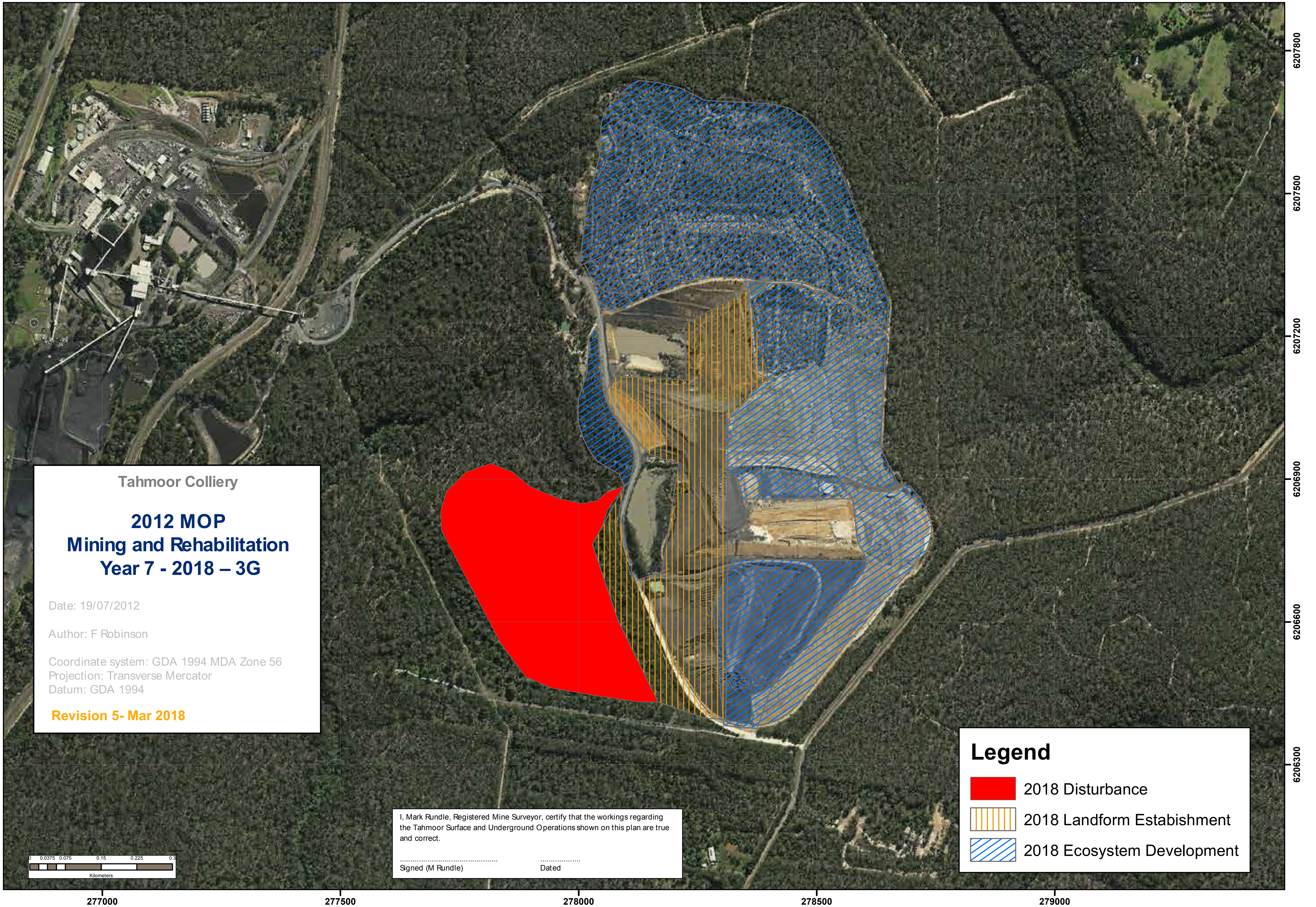

Tahmoor Colliery
2012 MOP
Mine Domains –
Domains and Approval
Boundaries
Date: 19/07/2012
Author: F Robinson
Coordinate system: GDA 1994 MDA Zone 56
Projection: Transverse Mercator
Datum: GDA 1994
I, Mark Rundle, Registered Mine Surveyor, certify that the workings regarding the Tahmoor Surface and Underground Operations shown on this plan are true and correct.
Signed (M Rundle)
Dated
ML1539
ML1376
EA410
ML1308
ML1642
EA206
CCL716
CCL747
Legend
Domain 1
Domain 2
Domain 3
Domain 4
Domain 5
Domain 6
Domain 7
Colliery Holding Boundary
Authority Boundary
Contour- 10m
Longwall
Kilometers
272000
275000
278000
281000
6216000
6212000
6208000
6204000
6200000

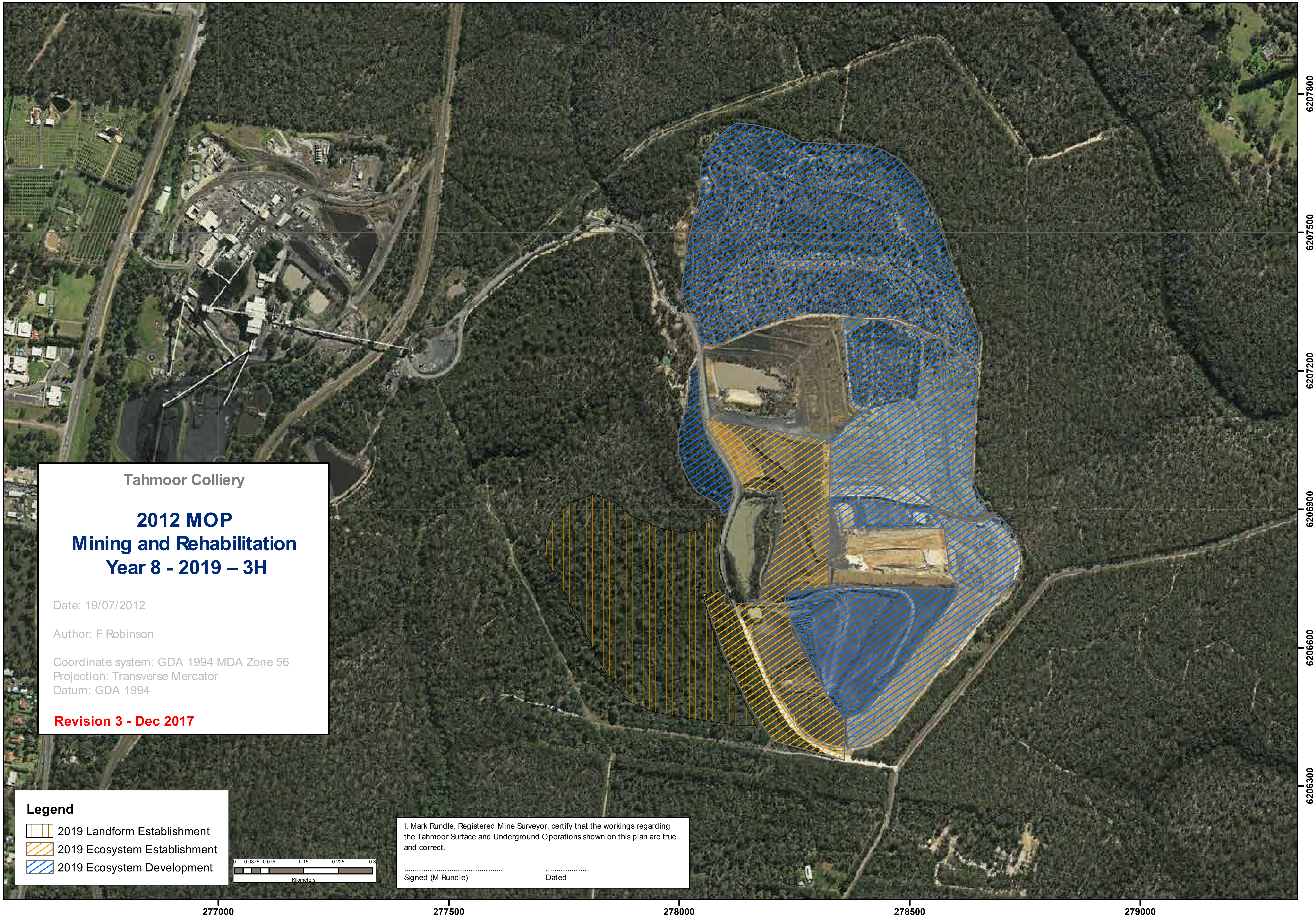

Legend
Chemical Storage Areas
Diesel Tanks
Explosives
Conveyor Belts
Gas Drainage Facilities
Water Pathways
Haul Roads
Railway
Hardstand Area
Tailing Dams
Topsoil Stockpiles
ROM and Product Stockpiles
Waste Rock Emplacement
Natural Drainage Lines
Mineral Processing Facilities
Mine Water Dams
Administration Area, Car Park
Mine Entries and Portals
Heritage Protection Areas
Mine Plan
1,500 750 0 1,500 Meters
Tahmoor Colliery
2012 MOP
Mine Domains –
Mine Plans and Infrastructure
Date: 19/07/2012
Author: F Robinson
Coordinate system: GDA 1994 MDA Zone 56
Projection: Transverse Mercator
Datum: GDA 1994
Revision 2 - Sept 2015
I, Mark Rundle, Registered Mine Surveyor, certify that the workings regarding the Tahmoor Surface and Underground Operations shown on this plan are true and correct.
Signed (M Rundle)
Dated
272000
274000
276000
278000
280000
282000
6217000
6214000
6211000
6208000
6205000
6202000

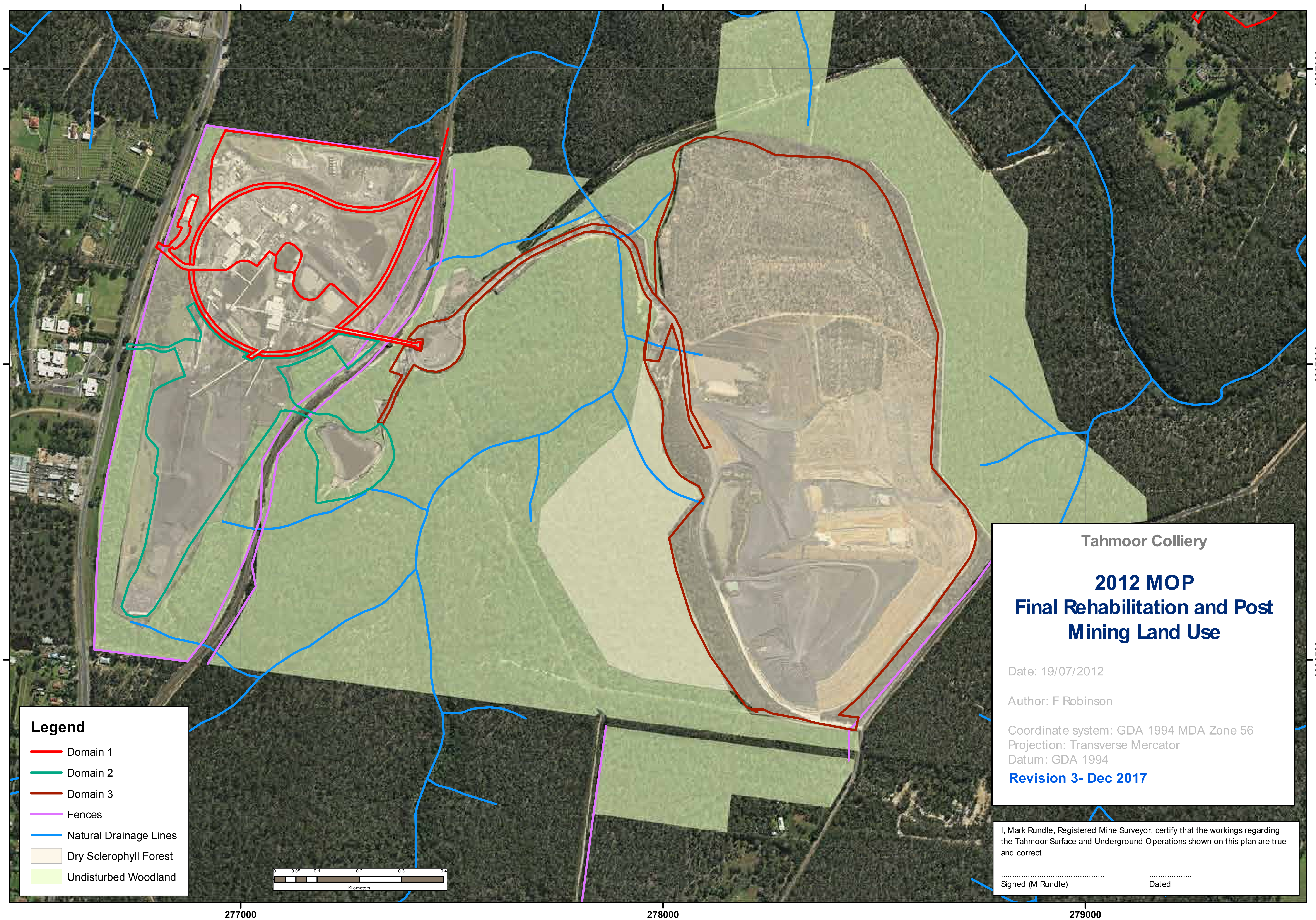

Legend
Chemical Storage Areas
Diesel Tanks
Explosives
Conveyor Belts
Gas Drainage Facilities
Water Pathways
Haul Roads
Railway
Hardstand Area
Tailing Dams
ROM and Product Stockpiles
Waste Rock Emplacement
Longwall Panels
Natural Drainage Lines
Mineral Processing Facilities
Mine Water Dams
Administration Area, Car Park
Mine Entries and Portals
Heritage Protection Areas
Topsoil Stockpiles
Tahmoor Colliery
2012 MOP
Mine Domains –
Pit-top Infrastructure
Date: 19/07/2012
Author: F Robinson
Coordinate system: GDA 1994 MGA Zone 56
Projection: Transverse Mercator
Datum: GDA 1994
Revision 3 - Dec 2017
I, Mark Rundle, Registered Mine Surveyor, certify that the workings regarding the Tahmoor Surface and Underground Operations shown on this plan are true and correct.
Signed (M Rundle)
Dated
380 190 0 380 Meters
275500 276000 276500 277000 277500 278000 278500 279000 279500
6208000 6207700 6207400 6207100 6206800 6206500 6206200 6205900 6205600



LDP1
Mine Water
M1
M2
M3
M4
STP1 & 2
S2
S3
S4
S5
S6
S7
S7A
S7B
S8
S9
S10
276400
276800
277200
277600
278000
278400
278800
6207900
6207600
6207300
6207000
6206700
6206400
Legend
Water Pathways
Natural Drainage Lines
Contours - 2m
Dirty Water Catchment
Mine Water Dams
0 0.05 0.1 0.2 0.3 0.4
Kilometers
Tahmoor Colliery
2012 MOP
Mine Domains – Water Pathways
Date: 19/07/2012
Author: F Robinson
Coordinate system: GDA 1994 MDA Zone 56
Projection: Transverse Mercator
Datum: GDA 1994
Revision 3: Dec 2017
I, Mark Rundle, Registered Mine Surveyor, certify that the workings regarding the Tahmoor Surface and Underground Operations shown on this plan are true and correct.
Signed (M Rundle)
Dated

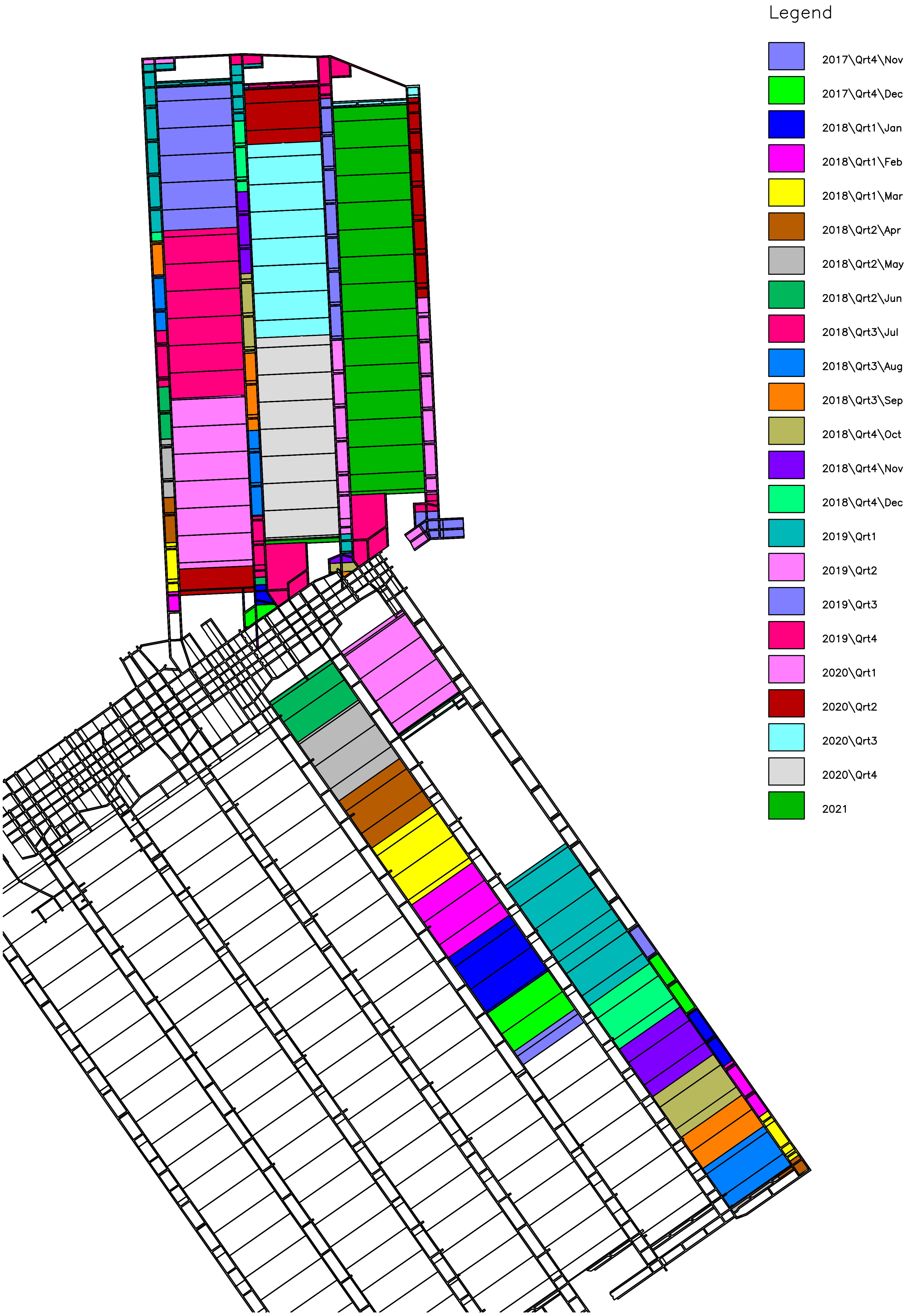

Tahmoor Colliery
2012 MOP
Mining and Rehabilitation
Year 7 - 2018 – 3G
Date: 19/07/2012
Author: F Robinson
Coordinate system: GDA 1994 MDA Zone 56
Projection: Transverse Mercator
Datum: GDA 1994
Revision 5- Mar 2018
Legend
2018 Disturbance
2018 Landform Estabishment
2018 Ecosystem Development
I, Mark Rundle, Registered Mine Surveyor, certify that the workings regarding the Tahmoor Surface and Underground Operations shown on this plan are true and correct.
Signed (M Rundle)
Dated
0 0.0375 0.075 0.15 0.225 0.3
Kilometers
277000
277500
278000
278500
279000
6207800
6207500
6207200
6206900
6206600
6206300


Tahmoor Colliery
2012 MOP
Mining and Rehabilitation
Year 8 - 2019 – 3H
Date: 19/07/2012
Author: F Robinson
Coordinate system: GDA 1994 MDA Zone 56
Projection: Transverse Mercator
Datum: GDA 1994
Revision 3 - Dec 2017
Legend
2019 Landform Establishment
2019 Ecosystem Establishment
2019 Ecosystem Development
0 0.0375 0.075 0.15 0.225 0.3
Kilometers
I, Mark Rundle, Registered Mine Surveyor, certify that the workings regarding the Tahmoor Surface and Underground Operations shown on this plan are true and correct.
Signed (M Rundle)
Dated
277000
277500
278000
278500
279000
6207800
6207500
6207200
6206900
6206600
6206300



Tahmoor Colliery
2012 MOP
Final Rehabilitation and Post Mining Land Use
Date: 19/07/2012
Author: F Robinson
Coordinate system: GDA 1994 MDA Zone 56
Projection: Transverse Mercator
Datum: GDA 1994
Revision 3- Dec 2017
I, Mark Rundle, Registered Mine Surveyor, certify that the workings regarding the Tahmoor Surface and Underground Operations shown on this plan are true and correct.
Signed (M Rundle)
Dated
Legend
Domain 1
Domain 2
Domain 3
Fences
Natural Drainage Lines
Dry Sclerophyll Forest
Undisturbed Woodland
0
0.05
0.1
0.2
0.3
0.4
Kilometers
277000
278000
279000
6207900
6207200
6206500

# December Forecast
# Period Plot



# Appendix 2 - Reject Area Extension

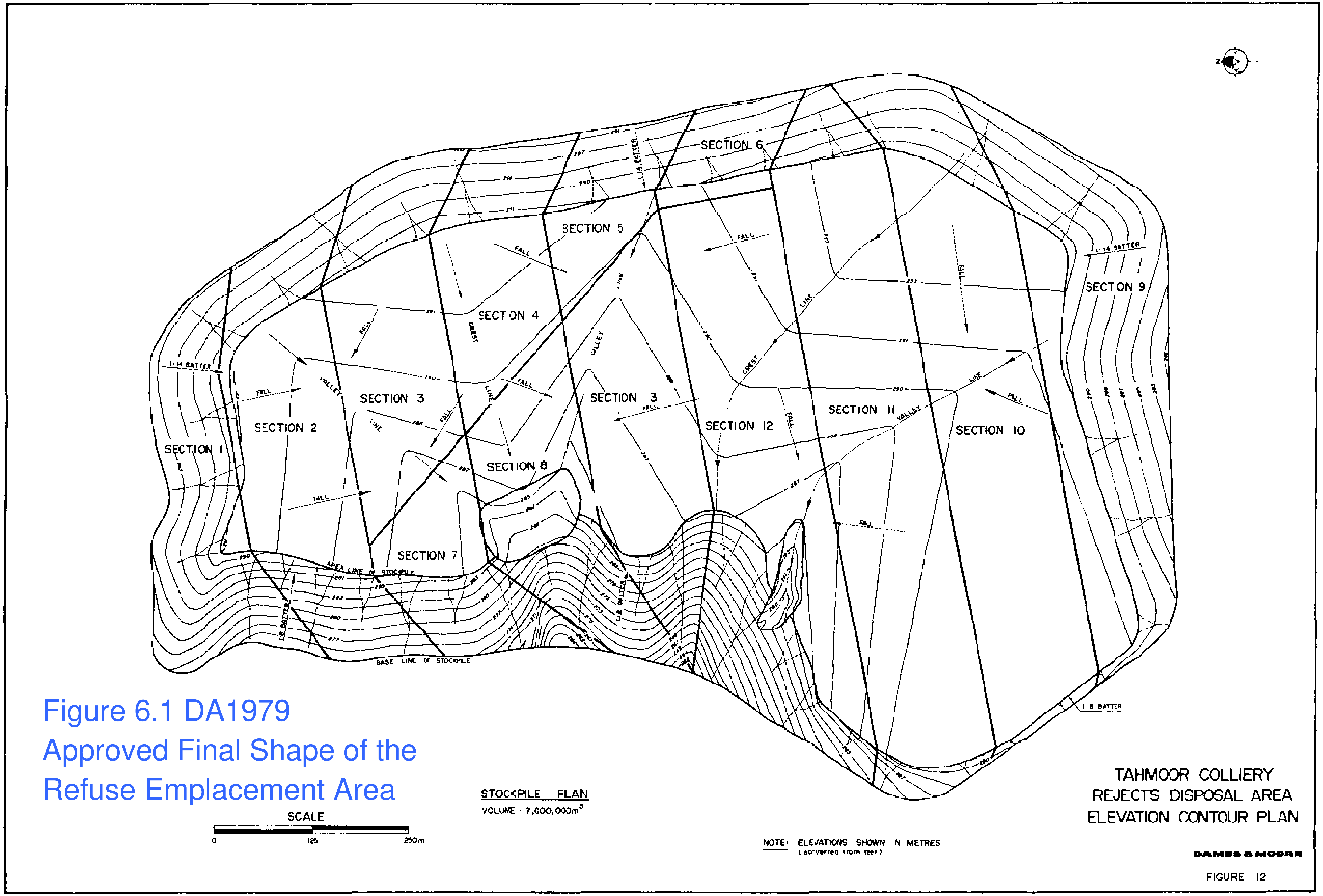
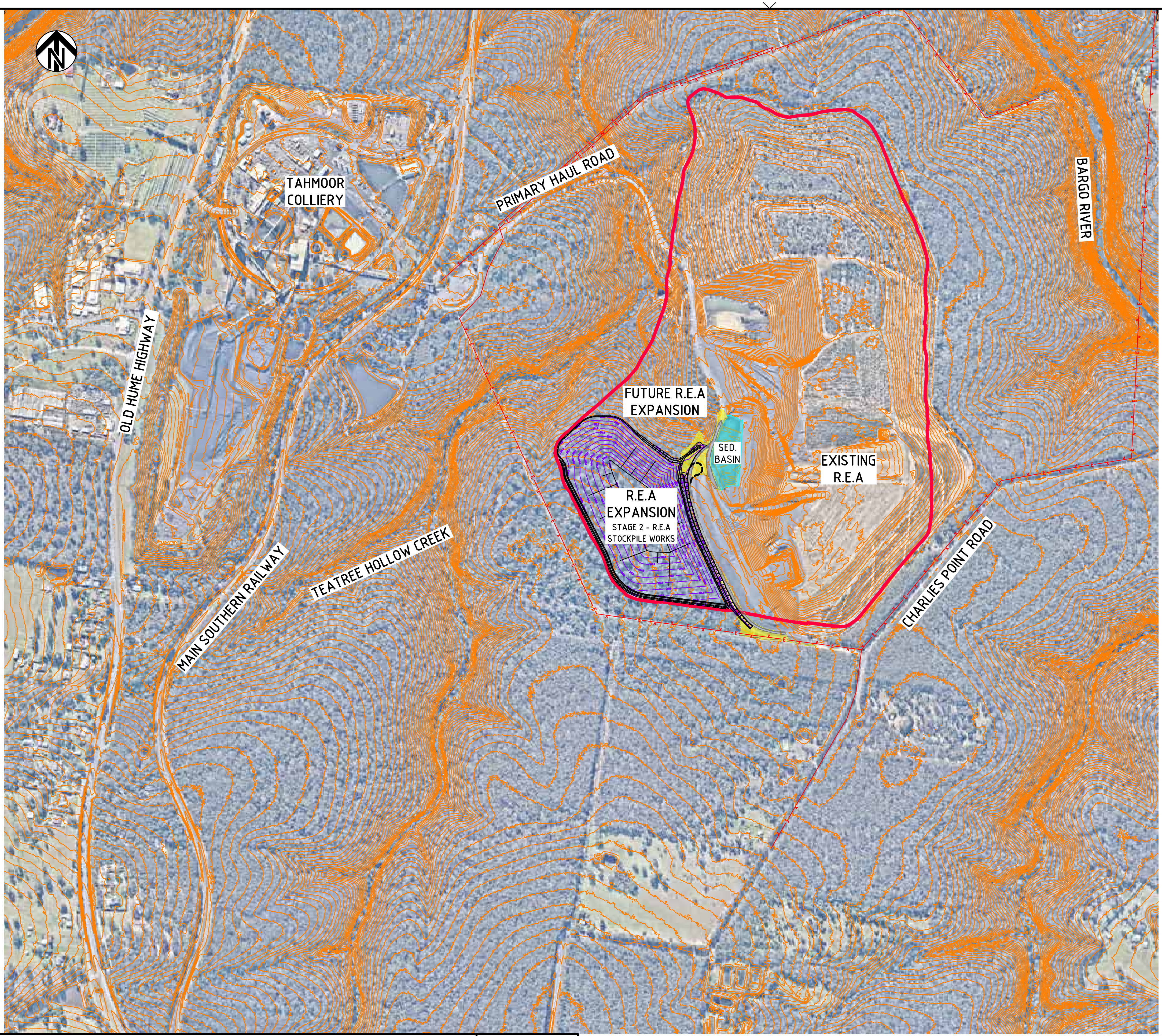



Figure 6.1 DA1979 Approved Final Shape of the Refuse Emplacement Area




## LEGEND

- EXISTING R.E.A. CONSENT BOUNDARY (1979)
- EXISTING LIDAR CONTOUR (1m INTERVAL)
- EXTENT OF DETAIL SURVEY
- EXISTING OVERHEAD POWER
- EXISTING SEDIMENT BASIN S7a (APPROXIMATE)

## EXISTING R.E.A CONSENT BOUNDARY (1979)

THE EXISTING R.E.A BOUNDARY (1979) HAS BEEN INTERPRETED BY SMEC NOVEMBER 2017.
IT IS THE RESPONSIBILITY OF TAHMOOR COLLIERY TO CONFIRM THE BOUNDARY

## EXISTING LIDAR SURVEY

EXISTING LIDAR CONTOURS (1m INTERVALS) DERIVED FROM LIDAR SURVEY OBTAINED FROM NSW GOVERNMENT'S SPATIAL SERVICES RESOURCE ON 26/10/17. THE SURVEY WAS CONDUCTED ON 04/05/14.

## DETAIL TOPOGRAPHICAL SURVEY

ONLY IN AREA SHOWN (SEE LEGEND)
PRODUCED BY 'SMEC' DATED 26/04/2018

## AERIAL IMAGE

AERIAL IMAGE OBTAINED FROM © NEARMAP 2017 ON 20/11/17.
THE IMAGES WERE CAPTURED ON 28/05/17.

DIAL 1100
BEFORE YOU DIG

WARNING
"DIAL BEFORE YOU DIG" - 1100
IT IS ESSENTIAL THAT BEFORE ANY EXCAVATION WORK IS UNDERTAKEN, FURTHER INVESTIGATION INTO THE LOCATION OF SERVICES SHOULD BE CARRIED OUT WITH THE RELEVANT AUTHORITY.

## DISCLAIMER

WHILE EVERY CARE IS TAKEN TO ENSURE THE ACCURACY OF THE SURVEY DATA, SMEC MAKES NO REPRESENTATIONS OR WARRANTIES ABOUT ITS ACCURACY, RELIABILITY, COMPLETENESS OR SUITABILITY FOR ANY PARTICULAR PURPOSE AND DISCLAIM ALL RESPONSIBILITY AND ALL LIABILITY WHETHER IN CONTRACT, NEGLIGENCE OR OTHERWISE FOR ALL EXPENSES, LOSSES, DAMAGES (INCLUDING INDIRECT OR CONSEQUENTIAL DAMAGE) AND COSTS WHICH MAY BE INCURRED AS A RESULT OF DATA BEING INACCURATE OR INCOMPLETE IN ANY WAY AND FOR ANY REASON.

**PRELIMINARY**

150 mm ON ORIGINAL
A1

DRAWING FILE LOCATION / NAME
T:\Projects\30012098\CAD\DWG\30012098-2001__[01].dwg

PLOT DATE 24 May 2018 TIME 18:20:35

EXTERNAL REFERENCE FILES
X_Newc_a1_30012098
X_ECW_LRG
X_LIDAR
X_1_DSGN_ADDL
X_2_DSGN

| REV | DATE | AMENDMENT / REVISION DESCRIPTION | WVR No. | APPROVAL |
|---|---|---|---|---|
| 01 | 24.06.18 | ISSUED FOR CLIENT REVIEW | 05 | E.W |

| TITLE | NAME |
|---|---|
| DRAFTER | M.SKINNER |
| DRAFTING CHECK | N.HOLE |
| DESIGNER | N.HOLE |
| DESIGN CHECK | E.WINGATE |
| PROJECT MANAGER | L.COOK |
| PROJECT DIRECTOR | E.WINGATE |

SCALES AT A1 SIZE DRAWING
SCALE 1:5000 50 0 100 200

DESIGNER
SMEC
SMEC AUSTRALIA PTY LTD
© ABN 47 065 475 149
74 HUNTER STREET
NEWCASTLE NSW 2300
PH +61 2 4925 9600 FAX +61 2 4925 3888
SMEC PROJECT No 30012098

CLIENT
TAHMOOR UNDERGROUND
GLENCORE

PROJECT TITLE
TAHMOOR COLLIERY
REFUSE EMPLACEMENT AREA UPGRADE
STAGE 2 - R.E.A STOCKPILE WORKS
SITE PLAN & GENERAL NOTES

| SCALE | PHASE | PROJECT / DRAWING No. | REVISION |
|---|---|---|---|
| AS NOTED | PRELIMINARY | 30012098-2001 | 01 |

# Appendix 3 - Reject Emplacement Area Extension Drainage Model

**TAHMOOR UNDERGROUND - REA EXTENSION PROJECT**

**DRAINAGE MODEL & PRELIMINARY RISK ASSESSMENT**

---

## <u>Drainage Model:</u>

Flow design calculations were undertaken using DRAINS software, where the following details determined the preliminary sizing of pipes:

- Models and data:
  - Hydrological Model (ILSAX):

    Paved area depression storage = 1mm

    Supplementary area depression storage = 1mm

    Grassed area depression storage = 5mm

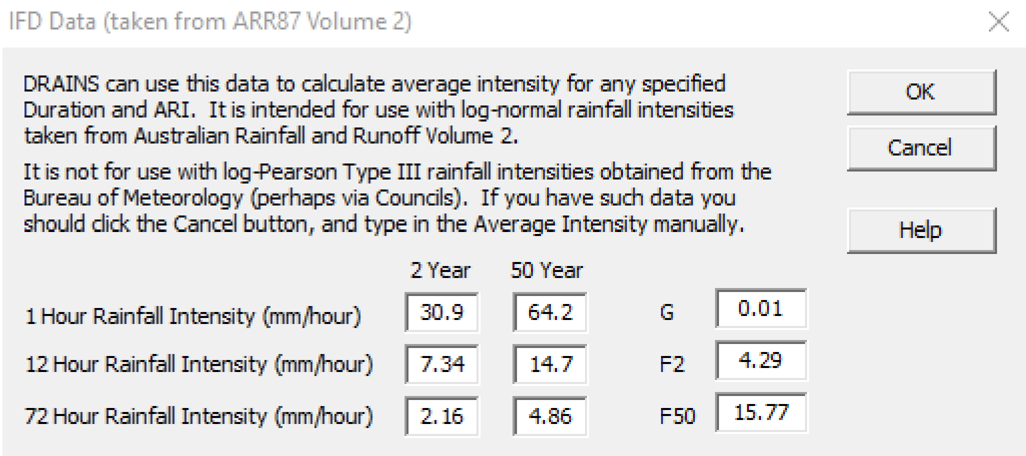
    Soil Type = 3

    Overland flow equation = Friend's Equation

  - Rainfall Data:

    Design level = 100yr ARI (major storm)

    IFD Data = ARR87 (obtained from Bureau of Meteorology). See below.



IFD Data (taken from ARR87 Volume 2)

DRAINS can use this data to calculate average intensity for any specified Duration and ARI. It is intended for use with log-normal rainfall intensities taken from Australian Rainfall and Runoff Volume 2.

It is not for use with log-Pearson Type III rainfall intensities obtained from the Bureau of Meteorology (perhaps via Councils). If you have such data you should click the Cancel button, and type in the Average Intensity manually.

OK

Cancel

Help

| | 2 Year | 50 Year | | |
|---|---|---|---|---|
| 1 Hour Rainfall Intensity (mm/hour) | 30.9 | 64.2 | G | 0.01 |
| 12 Hour Rainfall Intensity (mm/hour) | 7.34 | 14.7 | F2 | 4.29 |
| 72 Hour Rainfall Intensity (mm/hour) | 2.16 | 4.86 | F50 | 15.77 |

- Clean drainage:
  - Catchment: Area = 61.33ha of which is 100% grassed. See shape in figure below.

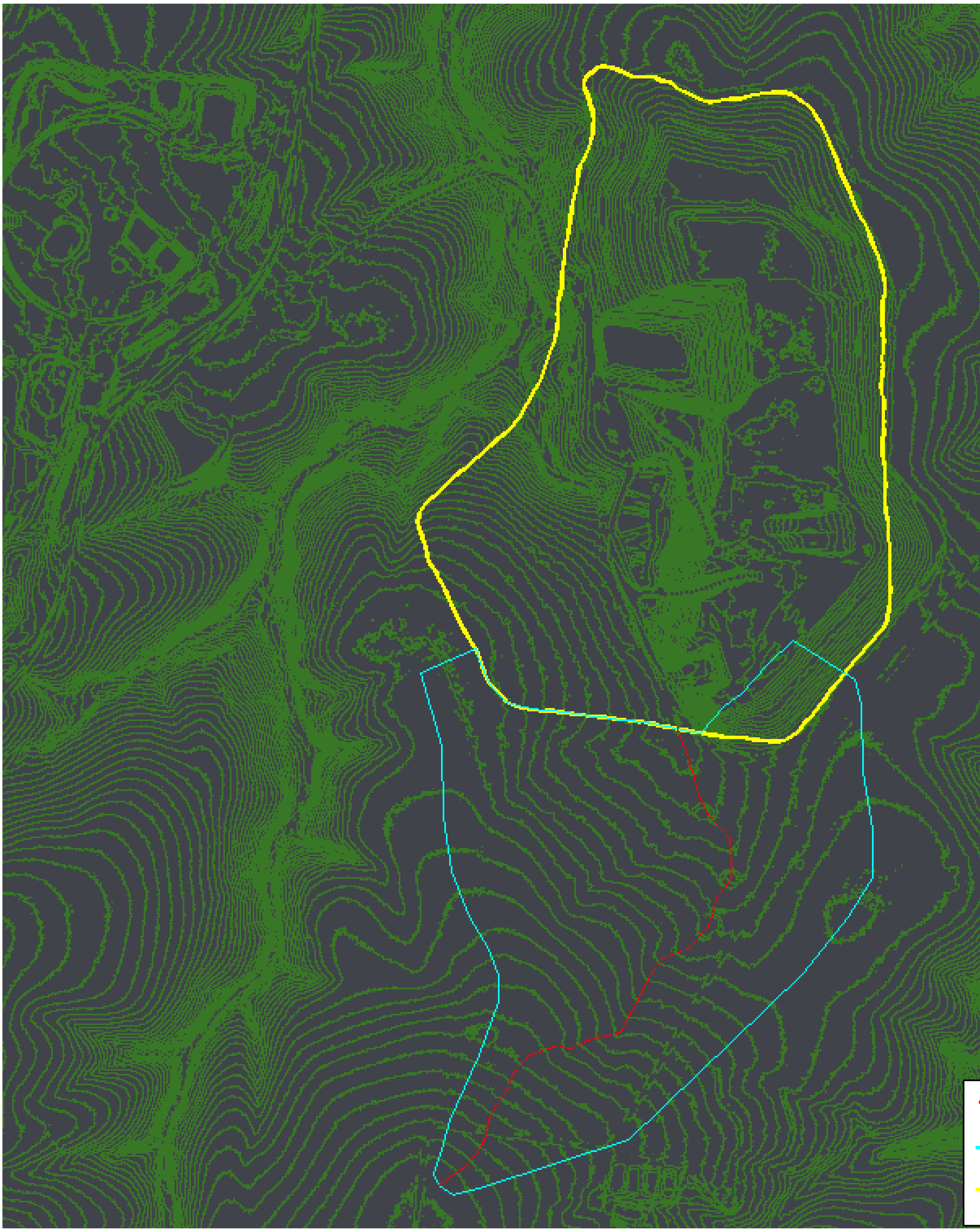
    Overland concentrated flow time = 34mins (based on average flow velocity = 0.6m/s)

    Flow path = 1215m with an average slope of 2.44%.

    Horton roughness n = 0.3

    $Q_{100} = 5.15m^3/s$

    Critical storm duration = 6hrs



- Piping: Pipe length = 500m
  Upstream invert level = 280m AHD
  Downstream invert level = 267.5m AHD
  Pipe slope = 2.50%
  Pipe roughness = 0.013
  Pipe dimensions = 3 x 900mm diam. (2700W x 1200H box culvert equiv.)
  (**Note:** A conservative approach was taken when sizing pipes).

Min. crown cover = 0.9m

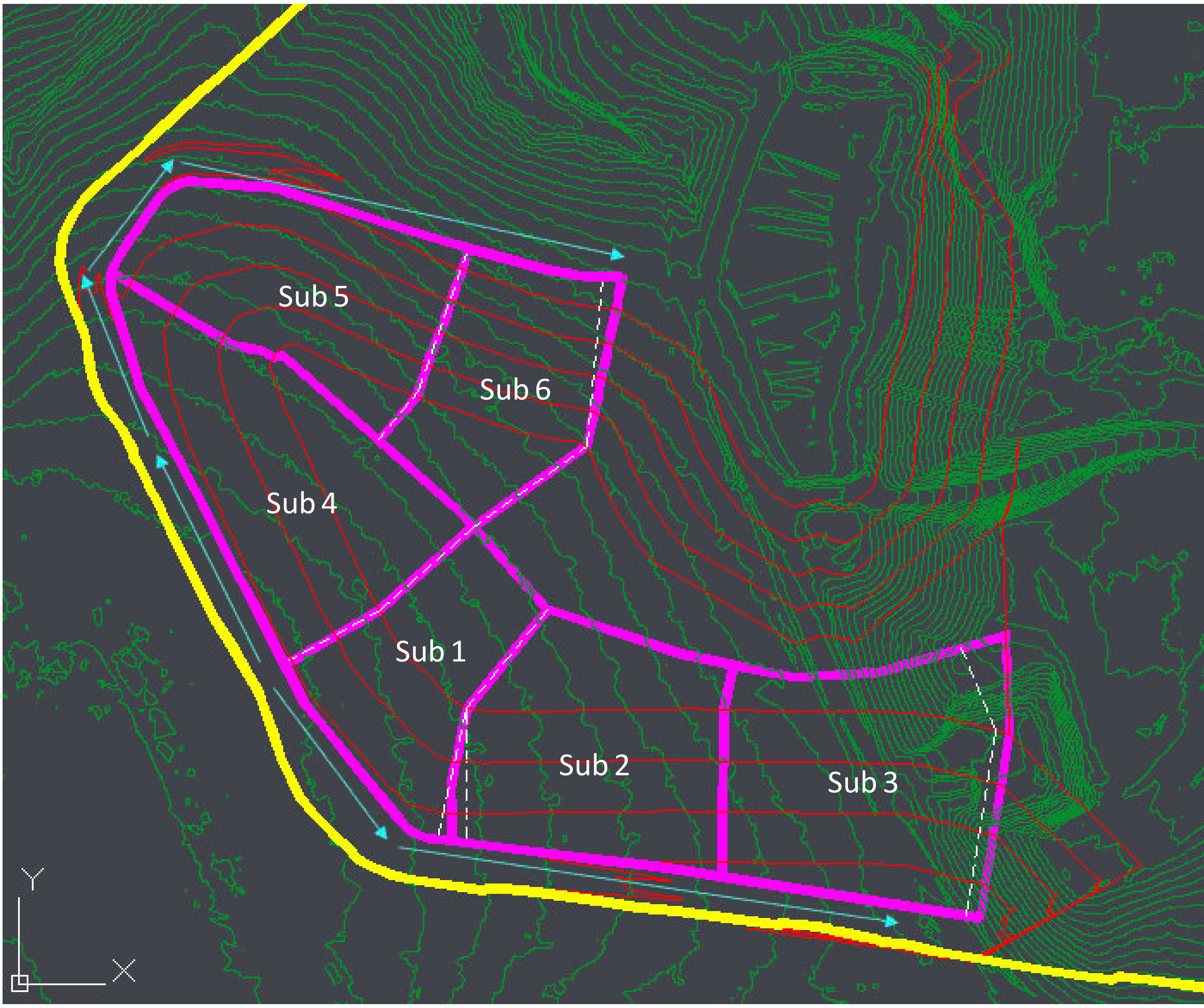
Approx. upstream road crown level at pipe crossing = 284m AHD providing approx. 2.5m freeboard from max. upstream headwater level of 281.5m AHD. Note: road levels subject to change upon receipt of detailed survey.

**Please note** that the 100yr ARI results in maximum flow velocities of up to 4.7m/s for stormwater in the clean water piping – scour protection/energy dissipaters will need to be implemented as a result.

- Dirty drainage:
  - Catchment (the REA extension was separated into six sub-catchments – see shapes in figure below):
    - Sub-catchment 1: Area = 1.41ha
      Overland concentrated flow time = 6mins
      Flow path = 153m with an average slope of 8.5%.
      Horton roughness n = 0.25
      $Q_{100}$ = 0.16m$^3$/s
    - Sub-catchment 2: Area = 2.04ha
      Overland concentrated flow time = 6mins
      Flow path = 153m with an average slope of 10.3%.
      Horton roughness n = 0.25
      $Q_{100}$ = 0.235m$^3$/s
    - Sub-catchment 3: Area = 2.29ha
      Overland concentrated flow time = 6mins
      Flow path = 150m with an average slope of 13.8%.
      Horton roughness n = 0.25
      $Q_{100}$ = 0.271m$^3$/s

      **Total draining south = 0.647m$^3$/s**
    - Sub-catchment 4: Area = 2.26ha
      Overland concentrated flow time = 6mins
      Flow path = 138m with an average slope of 8%.
      Horton roughness n = 0.25
      $Q_{100}$ = 0.258m$^3$/s
    - Sub-catchment 5: Area = 1.91ha
      Overland concentrated flow time = 6mins
      Flow path = 126m with an average slope of 18.3%.
      Horton roughness n = 0.25
      $Q_{100}$ = 0.245m$^3$/s
    - Sub-catchment 6: Area = 1.44ha
      Overland concentrated flow time = 6mins
      Flow path = 182m with an average slope of 13.2%.
      Horton roughness n = 0.25
      $Q_{100}$ = 0.165m$^3$/s

**Total draining north = 0.639m$^3$/s**




- Piping (for dirty water draining south):

  Pipe length = 285m

  Upstream invert level = 279.2m AHD
  Downstream invert level = 274.88m AHD
  Pipe slope = 1.52%
  Pipe roughness = 0.013
  Pipe dimensions = 1 x 750mm diam. (**Note:** A conservative approach was taken when sizing pipes).

  Min. crown cover = 0.9m

Note: Piping already in place for sub-catchments draining north towards sediment basin s7A.

Please note that all drainage calculations are preliminary and therefore may not be of the highest level of accuracy, particularly without any survey of the area. These will be subject to change after receipt of survey during the revised detailed design.

PRELIMINARY RISK ASSESSMENT – PIPELINE MANGEMENT

| **Activity**<br>*Break the job down into steps* | **Hazard**<br>*What could cause harm?* | **Existing Controls**<br>*Identify the existing controls to manage the identified risk.* | **Risk Assessment On Current Controls** | | | **Additional Controls** | **Responsibility for Controls**<br>*Who will make sure it happens* |
|---|---|---|---|---|---|---|---|
| | | | **L-ho od** | **Cons** | **Risk** | | |
| Operation of a clean water diversion pipeline beneath the Refuse Emplacement Area (REA) | Pipe blockage – due to natural debris (branches), causing locailised flooding nearby pipe inlet. | Grill spacing, shaping and lining of inlet structure, armoured (rock) inlet.<br>Experienced designer.<br>Design for $Q_{100}$ flow. | A | 1 | 1 | | Community & Environment Manager |
| | Pipe blockage due to excessive sediment caused by erosion of REA stockpile toe, or erosion of watercourse upstream of pipe inlet, causing localised flooding nearby pipe inlet. | Erosion control – shaping and lining of inlet structure, armoured (rock) inlet | C | 2 | 8 | | Community & Environment Manager |
| | Pipe blockage due to rubbish collecting at inlet causing localised flooding nearby pipe inlet. | Grill spacing, shaping and lining of inlet structure, armoured (rock) inlet | D | 2 | 5 | | Community & Environment Manager |
| | Blocakage of water course upstream from the inlet (branches and trees) causing water to be diverted away from pipes. | Clearing and shaping water course immediately upstream of pipe inlet | C | 1 | 4 | | Community & Environment Manager |
| | Unauthorised entry to pipe | Site security.<br>Grillage fixed in place at pipe entry. | D | 3 | 9 | | Coal Handling Plant Manager |
| | Pipe collapse + storm event, causing localised flooding nearby pipe inlet | Experienced designer, Built to design specifications. | E | 3 | 6 | | Community & Environment Manager |

| **Activity**<br>*Break the job down into steps* | **Hazard**<br>*What could cause harm?* | **Existing Controls**<br>*Identify the existing controls to manage the identified risk.* | **Risk Assessment On Current Controls** | | | **Additional Controls** | **Responsibility for Controls**<br>*Who will make sure it happens* |
|---|---|---|---|---|---|---|---|
| | | | **L-hood** | **Cons** | **Risk** | | |
| Mine closure - existing pipeline beneath the REA beyond Mine Closure | As above | | C | 2 | 8 | | Community & Environment Manager |
| | Extend REA – increase catchment due to change in mine plan | Decommission pipeline. Commission new water management infrastructure with approval of Tahmoor South EIS | B | 1 | 7 | | Community & Environment Manager |
| | Significant Rainfall Events causing overflow of pipe, damage to existing controls | Model flows based on catchment shapes, sizes, flow paths for a flood discharge having a AEP of 1% or 1 in 100 year flood | D | 4 | 14 | | Community & Environment Manager |
| Operation of the Pipeline | Breach of Legislative requirements | SEPP (Mining) 2007 Under Part 2 – Permissible Development, Section 10A | D | 3 | 9 | | Community & Environment Manager |
| | Breach of Consent Approval | DA 57/93 Condition 41 relates to the Management Plan for REA, specifically pipe sizes and placement | D | 3 | 9 | | Community & Environment Manager |

| **Name:** | **Signature** |
|---|---|
| Andrew Reid (Tahmoor) | |
| Bill Rhodes (Project Manager) | |
| | |

## Likelihood Criteria

LIKELIHOOD [of the event occurring with that consequence]

| Basis of Rating | E - Rare | D - Unlikely | C - Possible | B - Likely | A – Almost Certain |
|---|---|---|---|---|---|
| LIFETIME<br>OR<br>PROJECT OR TRIAL OR FIXED TIME PERIOD<br>OR<br>NEW PROCESS / PLANT / R&D | Unlikely to occur during a lifetime<br>OR<br>Very unlikely to occur<br>OR<br>No known occurrences in broader worldwide industry | Could occur about once during a lifetime<br>OR<br>More likely NOT to occur than to occur<br>OR<br>Has occurred at least once in broader worldwide industry | Could occur more than once during a lifetime<br>OR<br>As likely to occur as not to occur<br>OR<br>Has occurred at least once in the mining / commodities trading industries | May occur about once per year<br>OR<br>More likely to occur than not occur<br>OR<br>Has occurred at least once within Glencore | May occur several times per year<br>OR<br>Expected to occur<br>OR<br>Has occurred several times within Glencore |
| 5 Catastrophic | 15 (M) | 19 (H) | 22 (H) | 24 (H) | 25 (H) |
| 4 Major | 10 (M) | 14 (M) | 18 (H) | 21 (H) | 23 (H) |
| 3 Moderate | 6 (L) | 9 (M) | 13 (M) | 17 (H) | 20 (H) |
| 2 Minor | 3 (L) | 5 (L) | 8 (M) | 12 (M) | 16 (M) |
| 1 Negligible | 1 (L) | 2 (L) | 4 (L) | 7 (M) | 11 (M) |

## Risk Matrix

| | | Likelihood Rating | | | | |
|---|---|---|---|---|---|---|
| | | E | D | C | B | A |
| Consequence Rating | 5 | 15 | 19 | 22 | 24 | 25 |
| | 4 | 10 | 14 | 18 | 21 | 23 |
| | 3 | 6 | 9 | 13 | 17 | 20 |
| | 2 | 3 | 5 | 8 | 12 | 16 |
| | 1 | 1 | 2 | 4 | 7 | 11 |

## Consequences Table

CONSEQUENCE [potential foreseeable outcome of the event]

| | Health & Safety | Environment | Financial Impact | Image & Reputation / Community | Legal & Compliance |
|---|---|---|---|---|---|
| 5 Catastrophic | • Multiple fatalities<br>• Multiple cases of permanent total disability / health effects | • Environmental damage or effect (permanent; >10 years)<br>• Requires major remediation | • >$600M investment return<br>• >$100M operating profit<br>• >$20M property damage | • Negative media coverage at international level<br>• Loss of multiple major customers or large proportion of sales contracts<br>• Loss of community support<br>• Significant negative impact on the share price | • Major litigation / prosecution at Glencore corporate level<br>• Nationalisation / loss of licence to operate |
| 4 Major | • Fatality or permanent incapacity / health effects | • Long-term (2 to 10 years) impact<br>• Requires significant remediation | • $60-600M investment return<br>• $20-100M operating profit<br>• $2-20M property damage | • Negative media coverage at national level<br>• Scrutiny from government and NGOs<br>• Complaints from multiple "final" customers<br>• Loss of major customer<br>• Loss of community support<br>• Negative impact on share price | • Major litigation / prosecution at Division level |
| 3 Moderate | • Lost time / disabling injury / occupational health effects / multiple medical treatments | • Medium-term (<2 years) impact<br>• Requires moderate remediation | • $6-60M investment return<br>• $2-20M operating profit<br>• $200K-2M property damage | • Negative media coverage at local / regional level over more than one day<br>• Complaint from a "final" customer<br>• Off-spec product<br>• Community complaint resulting in social issue | • Major litigation / prosecution at Operation level |
| 2 Minor | • Medical Treatment Injury (MTI) / occupational health effects<br>• Restricted Work Injury (RWI) | • Short-term impact<br>• Requires minor remediation | • $600K-6M investment return<br>• $200K-2M operating profit<br>• $10-200K property damage | • Complaint received from stakeholder or community<br>• Negative local media coverage | • Regulation breaches resulting in fine or litigation |
| 1 Negligible | • First Aid Injury (FAI) / illness | • No lasting environmental damage or effect<br>• Requires minor or no remediation | • <$600K investment return<br>• <$200K operating profit<br>• <$10K property damage | • Negligible media coverage | • Regulation breaches without fine or litigation |

## THE HIERARCHY OF CONTROLS

| | | |
|---|---|---|
| MOST EFFECTIVE | **ELIMINATION** | This is the most effective form of control. The hazard is eliminated.<br>Typical examples are removing dangerous equipment from the site or ceasing certain activities such as re-fuelling vehicles over stormwater drains |
| | **SUBSTITUTION** | The dangerous process is substituted with a less dangerous method.<br>A typical example is the use of water-based paint instead of solvent (oil) based paint. |
| | **ISOLATION** | The hazard is isolated. i.e. so that staff or environmental receptors are physically separated from the hazard.<br>Typical examples of this method are the installation of a noise reduction enclosure around a machine, fitting guard rails/fences to elevated walkways, insulating electrical equipment and the provision of secondary containment for bulk storage tanks. |
| | **ENGINEERING CONTROLS/ MODIFICATION** | The risk is 'engineered out' so that the hazard is significantly reduced. Processes or equipment design can be modified so that the operation does not present a hazard or so that the hazard is controlled.<br>Typical examples are the use of physical lockout devices, machine guarding or the installation of a silt trap for stormwater discharges. |
| | **ADMINISTRATIVE CONTROLS** | Administrative controls use management systems to minimise workplace risks and promote workplace safety and environmental protection. The primary administrative control is the use of Safe Work Procedures (SWP).<br>Other administrative controls include:<br>• Job rotation, to reduce workers' exposure<br>• Rescheduling operations so that the minimum number of employees are present<br>• Instituting purchasing controls on hazardous materials<br>• Providing adequate training and supervision<br>• Developing a spill response plan |
| LEAST EFFECTIVE | **PERSONAL PROTECTIVE EQUIPMENT (PPE)** | Use of PPE involves the provision of some form of equipment, which is worn by employees to shield their bodies from harm.<br>Typical examples are the use of helmets, gloves, safety glasses and ear muffs/plugs.<br>The use of PPE is the lowest level of control but if used sensibly can be effective. In some instances PPE can be the interim method of hazard control until a more permanent method is found/installed. In some cases it is the only method available. If PPE is provided, employees must be trained in its use, fit, selection and maintenance. |

# Appendix 4 - Rehabilitation and Topsoil Management Procedure

*Procedure*

# Rehabilitation and Topsoil Management Procedure

| | |
|---|---|
| **Document Number:** | TAHUG-502308417-2435 |
| **Status:** | Approved |
| **Version:** | 3.0 |
| **Effective:** | 30/12/2015 |
| **Review:** | 30/12/2018 |
| **Owner:** | Environmental Coordinator |

## Table of Contents

## List of Tables and Figures

# 1 Purpose

The purpose of this document is to guide the salvage, management and use of topsoil and rehabilitation activities at Tahmoor Coal to help achieve Mining Operation Plan (MOP) objectives, the post mining land use vision for the site and completion criteria.

# 2 Scope

This document applies to the Reject Emplacement Area at Tahmoor Coal.

and covers the following rehabilitation stages:

a) Land Preparation

b) Landform Establishment

c) Growth Medium Development

d) Ecosystem Establishment

e) Ecosystem Development

# 3 Objectives

The objectives of the Rehabilitation and Topsoil Management Procedure are to:

a) Provide guidance for clearing of vegetation, topsoil and subsoil materials including options for mulching, temporary storage, respreading, amelioration, surface preparation and revegetation.

b) Maximise topsoil resource recovery (including reuse, reprocessing, recycling and stockpiling)

c) Provide for appropriate segregation, storage and transportation of topsoil

d) Provide guidance as to how topsoil should be used at the Reject Emplacement Area and where to source it from

e) ensure proper management of topsoil in regards to vegetation and rehabilitation such as methods of ripping, depth of cover etc.

# 4 Major Hazards

a) Breach of Regulatory environmental approvals

b) Unsatisfactory rehabilitation resulting in delay to relinquishment of the mining lease at the end of the Life of Mine

c) Poor reputation within the community for rehabilitation

d) Risk to future approvals and projects from poor environmental performance

# 5 Regulatory Requirements

**Table 1: Approval conditions and regulatory requirements**

| Approval Title | Condition |
|---|---|
| DA 1975<br>(26th Mar 1975) | C1 On completion of mining activities the site shall be left safe, clean and tidy to the satisfaction of Council and including the following requirements:<br>i. where required by Council all buildings shall be either removed or satisfactorily covered;<br>ii. the site shall be so treated that all batters area at a safe angle of repose;<br>iii. exclusive only of sealed access roads, the surface area shall be satisfactorily graded, top-dressed to a depth of not less than 6" and established with approved trees and grasses; and<br>iv. the mine shaft shall be sealed in a substantial manner with adequate provision for drainage of the mine.<br>C6 *Reference to lease conditions related to shaft sealing and closure.* |
| DA 1979<br>(23rd Aug 1979) | 7) Rehabilitation and re-vegetation of the rejects area to be undertaken to the satisfaction of the Commission. Such satisfaction may be assumed if agreement is reached with the Wollondilly Shire Council and with the Lands Department, the Soil Conservation Service and the National Parks and Wildlife Service to the extent that their jurisdiction applies. |
| DA 1979 (M2)<br>(5th Nov 1986) | Rehabilitation and re-vegetation of the rejects area to be undertaken to the satisfaction of the Commission etc (as per Condition 7 – 23 August 1979). |
| CCL 716 | 21) If so directed by the Minister the lease holder shall rehabilitate to the satisfaction of the Minister any lands within the subject area which may have been disturbed by the lease holder.<br>22) Upon completion of operations on the surface of the subject area or upon the expiry or sooner determination of this authority or any renewal thereof, the lease holder shall remove from such surface such buildings, machinery, plant, equipment, constructions and works as may be directed by the Minister and such surface shall be rehabilitated and left in a clean, tidy and safe condition to the satisfaction of the Minister.<br>23) If so directed by the Minister the lease holder shall rehabilitate to the satisfaction of the Minister and within such time as may be allowed by the Minister any lands within the subject area which may have been disturbed by mining or prospecting operations whether such operations were or were not carried out by the lease holder. |
| ML 1642 | 7) Disturbed land must be rehabilitated to a sustainable/agreed end land use to the satisfaction of the Director-General. |
| Mine Operations Plan 2012 - 2019 | Operate in accordance with the 2012-2019 Tahmoor Colliery MOP, land use vision, rehabilitation objectives and completion criteria |

# 6 Post Mining Land Use

## 6.1 Vision

There are a number of post mining land use options that may be applicable to the Tahmoor Colliery domains including residential, light industrial or a return to native bushland. Currently, it is considered that the likely final land use option for most all of the Tahmoor Colliery closure domains will be a return to native bushland. However the final land use options will be confirmed in the detailed closure planning process, which involves undertaking a final land use analysis. The detailed closure plan, to be developed within five (5) years of mine closure, will be prepared using the selected final land use at that time.

## 6.2 Rehabilitation Objectives

The general rehabilitation objectives shared by the Tahmoor Colliery closure domains are:

a) Remove infrastructure and services;

b) Level, re-contour and grade areas to achieve safely battered slopes and surfaces;

c) Apply topsoil for rehabilitation where required;

d) Establish native bushland vegetation, or other type dependent on selected final land use;

e) Develop self-sustaining native bushland which requires minimal ongoing care and maintenance.

## 6.3 Completion Criteria

The preliminary rehabilitation indicators and completion criteria have been developed to meet the domain rehabilitation objectives from the site's various consents and approvals. These criteria will continue to be refined throughout the MOP term, following the implementation of rehabilitation and biodiversity monitoring programs, as part of the site's continue improvement process. Closure criteria will be refined for each specific rehabilitation domain in accordance with *CAAG HSEC PRO 0010 – 11.16 Completion Criteria and Rehabilitation Monitoring*.

Tahmoor Coal has adopted the DRE rehabilitation phases for mine closure in accordance with the *ESG3 Mining Operations Plan Guideline*. The following rehabilitation phases are used to describe the status of each closure domain:

a) Decommissioning

b) Landform Establishment

c) Growth Medium Development

d) Ecosystem and land use establishment

e) Ecosystem and land use sustainability.

f) Relinquished lands

Table 2 below shows the relevant closure criteria for the Reject Emplacement Area.

**Table 2: Closure Criteria for the REA**

| Domain | Rehabilitation Phase | Regulatory Requirement | Domain Objective | Indicator | Completion Criteria | Justification/Source | Complete (Yes/No) |
|---|---|---|---|---|---|---|---|
| Domain 3:<br><br>Refuse Emplacement Area | Decommissioning | Plant will be eliminated when operations cease at the completion of mine life.<br><br>1979 EIS Section 5.4 | Infrastructure and services will be removed from the REA site. | All services related to refuse emplacement activities to be removed from the REA. | Yes | 1979 EIS<br><br>CCL716 | No |
| | Landform establishment | No specific regulatory requirement | Achieve design height and ensure maximum capacity is achieved. | Average depth of fill (height of refuse emplacement) will be 12m. | 12m | REA Rehabilitation & Water Management Plan / 1993 EIS | No |
| | | | Landform established to support native ecosystem. | Maximum slope on final landform external batters will be 1:4 (generally will be 1:8). | 1:4 | REA Rehabilitation & Water Management Plan / 1993 EIS | No |
| | | | Prevent erosion from stormwater runoff following rehabilitation of external batters. | External batters should have gently sloping contour drains, reporting to water storage dams. | Yes | REA Rehabilitation & Water Management Plan / 1993 EIS | No |
| | Growth medium development | No specific regulatory requirement | Apply topsoil for rehabilitation. | Topsoil placement depth. | >300mm | REA Rehabilitation & Water Management Plan / 1993 EIS | No |
| | | | Reduce erosion on slopes, and provide furrows for seed beds. | All final landform slopes to be contour ploughed. | Yes | REA Rehabilitation & Water Management Plan / 1993 EIS | No |
| | Ecosystem establishment | No specific regulatory requirement | Establish native bushland rehabilitation. | Conduct seeding and/or planting. | Yes – seeding and/or planting completed. | REA Rehabilitation & Water Management Plan / 1993 EIS | No |
| | Ecosystem development | No specific regulatory requirement. | Self-sustaining native bushland rehabilitation (REA Rehabilitation & Water Management Plan). | Presence of weeds in monitoring transects (%). | <10% | Analogue sites 1 & 2 | No |
| | | | | Evidence of second generation flora germination in monitoring transects. | Yes | Analogue sites 1 & 2 | No |
| | | | | Rehabilitation monitoring transects contain flora species and structural characteristics similar to the desired vegetation communities at the analogue sites. | Yes | Analogue sites 1 & 2 | No |

# 7 Landform Establishment

## 7.1 Vegetation and Topsoil Removal

The following summarises the process of vegetation and topsoil stripping and salvaging for new REA areas.

a) Clear the area of vegetation. The removed timber and brush vegetation is spread immediately over freshly topsoiled areas to assist the revegetation process and to prevent soil erosion. Logs should be placed along the contour where possible

b) Mulching of the standing timber/brush material prior to collection of topsoil is likely to increase the organic matter in the topsoil and will result in a greater volume of 'topsoil' and allow rehabilitation of greater areas with this precious resource as well as minimising erosion impacts. Once topsoil is obtained the mulch should be mixed into the topsoil during scraper operations. However, hollow bearing trees should be kept as habitat features and strategically placed throughout the REA, where practicable

c) Prior to capping and establishment of revegetation layers, construct slopes, drainage system, and diversion channels, etc, as directed by the Environmental Coordinator. The ideal slope profile will be roughly S Shaped, Convex in the upper 20-30% and concave for the lower 70 to 80% of its length.

d) Strip the area of topsoil and subsoil and rock to refusal. Where possible, use this material immediately to cover completed areas or stockpile along the proposed reject batter toe line.

e) Separate rock, subsoil and topsoil.

f) Cover new emplacement area with about 1m depth of reject to form a stable 'all-weather' working surface.

## 7.2 Emplacement of refuse

Refuse emplacement will be conducted in accordance with TAH CHP PRO 0063 Reject Disposal. The design and landform of the emplacement are will be in accordance with the Tahmoor Mine – Refuse Emplacement Area Management, Rehabilitation and Water Monitoring Plan.

## 7.3 Topsoil Management

The stockpiling and management of excavated and disturbed soils should be undertaken in accordance with *Landcom – Managing Urban Stormwater: Soils and Construction – Volume 1 (2004)* and should be implemented using appropriate erosion and sedimentation controls.

The topsoil should be removed immediately following flowering where possible. This will ensure that the seed stock is highest in the topsoil material and provide the greatest opportunity for rehabilitation. This represents the period January-April in the local region. Topsoil stripping should also be avoided during excessively wet or dry periods as this can lead to compaction, loss of structure and loss of viability of seed stock. Topsoil is best collected when moist (not wet) to retain soil structure and minimise dust.

The following methods should be employed during the stockpiling activities to minimised erosion and maintain soil and seed integrity:

### 7.3.2 Stockpile Management

a) Stockpiles must be seeded no less than three months after placement.

b) Stockpiling longer than twelve months causes a gradual deterioration in quality due to the death of seeds and a shift in the dominance of mycorhizal fungi and other soil micro-organisms. If stockpiles are to be kept for longer than twelve months a process of management is required to ensure anoxic conditions are not reached within the stockpile depleting it of nutrients:

i. Stockpiles are to be shaped, deep ripped (to 300 mm) where practicable and seeded with a suitable cover crop to minimise erosion and dust generation and to prolong the fertility of the in-situ seed bank.

ii. Weed growth should be monitored and subsequently controlled as required. Maintenance fertilising should also be conducted as required.

iii. Stockpiles are to be appropriately signposted to identify the area and minimise the potential for unauthorised use or disturbance.

c) Topsoil stockpiles should be as low as possible with a large surface area, constructed with gentle batters, and be less than 3m in height for stability

d) Topsoil stockpiles should be finished with rough surfaces to encourage germination and reduce erosion.

e) Stockpiles should be orientated lengthwise to the dominant wind direction so they offer minimal cross sectional area prevailing winds where possible.

f) Topsoil stockpiles should be revegetated / seeded to protect from erosion, discourage weeds and maintain active soil microbes. Japanese millet may be used in spring/summer and Rye Corn in autumn/winter at a rate of 40 kg/ha.

g) Topsoil stockpiles should be located in areas where they will not be disturbed by future activities or subject to erosion.

## 7.4 Drainage Strategy and Waterway Design

Graded banks and contour drains should be utilised throughout the REA to minimise erosion, divert run-off water around the disturbed areas and re-direct contaminated runoff into sediment control dams. Clean water diversion banks should be constructed to separate clean run-on water from contaminated catchments, thus minimising the extent of dirty water catchments.

Graded banks should be constructed at intervals down the slope of the reject emplacement rehabilitation area to control surface flow velocities and minimise erosion on the emplacement batters. As the slope angle increases, the banks should be spaced closer together –stopping before the point is reached where they are no longer effective. Engineered waterways using rip rap should be constructed to safely dispose of runoff down slope.

Permanent or temporary waterways located within or adjacent to the REA are to be managed in accordance with the Landcom – Managing Urban Stormwater: Soils and Construction – Volume 1 (2004) to comply with relevant standards and minimise erosion and sedimentation potential. This may include the placement of geotechnical material, rip rap or other armouring materials.

### 7.4.2 Contour Development and Clean Water Drainage

Contour development and clean water drainage will be undertaken as depicted in the Environmental Impact Statement for the 1994 Tahmoor North Development Consent. Armouring material and rip rap will be utilised to achieve the clean water design parameters. In order to achieve the desired drainage pathways these controls will be placed at points structures and should be designed by appropriately qualified consultants, with their locations determined by them. These structures will be incorporated into the rehabilitation progression plan for each stage of the REA, and be implemented as a stage is to be rehabilitated.

### 7.4.3 Ripping

Prior to topsoiling and seeding the REA rehabilitation site, the underlying material (reject or subsoil) is to be contour ripped down to the first graded bank to between 400 and 500mm depth. This method is shown in Figure 1 below and is undertaken in this sequence to avoid reject material being brought to the surface.

Following the placement of topsoil, it may be lightly scarified (i.e. less than 200mm) using agricultural equipment (e.g. harrows or shallow chisel plough) to improve the seedbed.

***Figure 1 Examples of contour ripping and graded banks***

# 8 Growth Medium Development

## 8.1 Placement and Improvement of Topsoil

Soil is sampled prior to rehabilitation to assess its suitability as a growth medium and any ameliorants required. Analysis  includes:

a) pH (acidity - 1 soil : 5 water)

b) EC (salinity – 1 soil : 5 water)

c) ESP (sodicity).

d) CEC (cation exchange capacity)

e) Available N

f) Available P

g) Available K

h) Available S

i) Total organic %

As required, a range of techniques may be considered to improve the condition of soils available for rehabilitation, including

a) Application of organic matter;

b) Chemical improvements (gypsum / lime);

c) Soil conditioners;

d) Growing green manure crops;

e) Use of nitrogen fixing species (legumes); and

f) Application of mulch.

Based on experience at Tahmoor, typical fertiliser application rates used are as follows.

Some subsoil material available on site may be suitable for ripping into the coal washery reject as a base layer or mixing with topsoil material in base layers over the coal washery reject. However, the suitability of the subsoil material will be based on sampling of its physical and chemical properties prior to use, as required. A variety of options for the use of the subsoil material are provided in **Table 3**.

***Table 3 Fertiliser Application Rates***

| Activity | Rate (kg/ha) |
|---|---|
| Tree seeding | 100 |
| Pasture seeding | 200 |
| Maintenance fertilising | 150 |

### 8.1.2 Topsoil Benchmark Values

Topsoil is to be assessed and tested prior to distribution onto rehabilitation areas. The derived completion criteria for topsoil are taken from the baseline monitoring sites in the long term rehabilitation inspection. Soil testing is undertaken for each rehabilitation area. A report interpreted by a consultant will be used to identify which parameters should be adjusted for the top soil in order to meet the soil completion criteria. Rehabilitated areas are continually tested during annual and long term inspections to identify if further action is required to build up nutrient levels.

Completion criteria have been derived from long term, off-site reference sites around the REA as the rehabilitation progresses the values will be refined with further research, capturing data obtained from annual and long tern inspections of the rehabilitation sites. The completion criteria are design to be achieved through monitoring over a prolonged period of time, the purpose is to derive suitability of topsoil prior to its application onto prepared rehabilitation areas.

The completion criteria for topsoil is as follows:

**Table 4: Long-term Topsoil Completion Criteria**

| Assessment Criteria | Comments |
|---|---|
| Soil pH | pH of replaced topsoil to be in the range of 5.5 to 7.5 after 5 years (or within half a pH unit of the average of the off-site (analogue) reference sites |
| Soil Conductivity | The EC of replaced topsoil to be below 900 µS/cm after 5 years (or no more than 10% higher compared to the average EC value of the off-site reference sites |
| Soil Fertility | Nitrogen, phosphorous, potassium and sulphur levels to be no lower than 20% of levels in the off-site reference sites after 10 years |
| Soil Biota | Presence of micro and macro organisms after 5 years |
| Soil loss | Soil loss to be less than 40 t/ha/year after 5 years; |
| Runoff water quality | To be less than 600 µS/cm after 5 years. Also, surface water quality in main streams to meet ANZECC |

| Assessment Criteria | Comments |
|---|---|
| | guideline water quality criteria for upland rivers during all time periods |
| Soil Sodicity | Sodicity levels (ESP – Exchangeable Sodium Percentage) to be no higher than 5 after five years |
| Soil organic %: | To be no lower than 20% of the average for off-site reference sites after 10 years |

### 8.1.3 Soil Depth

After soil has been placed on the REA, a verification audit of the area shall occur. This audit will select a number of random points throughout the newly rehabilitated area. At these points the topsoil will be monitored to ensure that a minimum 300mm of topsoil. A verification report will be completed with photographic evidence of topsoil depth and be submitted with the Annual Review.

# 9 Ecosystem and Land use Establishment

## 9.1 Cleared Timber Placement

After the topsoil has been placed and graded banks and scarification completed, cleared timber removed from the new sections of the REA may be placed in clumps around the area. The cleared timber is distributed using a long-reach excavator (or similar) to create microhabitats for native plants and animals and to assist in erosion control.

Cleared logs will also to be placed on contours to minimise erosion and capture seed and topsoil runoff from slopes in high rain events, where available and practicable.

## 9.2 Direct Seeding

### 9.2.1 Native Tree and Shrubs

Native tree and shrub seeds are directly seeded at a rate of between 7-10 kg/ha and jointly applied with fertilizer (Granulock 15) at a rate of 100 kg/ha on the top (flat) section of the completed REA down to the first Graded Bank with a quad-mounted spreader or by hand. Seed is mixed with a cover of crop oats.

Examples of suitable native species are provided in **list** below however other native grasses and other groundcover species may be sown to complement species diversity.

**Native tree and shrub species used in direct seeding**

a) Acacia decurrens

b) A. longifolia

c) A. culeat

d) A. suaveolens

e) A. terminalis

f) Eucalyptus globoidea

g) E. eugenoides

h) E. culeate
i) E. scerophylla
j) E. moluccana
k) E. tereticornis
l) E. rossii
m) Angophora floribunda
n) Allocasuarina littoralis
o) Banksia spinulosa
p) Dodonaea culeat
q) Leptospermum flavescens
r) Loptospermum juniperinum
s) Hakea dactyloides
t) Hakea sericea
u) Kunzea ambiqua
v) Hardenbergia violaceae
w) Kennedia rubicunda
x) Lomandra longifolia
y) Lomandra obliqua
z) Dianella culeate
aa) Cassinia culeate

### 9.2.2 Pasture Mix

Pasture seeding is aimed at producing ground cover to stabilise the batters and reduce erosion. The steeper sloped sections of the REA are typically sown with pasture seed at rates shown in **Table 6** below:

**Table 5: Pasture species**

| Species | Sowing Rates |
|---|---|
| Oats | 20 kg/ha |
| Couch | 10 kg/ha |
| Perennial rye grass | 10 kg/ha |
| Lucerne | 5 kg/ha |
| Haifa White Clover | 5 kg/ha |
| Fertilizer (Granulock 15) | 200 kg/ha |

# 10 Ecosystem and Land use Sustainability

## 10.1 Maintenance and Monitoring

Permanent monitoring sites have been established throughout the REA and are monitored in accordance with the 'Tahmoor Coal Reject Emplacement Area Rehabilitation Monitoring Management Plan'. In addition to the rehabilitation monitoring program:

a) All rehabilitation activities undergo an as constructed survey to ensure construction to design;

b) All rehabilitation campaigns are recorded on the internal Form GCAA HSEC FRM 0024 Rehabilitation Implementation Record Form.

c) An annual rapid style walkover inspection is completed in line with GCAA HSEC FORM 0024 Annual Rehabilitation Inspection.

### 10.1.2 Annual Rehabilitation Inspections

Annual rehabilitation inspections are conducted to evaluate the success of annual rehabilitation works, and to assess the general trajectory of all existing rehabilitation towards completion criteria. The scope of the inspection includes all existing and recently completed rehabilitation areas on site.

### 10.1.3 Long Term Rehabilitation Monitoring

The long term monitoring evaluate progress of rehabilitation towards fulfilling long term Post Mining Land use, any agreed completion criteria and the statutory requirements that apply to the site. Outcomes and recommendations are provided in an annual monitoring report to Tahmoor. The report compares the following:

a) outline compliance against Approval conditions and other statutory commitments;

b) compare results for landform, soil, water, flora and fauna aspects against completion criteria;

c) report key trends in monitoring results and progression towards achievement of rehabilitation objectives and completion criteria (see recommended performance categories below);

d) assess effectiveness of rehabilitation methods implemented;

e) identify any opportunities for continual improvement in rehabilitation practices or additional trials or research; and

f) Where required, identify modifications required for the monitoring program.

Adaptive Management is utilised supplementing the monitoring strategy as required by CAAG HSEC PRO 0010 11.16 Completion Criteria and Rehabilitation Monitoring. This enables Tahmoor to respond to rehabilitation performance and implement changes as required. , this focuses on areas such as the following:

a) Nutrient availability;

b) PH, salinity and metal toxicity;

c) Suitability of the species used;

d) Seeding time;

e) Moisture availability;

f) Shallow root depth;

g) Other soil limitations;

h) Insect attack;

i) Lack of N-fixing legumes;

j) Lack of organisms involved in litter breakdown (e.g. fungal fruiting bodies) and nutrient cycling (e.g. puff balls);

k) Excessive grazing;

l) Predation;

m) Evidence of drought effects or storm damage;

n) Poor soil preparation; and

o) Weed competition

## 10.2 Water Monitoring Program

A water monitoring programme associated with the REA has been established. The programme monitors the effectiveness of runoff water management and treatment measures on the site and to satisfy EPA requirements for runoff water analysis. Sampling and analysis is undertaken by qualified consultants using methods in accordance with Schedule 1 of the Clean Waters Act 1970 and current code of practice. Consultants engaged in monitoring activities are required to report to the Environmental Coordinator before taking each series of samples and continue that liaison during the analysis and until the results are available. The Water Monitoring Procedure is outlined in the 'Reject Emplacement Area Management Strategy'

## 10.3 Completion Criteria

Rehabilitation closure criteria have been developed in line with rehabilitation indicators and completion criteria, contained within Section 5.5 of the *Tahmoor Colliery Mine Operations Plan 2012 – 2019* (MOP) and CAAG HSEC PRO 0010 11.16 Completion Criteria and Rehabilitation Monitoring. Rehabilitation progress across the REA is evaluated in line with these criteria, and progress is summarised in an Annual Monitoring report.

# 11 Document Information

Related documents and reference information in this section provides a single reference point to develop and maintain site compliance information.

## 11.1 Related Documents

Related documents, listed in ***Table 11-1*** below, are internal documents directly related to or referenced from this document.

**Table 11-1 – Related documents**

| Number | Title |
|---|---|
| CAAG HSEC PRO 0010 11.16 | Completion Criteria and Rehabilitation Monitoring |
| GCAA HSEC FRM 0024 | Rehabilitation Implementation Record Form |
| TAH SD PLN 0002 | Biodiversity and Land Management Plan |
| TAH SD PRO 0068 | Rehabilitation Monitoring Procedure |

## 11.2 Reference Information

Reference information, listed in ***Table 11-2*** below, is external information that is directly related to the development of this document or referenced from within this document.

**Table 11-2 – Reference information**

| Reference | Title |
|---|---|
| | EPA (1995) ‘Rehabilitation and Revegetation’ Best Practice Environmental Management in Mining. Commonwealth of Australia |

## 11.3 Change Information

Full details of the document history are recorded in the document control register, by version. A summary of the current change is provided in ***Table 11-3*** below. Example detail shown below.

**Table 11-3 – Change information summary**

| Version | Date | Review team (consultation) | Change Summary |
|---|---|---|---|
| 0.1 | 27/8/14 | F Robinson<br>C Standing | - Previously named Topsoil Management Plan<br>- Review to include improvements identified in the 2013 AEMR Inspection |
| 0.2 | 23/9/14 | F Robinson<br>C Standing<br>W Mitry (DRE) | - Incorporation of comments from DRE and development of monitoring scope and soil completion criteria. |
| 0.3 | 20/1/15 | F Robinson<br>C Standing | - Incorporation of comments from GCAA Manager – Land and |

| | | | |
|---|---|---|---|
| | | N Charnock | Property, finalisation of document for submission to DRE. |
| 2 | 29/12/15 | F Robinson, Ian Sheppard | - Increase to 300mm of topsoil as per request from DRE<br>- Remove contour drains drawing |
| 3 | 24/8/18 | F Robinson, R Bush | - Include procedure to ensure topsoil depth is adequate and in line with procedure |

# Appendix 5 - REA Extension Ecological Survey

Niche Environment and Heritage
PO Box 2443 North Parramatta NSW 1750
T 02 9630 5658 F 02 4017 0071
E info@niche-eh.com ABN 19 137 111 721

29 January 2018

Fiona Robinson
Environment Coordinator
Tahmoor Underground– A Glencore Company
Via email: Fiona.Robinson@glencore.com.au

Dear Fiona

**Re: Refuse Emplacement Area (REA) Vegetation Pre-clearing Inspection**

Niche was commissioned by Tahmoor Underground to undertake a pre-clearing inspection for the clearing of approximately 15 hectares of vegetation within the south eastern section of the Refuse Emplacement Area (REA) (Figure 1). This letter report summarises the results of the pre-clearing inspection including details of survey methodology, a description of key habitat features at each clearing site, and mapping of hollow-bearing trees, hollow-bearing stags, hollow logs, trees with nests or dreys and threatened flora and fauna listed under the NSW *Biodiversity Conservation Act 2016* (BC Act) and the commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act). Recommendations are provided to avoid and minimise ecological impacts.

**Field survey**

A pre-clearing inspection was undertaken by Alex Christie and Cairo Forrest, Ecologists with Niche Environment and Heritage, on the 17th of January 2018. The proposed clearing site was investigated to confirm the location of biodiversity features and to check for the presence of flora and fauna species and habitat within the clearing boundary. Line transects were walked at regular intervals to ensuring a thorough survey effort of all areas within the study area (Figure 2). Habitat trees to be removed within the clearing boundary were flagged with pink flagging tape (see Photo 1) and GPS coordinates were recorded. These included hollow-bearing trees, hollow-bearing stags, hollow logs or trees with nests or dreys with potential to support fauna. Locations of threatened flora listed under the BC Act and EPBC Act were also flagged and locations recoded. All biodiversity identified as a constraint has been mapped and can be seen in Figure 3.

**Photo 1. Hollow bearing tree flagged with pink flagging tape**

**Suitable habitat for relocated fauna**

Fauna should be released into similar habitats, as near as possible to their capture location. The area adjacent to the REA along Teatree Hollow would constitute suitable recipient habitat for relocated fauna, based on the patch size of vegetation, hollow availability and habitat condition.

Depending on where fauna are captured, a more appropriate release location may be determined by the project ecologist during the clearing procedure (e.g. if suitable habitat is identified closer than the above locations). This would be discussed prior to releasing fauna.

If bats are captured or any fauna are injured they will need to be placed into care with a suitably trained and equipped wildlife carer until they can be safely released into suitable habitat. Nocturnal animals that are captured would be held and released the next evening into the nearest suitable habitat.

For rescued fauna requiring care, call Wildlife Rescue Wollondilly (WIRES) (Hotline 1300 094 737). The wildlife carer would make an assessment whether or not the animal needs veterinary care if it is injured and make the necessary arrangements.

**Flora and fauna**

A total of 60 habitat trees were recorded within the clearing boundaries, including 57 hollow-bearing trees and three hollow-bearing stags. Most of these habitat trees were concentrated around the creek line which runs into Teatree Hollow. This area appears to have avoided historic clearing and contains some large hollow-bearing trees. The creek line also contains an abundance of rocky sandstone outcrops and boulders which may provide habitat for reptiles and amphibians. No fauna species were observed actively using any habitat features identified during the field survey.

One Wombat burrow was identified during the field survey, as well as seven large fallen logs which contained hollows and may provide habitat for small ground dwelling fauna.

Two threatened flora species were recorded during the site inspection. These records were both of *Persoonia bargoensis*, which were both isolated individuals.

**Table 1: Number of habitat features identified within the study area**

| Habitat Feature | Count |
|---|---|
| Hollow-bearing tree | 57 |
| Threatened flora (*Persoonia bargoensis*) | 2 |
| Wombat burrow | 1 |
| Hollow-bearing stag | 3 |
| Fallen timber (hollow logs) | 7 |

**Recommendations**

Where possible habitat features should be retained to avoid ecological impacts by staging clearing, in particular along the creek line where high densities of hollow-bearing trees and sandstone outcropping were identified.

The two-staged habitat removal process is to be used where habitat trees have been identified (Table 2; Figure 3) to minimise impacts on native fauna which may be present. Non-habitat vegetation is to be removed first, allowing a minimum of 24 hours for fauna to vacate. An ecologist should be on site for the clearing of the remaining habitat trees to inspect trees before and after felling to capture and relocate any fauna encountered.

Machinery working on site should be cleaned before entering and leaving site to minimise the spread of noxious and environmental weeds.

Appropriate sediment fencing and mitigation should be used, especially around the creek line, to ensure sediment does not impact on downstream environments.

**Disclaimer**

Niche have undertaken this work on the understanding that all relevant state and federal approvals required for the clearing of shale-sandstone transition forest have been attained by Tahmoor Underground.

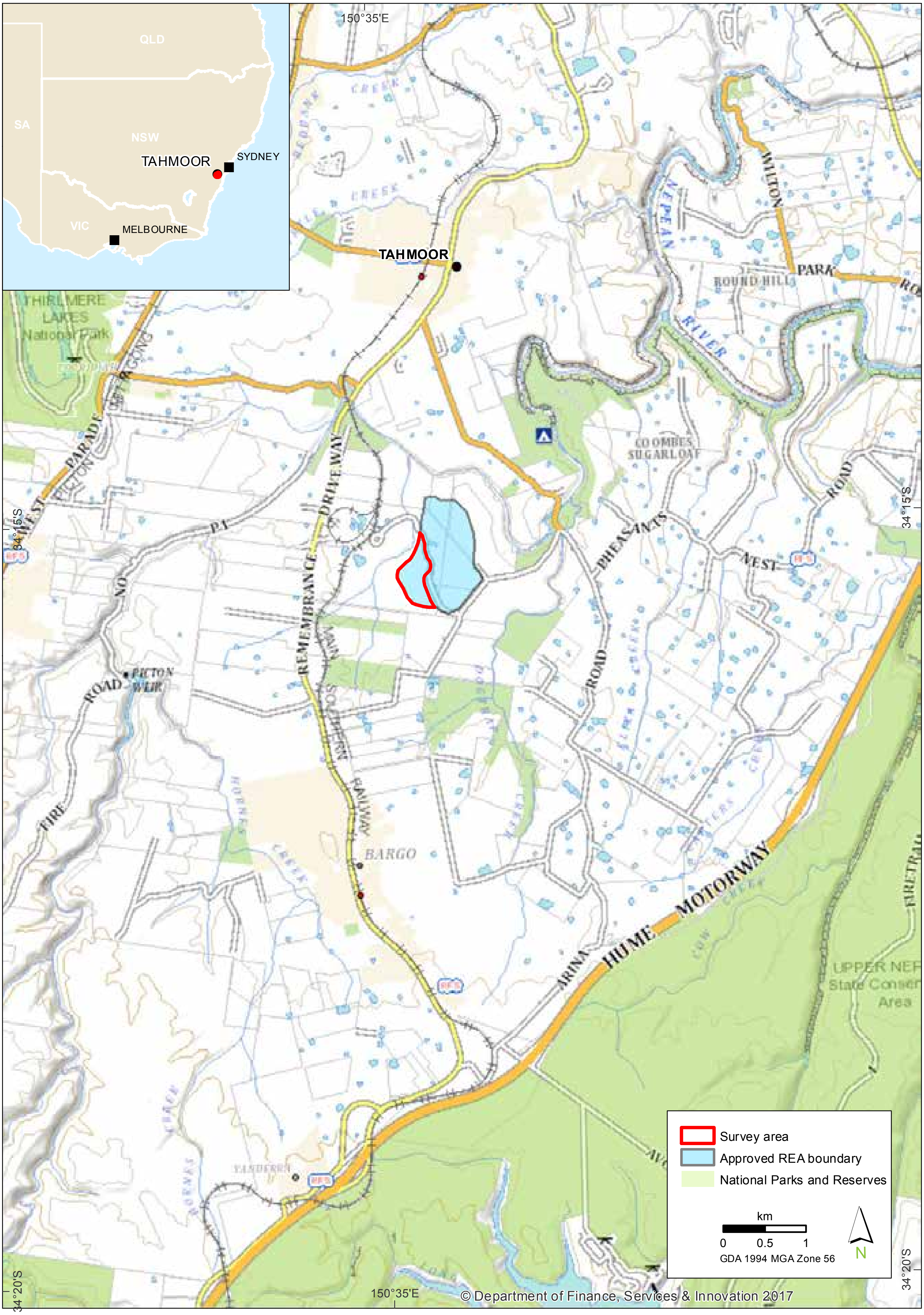
Please do not hesitate to contact myself or Luke Baker should you require any further information.

Yours sincerely

Alex Christie
Ecologist
Niche Environment and Heritage

0488 224 123

Drawn by: GT Project Manager: LB Project Number: 3956 Date: 22/01/2018 T:\spatial\projects\a3900\a3956_Tahmoor_Tree_Clearing\Maps\report\3956_Figure_1_Location.mxd

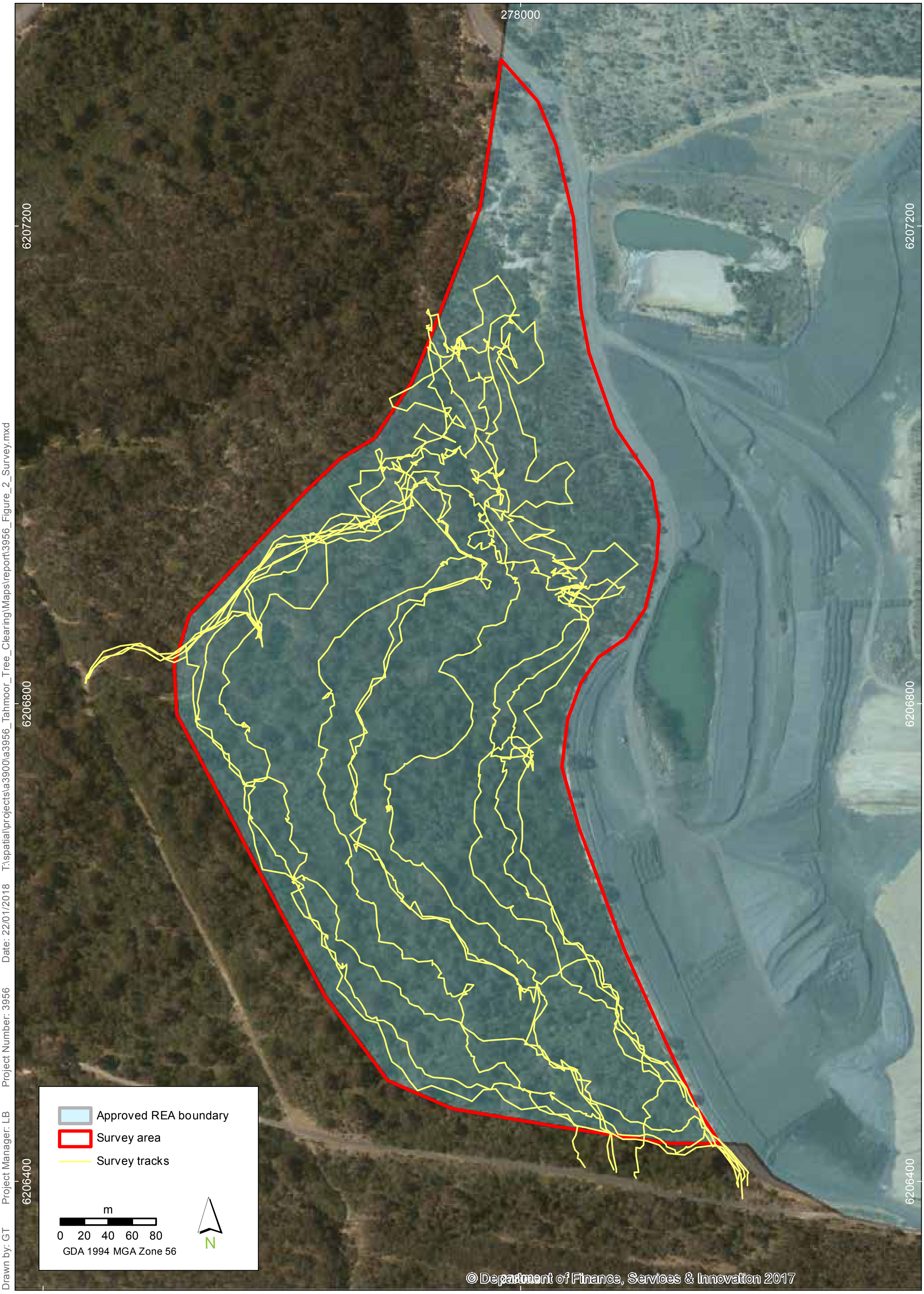



Location

Tahmoor Coal REA Approved Vegetation Clearing Inspection

**FIGURE 1**

niche Environment and Heritage

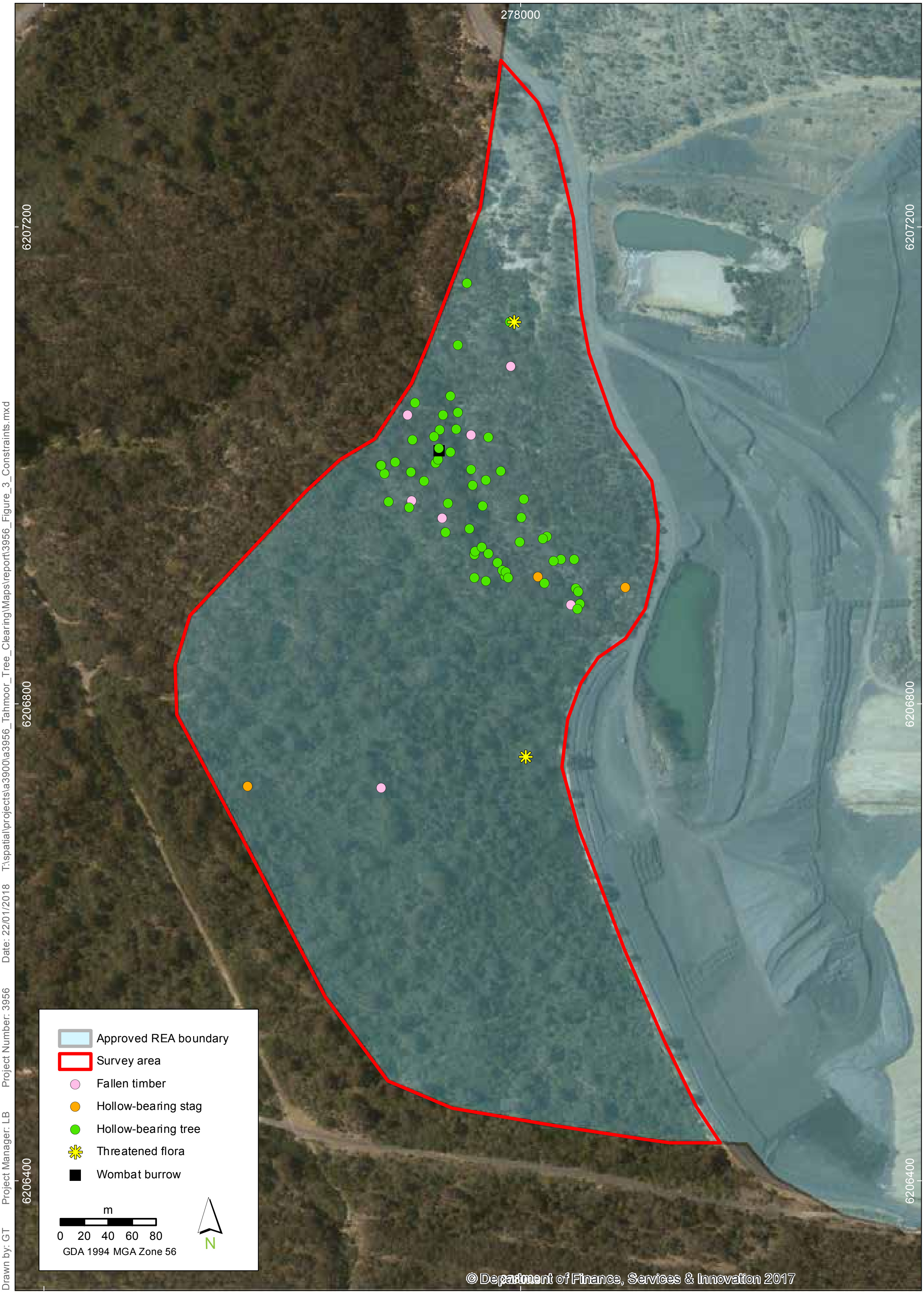



Survey effort

Tahmoor Coal REA Approved Vegetation Clearing Inspection

**FIGURE 2**

Imagery: (c) LPI 2016-11-04




Constraints

Tahmoor Coal REA Approved Vegetation Clearing Inspection

**FIGURE 3**

Imagery: (c) LPI 2016-11-04

**Table 2: Summary of habitat features and their location within the clearing site (displayed on Figure 3)**

| Habitat Feature | Latitude | Longitude |
|---|---|---|
| Fallen timber (hollow log) | -34.254703 | 150.588098 |
| Hollow-bearing tree | -34.254709 | 150.587882 |
| Hollow-bearing tree | -34.254423 | 150.588318 |
| Hollow-bearing tree | -34.254343 | 150.588462 |
| Hollow-bearing tree | -34.254346 | 150.588360 |
| Hollow-bearing tree | -34.254397 | 150.588342 |
| Fallen timber (hollow log) | -34.254216 | 150.588653 |
| Hollow-bearing tree | -34.253922 | 150.588469 |
| Hollow-bearing tree | -34.253533 | 150.588547 |
| Fallen timber (hollow log) | -34.253705 | 150.589027 |
| Hollow-bearing tree | -34.253373 | 150.589025 |
| Hollow-bearing tree | -34.254239 | 150.588808 |
| Hollow-bearing tree | -34.254500 | 150.588916 |
| Hollow-bearing tree | -34.254563 | 150.588774 |
| Hollow-bearing tree | -34.254601 | 150.588658 |
| Hollow-bearing tree | -34.254481 | 150.588640 |
| Hollow-bearing tree | -34.254753 | 150.588739 |
| Hollow-bearing tree | -34.254927 | 150.588614 |
| Hollow-bearing tree | -34.255123 | 150.588656 |
| Hollow-bearing tree | -34.255098 | 150.588667 |
| Hollow-bearing tree | -34.255069 | 150.588724 |
| Hollow-bearing tree | -34.255115 | 150.588785 |
| Hollow-bearing tree | -34.255186 | 150.588863 |
| Hollow-bearing tree | -34.255291 | 150.588926 |
| Hollow-bearing tree | -34.255244 | 150.588909 |
| Hollow-bearing stag | -34.255303 | 150.589225 |
| Hollow-bearing tree | -34.255260 | 150.588933 |
| Hollow-bearing tree | -34.255350 | 150.589286 |
| Hollow-bearing tree | -34.255396 | 150.589573 |
| Fallen timber (hollow log) | -34.256867 | 150.587760 |
| Hollow-bearing tree | -34.255300 | 150.588957 |
| Hollow-bearing stag | -34.256835 | 150.586540 |
| Hollow-bearing tree | -34.254407 | 150.587951 |
| Hollow-bearing tree | -34.254433 | 150.587820 |
| Hollow-bearing tree | -34.254493 | 150.587851 |
| Hollow-bearing tree | -34.254431 | 150.587827 |

| | | |
|---|---|---|
| Hollow-bearing tree | -34.254488 | 150.588096 |
| Hollow-bearing tree | -34.254242 | 150.588117 |
| Hollow-bearing tree | -34.254174 | 150.588366 |
| Hollow-bearing tree | -34.254223 | 150.588312 |
| Wombat burrow | -34.254331 | 150.588357 |
| Hollow-bearing tree | -34.254309 | 150.588357 |
| Hollow-bearing tree | -34.254171 | 150.588517 |
| Hollow-bearing tree | -34.254049 | 150.588534 |
| Hollow-bearing tree | -34.254063 | 150.588396 |
| Hollow-bearing tree | -34.253965 | 150.588145 |
| Fallen timber (hollow log) | -34.254054 | 150.588077 |
| Hollow-bearing tree | -34.253068 | 150.588648 |
| Threatened flora (*Persoonia bargoensis*) | -34.253370 | 150.589068 |
| Hollow-bearing tree | -34.254712 | 150.589114 |
| Hollow-bearing tree | -34.254848 | 150.589092 |
| Hollow-bearing tree | -34.254995 | 150.589320 |
| Hollow-bearing tree | -34.255038 | 150.589068 |
| Hollow-bearing tree | -34.255014 | 150.589278 |
| Hollow-bearing tree | -34.255176 | 150.589559 |
| Hollow-bearing tree | -34.255174 | 150.589445 |
| Hollow-bearing tree | -34.255183 | 150.589376 |
| Hollow-bearing stag | -34.255399 | 150.590021 |
| Hollow-bearing tree | -34.255511 | 150.589604 |
| Hollow-bearing tree | -34.255423 | 150.589594 |
| Fallen timber (hollow log) | -34.255519 | 150.589526 |
| Hollow-bearing tree | -34.255550 | 150.589578 |
| Threatened flora (*Persoonia bargoensis*) | -34.256657 | 150.589077 |
| Hollow-bearing tree | -34.255323 | 150.588756 |
| Hollow-bearing tree | -34.255298 | 150.588652 |
| Hollow-bearing tree | -34.254948 | 150.588396 |
| Fallen timber (hollow log) | -34.254841 | 150.588370 |
| Hollow-bearing tree | -34.254732 | 150.588423 |
| Hollow-bearing tree | -34.254559 | 150.588216 |
| Hollow-bearing tree | -34.254752 | 150.588069 |

# Appendix 6 – CMAP

TAHMOOR UNDERGROUND

GLENCORE


# Corrective Management Action Plan

| | |
|---|---|
| **Document Number:** | Corrective Management Action Plan |
| **Status:** | Final Rev B |
| **Version:** | 1.0 |
| **Effective:** | 16/06/2017 |
| **Review:** | na |
| **Owner:** | Approvals & Community Coordinator |

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# Executive Summary

A Notice under Section 240 of the Mining Act (1992) was issued to Tahmoor Coal Pty Ltd (Tahmoor Colliery) by the Division of Resources and Geoscience on 5 December 2016 to prepare a Corrective Management Action Plan (CMAP) to address exceedances of impact assessment criteria or predictions in relation to surface water (copy in **Appendix A1**).

This CMAP is the subject of that Notice and has been prepared to comply with Tahmoor Colliery's approval conditions outlined in this document, which details Tahmoor Colliery's proposed approach and requirements to assess the potential rehabilitation techniques and methods that may be suitable for rehabilitation of Myrtle Creek.

The documents required prior to commencement of work will be developed in consultation with and approved by key Government Agencies as outlined in **Section 6** of this document.

Tahmoor Colliery is mining coal by longwall in the vicinity of Tahmoor, a small township located approximately 70km southwest of Sydney.   Longwalls have been extracted beneath Myrtle Creek, which is a tributary of the Nepean River, since 1989, which has caused subsidence impacts to drain the pools in the creek overlying Longwalls 25 to 28, which now only have standing water and / or connected stream flow after prolonged heavy rainfall.

Longwalls have also been extracted beneath Redbank Creek, which is a tributary of Stonequarry Creek and subsequently, the Nepean River.  Redbank Creek is currently being undermined by Longwall 30, and in the future by Longwall 31 and Longwall 32.

Now that mining has moved away from Myrtle Creek and subsidence movements in the creek have effectively ceased.  This will involve a staged approach, with outcomes from each stage being assessed to provide the best approach for the next stage.  The purpose of this approach is to provide a strategy of continuous improvement from the staged outcomes.

This document presents a plan with a particular focus on the first stage (Myrtle Creek CMAP Trial Project), which involves initial characterisation of the hydraulic controls and fracture characterisation along Myrtle Creek as a whole, as well as trial remediation of a rock bar constrained pool at Site 23 in Myrtle Creek.  On approval of this document, a detailed Project Plan will be developed in consultation with key Government Agencies.  On completion of the Myrtle Creek CMAP Trial Project, outcomes will be assessed to determine the best approach for a future Stage 2 remediation works in Myrtle Creek.

In addition, when extraction of Longwall 32 beneath Redbank Creek is complete, a further CMAP for Redbank Creek will be prepared in consultation with key Government Agencies to commence remediation of Redbank Creek.

The main subsidence impact to Myrtle Creek caused by longwall mining at Tahmoor has been due to approximately 250mm of horizontal valley closure.  These movements have fractured the base of the creek channel and resulted in diversion of surface water into the sub-surface fracture network so that surface flows and pool standing water levels are no longer maintained, except after significant storm runoff events. There has been no loss of catchment yield as evidenced by unaffected pools and stream flow downstream of the mining area.

Following initial site characterisation work pre-empting this CMAP, the remediation stage of the Myrtle Creek CMAP Trial Project will focus on remediating a rock bar and associated pool at the downstream end of Site 23 trial and confirm focus on remediating surface water and pool standing levels.

Subsequent stages are intended to focus on targeting other rock bar constrained pools upstream of Site 23 based on the Myrtle Creek CMAP Trial Project site characterisation findings.

Flows in Myrtle Creek at Site M7 (which is located downstream of Longwall 28, the last Longwall to undermine Myrtle Creek) are estimated to exceed 0.8ML/day for 50% and 0.3ML/day for 70% of the time.  These flows are relatively small compared to other Southern Coalfield sites where remediation has been successful, and so it is expected that infilling fractures sufficiently to return flow to the surface could be challenging.

The initial Myrtle Creek CMAP Trial Project will undertake a program of investigative drilling at the rock bar downstream of Site 23.  The primary objectives of the drilling are to determine the void profile with depth, evaluation of fracture connectedness and determine the lateral extent (and depth) of fracturing beyond the creek boundaries.

Caliper logging and permeability testing are planned to identify the location and distribution of mining induced fracturing, which will guide the required depth and width of fracture grouting.

A program of infilling fractures is planned. The primary strategy is to fill the mining induced fracture network evident with the Site 23 rock bar such that the permeability of the rock bar is restored to pre-mining levels as far as practicable. At this stage an options analysis is required to determine the grout to be used. However it is recognised that polyurethane (PUR) has been proven to be successful elsewhere and previous success will be a major determining factor.

On completion of these works the effectiveness will be assessed for the appropriate approach and implementation at future sites within Myrtle and Redbank Creeks.

# 1 Introduction

In May 2017, Tahmoor Colliery completed extraction of Longwall 30 in the Bulli Seam in the Southern Coalfield of New South Wales, approximately 70km southwest of Sydney. Longwall 31 is planned to start in June 2017.

Myrtle Creek was undermined by Longwalls 22 to 28, whilst Redbank Creek was first undermined by Longwall 25 and is currently being undermined by Longwall 30. The last Longwall to undermine Redbank Creek is Longwall 32.

Myrtle Creek is a tributary of the Nepean River and its headwaters are located over Longwall 4, which is upstream of Longwall 22 as shown in **Figure 2**. It generally consists of small grass covered channels in its headwaters which become wider and more incised into the Hawkesbury Sandstone downstream of Longwalls 23 to 29.

Redbank Creek within the undermined reach under and downstream of Longwall 25 is more incised into the Hawkesbury Sandstone, with the creek becoming deeper, wider and more incised down to Longwall 31.

This CMAP outlines the general remediation strategy to be applied to all remediation sites as outlined in **Section 7** of this report. **Section 8** of this report outlines the proposed remediation trial strategy at Site 23 on Myrtle Creek. The initial trial site will be used to confirm and refine the methodology. The remediation of the rock bar immediately downstream of Site 23 is included in Myrtle Creek CMAP Trial Project.

The outcomes of the Myrtle Creek CMAP Trial Project will be assessed and used to determine the appropriate approach at future sites within Myrtle Creek and Redbank Creek.

Myrtle Creek CMAP Trial Project includes initial site characterisation at other sites along Myrtle Creek, i.e.:

a) Sites 12 to 19 inclusive over Longwall 27.

b) Sites 20, 21, and 26 over Longwall 28.

The site characterisation in the Myrtle Creek CMAP Trial Project will include a hydrological assessment of key hydrological controls for the length of the impacted reach of Myrtle Creek, of which Site 23 is one. Initial site characterisation drilling will define the fracture network in detail at Site 23 and subject to site access constraints and further approvals, will define the fracture network at the other Myrtle Creek sites listed above.

Myrtle Creek CMAP Trial Project will include implementation of the grouting strategy determined after consideration of site characterisation results and options analysis for grouting options.

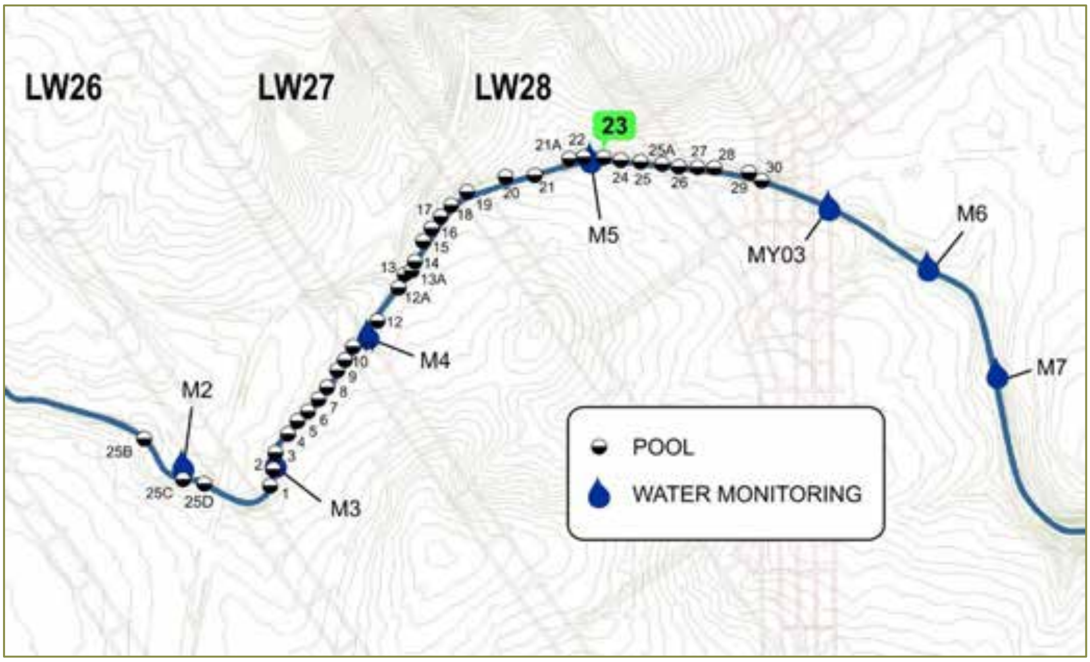


*Figure 1 Initial site characterisation at sites along Myrtle Creek*

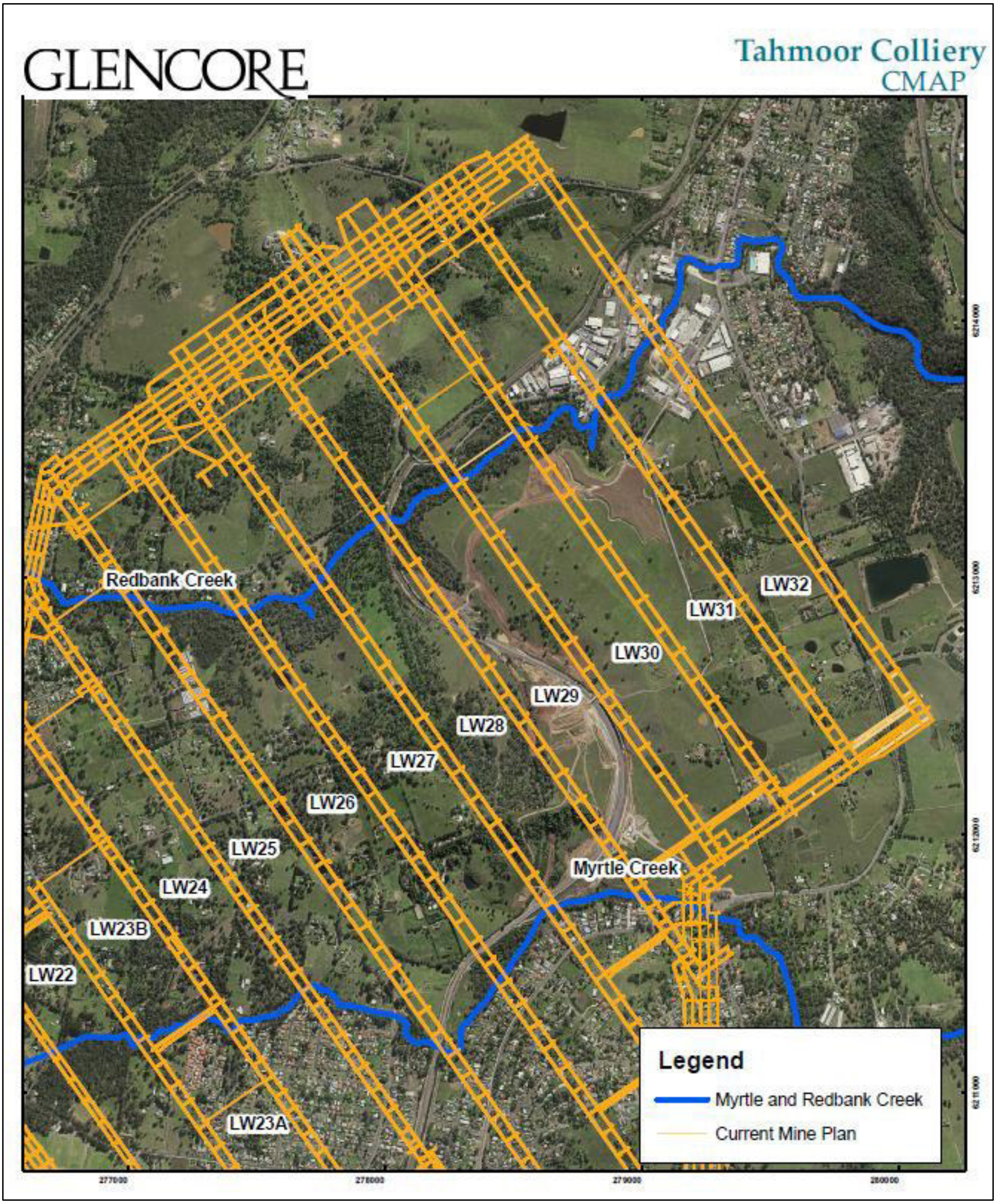


*Figure 2 Myrtle and Redbank Creeks relative to Tahmoor Colliery mine plan*

# 2 Approach

This document will be submitted to the Division of Resources and Geoscience and on receipt of approval, the required documents outlined in **Section 3** will be prepared for the Myrtle Creek CMAP Trial Project. They will be developed in consultation with key stakeholders and Government Agencies. On receipt of all required Myrtle Creek CMAP Trial Project documents and approvals and completion of all inductions and training, the Myrtle Creek CMAP Trial Project will be executed.

This document outlines the general remediation strategy to be conducted at each site. The approach broadly includes:

a) Rehabilitation strategy - aims and objectives.

b) Ground characterisation methodology.

d) Rehabilitation design.

g) Construction documentation and reporting.

The general remediation strategy is based on the successful remediation program developed at the Waratah Rivulet. It should be recognised that each site is expected to have unique challenges and it is considered prudent to adopt a staged approach for the remediation of Myrtle Creek as a whole. The knowledge gained from the first and subsequent stages will inform continuous improvement of the process over the remainder of Myrtle Creek and Redbank Creek.

It should be recognised that not all reaches of a water course are characterised by well defined rock bars and retained pools and in some cases, remediation of a key rock bar may restore surface flow to extended reaches. Whilst there are a number of identified 'subsidence impact sites' and whilst each site will be individually assessed, the overall remediation strategy should be considered a 'whole of creek' exercise with particular focus at key hydrological controls subject to access constraints.

This document is structured to provide:

a) Approvals required for Myrtle Creek CMAP Trial Project execution.

b) Redbank Creek Assessment:

    i. Currently being undermined and affected by active subsidence.

c) Myrtle Creek Assessment:

    i. Environmental study.

    ii. Pool Mapping and hydrology assessment.

    iii. Ground / strata characterisation.

    iv. Impacts.

    v. Site 23.

    vi. Environmental controls and key risks.

d) Rehabilitation objectives and equipment to be used.

e) Consultation & Communication Plan.

Redbank Creek is currently experiencing active subsidence and will be directly undermined by Longwall 31 and Longwall 32. Tahmoor Colliery will focus on remediating Redbank Creek on completion of active subsidence after the extraction of Longwall 32. See **Section 4** for further details.

# 3 Approvals

## 3.1 Approvals & Consent Conditions

Tahmoor Colliery operates in accordance with various Development Approvals, including DA67-98 granted on 25 February 1999 by the then Minister for Urban Affairs and Planning, and Consolidated Coal Lease (CCL) 716, and Mining Leases (ML) 1308, 1376, 1539 and 1642 that are granted under the Mining Act (1992). The abovementioned instruments permit Tahmoor Colliery to undertake longwall mining in accordance with an approved Subsidence Management Plan (SMP) and other related approvals.

### 3.1.2 Development Approval DA67-98

The development consent was modified in 2006 and twice in 2012 after it had been granted on 25 February 1999.

The Environmental Impact Statement (EIS) for the Tahmoor North Mine Expansion predicted that mining beneath minor streams (such as Myrtle and Redbank Creeks) would not be subject to major damage, cliff line instability or damage to stream banks. (Noting that major damage was not defined in the EIS). The EIS stated further studies on creek impacts would be undertaken prior to longwall mining.

Development Consent (DA67/98) requires that an SMP be approved by the now Division of Resources and Geoscience prior to commencing longwall extraction, and that subsidence and environmental monitoring, reporting and notification be undertaken.

Where damage to watercourses has occurred as a result of mining induced subsidence, Condition 13 of the Development Consent requires that restoration works be undertaken in accordance with an Erosion and Sediment Control Plan prepared to the requirements of Department of Primary Industries - Water (DPI-Water formerly NSW Office of Water) and in consultation with and Wollondilly Shire Council and then approved by the Secretary of Planning and Environment.

### 3.1.3 Longwall 27 to 30 SMP

An SMP application for the extraction of Longwalls 27-30 at Tahmoor Colliery was submitted to the then Industry and Investment NSW (now Department of Industry) in August 2009 and approval was granted on 31 October 2012.

Myrtle Creek is described in Volume 3 of the Longwall 27-30 SMP Application: Longwall 27-30 Surface & Groundwater Assessment Report (GeoTerra, 2009). At the time of preparing the Longwall 27-30 SMP application no adverse effect on plateau stream flow, water quality, bed and bank stability or erosion had been observed in Myrtle Creek due to mining at Tahmoor Colliery except for limited cracking of exposed sandstone and reported water loss in a small, ephemeral pool in the creek bed over Longwall 22, as well as soil profile cracking in the stream bed and bank over Longwall 23, at the time of preparing the Longwall 27-30 Surface & Groundwater Assessment Report (GeoTerra, 2009).

Due to the low predicted strains and the lack of effects on stream flow observed over earlier longwall panels at Tahmoor Colliery, it was predicted that no significant observable change to the overall flow through Myrtle Creek due to subsidence within the Longwall 27-30 SMP Project Area would occur.

It was predicted that cracking may occur in the creek bed which could lead to loss of flow into the underlying dilated strata or drainage of ponds, however it was not anticipated to generate a net loss of water from the creek system since the subterranean flow, if it occurred, would re-emerge downstream. After heavy rain, the majority of runoff would flow along the creek bed, with a lesser proportion flowing through the dilated, subsided strata, whilst during low flows, a greater proportion of water would flow in the bedrock.

As the incision depth of Myrtle Creek increases downstream from Longwall 25, it was predicted that isolated, localised changes in either stream flow volume or the location of groundwater seepage into the creek may occur due to uplift, valley closure or cracking of exposed sandstone shelves within the creek bed. Any adverse stream flow changes were predicted to be isolated in extent and temporary in nature, although these changes were predicted to last for a few months, depending on the actual manifestation of subsidence effects on a stream.

It was predicted that if an adverse stream flow effect developed, the effect was anticipated to be temporary as the cracks can potentially fill in with mobilised sediments. In cases where the cracking did not fill in with sediments, the affected area may require rehabilitation.

The Longwall 27-30 SMP Application (see Main Report Attachment A – Consultants Recommendations and Longwall 27-30 Surface & Groundwater Assessment Report) predicted that impact to surface water in Myrtle Creek would be;

> *No observable adverse change in overall plateau stream flow volume, with possible minor localised redistribution where, and if, significant cracking occurs in exposed sandstone shelves / rock bars.*

SMP approval was granted on 31 October 2012. The SMP Approval for Longwalls 27-30 at Tahmoor Colliery includes the following Conditions:

### 3.1.3.2 Limits on Approval

**Condition 1**

The Leaseholder must carry out the activity strictly in accordance with SMP Approved Plan.

**Condition 2**

The Leaseholder must carry out the activity generally in accordance with the SMP, subject to the conditions of this Approval.

In the event of any inconsistency between the conditions of this Approval and the SMP, the conditions of this Approval prevail to the extent of any inconsistency.

**Condition 3**

Where this Approval requires actions to be undertaken by the Leaseholder, including remediation of subsidence impacts, the obligation continues until the Director General notifies the Leaseholder that the action has been completed to his or her satisfaction.

### 3.1.3.3 General Obligation to Minimise Harm to the Environment

**Condition 6**

The Leaseholder must implement the SMP (as amended by the conditions of this Approval) and carry out any additional practicable measures necessary to prevent any harm to the environment that may result from the construction, operation, or rehabilitation of the activity. Where prevention cannot be achieved the leaseholder is to demonstrate minimisation of harm to the environment that may result from the construction, operation, or rehabilitation of the activities.

### 3.1.3.4 Environmental Management

**Condition 13**

The Leaseholder must submit to the Director Environmental Sustainability & Land Use for approval an Environmental Management Plan (EMP) for the panels which are the subject of this Approval. This plan must address subsidence impacts on:

a) Surface and groundwater (quality and quantity), including Myrtle and Redbank Creeks.

b) Flora and fauna.

c) Heritage sites including Aboriginal heritage sites.

d) Geomorphology, including rock bars and cliff lines.

e) Surface and groundwater (quality and quantity); including groundwater bores on privately owned land within a 3 kilometre radius of the limit of mining.

The Leaseholder must not operate other than in accordance with an EMP approved by the Director Environmental Sustainability & Land Use. This Plan must address subsidence impacts above and must include:

a) A detailed monitoring programme.

b) Trigger levels for subsidence impacts that require actions and responses.

c) The procedures that would be followed in the event that the monitoring indicates an exceedance of trigger levels.

d) Measures to mitigate, remediate and / or compensate any identified impacts.

e) A protocol for the notification of identified exceedances of the trigger levels.

f) A contingency plan.

The Leaseholder shall ensure that underground mining does not cause the performance outcomes in **Table 1** from the SMP Approval to be exceeded.

***Table 1 Subsidence Impact Performance Outcomes***

| Watercourses | Subsidence Impact Performance Outcomes |
|---|---|
| Myrtle and Redbank Creeks | Minor* environmental consequences |

Note: minor is defined as ‘relatively small in quantity, size and degree given the relative context.

Tahmoor Colliery is currently extracting coal in accordance with Longwalls 27 to 30 EMP (Revision D) dated February 2013. The EMP describes that;

> *If significant fracturing were to occur, it is possible that partial or complete loss of water may occur at some locations if the rate of flow diversion is greater than the rate of incoming surface water. In times of heavy rainfall, the majority of the runoff would flow over the beds of the creeks and would not be diverted into the dilated strata below the creek beds. In times of low flow, however, some or all of the water could be diverted into the strata below the creeks. This could temporarily affect the quantity and quality of the water flowing in the creeks.*
>
> *If it is found that the fractures in the creek beds do not seal naturally, some remedial measures may be required after subsidence at a particular location is completed. Remediation of fractured rock bars has been successfully undertaken at other streams in the Southern Coalfield (DoP, 2008).*

The EMP describes the monitoring programs that are undertaken in Myrtle and Redbank Creeks including measurement and observation of subsidence movements, water flow and quality, and visual inspection of pools, creek bed cracking and comparison to the pre-miming state of the creek.

The EMP provides a Trigger Action Response Plan (TARP) that describes monitoring and management actions that will be undertaken in respect to potential subsidence effects and impacts. The relevant TARP for impacts to Myrtle and Redbank Creeks is provided in the EMP and Appendix A1 in this document.

The TARP outlines what actions will be taken in the case where exceedance of the approved impact assessment criteria occur. Site specific mitigation, or corrective management action (CMA) plans, may be required, and may include:

a) Description of the impact to be managed.

b) Results of the investigations.

c) Aims and objectives for the Plan.

d) Specific actions required to mitigate/manage the issue.

e) Timeframes for implementation.

f) Roles and responsibilities.

g) Identification of and gaining appropriate approvals from key government agencies.

h) Providing a consultation and communication plan.

The mitigation or remediation plans will outline methods to ensure that ongoing impacts reduce to levels below the impact assessment criteria as quickly as possible.

The EMP outlines the aims of the stream mitigation and remediation measures which include:

a) Conducting remediation works that protect to the greatest practicable extent the ecological values of the area.

b) Repairing aesthetic values where necessary.

c) Reducing the interaction of surface and groundwater flow where enhanced through mining.

d) Having creeks and pools function in a similar manner to the pre-impact state.

e) Having surface flows and pool water quality continue to provide suitable aquatic habitat.

f) Re-establishing the ecological values to a similar state to before mining.

g) Creeks and catchments yielding similar water quantity and quality following mining.

h) Monitoring and reporting effectiveness of the program.

The EMP further describes a number of potential remedial stream mitigation and remediation techniques with may be appropriately considered and deployed where approved environmental performance outcomes are exceeded. These include:

a) Natural stream remediation.

b) Hand mortaring.

c) Injection grouting.

d) Pattern grouting.

e) Deep angled hole grouting.

f) Permeation grouting.

g) Impermeable blankets and linings.

h) Curtain grouting.

i) Stream surface treatment.

The EMP provides a TARP that describes monitoring and management actions that will be undertaken in respect to potential subsidence effects and impacts. The relevant TARP for impacts to Myrtle and Redbank Creeks is provided in the EMP and **Appendix A1** in this document.

The TARP outlines what actions will be taken in the case where exceedance of the defined impact assessment criteria occur. Site specific mitigation, or a CMAP, may be required, and may include:

a) Description of the impact to be managed.

b) Results of the investigations.

c) Aims and objectives for the Plan.

d) Specific actions required to mitigate/manage the issue.

e) Timeframes for implementation.

f) Roles and responsibilities.

g) Identification of and gaining appropriate approvals from key government agencies.

h) Providing a consultation and communication plan.

## 3.2 Subsidence Event Notifications

During the extraction of Longwalls 27 to 30, Tahmoor Colliery submitted Subsidence Event Notifications to the Division of Resources and Geoscience in regard to defined subsidence related impacts to Myrtle and Redbank Creeks.

Specifically, subsidence movements have caused cracking in bed and rock bars of these creeks which has resulted in the diversion of surface flow and loss of water in pools.

## 3.3 Notice to prepare Corrective Management Action Plan

A Notice under Section 240 of the Mining Act (1992) was issued to Tahmoor Colliery on 5 December 2016 to prepare a CMAP to address exceedances of impact assessment criteria or predictions in relation to surface water TARP's specified in the Tahmoor Colliery Longwall 27-30 EMP.

This document is the subject of that Notice.

## 3.4 Further Environmental Approvals Required

A number of further environmental approvals, licenses or permits are required prior to the execution of the works proposed under the CMAP.

### 3.4.2 Environmental Planning & Assessment Act 1979 – Development Approval (DA67/98)

The Development Approval (DA67/98) foreshadows that rehabilitation of watercourses may be required to rectify impacts attributed to mine subsidence. Condition 13 of DA/98 requires:

a) If determined necessary by the Director-General in consultation with Council and DPI-Water, the Applicant shall carry out works in accordance with an Erosion and Sediment Control Plan, prepared to the requirements of DPI-Water, to restore any damage to watercourses (including the banks) resulting from the mining operations, subject to any other necessary approvals.

As such, prior to any rehabilitation works being undertaken, a Sediment and Erosion Control Plan will need to be prepared to the requirements of DPI-Water as well as in consultation with Wollondilly Shire Council and the Department of Planning and Environment (DPE).

The potential for damage to waterways due to mine subsidence and subsequent remedial works was envisaged within the 1998 EIS and precursor environmental assessments / approvals. As such, no further approval under the Environmental Planning and Assessment Act 1979 is likely for rehabilitation works.

### 3.4.3 Mining Act 1992

Mining title such as Consolidated Coal Leases (CCL) or Mining Leases (ML), is granted under the Mining Act 1992. Tahmoor Colliery operates in accordance with leases CCL716 and ML 1376, 1308, 1539 and 1642.

A condition of these Leases is for underground mining operations that may cause subsidence movements and / or impacts to be undertaken in accordance with an approved SMP.

Amongst other things, the approved SMP requires that the extraction of coal from Longwalls 27-30 be undertaken in accordance with an approved Tahmoor Colliery Longwalls 27 to 30 Environmental Management Plan.

In response to reported exceedances of the performance measures specified in both the approved Longwall 27-30 SMP and EMP, the Division of Resources and Geoscience issued a s240(1)(b) Notice under the Mining Act on 5 December 2016 to prepare a Corrective Management Action Plan (CMAP) to mitigate / manage subsidence impacts to Myrtle and Redbank Creeks.

Similarly, the CMAP may also need to be incorporated into the Mine Operation Plan (MOP) prior to execution of the remedial works.

### 3.4.4 NSW Fisheries Management Act 1994

There are a number of activities impacting or potentially impacting aquatic habitats and species for which a permit under the NSW Fisheries Management Act 1994 is required.

A Part 7 Fisheries Management Act permit is required for:

a) Activities involving dredging and reclamation work.

b) Activities temporarily or permanently obstructing fish passage.

c) Using explosives and other dangerous substances.

d) Harming marine vegetation.

In freshwater environments these apply to streams mapped as 'key fish habitat'; which includes Myrtle and Redbank Creeks.

For the proposed scope of works it is likely that the remediation of Myrtle Creek will require temporary blockage of the waterway and this may temporarily affect fish passage.

As such a Part 7 Permit is required for activities that temporarily obstruct fish passage.

### 3.4.5 NSW Protection of the Environment Operations Act 1997

It is an offence under Section 120 of the Protection of the Environment Operations Act 1997 (POEO Act) to pollute waters.

Various activities in NSW, including mining for coal, must operate in accordance with an Environment Protection License issued by the NSW Environment Protection Authority. Tahmoor Colliery undertakes its coal mining operations in accordance with EPL 3189.

In light of the nature of the proposed remedial works, there is some potential to temporarily pollute waters with materials used to fill streambed cracks caused by subsidence.

As such, prior to the execution of the remedial works, Tahmoor Colliery will consult with the EPA and may require that a variation to EPL 3189 be granted to undertake the works.

Every effort will be made to minimise any impact to the environment during the execution of the remedial works.

### 3.4.6 Water Management Act 2000 – Controlled Activity Approval

Under the Water Management Act 2000 (WM Act) an approval is required to undertake controlled activities on waterfront land, unless that activity is otherwise exempt.

Controlled activities include the carrying out of building work, such as erecting buildings and other structures and the installation of infrastructure. They also include excavating or depositing material.

Waterfront land is the bed of any river, lake or estuary and any land within 40 metres of the highest bank of the river, the lake shore or the mean high water mark of the estuary.

Tahmoor Colliery will consult with DPI-Water to determine if a controlled activity approval is not required if the controlled activity is undertaken in accordance with any mining, crown lands or western lands lease, licence, permit.

In this instance, the proposed Corrective Management Actions will be carried out under Leases CCL716 and ML 1308, 376, 1538 & 1642 granted under the Mining Act 1992, any sub-ordinate conditions and any approved SMP's under those mining leases.

As such, the proposed remedial works are exempt from a Controlled Activity Approval under the Water Management Act 2000.

Notwithstanding this exemption, all works will be generally undertaken with the DPI-Water guidelines for instream works on waterfront land and in consultation with DPI-Water.

### 3.4.7 National Parks & Wildlife Act 1974

It is an offence to damage or destroy Aboriginal Objects or Places in NSW under the National Parks and Wildlife Act 1974.

Prior to the execution of any remedial works, the area of disturbance will be assessed to ensure that no Aboriginal objects are impacted.

In the event that an Aboriginal object is identified during works, then all works must cease and an appropriate impact assessment must be undertaken.

If it is unavoidable that impacts to an Aboriginal object will occur, an Aboriginal Heritage Impact Permit will need to be sought from the Office of Environment and Heritage (OEH).

### 3.4.8 Threatened Species Conservation Act 1995

It is an offence to pick, damage or destroy threatened species in NSW under the Threatened Species Conservation Act 1995.

Prior to the execution of any remedial works, the area of disturbance will be assessed to ensure that no threatened species are impacted.

In the event that any threatened species is identified during works, then all works must cease and an appropriate impact assessment must be undertaken.

If it is unavoidable that impacts to a threatened species will occur, an s91 Permit will need to be sought from OEH.

# 4 Redbank Creek Assessment

Tahmoor Colliery's Longwalls 25 to 30 have directly extracted beneath Redbank Creek. The Creek is currently experiencing active subsidence movements from the continued extraction of Longwall 30 as shown in **Figure 2**. Longwall 31 and Longwall 32 will also extract directly beneath Redbank Creek. Mine subsidence movements will continue at Redbank Creek until extraction of Longwall 31 is completed. This is scheduled to occur in the middle to end of 2019.

Predictions of subsidence, upsidence and valley closure along Redbank Creek due to the extraction of Longwall 31 and Longwall 32 were provided in Report No. MSEC647, which was prepared in support of Tahmoor Colliery's SMP Application for Longwalls 31 to 37. The predictions are shown in **Figure 3** below, with the predicted incremental subsidence, upsidence and closure due to the extraction of Longwall 31 highlighted in red.

It can be seen from **Figure 1** that substantial additional subsidence movements are predicted to occur for the section of Redbank Creek directly above Longwall 31 and Longwall 32. Continued valley closure movements are also predicted occur beyond Longwall 31, extending to the section of Redbank Creek located directly above Longwall 27.

Tahmoor Colliery has regularly measured valley closure across Redbank Creek. Measured incremental valley closure due to the extraction of Longwall 29 is shown in Drawing No. MSEC834-02. It can be seen that ongoing valley closure of 11 mm to 26 mm was measured above the section of Redbank Creek directly above Longwall 27 during the extraction of Longwall 29. **Figure 5** shows the development of valley closure across Redbank Creek over time, where it can be seen that valley closure gradually developed for the section of Redbank Creek above Longwall 27 during the extraction of Longwall 29.

At the completion of Longwall 32 a CMAP for Stage One Redbank Creek Trial Project will be prepared in consultation with key Government Agencies and submitted for approval and Project execution.

At the completion of Longwall 32 a CMAP for Stage One Redbank Creek Trial Project will be prepared in consultation with key Government Agencies and submitted for approval and Project execution.

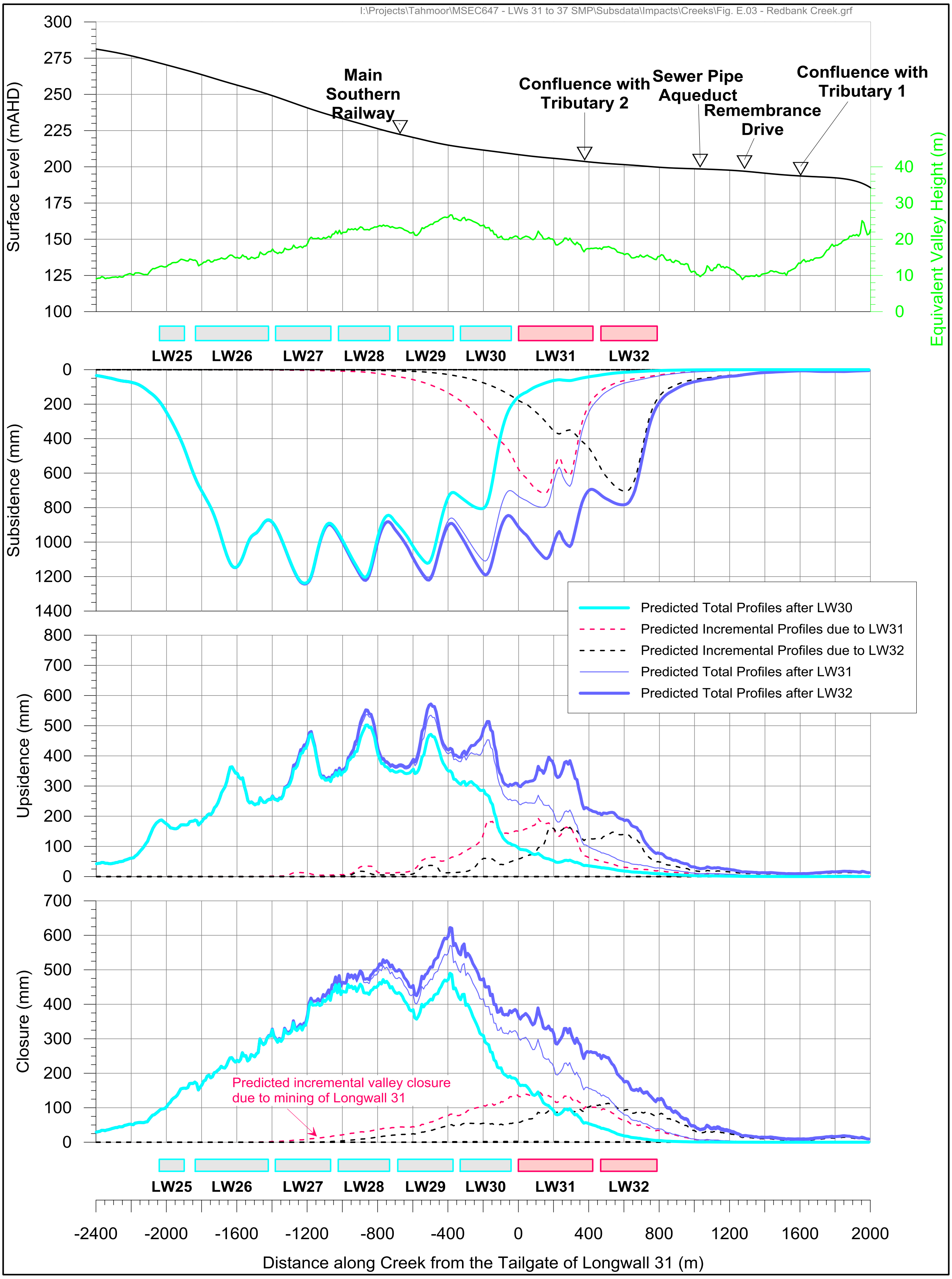


*Figure 3 Predicted subsidence, upsidence and valley closure along Redbank Creek due to the mining of LW's 22 to 32*

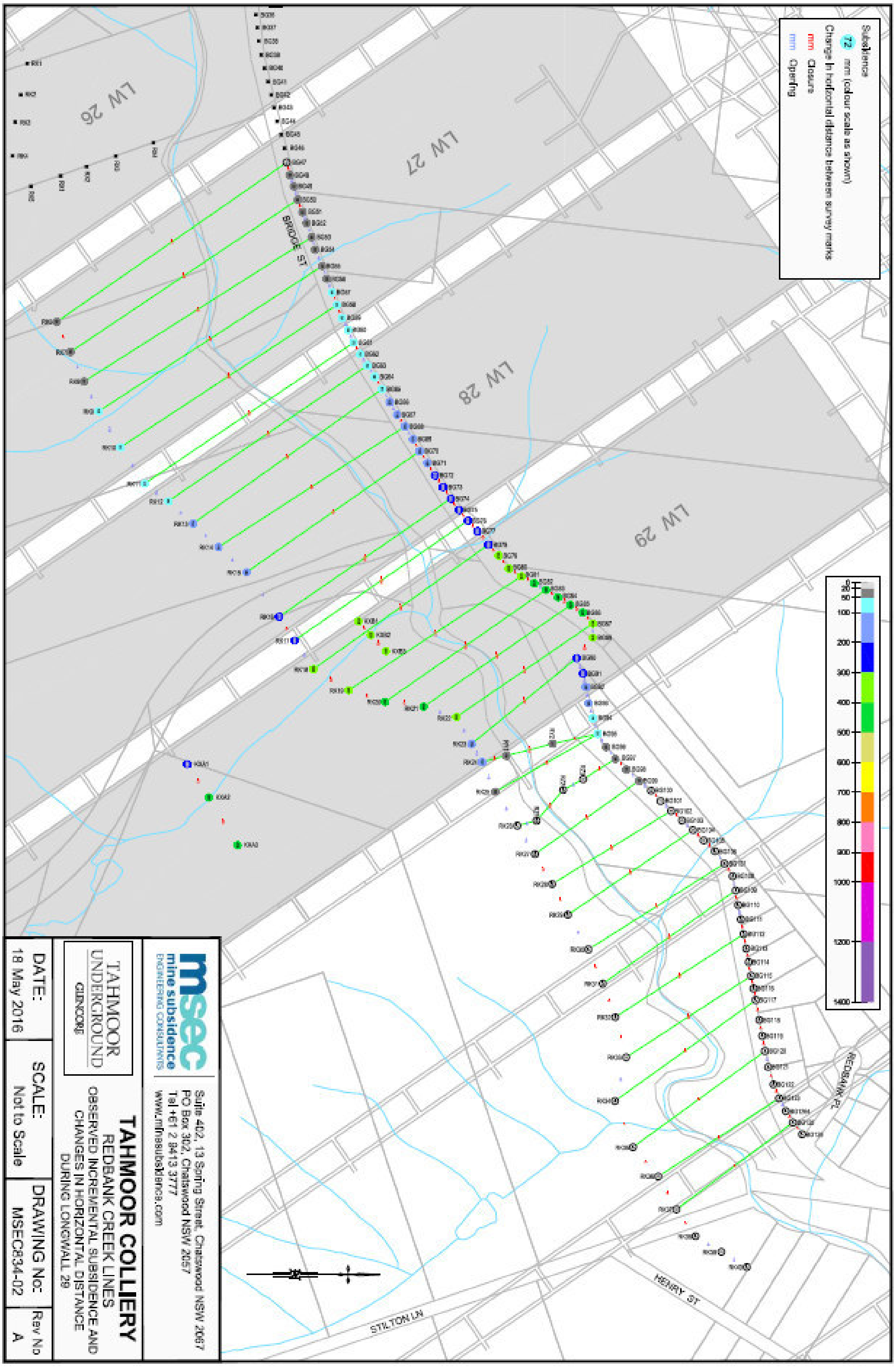


***Figure 4 Measured incremental valley closure at Redbank Creek due to LW29***


*Figure 5 Observed development of closure across Redbank Creek and its tributaries over time*

# 5 Myrtle Creek Assessment

## 5.1 Mining Progression

Tahmoor Colliery extracted coal from the Bulli Seam between 420 – 500m below surface by longwall mining under Myrtle Creek with Longwalls 22 to 28.

As outlined in **Table 2**, Myrtle Creek was first undermined by Longwall 4 in early 1989, then by Longwall 22 around early March 2005, and was last undermined by Longwall 28 around mid-May to early June 2014.

Longwalls 23A and 24A did not undermine the creek.

Although Longwall 29 did not undermine the creek, its 20mm subsidence zone intersected the creek, whilst Longwall 30, which also did not undermine the creek, is currently being extracted.

Seam thickness varies from 1.8m at the finish end of Panel 24B / Panel 25 up to 2.15m in Longwall 29. Longwalls 22 to 29 are 283m wide rib to rib, with 34.5m to 40m wide chain pillars, cut-throughs at 100m centres and the Longwalls were from 771 - 3, 730m long as shown in **Figure 2**.

Earlier Longwalls were narrower with widths ranging from 143m to 240m.

***Table 2 Myrtle Creek – period of undermining***

| Longwall | Longwall Start | Longwall Finish | Period of Myrtle Creek Undermining | Depth of Cover (mbgl) |
|---|---|---|---|---|
| **4** | 04/02/89 | 09/05/89 | April 1989 | approx. 400m |
| **22** | 02/06/04 | 11/07/05 | early March 2005 | 420 – 432m |
| **23A** | 07/09/05 | 20/02/06 | not undermined by creek | 430 – 450m |
| **23B** | 15/03/06 | 21/08/06 | early – mid September 2005 | 430 – 440m |
| **24B** | 15/10/06 | 26/08/07 | mid-February 2007 | 430 – 440m |
| **24A** | 15/11/07 | 190/7/08 | not undermined by creek | 420 – 448m |
| **25** | 22/08/08 | 27/02/11 | early May – early September 2009 | 440 – 460m |
| **26** | 30/03/11 | 11/10/12 | mid – end August 2011 | 440 – 470m |
| **27** | 10/11/12 | 22/03/14 | early – late March 2013 | 420 – 495m |
| **28** | 20/04/14 | 01/05/15 | mid May – early June 2014 | 420 – 500m |
| **29** | 29/05/15 | 03/04/16 | not undermined by creek | 425 – 490m |
| **30** | 20/6/16 | ongoing | not undermined by creek | 425 – 490m |

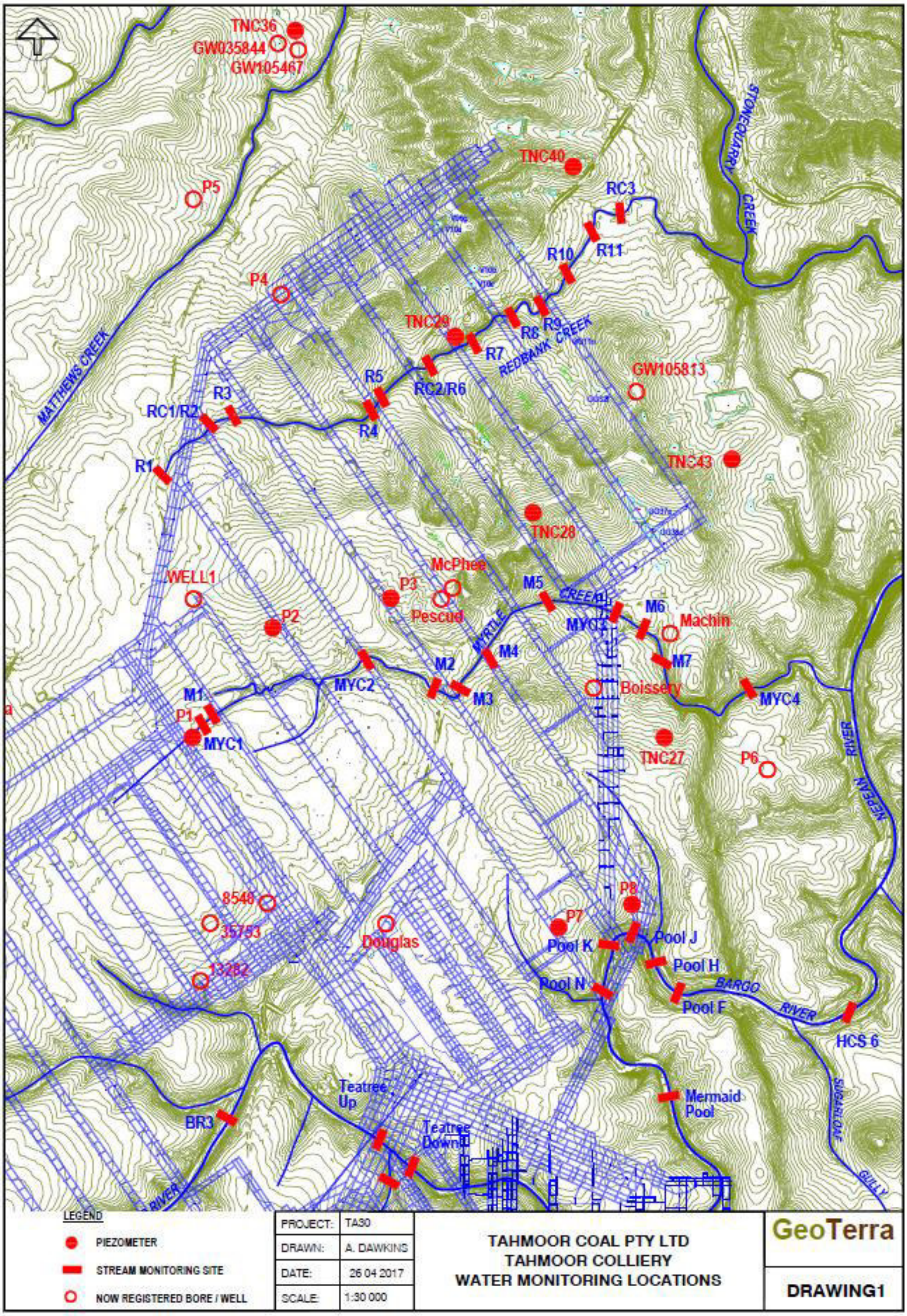


*Figure 6 Tahmoor Colliery water monitoring locations*

## 5.1.2 Physical Characteristics

The approximately 720 hectare (ha) catchment of Myrtle Creek flows to the north east into the Nepean River. The 1st and 2nd Order tributaries of Myrtle Creek have been undermined by Longwalls 3 to 9 in the southern tributary and by Longwalls 20 and 21 in the northern tributary.

The main channel of Myrtle Creek has been undermined by Longwalls 22, 23B, 24B and 25 to 28, whilst Longwall 29 is located approximately 85m to the north of the main creek channel.

The southern riparian flanks have been significantly altered by residential development in Tahmoor, whilst the channel has not been significantly affected except where general rubbish or solid waste has been dumped in the creek or it is overgrown by invasive weeds. Some isolated weeding and stream bank regeneration works have been conducted, however many of the areas are re-infested with weeds.

The stream bed and banks are generally well vegetated, and do not show significant erosion or bank instability. No Department of Primary Industries Water (formerly NSW Office of Water) registered water extraction is listed within the creek, however an unlicensed pump was present over the middle of Longwall 25, off Castlereagh Street.

**Figure 8** shows a plan of the Myrtle Creek Catchment. The upper reaches of the catchment are located in an area that transitions from rural to semi-rural development.

The creek passes around the northern edge of Tahmoor township and passes under the Main Southern Railway and Remembrance Drive before cutting down into a gorge and flowing to the Nepean River.

The average stream gradient varies along the length of Myrtle Creek from about 13mm/m (1.3%) upstream of the railway crossing, to 21mm/m (2.1%) over the section of interest between the railway crossing and Remembrance Drive and about 60-75mm/m (6-7.5%) downstream of Remembrance Drive to the Nepean River.

***Figure 7 Myrtle Creek Site 23 – northern bank***

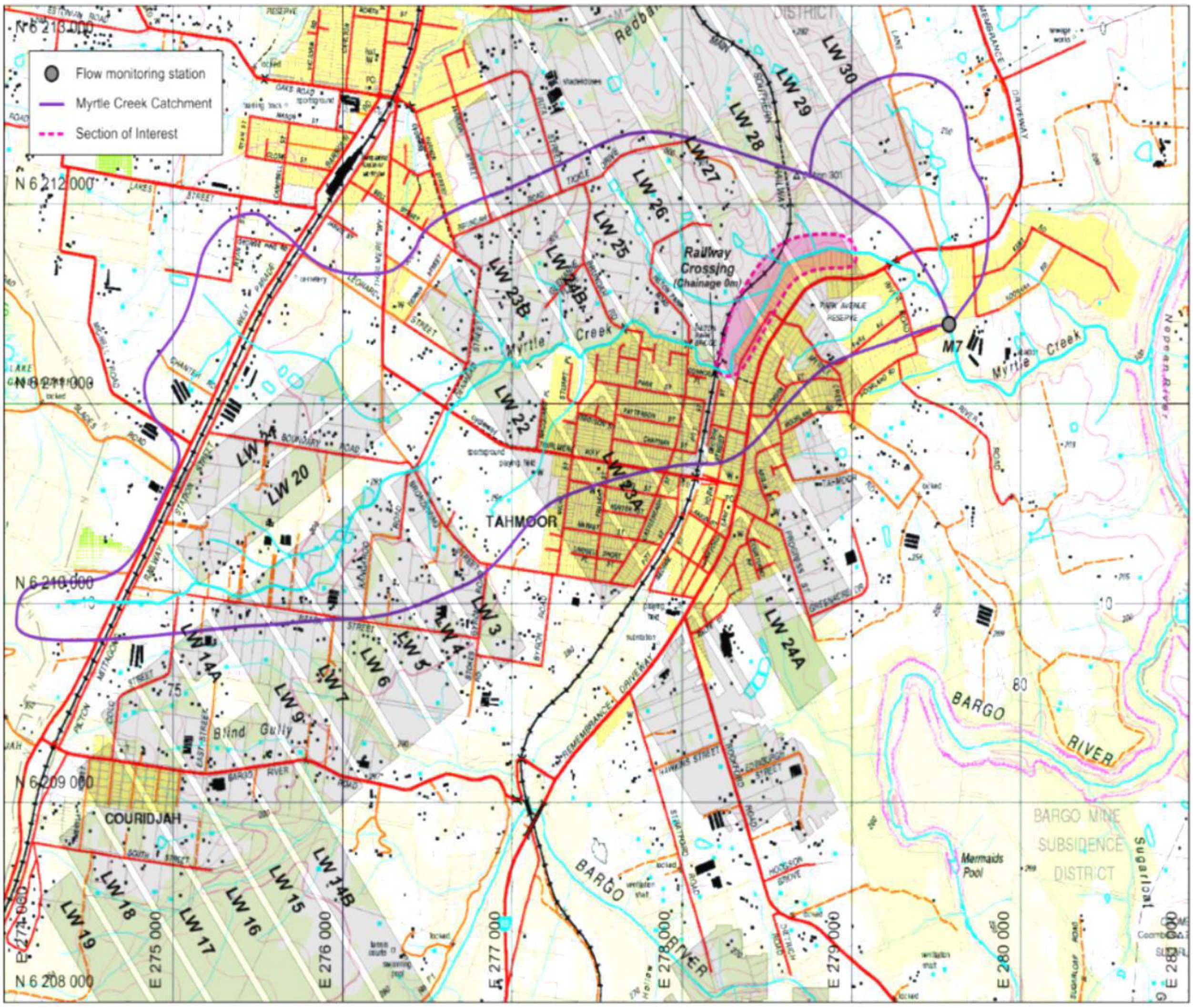


*Figure 8 Myrtle Creek Catchment*

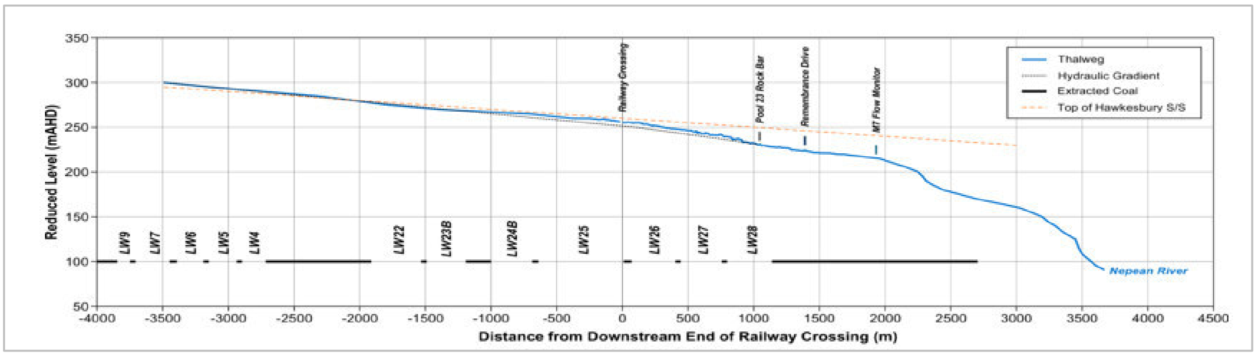


*Figure 9 Myrtle Creek thalweg survey*

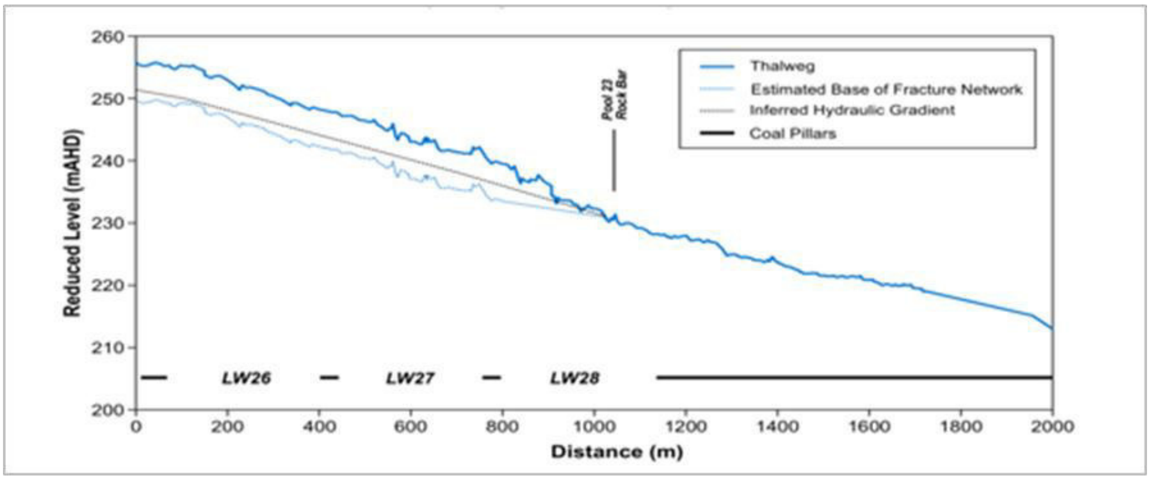


*Figure 10 Myrtle Creek hydraulic gradient*

## 5.1.3 Pool Mapping

Regular pool mapping was instigated within Myrtle Creek when Longwall 26 undermined the creek at identified rock bars, boulder fields, exposed Hawkesbury Sandstone rock shelves and their associated pools and has continued to the present day at sites shown in **Figure 53.**

Selected sites were identified, described, mapped and photographed prior to each longwall undermining the creek, as well as for a longwall width both upstream and downstream of the actively undermining panel.

As Longwall 26 moved to Longwall 27, and so on, the reach of mapping sequentially migrated 1 longwall width downstream, to culminate in the reach over Longwall 27, Longwall 28 and 250m downstream of Longwall 28 being monitored.

Prior to each Longwall undermining the creek, inspections were conducted every two months, then when the Longwall was located 150m before undermining the creek, weekly inspections commenced, until the panel was completed, at which time inspections reverted back to bi-monthly.

During inspections the stream flow, pool water levels, rock cracking / shelving, presence of iron hydroxide flocculent and presence of any upwelling seeps were noted, and any changes from previous weeks were documented and reported to Tahmoor Colliery in an email report.

## 5.1.4 Rainfall

Rainfall has been monitored at Tahmoor Colliery pit top since January 2004, with the rainfall residual plot shown in **Figure 11** indicating an overall rainfall reduction up to November 2011, followed by a rising trend up to March 2013, then an essentially flat trend, although impacted by storm and extended dry periods, up to the present.

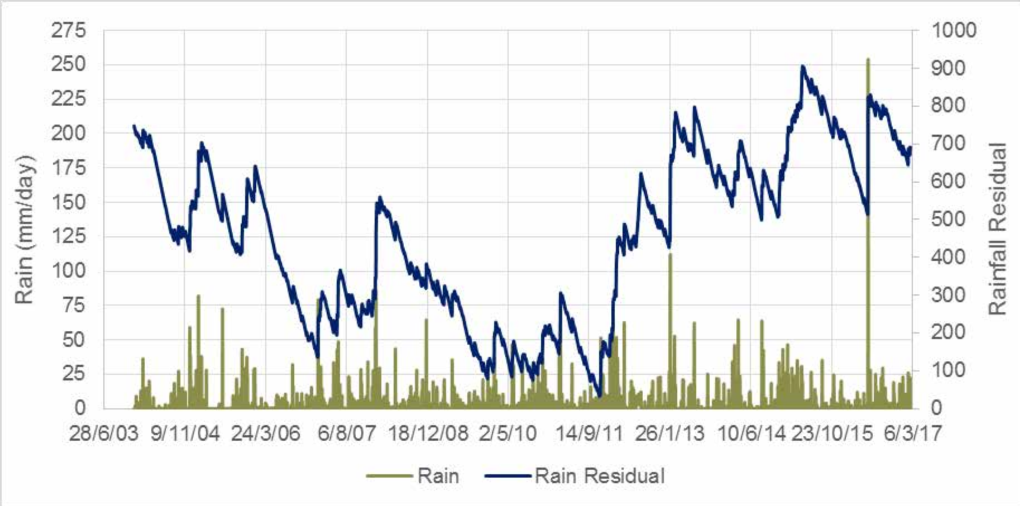


***Figure 11 Rainfall residual plot***

The below **Table 3** outlines the annual rainfall recorded at the Tahmoor Colliery meteorological station during the periods of 2004 and 2015.

***Table 3 Annual rainfall recorded at Tahmoor Colliery meteorological station***

| Tahmoor Colliery | Year | Annual Rainfall |
|---|---|---|
| **Annual Meteorological Data** | **2004** | 551 mm |
| | **2005** | 778 mm |
| | **2006** | 396 mm |
| | **2007** | 845 mm |
| | | |
| | **2008** | 853 mm |
| | **2009** | 525 mm |
| | **2010** | 849 mm |
| | **2011** | 707 mm |
| | **2012** | 1,075 mm |
| | **2013** | 905 mm |
| | **2014** | 796 mm |
| | **2015** | 847 mm |
| | **2016** | 717 mm |

## 5.1.5 Ground Characterisation

Most of the upper catchment is located within the outcrop of the Wianamatta Shale, however, Myrtle Creek is incised through the Wianamatta Shale and the top of the Hawkesbury Sandstone for much of its length.

The creek bed between the railway crossing and Remembrance Drive (CH 0 - 1388m) as outlined in **Figure 10** is located entirely within outcropping Hawkesbury Sandstone.

## 5.1.6 Geomorphology

In the vicinity of Longwall 4, Myrtle Creek has a shallow gradient and is incised into shallow (<2m deep) narrow (<5m wide) sandy clay colluvial sediments.

At Longwall 22, the creek is slightly wider and deeper, along with limited exposed sandstone, whilst more exposed sandstone rock shelves, and rock bar constrained pools are present over Longwall 23.

The creek downstream of Longwall 24 becomes sequentially wider and deeper with distance downstream and the rock bar constrained pools and intervening rock shelves and limited boulder fields become more prevalent as the creek becomes more incised.

Over Longwalls 27 and 28, the stream is dominated by sequential rock bar and boulder constrained pools with intervening exposed rock shelves.

## 5.1.7 Vegetation

The Lucas Heights soil landscape contains remnant low open eucalypt woodland with a sclerophyll shrub understorey in uncleared areas. Dominant trees species include turpentine, smooth barked apple, red bloodwood, silvertop ash, snappy gum and Sydney peppermint. Understorey species include black she-oak, Blue Mountains mallee ash and heath banksia. Cleared areas are dominated by grasses.

The Blacktown soil landscape has been almost completely cleared of its tall open wet sclerophyll, open forest and dry sclerophyll woodland forest and has been replaced with grassland. In uncleared sections, it is covered by tall open forest, including the remnant Sydney Blue Gum and blackbutt which grow in higher rainfall areas.

Pockets of original woodlands and open forests remain in drier areas in the west, including forest red gum, narrow leaved iron bark and grey box.

Creek beds are generally well vegetated, albeit with grass in the rural areas and an abundance of weeds in the developed areas. Where wet, reeds, lilies and other water plants are present in the channel bed and ponds.

## 5.1.8 Hydrology

### 5.1.8.1 Stream Monitoring Locations

Bi-monthly (unless otherwise specified in the relevant TARP) stream water level, along with stream flow monitoring, as well as field chemistry and laboratory analysis of water samples has been conducted in Myrtle Creek since December 2004 at the water level and / or chemistry monitoring sites summarised in **Table 4** and shown **Table 5**.

The "Myc" sites have been monitored by GeoTerra, whilst the "M" designated sites have been monitored by Hydrometric Consulting Services Pty Ltd (HCS).

The "Myc" sites water level monitoring was discontinued in March 2010 when the "M" series of water level monitoring sites replaced and added additional sites to the original "Myc" suite within Myrtle Creek.

***Table 4 Myrtle Creek water level and / or chemistry monitoring locations***

| Site | Description | Monitored Parameters |
|---|---|---|
| **Myc1** | Upstream of Thirlmere Way culvert | Pool depth*, field and laboratory chem. |
| **Myc2** | Downstream of Brundah Road culvert | Pool depth*, field and laboratory chem. |
| **Myc3** | At Remembrance Driveway bridge | Pool depth*, field and laboratory chem. |
| **Myc4** | Downstream of old Jay-R Stud | Pool depth*, field and laboratory chem. |
| **M1** | Thru park off Thirlmere Way | Dirt / vegetation pool depth and flow |
| **M2** | Access off railway culvert | Root / dirt pool depth and flow |
| **M3** | Downstream of York Park | Root growth pool depth and flow |
| **M4** | Downstream of M3 | Rock bar pool depth and flow |
| **M5** | Near vacant block in Remembrance Driveway | Rock bar pool depth and flow |
| **M6** | Opposite 12 River Road | Rock bar pool depth and flow |

| Site | Description | Monitored Parameters |
|---|---|---|
| **M7** | Suffolk Street Lane near Sydney Water pump station | Concrete weir |

* In above table refers to discontinued pool depth monitoring.

### 5.1.8.2 Flow Characteristics

Stream water levels in Myrtle Creek have been monitored since March 2010 at seven (7) locations being M1 to M7 and outlined in **Figure 6.** Myrtle Creek is ephemeral and experiences extended period.

Monitoring station M7 is located approximately 520m downstream of Remembrance Drive at chainage (CH) 1,909m. This station has been in operation since 2010 and provides a near continuous record of flow in the creek at this point. The catchment area above M7 is approximately 8km$^2$ in area.

Due to the erratic data set and difficulty in obtaining field calibrations, the M6 volumetric flow data is not as reliable as M7, which is preferentially referred to in this document.

**Figure 12** shows a summary of the flow indicated at the M7 monitoring station and the rainfall residual. The location of Longwalls that underlie Myrtle Creek are also shown.

Site M1 is located upstream of Longwall 22 and has not been affected by subsidence.

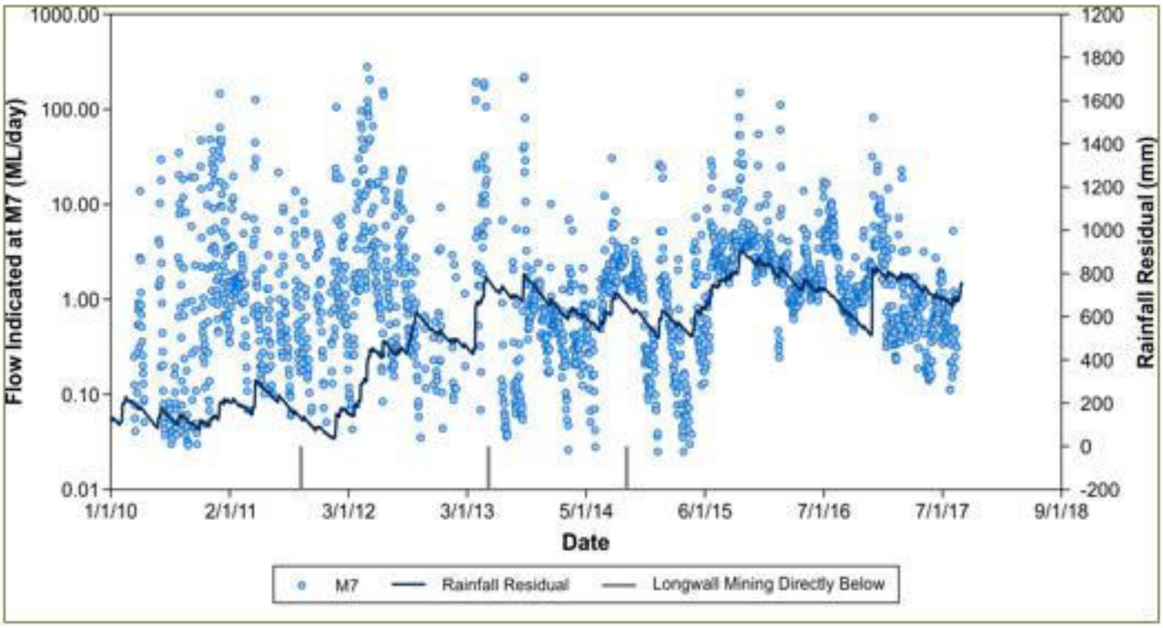


*Figure 12 Myrtle Creek flow at M7 and rainfall residual*

The below **Table 5** outlines the monitoring sites that were designated for weekly monitoring in the relevant EMP TARP before, during and after active mining periods.

*Table 5 Myrtle Creek monitoring sites – including descriptions*

| Site | Description | Other Site Name |
|---|---|---|
| **1** | Pool upstream of culvert | na |
| **2** | Pool with culvert and willow constrained pool and M3 site | M3 (HCS) |
| **3** | Pool behind log jam | na |
| **4** | Extended pool | na |
| **5** | Extended pool | na |
| **6** | Extended pool | na |
| **7** | Extended pool | na |
| **8** | Race over rock shelf / pool at creek bend | na |
| **9** | Extended pool with motorbike wheel | na |
| **10** | Extended pool with large fallen tree | na |
| **11** | Extended pool in landowner cleared area | M4 (HCS) |
| **12 (12A)** | Extended pool | na |
| **13 (13A)** | Race over rock shelf and downstream pool with tractor tyre | na |
| **14** | Exposed rock shelf | na |
| **15** | Extended pool (with gas cylinder) | na |
| **16** | Small waterfall / rock race | na |
| **17** | Extended pool (with concrete cylinder) | na |
| **18** | Railway works outflow pool | na |
| **19** | Extended pool and race over exposed sandstone plus small rock spall | na |
| **20** | Race over exposed sandstone | na |
| **21** | Race over exposed sandstone, 2-3m waterfall and downstream pool | na |
| **22** | Race over exposed sandstone | na |
| **23** | Large rock bar constrained pool | M5 (HCS) |
| **24** | Pool downstream of M5 site | na |
| **25** | Rock pool | na |
| **26** | Overgrown boulder race | na |
| **27** | Rock pool | na |
| **28** | Exposed sandstone race | na |
| **29** | Rock pool | na |
| **30** | Exposed sandstone race | na |
| **31** | Boulder pool | MYC3 (GeoTerra) |

**Figure 13** shows the time weighted stream discharge duration curve based on the M7 monitoring results. This curve demonstrates the period of time that flow in the creek is greater than indicated for any given flow rate. The dataset includes periods when the flow estimates may be on the low side due to damage to the flow monitoring system and periods when the station was not able to accurately monitor flood peaks.

The flow in Myrtle Creek at M7 is indicated as being 1Ml/day at least 50% of the time and greater than 0.4ML/day at least 70% of the time. At the location of interest, these values are decreased by about 12-25% based on catchment area. Flow in the section of Myrtle Creek of interest is therefore

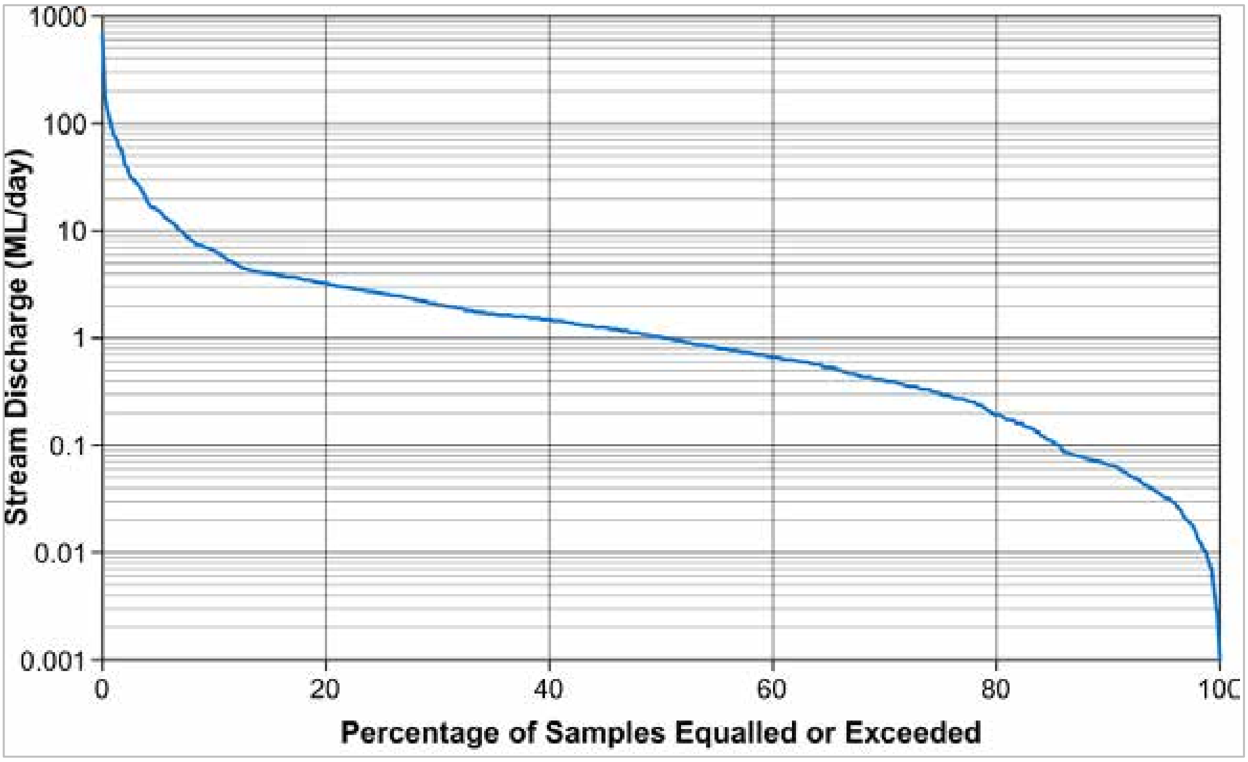


***Figure 13 Myrtle Creek time weighted stream discharge duration curve***

estimated to be 0.8Ml/day or greater at least 50% of the time and 0.3Ml/day or greater at last 70% of the time.

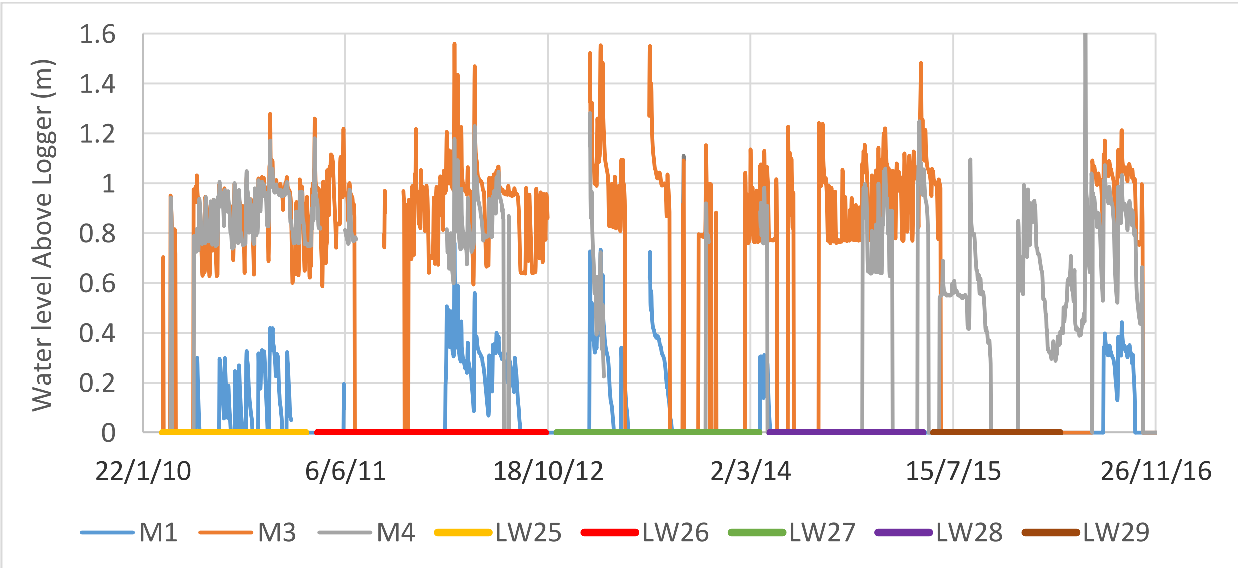


***Figure 14 Myrtle Creek monitoring – water level above logger sites M1, M3 & M4***

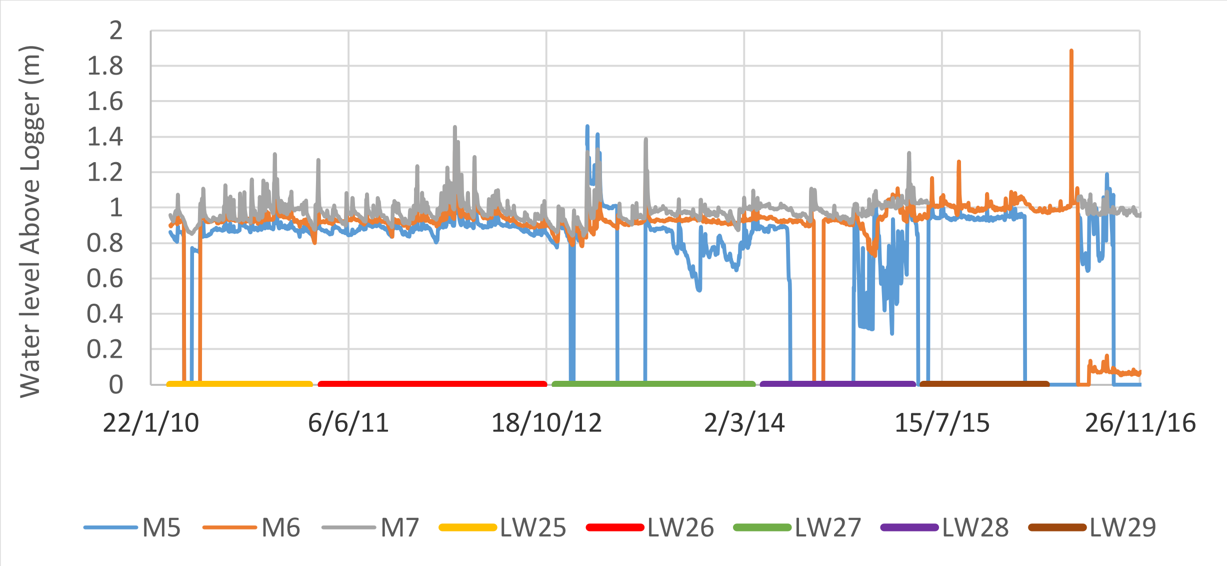


***Figure 15 Myrtle Creek monitoring – water level above logger sites M5, M6 & M7***

### 5.1.8.3 Water Quality

MYC1 is located upstream of MYC2, with MYC3 and MYC4 being located progressively downstream as shown in **Figure 6**  Myrtle Creek has an electrical conductivity (EC) range from 125 to 2630uS/cm, with pH between 5.31 and 8.34. Myrtle Creek becomes mildly more alkaline and slightly more saline with flow downstream as shown in **Figure 16**.

During the Longwall 28 mining period, the Myrtle Creek pH trended to being slightly more alkaline then became more acidic at all four (4) monitoring sites, whilst salinity peaked at around 2070uS/cm at MYC3 (approximately 285m downstream of Longwall 28) and at MYC4.

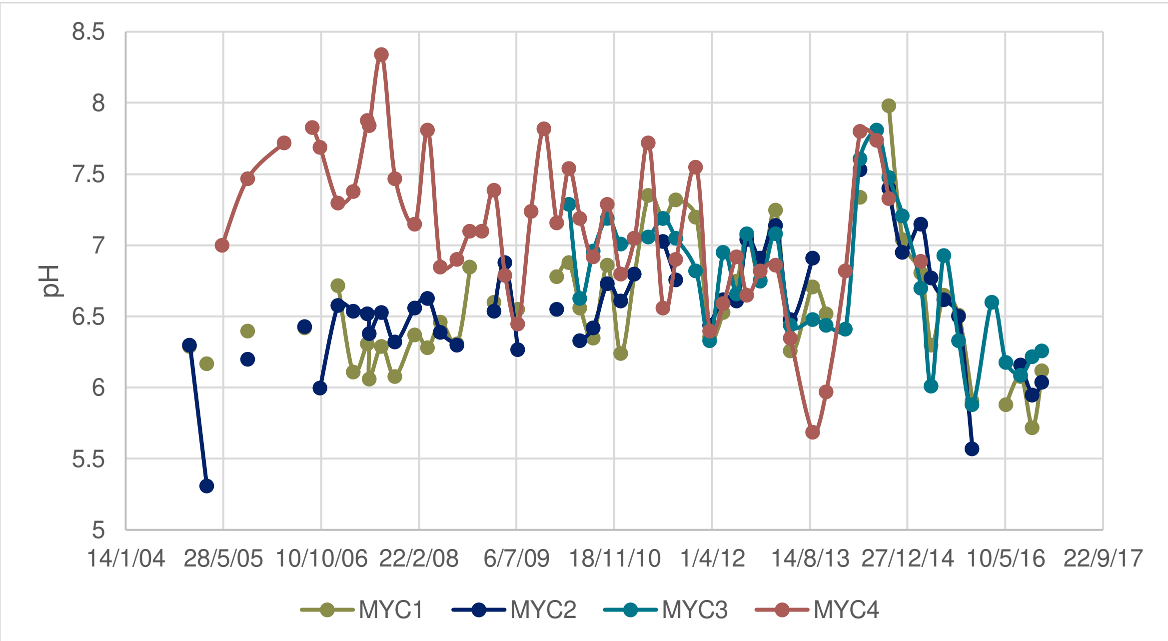


***Figure 16 Myrtle Creek monitoring – pH***

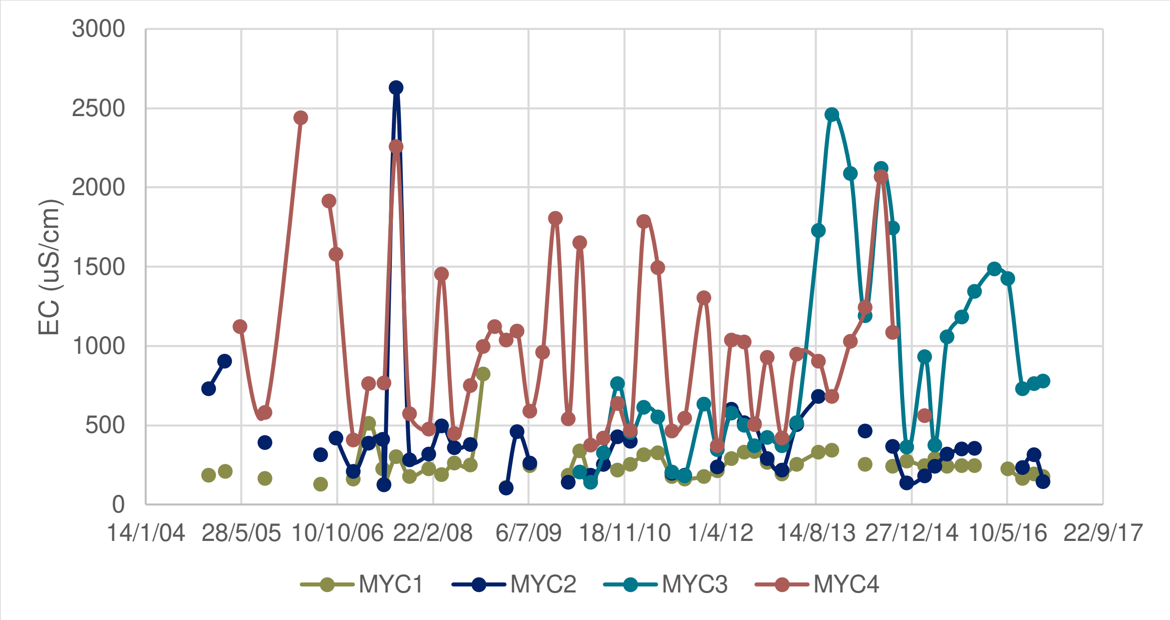


*Figure 17 Myrtle Creek monitoring – electrical conductivity*

Iron (Fe) and manganese (Mn) levels are generally not elevated in Myrtle Creek, apart from isolated occasions at MYC1 and MYC2 during extraction of Longwall 27, with no long term trend or increase over subsided areas as shown in **Figure 18** and **Figure 19**.

A new ferruginous seep was generated downstream of a small (<1.5m high) waterfall at Site 21A during extraction of Longwall 28.

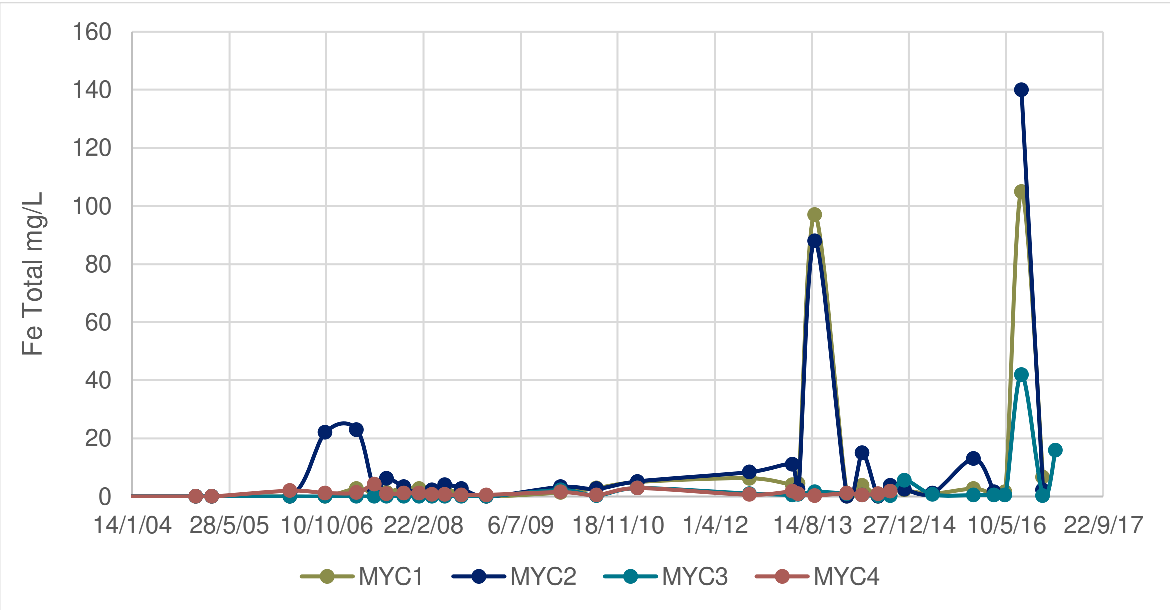


*Figure 18 Myrtle Creek monitoring – iron*

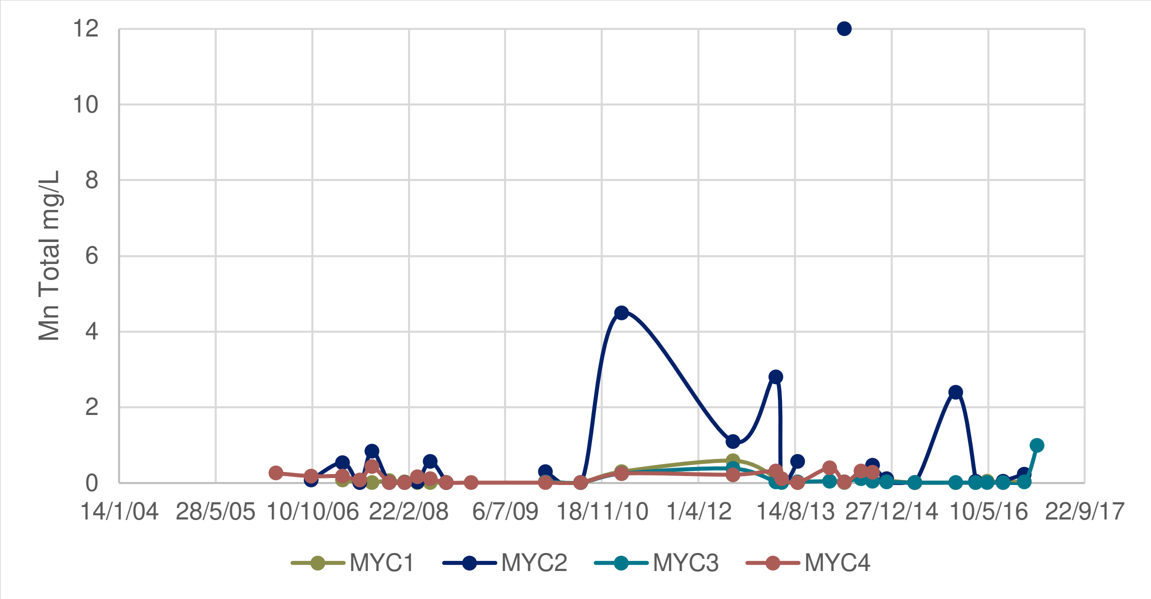


***Figure 19 Myrtle Creek monitoring – manganese***

Myrtle Creek can have total nitrogen up to 190mg/L and total phosphorous up to 30mg/L, which are above the ANZECC 2000 SE Australian Upland Stream criteria, generally at all water quality monitoring sites, but not at all times, as shown in **Figure 6**.

The high nutrient levels at Site MYC4 are present as the site is a watering hole for a mob of goats that live around the now decommissioned JR Horse Stud, and the site is also downstream of an abattoir and the commercial industrial area of Picton.

The other three sites show typical, variable, levels of nutrients for a residential / rural catchment area.

The above criteria nutrients are present due to urban and rural / residential runoff in the catchment from house gardens, market gardens, as well as properties with poultry and stock, along with leakage from sewers and are not related to mining influences.

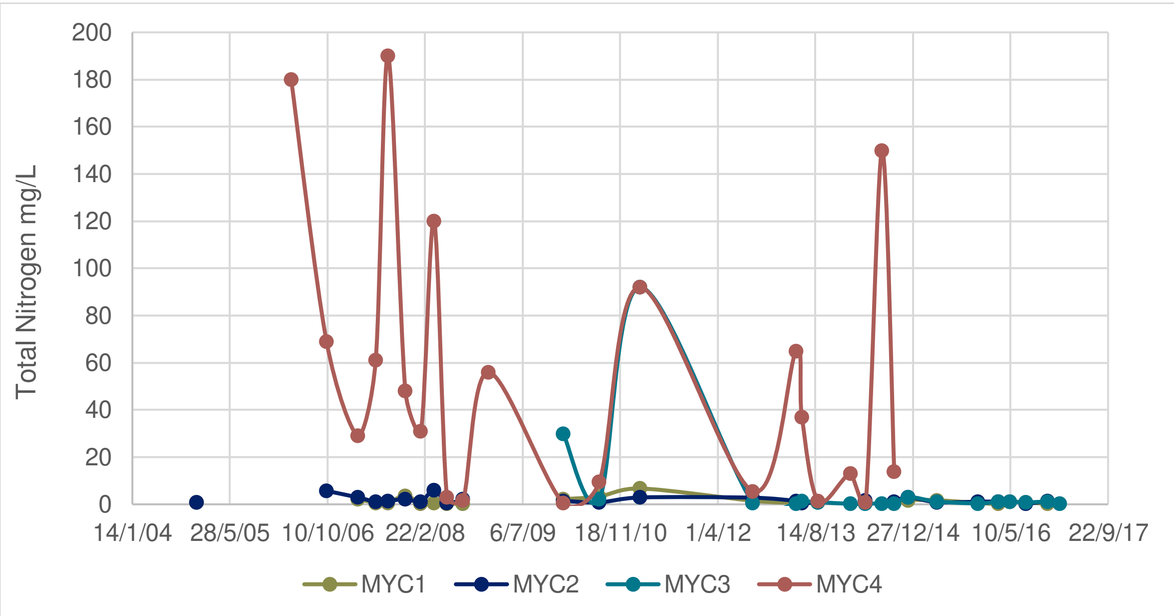


***Figure 20 Myrtle Creek monitoring – nitrogen***

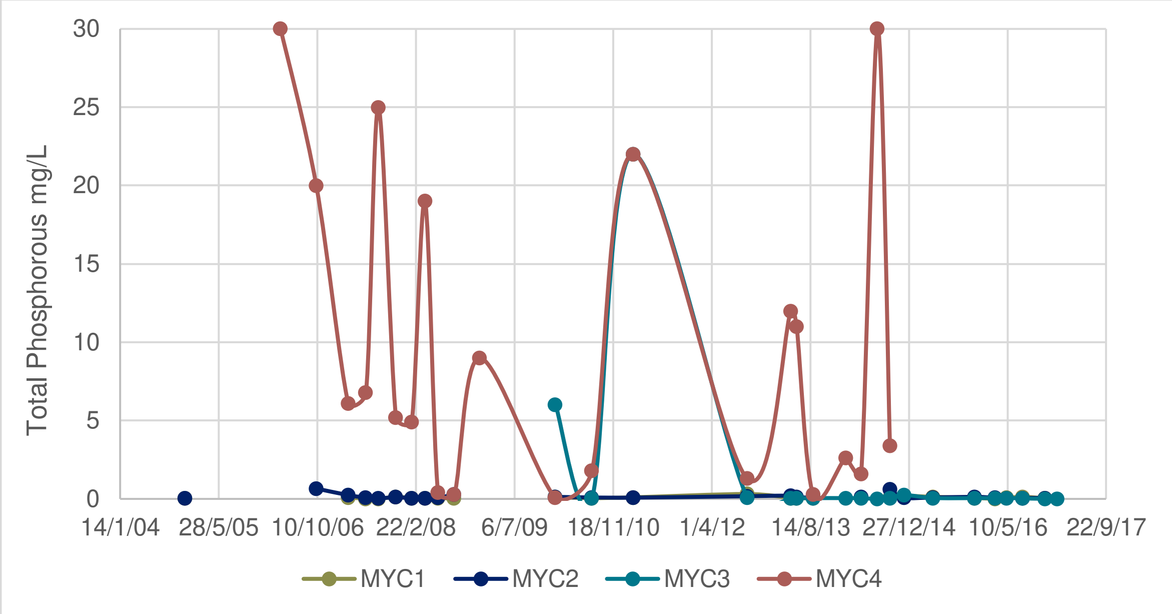


***Figure 21 Myrtle Creek monitoring – phosphorous***

Myrtle Creek can also exceed the ANZECC 2000 trigger levels for filterable aluminium (<1.0mg/L), copper (<0.009mg/L) or zinc (0.027mg/L) at all sites, for variable times at each monitoring site. A notable increase in copper occurred at MYC2 (over the chain pillar between longwalls 24B and 25) and for zinc at MYC2 and MYC4 (approximately 1.5km downstream of Longwall 28) during the extraction period of Longwall 28 as shown in **Figure 24**.

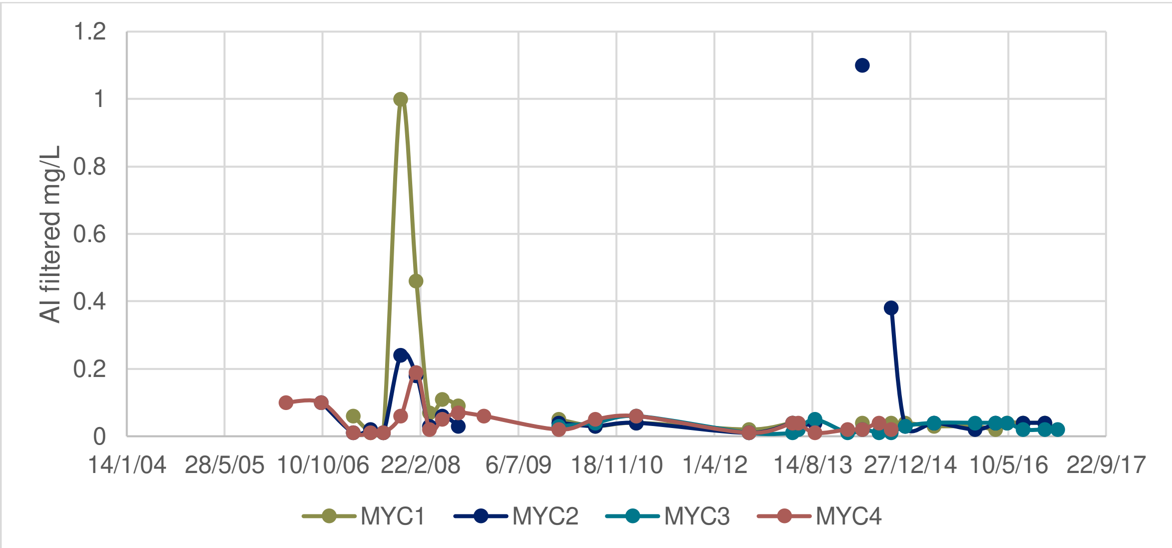


***Figure 22 Myrtle Creek monitoring – aluminium***

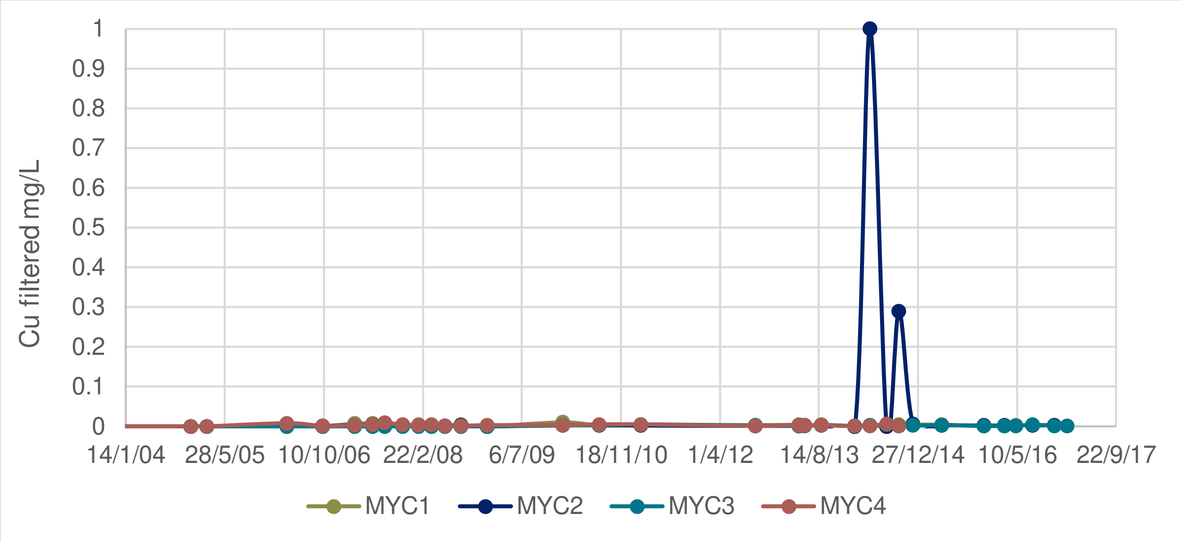


***Figure 23 Myrtle Creek monitoring – copper***

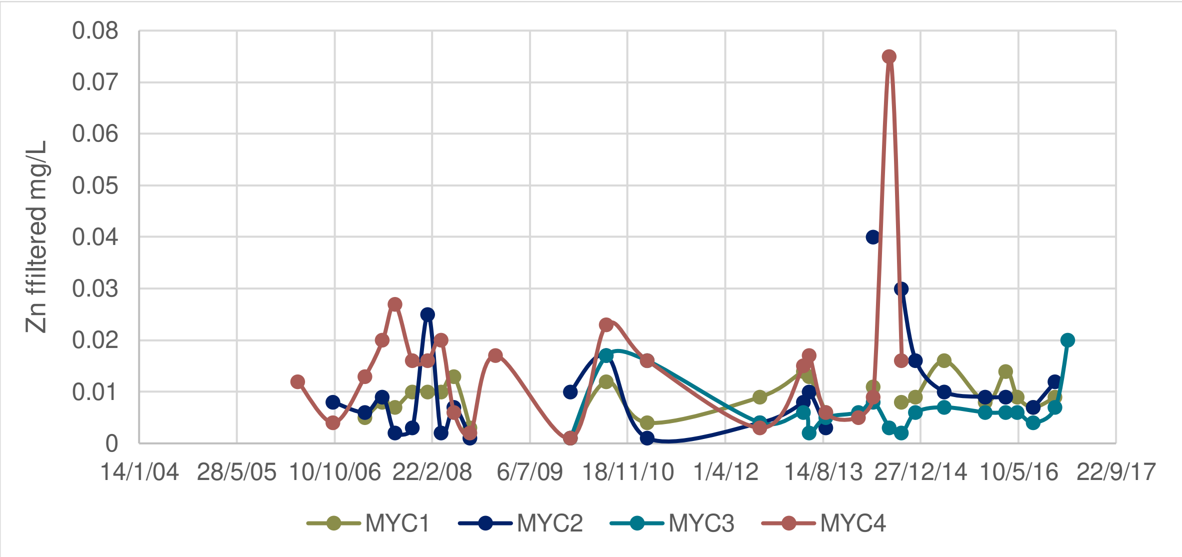


***Figure 24 Myrtle Creek monitoring – zinc***

It has been observed that increased flow through the newly fractured sandstone, in addition to extended dry periods, causes a higher concentration of total and dissolved metals such as iron, manganese, zinc and copper. However, depending on the flow conditions prior to and during sampling, if there has not been a significant rain event to induce connective stream flow, the elevated levels represent evaporative enhancement in isolated standing pools and not natural flow conditions.

Due to the increased water / rock interaction through the new / fresh fracture network, and therefore the increased dissolution of freshly exposed sulfide and other minerals, the stream water has undergone an essential acidification of from 1 to 2 pH units at the monitored sites (MYC1 - MYC3) since mid-2014, along with increased salinity during extended dry periods at MYC3 of up to 2500µS/cm from a baseline range of up to 750µS/cm prior to February 2013.

Significant localised changes have occurred due to mining induced subsidence and valley closure at and downstream of cracked / dried pools where the stream flow re-enters the creek as overland connected flow. These changes generally manifest as a significant increase in iron hydroxide flocculent and associated increases in manganese, zinc and copper.

To date, there is no apparent improvement in stream chemistry at MYC3, however this is primarily due to the extended periods that pools remain low and gradually evaporate, thereby increasing the salinity and metals content of the evaporating ponded water.

During flood periods after heavy storms the creek reverts back to its original water quality.

# 6 Myrtle Creek Impacts

## 6.1 Systematic Subsidence Movements

Subsidence associated with longwall mining has potential to impact on stream channels such as Myrtle Creek in a variety of ways. In this section, the key impacts are discussed.

Vertical subsidence in the range 0.8-1.2m has been measured in the vicinity of Myrtle Creek.

This vertical subsidence causes lowering of the surface that may lead to ponding in areas of flat terrain and tilting of generally less than 3mm/m.

The channel of Myrtle Creek is sufficiently incised that ponding within the channel is not evident to any significant extent.

The maximum tilt associated with mining subsidence is typically in the range 1-3mm/m. With stream gradients averaging 13-75mm/m along Myrtle Creek, any tilting is small by comparison with the average grade and is not expected to have any perceptible impact.

The maximum systematic subsidence movements at the completion of Longwall 29 are shown in **Table 6**.

***Table 6 Maximum subsidence parameters at the completion of Longwall 29***

| Myrtle Creek | |
|---|---|
| **Component** | **Observed Total Movement** |
| **Vertical subsidence** | 1124 mm |
| **Tilt** | 6.3 mm/m |
| **Tensile / Compressive Strain** | 2.1 / -7.7 mm/m |

## 6.2 Valley Closure

The most significant effect of non-systematic subsidence in creek channels located in Hawkesbury Sandstone outcrop is one associated with horizontal movements associated with valley closure. These horizontal compression movements become concentrated across topographic low points such as creek channels. They cause low angle fracturing in the base of the creek that provides an additional pathway for sub-surface flow.

Section 3.1.4 of the Longwall 27-30 EMP states (After MSEC355):

a) *'While no surface flow diversions have been confirmed from previous mining, major fracturing and sub-surface water flow diversion could occur in Myrtle and Redbank Creeks during the mining of Longwalls 27-30. Compressive strains due to closure are expected to be sufficient to potentially cause the underlying strata to dilate and buckle and induce cracking at the surface at some locations. This could potentially lead to the diversion of water from the creek beds into the dilated strata beneath it.'*

There are many factors that are considered to potentially contribute to the valley closure mechanism. Hebblewhite, (2009) list these factors to include:

a) Simple elastic horizontal deformation of the strata within the exponential 'tail' of the subsidence profile that applies in conventional circumstances.

b) Influence of valleys and other topographical features which remove constraints to lateral movement and permit the overburden to move 'en masse' towards the goaf area, possibly sliding on underlying weak strata layers.

c) Unclamping of near-surface horizontal shear planes.

d) Influence of unusual geological strata which exhibit elasto-plastic or time dependent deformation.

e) Stress relaxation towards mining excavations.

f) Horizontal movements aligned with the principal in-situ compressive stress direction.

g) Valley notch stress concentrations.

h) Movements along regional joint sets and faults.

i) Unclamping of regional geological plates.

It is beyond the scope of this document to speculate further on the precise mechanisms that have contributed to the non-systematic valley closure effects recorded at Myrtle and Redbank Creeks other than to confirm that closure to the extent required to cause shallow cracking has occurred and has impacted surface stream flow.

The process of valley closure occurs naturally as valleys are cut down into the host rock by the erosive action of the creek. The interaction of vertical stress relief and diurnal and annual temperature variations causes rock close to the surface to become overloaded and fractured (Mills 2015). Generally, the rates of natural processes are slow enough that sufficient sediment is deposited within the fracture network to maintain a high proportion of the total flow as surface flow.

As the flow diminishes upstream, surface flow becomes more and more intermittent until all the flow occurs as sub-surface flow and there is no surface flow evident.

## 6.3 Fracture Distribution below Creek Channel

**Figure 25** shows the distribution of the fracturing observed at a site in the Southern Coalfield of NSW impacted by valley closure of approximately 600mm (ACARP 2009). The fracture network was determined using a program of intensive drilling and borehole calliper logging.

A zone of intense fracturing is evident below the creek bed. This zone is typically evident to a depth of less than 6m, but has been observed to range up to about 12m below the surface at some sites. The intense fracturing is evident as open fractures of up to several hundred millimetres wide. These develop as low angle conjugate fractures to form wedges that lift the surface causing localised upward movement or upsidence directly above the zone of intense fracturing.

A basal shear plane extends outward from the base of the zone of intense fracturing on either side of the river channel. Shear on this basal plane enables horizontal movement of the valley sides' inward toward the creek to generate the zone of intense fracturing. Measurements at various sites indicate that basal shear planes are likely to follow bedding and may extend hundreds of metres either side of the valley. They may be formed as part of natural valley forming processes and are then remobilised by the dilation associated with mining subsidence.

Depending on the magnitude of valley closure, both the zone of intense fracturing and the basal shear plane have potential to be hydraulically conductive. At low flows, all the flow in the creek can flow through these fracture networks without appearing on the surface.

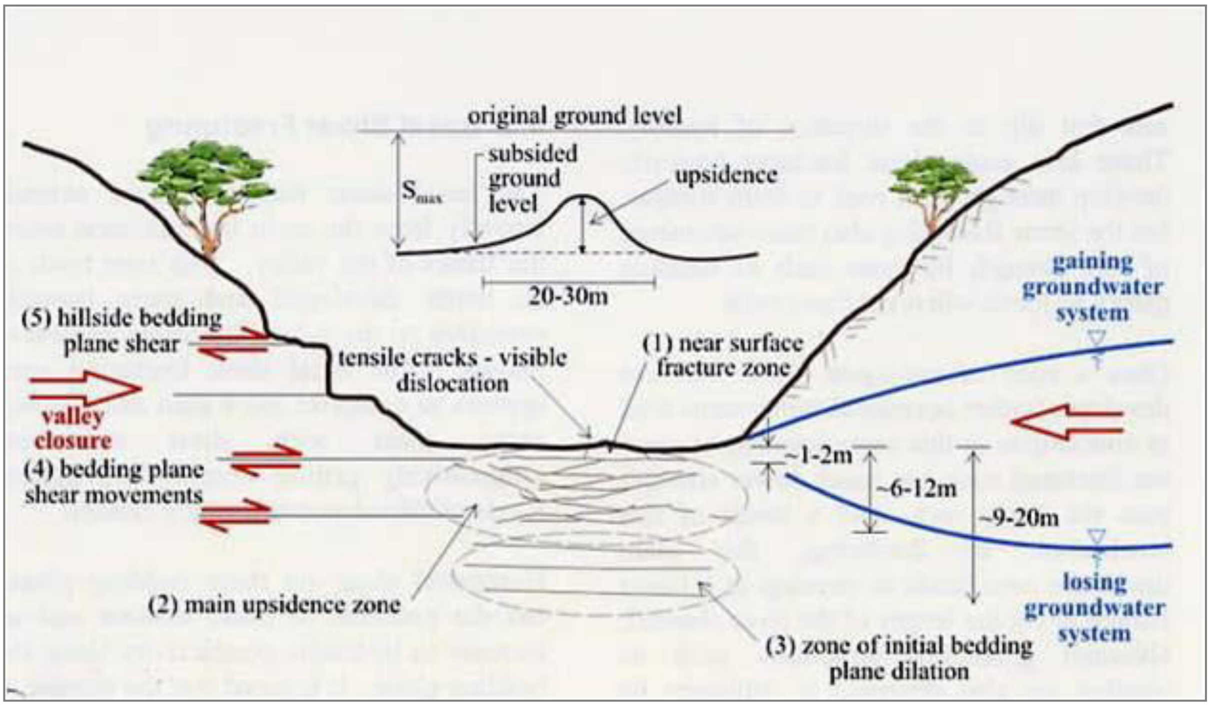


***Figure 25 Idealised fracture network typical of that seen in the Waratah Rivulet***

## 6.4 Fracture Distribution within the Overburden Strata Generally

Mining subsidence also disturbs the overburden strata more generally causing fracturing and increased hydraulic conductivity unrelated to the local disturbance in creek channels caused by valley closure. At Tahmoor Colliery, this effect is relatively insignificant, but it is described here for completeness. Remediation efforts discussed in this report are not focussed on reducing downward flow through the overburden strata generally.

Prior to mining, the overburden strata has some hydraulic conductivity mainly through natural joints, but also through the matrix permeability of the rock materials themselves. This hydraulic conductivity decreases gradually with depth.

Mining-induced disturbance of the strata is greatest at seam level and decreases upward. The degree of disturbance and the nature of the disturbance influence the hydraulic conductivity of the fracture network created. More disturbance causes greater hydraulic conductivity. Bedding plane separation usually evident higher in the overburden strata tends to increase horizontal conductivity more than vertical conductivity.

For the recent mining geometry at Tahmoor Colliery, the height of fracturing is estimated to be about 190m above the mining horizon and several hundred metres below the surface. This barrier is expected to limit vertical flow downward through the strata into the mine to very low magnitudes so that rainfall recharge is able to maintain groundwater levels at close to the surface.

Any downward flow that may occur downward through the tortuous fracture network created by mining subsidence is likely to be difficult to stop because of its low magnitude and the lateral extent of the tortuous fracture network. Remediation efforts discussed in this report are not focussed on reducing downward flow through the overburden strata generally.

## 6.5 Impact Monitoring

Myrtle Creek was first noted to start drying out over Longwall 22 in an isolated pool after Longwall 23B undermined the creek around September 2005.

Further cracking and pool draining impacts were not subsequently observed until the creek was undermined by Longwall 25 between May and September 2009.

Creek bed cracking and pool drainage continued and sequentially expanded downstream into a disconnected flow reach and extent of dry pools as Longwalls 26 to 28 were extracted up to May 2015.

The creek essentially stayed dry over an approximately 1.2km reach up until the East Coast Low floods in June 2016, after which time Sites 1 to 3 over Longwall 26 re-gained full pools and a connected flow regime.

Sites both upstream (over Longwall 25) and downstream of the approximately 140m long “recovered” reach over Longwall 26 have remained essentially dry to date, except after sufficient runoff after prolonged and heavy storm events.

A description of the sequential impacts through Tahmoor Colliery undermining Myrtle Creek is outlined below.

### 6.5.2 Longwall 4

No impacts on the soil dominated creek bed or banks in the headwaters of Myrtle Creek were observed or reported over Longwall 4 when the creek was undermined around April 1989.

### 6.5.3 Longwall 22

Myrtle Creek was undermined by Longwall 22 around early March 2005.

Valley closure and upsidence occurred in a tributary of Myrtle Creek near the centre of the panel, although no creek bed cracking or other subsidence effects were observed after Longwall 22 undermined the creek.

The reduced subsidence observed on Macquarie Place is due to the presence of a dilatational igneous intrusion in the Bulli Seam beneath Macquarie Place and Stuart Place, with an increased tilt into the subsidence bowl of approximately 9 mm/m. The observed strains are less than 2 mm/m.

Observed subsidence in Myrtle Creek was approximately 0.5m, with strains generally between -1.6 mm/m tensile and 0.6 mm/m compressive, although higher strains were observed near the intrusion which necessitated Longwall 23 to be subdivided into two sections.

### 6.5.4 Longwall 23A

Longwall 23A did not undermine or have any impact on Myrtle Creek.

### 6.5.5 Longwall 23B

Myrtle Creek was undermined by Longwall 23B from early to mid-September 2005.

The starting point of the subdivided northern section of the Longwall (23B) is close to Myrtle Creek and therefore the creek did not undergo significant additional subsidence associated with extraction of Longwall 23B, whilst tilts and strains at the southern starting point of the longwall, north of the dilatational intrusion in the Bulli Seam, were likely to be high, although were not directly measured in the creek.

Cracking of the soil and bedrock over Longwalls 22 and 23B, probably due to non-systematic upsidence and valley closure movements occurred after Longwall 23B undermined the creek bed in various locations.

**Figure 26** shows sandstone pool base cracking that developed over Longwall 22 after Longwall 23 undermined the creek.

The cracking was up to 10mm wide and limited to the base of the creek within a small rock bar over Longwall 22, whilst the soil cracking occurred at the southern end of Longwall 23B, close to the barrier pillar between Longwalls 23A and 23B.

The bedrock crack in the creek bed over Longwall 22 is within a small sandstone rock bar outcrop, with no observable adverse effect on stream flow, and therefore, no rehabilitation of the Longwall 22 cracking was proposed.

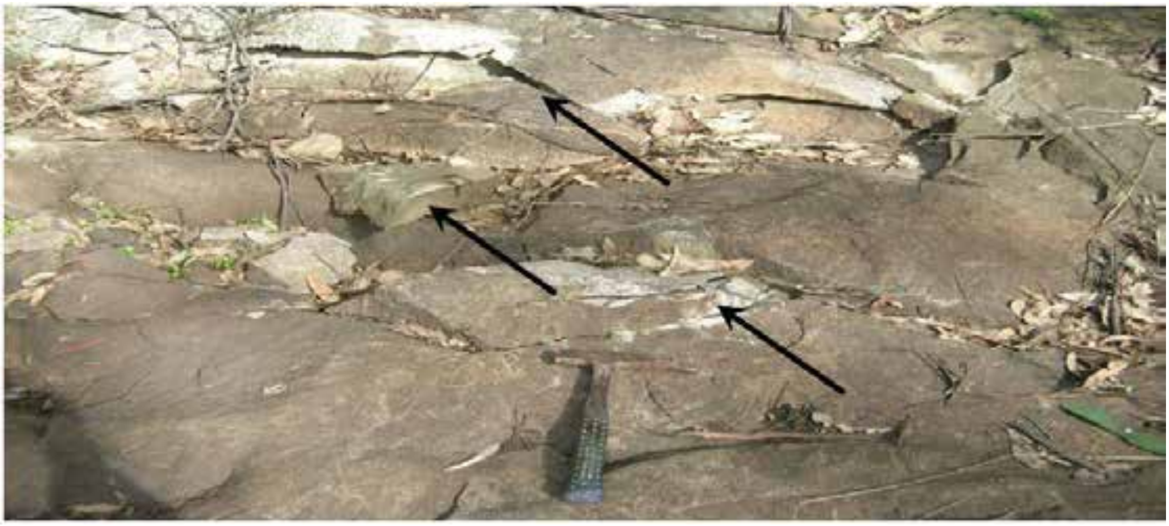

*Figure 26 Myrtle Creek over LW22 – cracking*

The soil crack over 23B was located close to the Longwall 23A and 23B barrier pillar. It was up to 65mm wide and extended into the soil to approximately 1.5m - 2.0m over an approximate length of 40m, however, it did not develop within the bed of Myrtle Creek, even though it was observed on both the upper banks and flank of the creek.

Even though soil cracking was noted in the creek over Longwall 23B, it did not instigate bed or bank instability and was not rehabilitated. No surface flow diversion, reduction in water quality or change to ponding or pool storage capacity was observed in the creek.

*Figure 27 Myrtle Creek over LW23B – cracking*

### 6.5.6 Longwall 24B

Myrtle Creek was undermined by Longwall 24B around mid-February 2007.

No creek bed cracking was observed over the longwall, along with no observable adverse effects on stream bed or bank stability, flow or pool holding capacity.

Valley closure and upsidence was observed on monitoring lines across the creek near Huen Place and Elphin Street. Valley closure was first observed following the 900 metre survey and the observed peak compressive strains aligned with the base of the creek.

Upsidence movements are less evident than the valley closure related compressive strains.

No impacts were observed on the Castlereagh Street bridge over the creek, with a maximum subsidence of 58 mm along with negligible tilts and strains as summarised in the table below.

*Table 7 Myrtle Creek subsidence, tilt and strain parameters*

| Longwall | East | Subsidence | Tilt | Strain |
|---|---|---|---|---|
| Over LW24B | Elphin Street | 300mm subsid | 2mm tilt | +0.5 to -0.75mm/m |
| Over LW24B | Elphin Street / Myrtle Creek | 75mm subsid | -1.5mm/m tilt | -4.5 to 0.5mm/m strain |
| Over LW24B | Huen Place | 450mm subsid | 2mm /m tilt | -3.5 to 0.25mm/m strain |
| Over LW22 | Turner Denmead | 275mm subsid | -2mm tilt | -5.0 to 0.5mm/m strain |

### 6.5.7 Longwall 24A

Longwall 24A was mined after Longwall 24B. It did not undermine, or have any effect on Myrtle Creek.

### 6.5.8 Longwall 25

Myrtle Creek was undermined by Longwall 25 between early May and early September 2009.

After Myrtle Creek was undermined by the longwall, subsidence within the creek was observed to have generated limited exposed sandstone stream bed cracking or isolated exposed sandstone through flow over Longwalls 22, 23B and 25, along with soil cracks in the upper bank and flanks over Longwall 23B in various locations.

The available measured maximum subsidence parameters from the limited data relevant to the channel of Myrtle Creek (from seven monitoring sites) was:

*Table 8 Myrtle Creek subsidence parameters*

| East | Comments |
|---|---|
| Subsidence | 200 to 660 mm |
| Upsidence | 20 to 110 mm |
| Closure | 25 to 181 mm |
| Strain | -1.1 to -37 mm |

Three areas of isolated cracking of exposed sandstone in the base or sides of generally dry pools occurred after the completion of Longwall 25 as summarised in **Table 6** and shown in **Figure 28, Figure 29** and **Figure 30**.

*Table 9 Myrtle Creek observed cracking after extraction longwalls*

| Location | North | East | Comments |
|---|---|---|---|
| **LW22** | **277000** | 6211200 | Small isolated cracking in exposed sandstone in ephemeral pool |
| **LW23B** | **277300** | 6211285 | Up to 5cm wide cracking in soil on a first order tributary |
| **LW25** | **278155** | 6211203 | Small isolated cracking in exposed sandstone in ephemeral pool |
| **LW25** | **278100** | 6211198 | Small isolated cracking in exposed sandstone in ephemeral pool |
| **LW25** | **277845** | 6211320 | Small isolated spalling of sandstone in ephemeral pool |

Due to the low quantum of subsidence and high vegetative cover in the creek, no erosion from the creek bed or banks or sediment accumulation in subsidence troughs was observed.

Reversal of flow in the creek did not occur as the creek gradient exceeds the subsidence tilt in the stream.

*Figure 28 Myrtle Creek over LW25 – soil cracking*

*Figure 29 Myrtle Creek over LW25 – cracking*

*Figure 30 Myrtle Creek over LW25 – cracking*

## 6.5.9 Longwall 26

Myrtle Creek was undermined by Longwall 26 between the mid to the end of August 2011.

As summarised in **Table 10**, physical subsidence effects such as bedrock cracking and pool level reduction to full desiccation were observed in Myrtle Creek as a result of Longwall 26 extraction at sites 5 to 9, over the central to maingate section of Longwall 26, as well as at sites 12 to 16 over the central to maingate section of Longwall 27.

*Table 10 Myrtle Creek subsidence effects after LW26 extraction*

| Sites | Site Location Relative to Longwall | Effect | Date Initially Observed |
|---|---|---|---|
| **Over Longwall 26** | | | |
| 5 | central / maingate | dry pool due to cracking | 05/03/13 |
| 6 | central / maingate | dry pool due to cracking | 05/03/13 |
| 7 | central / maingate | dry pool due to cracking | 05/03/13 |
| 8 | maingate | dry pool due to cracking | 05/03/13 |
| 9 | maingate | dry pool due to cracking | 05/03/13 |
| **Over Longwall 27** | | | |
| 12 | central / tailgate | pool level reduction and cracks in rock bar | 05/03/13 |
| 12 | central | cracking and dry pool continuation | 05/03/13 |
| 14 | central | dry pool due to cracking | 05/03/13 |
| 15 | central | cracking and dry pool | 05/03/13 |
| 16 | central / maingate | cracking and dry pool / race | 05/03/13 |

Heavy rain and stream flow preceded the first survey over Longwall 26 on the 5 March 2013, during extraction of Longwall 27.

Overall, no observable adverse effects on stream flow, water quality and bed or bank stability were observed in the creek at the end of mining Longwall 26, whilst reversal of flow in the creek did not occur as the creek gradient exceeds the imposed subsidence tilt.

Photographs of sites adversely affected by Longwall 26 are shown on the following pages.

*Figure 31 Myrtle Creek over LW26 – subsidence effects at Site 5*

*Figure 32 Myrtle Creek over LW26 – subsidence effects at Site 6*

*Figure 33 Myrtle Creek Site 7 – subsidence effects after LW26 extraction*

*Figure 34 Myrtle Creek Site 8 – subsidence effects after LW 26 extraction*

*Figure 35 Myrtle Creek Site 9 – subsidence effects after LW26 extraction*

*Figure 36 Myrtle Creek Site 12 – subsidence effects after LW26 extraction*

*Figure 37 Myrtle Creek Site 13 – subsidence effects after LW26 extraction*

*Figure 38 Myrtle Creek Site 14 – subsidence effects after LW26 extraction*

*Figure 39 Myrtle Creek Site 15 – subsidence effects after LW26 extraction*

*Figure 40 Myrtle Creek Site 16 – subsidence effects after LW26 extraction*

## 6.5.10 Longwall 27

Myrtle Creek was undermined by Longwall 27 around early to mid-March 2013, with the observed subsidence effects summarised in **Table 11** and shown in Myrtle Creek Status Report shown as **Figure 54**.

In addition to the sites over Longwall 26 that had previously been affected, additional subsidence effects were observed at:

a) Sites 9, 10 and 11 over the chain pillar between Longwall 26 and 27.

b) Sites 12 - 19 over Longwall 27, and, to a lesser degree.

c) Sites 21 - 24 over Longwall 28.

***Table 11 Myrtle Creek subsidence effects after LW27 extraction***

| Sites | Site Location Relative to Longwall | Effect | Date Initially Observed | TARP First Triggered |
|---|---|---|---|---|
| **Over Longwall 26** | | | | |
| **4** | central / tailgate | additional cracking and dry pool continuation | during LW26 & 22/03/13 | 10/05/13 |
| **5** | central / maingate | continuation of dry pool due to cracking | during LW26 | 10/05/13 |
| **6** | central / maingate | continuation of dry pool due to cracking | during LW26 | 10/05/13 |
| **7** | central / maingate | continuation of dry pool due to cracking | during LW26 | 10/05/13 |
| **8** | maingate | continuation of dry pool due to cracking | during LW26 | 10/05/13 |
| **9** | maingate | additional cracking and dry pool continuation | during LW26 & 13/06/13 | 10/05/13 |
| **10** | maingate | continuation of dry pool (no obvious cracking) | during LW26 | 10/05/13 |
| **11** | LW26 / 27 chain pillar | continuation of dry pool (no obvious cracking) | during LW26 | 10/05/13 |
| **Over Longwall 27** | | | | |
| **12** | tailgate | additional cracking, dry pool and fallen tree | 22/3/13 | 23/5/13 |
| **12A** | central / tailgate | pool level reduction and cracks in rock bar | during LW26 | no |
| **13 to 13A** | central | additional cracking and dry pool continuation | during LW26 & 5/4/13 | 10/5/13 |
| **14** | central | continuation of dry pool due to cracking | during LW26 | 10/5/13 |
| **15** | central | additional cracking and dry pool | during LW26 & 28/3/13 | 10/5/13 |
| **16** | central / maingate | additional cracking and dry pool / race | during LW26 & 11/4/13 | 12/6/13 |
| **17** | maingate | additional cracking and dry pool | during LW26 & 26/4/13 | 27/6/13 |

| Sites | Site Location Relative to Longwall | Effect | Date Initially Observed | TARP First Triggered |
|---|---|---|---|---|
| **18** | maingate | dry pool (no obvious cracking) | 22/3/13 | 23/5/13 |
| **19** | LW27 / 28 chain pillar | additional cracking of rock shelf, no overland flow | during LW26 & 26/4/13 | 27/6/13 |
| **Over Longwall 27** | | | | |
| **21** | tailgate / central | continuation of dry rock shelf due to cracking | during LW26 | 10/5/13 |
| **23** | central - maingate | new cracks and pool dry | 19/4/13 | no |
| **24** | maingate | No flow, strong iron hydroxide developed | 10/5/14 | no |

As shown in **Table 11**, the "re-direction of surface water flows and pool level / flow decline of >20% during mining compared to baseline variability for > 2 months, considering rainfall / runoff variability" TARP was triggered on 10 May 2013.

Where pools were cracked and drained, but the >20% pool level reduction did not last for longer than two months, the TARP trigger was not reached.

Photographs of new sites that were adversely affected by Longwall 27 are shown on the following pages.

***Figure 41 Myrtle Creek Site 4 – subsidence effects after LW27 extraction***

*Figure 42 Myrtle Creek Site 10 – subsidence effects after LW27 extraction*

*Figure 43 Myrtle Creek Site 11 – subsidence effects after LW27 extraction*

*Figure 44 Myrtle Creek Site 17 – subsidence effects after LW27 extraction*

*Figure 45 Myrtle Creek Site 18 – subsidence effects after LW27 extraction*

*Figure 46 Myrtle Creek Site 19 – subsidence effects after LW27 extraction*

*Figure 47 Myrtle Creek Site 21 – subsidence effects after LW27 extraction*

*Figure 48 Myrtle Creek Site 23 – subsidence effects after LW27 extraction*

*Figure 49 Myrtle Creek Site 24 – subsidence effect after LW27 extraction*

### 6.5.11 Longwall 28

Myrtle Creek was undermined by Longwall 28 between late May to mid-June 2014. New subsidence effects due to Longwall 28 were observed at Sites 20 to 26 over the longwall.

During and after undermining by Longwall 28, Myrtle Creek was observed to undergo pool cracking and significant to total pool water holding capacity reduction at sites:

a) 5 to 9, over the central to maingate section of Longwall 26.

b) Sites 9, 10 and 11 over the chain pillar between Longwall 26 and 27.

c) Sites 12 to 19 over all of Longwall 27.

d) Sites 20, 21 and 23, with less significant effects at Sites 21A to 28 over Longwall 28 as shown in **Figure 53.**

As shown in **Table 12**, the "*re-direction of surface water flows and pool level / flow decline of >20% during mining compared to baseline variability for > 2 months, considering rainfall / runoff variability*" TARP was triggered on;

a) 7th November 2014 between Sites 13A and 17.

b) 14th August 2014 at Site 20.

Where pools were cracked and drained, but the >20% pool level reduction did not last for longer than two months, the TARP trigger was not reached, or if rainfall / runoff re-filled pools, the TARP trigger "clock" was re-set.

Reversal of flow in the creek was also not observed as the creek gradient exceeded the degree of imposed tilt in the stream bed.

***Table 12 Myrtle Creek subsidence effects during LW28 Extraction***

| Sites | Site Location Relative to Longwall | Effect | Date Initially Observed | TARP First Triggered |
|---|---|---|---|---|
| **Over Longwall 27** | | | | |
| **12** | tailgate | additional cracking, dry pool and fallen tree | during LW27 & 02/07/14 | – |
| **12A** | central / tailgate | pool level reduction and cracks in rock bar | during LW27 & 02/07/14 | – |
| **13 to 13A** | central | additional cracking and dry pool continuation | during LW27 & 020/7/14 | 11/07/14 |
| **14** | central | continuation of dry pool due to cracking | during LW27 & 07/05/14 | 11/07/14 |
| **15** | central | additional cracking and dry pool | during LW27 & 07/05/14 | 11/07/14 |
| **16** | central / maingate | additional cracking and dry pool / race | during LW27 & 07/05/14 | 11/07/14 |
| **17** | maingate | additional cracking and dry pool | during LW27 & 07/05/14 | 11/07/14 |
| **18** | maingate | dry pool (no obvious cracking) | during LW27 & 07/05/14 | 11/07/14 |
| **19** | LW27 / 28 chain pillar | additional cracking of rock shelf, no overland flow | during LW27 & 06/08/14 | – |
| **Over Longwall 28** | | | | |
| **20** | tailgate | cracking and no flow or pool on sandstone shelf | during LW27 & 13/06/14 | 20/08/14 |
| **21** | tailgate / central | dry rock shelf due to cracking | during LW27 & 06/08/14 | – |
| **21A** | central | drying up of boulder pools in dense vegetation | during LW27 & 06/08/14 | – |
| **23** | central | no subsidence induced change | – | – |
| **22** | central - maingate | cracking and drying up of pool | during LW27 & 02/07/14 | – |
| **23** | maingate | no flow, strong iron hydroxide | during LW27 & 25/07/14 | – |

| Sites | Site Location Relative to Longwall | Effect | Date Initially Observed | TARP First Triggered |
|---|---|---|---|---|
| **Over Longwall 28** | | | | |
| **24** | maingate | cracking and drying up of rock pool | during LW27 & 01/08/14 | – |
| **25** | maingate – pillar | cracking and drying up of pool | during LW27 & 01/08/14 | – |
| **25A** | LW28 pillar | drying up of overgrown boulder race | during LW27 & 02/07/14 | – |
| **26** | tailgate | cracking and no flow or pool on sandstone shelf | during LW27 & 13/06/14 | 20/08/14 |

Photographs of new sites that were adversely affected by Longwall 28 are shown on the following pages.

***Figure 50 Myrtle Creek Site 20 – subsidence effects after LW28 extraction***

*Figure 51 Myrtle Creek Site 25 – subsidence effects after LW28 extraction*

*Figure 52 Myrtle Creek Site 26 – subsidence effects after LW28 extraction*

Bi monthly monitoring of Myrtle Creek at sites shown in **Table 5** was conducted during Longwall 29 extraction as the longwall did not undermine the creek, however no significant change occurred at the affected sites during and after the longwall being completed.

### 6.5.12 Longwall 30

A summary of the observed subsidence effects during the period of Longwall 30 extraction is shown in the below **Figure 53**. Longwall 30 did not undermine the Myrtle Creek, although bi-monthly monitoring of monitoring and observation sites over Longwalls 26, 27 and 28 is currently being conducted during the period of longwall extraction.

**Figure 53** outlines Myrtle Creek bi-monthly Status for 27 January 2017, however the legend does not accurately represent Myrtle Creek as the inspection was completed after a storm event and the Creek was flowing from top to bottom.

# 6.5.13 Subsidence Effects Summary

The recorded subsidence effects and environmental impacts are consistent with the predicted non-systematic subsidence movements (valley closure) predicted. It is considered highly likely that shallow fracturing similar to that recorded in the Waratah Rivulet has occurred. The fracturing and formation of voids has resulted in loss of surface flow during low flow conditions and pool holding capacity.

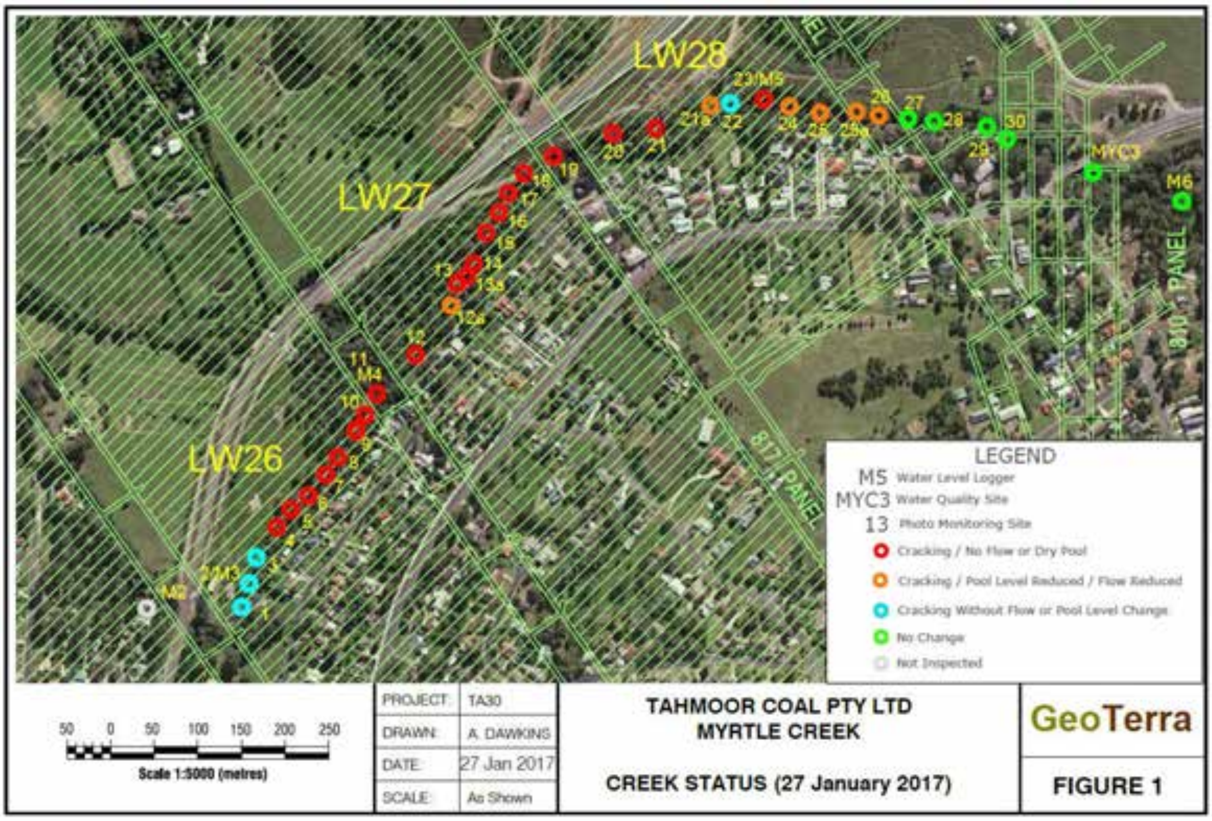


*Figure 53 Myrtle Creek – bi-monthly Creek Status Report 27 January 2017*

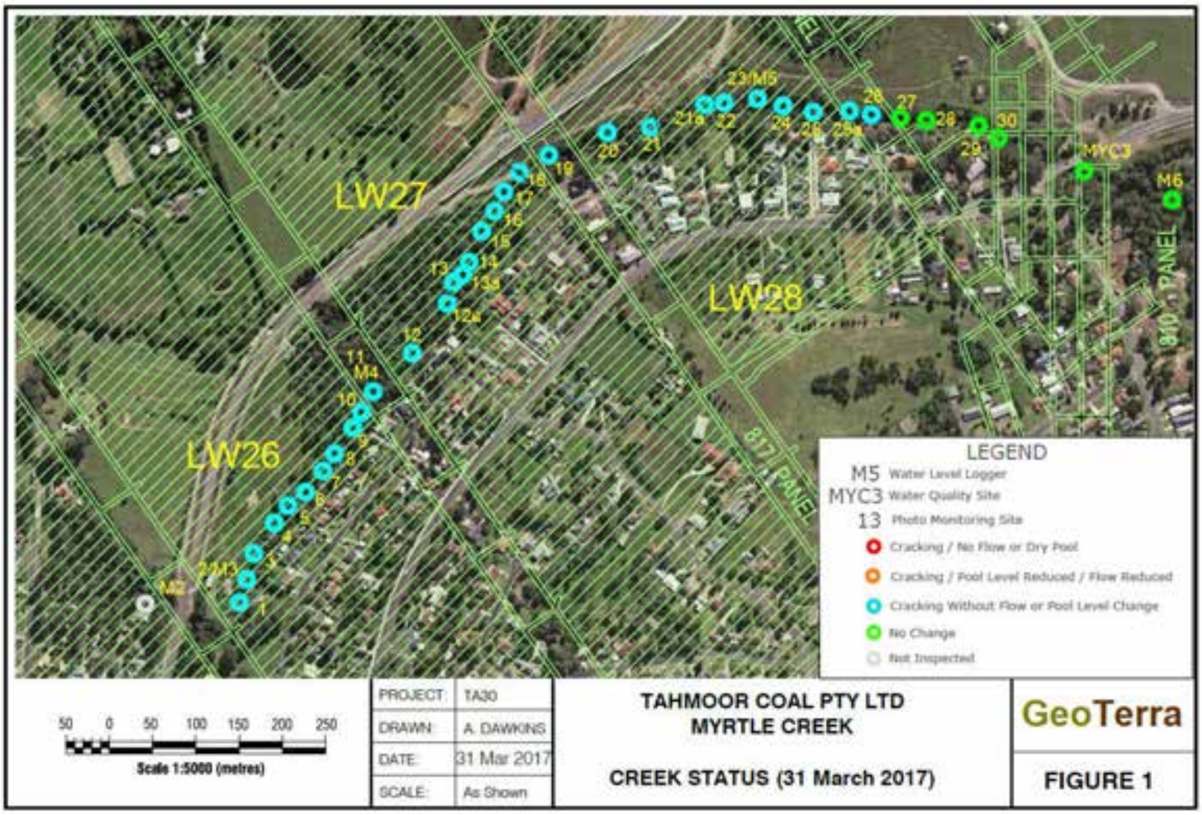


*Figure 54 Myrtle Creek – bi-monthly Creek Status Report 31 March 2017*

# 7 Myrtle Creek CMAP

## 7.1 Rehabilitation Strategy

The purpose of the rehabilitation strategy is to undertake a staged approach to determine effective corrective management and rehabilitation treatment. The rehabilitation strategy for all sites at Myrtle Creek is presented under the following key headings:

a) Aims and Objectives.

b) Ground Characterisation.

c) Data Review.

d) Rehabilitation Design.

e) Rehabilitation Plan.

f) Treatment Application.

g) Construction Documentation.

h) Reporting.

## 7.2 Project Aims and Objectives

At present the aims and objectives for corrective management are based on relatively conceptual understanding of the geomechanical and hydrogeological conditions of the ground conditions at Myrtle Creek.

In accordance with the Longwall 27-30 EMP, the objectives of the corrective action are to conduct rehabilitation works when required, including:

a) Conducting remediation works that protect to the greatest practicable extent the ecological values of the area.

b) Repairing aesthetic values where necessary.

c) Reducing the interaction of surface and groundwater flow where enhanced through mining.

d) Having creeks and pools function in a similar manner to the pre-impact state.

e) Having surface flows and pool water quality continue to provide suitable aquatic habitat.

f) Re-establishing the ecological values to a similar state to before mining;

g) Creeks and catchments yielding similar water quantity and quality following mining.

h) Monitoring and reporting effectiveness of the program.

The corrective action rationale and rehabilitation approach; and subsequent performance measures will be determined and agreed between key stakeholders and Government Agencies. Before an agreed rationale and approach can be established, a robust understanding of the ground and environmental conditions is required.

### 7.2.2 Ecological Values

The Longwall 29 End of Panel Report includes an assessment of the surface water, dams and groundwater (GeoTerra, 2016). The summary of observed impacts following extraction of Longwall 29. In relation to Myrtle Creek, determined that:

> *'No adverse effect on plateau stream ecology has been reported.'*

GeoTerra (2016) also provided a description of the Myrtle Creek ecology as follows:

> *'Myrtle Creek flows directly into the Nepean River approximately 1.8km southeast of Longwall 29. Its headwaters are located upstream of Panel 22 and generally consist of small grass covered channels that become larger and more incised downstream of Panels 23 to 29. Myrtle Creek*

*has been undermined by Longwalls 4, 22, 23B, 24B and 25 to 28, whilst Longwall 29 has not undermined the main channel of the creek The riparian flanks have been significantly altered by residential development in Tahmoor, whilst the channel has not been significantly affected except where general rubbish or solid waste has been dumped in the creek or it is overgrown by invasive weeds. Some isolated weeding and stream bank regeneration works have been conducted, however many of the areas are re-infested with weeds. The stream bed and banks are generally well vegetated, and do not show significant erosion or bank instability.'*

At this stage no ecological values have been affected by mining impacts and therefore do not require specific attention in this CMAP document. Tahmoor Colliery will continue to monitor the ecological values in accordance with the Longwall 27-30 EMP.

### 7.2.3 Water Level Ascension

One of the primary objectives of the rehabilitation is to restore the pool holding capacity of ponds. This would be expected to reduce the interaction between surface and groundwater flow.

The automated pond level monitors already installed at key locations along Myrtle Creek (for example at Site 23) will be used to quantitatively assess the effectiveness of the rehabilitation.

### 7.2.4 Surface Flow and Water Quality

Myrtle Creek is ephemeral, and requires review of baseline and proxy data to establish requisite flow conditions. The review will consider the following:

***Surface Flow***

a) Basin hydrology and run-off.

b) Trends in the data (e.g. precipitation).

c) Consideration of the prevailing and preceding meteorological conditions.

***Water Quality***

d) Consideration of activities being undertaken in the vicinity – land development, illegal waste tipping, contaminated run-off / leachates.

e) Consideration of any other significant events that may have an influence on water quality (e.g. bushfires).

Parameters under consideration will include: pH, EC, turbidity, Oxidation Reduction Potential (Eh), TOC, dissolved organic carbon (DOC), major ions (calcium [Ca], magnesium [Mg], sodium [Na], potassium [K], chloride [Cl], sulphate [SO4] and bicarbonate [HCO3]) and trace metals (aluminium [Al], iron [Fe] and manganese [Mn]).

Daily water quality monitoring can be put in place before during and after all rehabilitation works.

### 7.2.5 Creek and Catchment Yield

Since catchment yield has not been impacted by the mining impacts over Myrtle Creek (see **Figure 11**), this is not considered to be suitable rehabilitation completion criteria. Tahmoor Colliery will continue to monitor the flow at site M7 in accordance with the Longwall 27-30 EMP to assess any loss of catchment yield.

### 7.2.6 Aesthetic Values

The presence rehabilitation (construction works) may impact on ground and environmental conditions, caused by access (tracked equipment), site preparation (trimming of braches and minor clearing) drill-holes (i.e. cavities in the rock) and minor impact on the rock surface by plant and equipment (e.g. drill rig).

To repair any damage, the use of coloured grouts will be considered to restore the aesthetic values to the creek beds following corrective works. Coloured grouts have been used previously at the Waratah Rivulet and at Mahoney's Hole.

The use of aesthetic grouting will be considered following the grout injection program if drill-hole collars compromise the aesthetic appearance of the site.

Revegetation of cleared and impacted areas using appropriate native species may also be implemented at completion of works.

# 7.3 Ground Characterisation

Ground characterisation will occur at all impacted sites identified in through the SMP / EMP / TARP process subject to access constraints and approval conditions. These include:

a) 8 sites below Longwall 27 (Sites 12 to 19 inclusive); and

b) 4 sites below Longwall 28 (Sites 20, 21, 23 and 26).

Prior to any physical works, a robust understanding of the ground conditions is required. As such, Tahmoor Colliery propose the following ground characterisation approach:

***Desktop Study***

Based on existing data, a desktop study will be undertaken to provide a hypothetical ground model, including geological / geomechanical, geomorphological, hydrological and hydrogeological characteristics for each site.

This model will consider:

a) Geometrical configuration, i.e. provisional basin plans, long-sections and cross-sections.

b) The mode, volume and location of water loss.

***Investigation***

Undertake physical investigations to confirm desktop assumptions, supplement data gaps and acquire new information, including:

a) The depth and width to which the fracture network extends.

b) Characteristics of the fracture network, including fracture aperture and hydraulic conductivity.

c) The susceptibility of the rock mass to treatment e.g. grouting.

In turn, understanding of these conditions provides a basis for establishing the feasibility and method for rehabilitation. In addition, the information obtained during the Ground Characterisation Works will provide a baseline from which the efficacy of future rehabilitation can be compared. The works will also assist in estimating expected grout volumes, which has implications on environmental impact (e.g. duration of works).

## 7.3.2 Methods for Ground Characterisation

*In-situ* physical characteristics will be determined by intrusive investigation, including:

***Borehole drilling***

A number of drilling techniques can be employed for borehole drilling:

a) Mini track-mounted NMLC or open hole.

b) Pneumatic hand drill - open hole.

c) Percussion tube hand corer (soil).

d) Geotechnical logging - rock mass characteristics.

*Figure 55 Pneumatic hand drill*

### Geophysical Testing

Including:

a) Caliper Tool.

b) ATV (Acoustic Televiewer).

c) OTV (Optical Televiewer).

d) Seismic Tomography and ERI (Electrical Resistivity Imaging).

*Figure 56 Three arm Caliper tool downhole*

*Figure 57 Three arm Caliper tool*

### *Hydraulic Conductivity Testing*

Including:

a) Falling Head.

b) Packer Testing.

c) Flow Metre.

Additional remote technologies will be considered for environmentally sensitive sites to supplement physical information, including:

a) LiDAR - for hi-resolution topographic survey.

b) UAV - for photogrammetric topographic survey.

c) DifSAR - for 3-dimentional detection of surface topography change, i.e. deformation.

d) LANDSAT - for detection of vegetation change and identifying areas of water loss.

The above methods are addressed in more detail below.

## 7.3.3 Drilling Method

Accessing the fracture network typically requires a drill rig capable of drilling holes to 10m or so below the level of the base of the creek.

With 5m - 10m high bank sloping back from the creek, a drill rig with capacity to drill 30m deep holes should be used on the banks.

The drill rig will likely be a rotary machine using water to flush the cuttings rather than an air hammer. In holes drilled with compressed air, the compressed air tends to over-pressure existing fractures causing them to be extended and new fractures to be created.

Hand operated drilling machines have been used to drill short holes suitable to grout up near-surface fracture networks.  They are not suitable for accessing fractures deeper than about 2m.

Drilling of grout holes will be carried out by diamond coring  at a nominal NQ ~60 mm hole diameter, using a diesel-operated rubber tracked mini-drill rig such as Dando or Fraste Multidrill.

During drilling, flush water returned to the borehole collar will be captured in a surface sump and re-circulated via a holding tank to minimise creek contamination and maximize water re-cycling. Baffles and / or filters will be used in the tank and they will be removed daily for filter cake cleaning and removal. Water and cutting loss within fractures during drilling will be minimised by adopting a downstage drilling and grouting technique.

### 7.3.3.2 Fracture Assessment

Borehole geophysical logging for geotechnical investigations typically involves identification of defects and fractures, and *in-situ* assessment of rock properties, including assessing fluid properties and identifying features associated with fluid or contaminant flow, such as fracture zones and permeable geological units.

The following geophysical tool will be considered for Fracture Assessment:

***Caliper Tool***

Caliper tools records a single continuous borehole diameter log by means of three mechanically coupled arms in contact with the borehole wall. An indication of fracture aperture and spacing can be achieved.

***ATV and OTV***

ATV and OTV logging will be considered to acquire oriented defect information, aperture / thickness of features such as joints and bedding. Televiewer logging produces oriented, 360° images of the borehole wall. An acoustic televiewer achieves this by measuring the amplitude and travel time of a reflected acoustic beam, to infer rock hardness and borehole diameter.

An optical televiewer uses a conical mirror lens to capture a high-resolution 360° colour digital photograph of the borehole wall. Televiewers use magnetometer / accelerometer-based deviation modules to accurately orient data acquired downhole and log deviation of the borehole from vertical.

***Further Methods for Consideration***

Further methods Tahmoor Colliery will consider include cross-hole seismic tomography and ERI (surface or cross-hole). The resolution of these methods are much coarser than ATV or OTV, i.e. they will unlikely identify individual defects; however, larger zones of higher or lower fracture density maybe identifiable, based on rock strength (seismic) and porosity (ERI).

ERI images the distribution of electrical resistivity, and is highly dependent on water content – air filled fractures will have a high resistivity, while water filled fractures will have a low resistivity. ERI survey requires small (15 mm diameter x 100 mm deep) pilot holes for electrodes, drilled every 0.5 to 1.0 m. Electrical safety will be a key determining factor of method suitability/feasibility when working near water.

### 7.3.3.3 Hydrological Assessment

***Catchment Assessment***

Considerable hydrological data has been collated before, during and after longwall mining below Myrtle Creek, including development of stream gradient data. This data will be more closely analysed to identify and confirm key hydrological controls (e.g. pools) within the context of rehabilitation.

The hydrological assessment is the logical first phase to better inform the most appropriate locations for drilling fracture characterisation holes and to provide the hydrological background to inform the injection locations.

Stream flow and precipitation data will likely be used as input data for catchment hydrologic modelling.

Model inputs can include daily precipitation and daily measured catchment outflow. Outflow includes direct runoff, interflow via soils and base flow from shallow perched groundwater. By means of nonlinear optimization curve fitting, modelling can indicate a mass balance of water inputs and outputs by estimating daily evapotranspiration and the change in catchment soil and shallow groundwater storage in the modelled period.

To assess any potential mining impacts, a set of parameters will be obtained by using pre-mining precipitation and flow data. These parameters can provide the basis of a hydrologic model for each catchment (or sub-catchment) established over one or more years of pre-mining (baseline) rainfall and flow data, which can be subsequently applied to model periods of rainfall and flow data obtained during the mining period.

Modelling can be calibrated using gauged baseline data.

### *In-Situ Packer Testing*

Typical hydraulic testing methodologies employed at creek sites (e.g. Waratah Rivulet) utilise a modified packer assembly allowing testing without the support of a drilling rig. Packer testing will be considered to assess the permeability of specific fracture zones and the background permeability of the surrounding rock mass. Rising Head Tests (RHTs) can be carried out to supplement packer data.

### *Data Collection and Analysis*

Data analysis will be carried out in accordance to ISO22282-3:2012. A review of the hydraulic borehole test setup and procedure for ground characterization pre-grouting and for quality control will be undertaken during the grouting process and post grouting program.

### *Alternative Technologies*

Alternative technologies to water pressure testing in packer isolated test intervals for characterisation of defect permeability and connectivity include flow metre testing.

Flow meter testing of ground characterisation holes and across holes estimate transmissivity of single fractures (instead of multiple fractures within a test interval as typical for water pressure testing) intersected by the holes and connectivity of the fractures between a set of holes. This technology is most suitable for testing of the achieved level of ground improvement when conducted pre and post grouting across holes located at either site of a treat section. A schematic illustration of the setup is shown in the figure below.

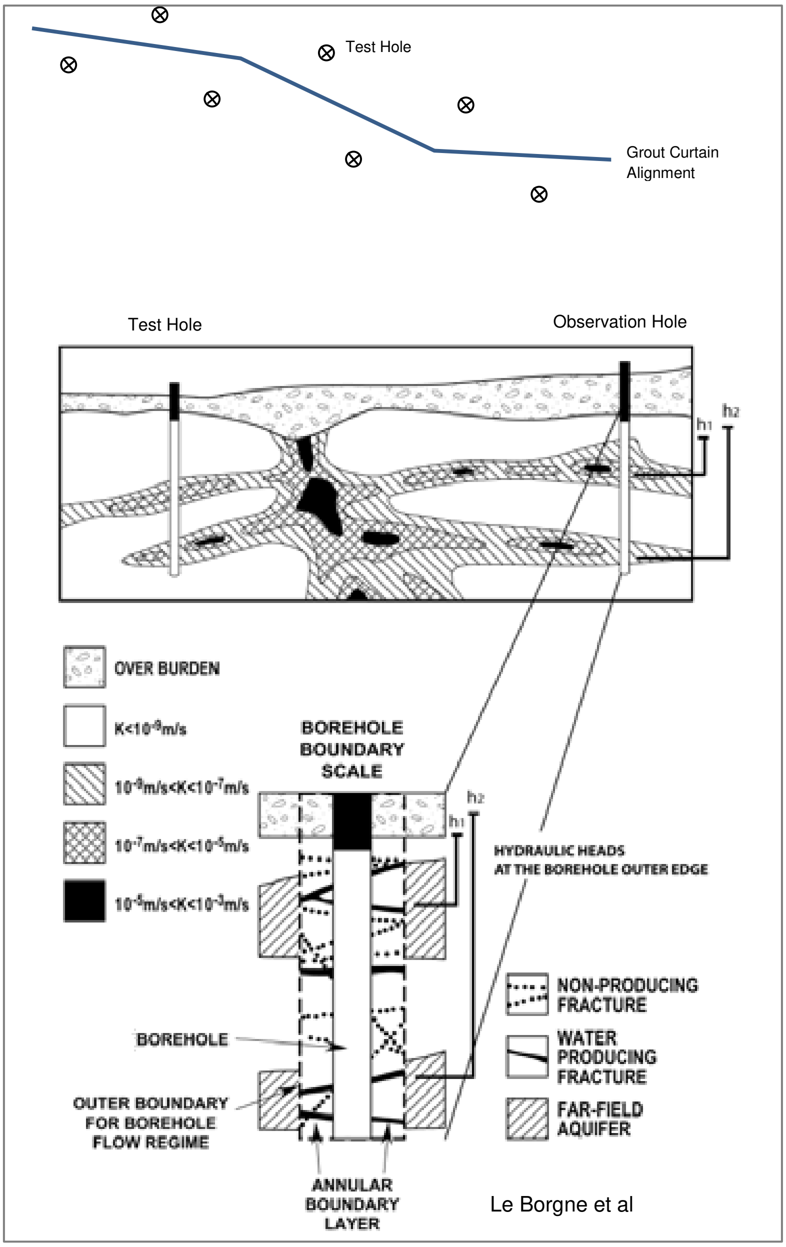


***Figure 58 Schematic illustration of the site setup***

#### *Impeller flowmeter logging*

Impeller flowmeter logging uses an impeller which revolves as fluid flows over it. The number of revolutions per second is logged and used to calculate the velocity of flow within the borehole at certain depths. The tool uses a geophysical logging winch and data logger to record the flow data, and control the depths and logging rate. The impeller flow meter can be used while trolling at a constant rate, to create a profile over a length of the borehole, or else stationary at regular intervals, to measure the flow at particular points. Using these flow values, a hydraulic conductivity can be determined.

### 7.3.3.4 Correlation of Geophysical and Hydrological Data

The hydraulic conductivity of the rock at the site is directly affected by the secondary porosity of the fracture network in the ground. As a result the findings of the geophysical survey will be reviewed in relation to the hydraulic testing, using software such as WellCAD.

## 7.4 Review

On completion of ground characterisation, the project team will analysis and review the data to calibrate the desktop study ground model, including geological / geomechanical, geomorphological, hydrological and hydrogeological characteristics for each site.

## 7.5 Rehabilitation Design

Following the data review, rehabilitation design will be undertaken against agreed rehabilitation criteria, aimed at improving:

a) Ecosystem function, including maintaining or establishing self-sustaining native ecosystems comprised of local native plant species; with a landform consistent with the surrounding environment.

b) Decrease water level recession rates for pools, such that they demonstrate a similar pool behaviour to that which existed prior to subsidence impact.

c) Aesthetic values where necessary.

Rehabilitation design includes:

a) Product selection (e.g. grout type).

b) Product application methodology.

c) Test specifications (for completion reporting).

### 7.5.1 Product Selection

There are a number of products available to the construction market for the filling of gaps, sealing of surfaces and reducing permeability of materials, some have previously been trialed in creek bed remediation.[1]

The use of sand, and sand with colloidal silica binder was initially trialled to remediate a rock bar in the Waratah Rivulet. The strategy proved to be unsuccessful as a consequence of grout material washing out of the fractures (Greg Tarrant, pers. comm). At times the flow in streams such as the Waratah Rivulet and Myrtle Creek can exceed 200 ML/day.

The injection of polyurethane (PUR) within the Waratah Rivulet was considered to be successful and won the UNSW Minerals Council Environmental Excellence Award. The rock bar is understood to still be overflowing to this day. Clearly the Waratah Rivulet experience should not be blindly applied to Myrtle Creek however it is considered prudent to adopt a strategy that recognises that PUR injection is the only proven rehabilitation method and to exclude PUR only if a viable alternative is developed. It is emphasised that whilst Tahmoor Colliery will make every endeavour to minimise costs, the most effective rehabilitation available will be implemented.

The outcomes of the site characterisation work, particularly the extent and width of open fractures, together with maximum potential flow rates will be key drivers in the selection of grout product at any given site.

1 Commonwealth of Australia 2014, Temperate Highland Peat Swamps on Sandstone: evaluation of mitigation and remediation techniques, Knowledge report, prepared by the Water Research Laboratory, University of New South Wales, for the Department of the Environment, Commonwealth of Australia.

*Table 13 High level considerations for selection of a product for creek bed remediation*

| Material | Flowability / Viscosity | Durability | Toxicology | Expandability | Control |
|---|---|---|---|---|---|
| **Cement** | Poor | Moderate | Moderate | Poor | Poor |
| **Sand** | Poor | Poor | Good | Poor | Poor |
| **Bentonite** | Moderate | Moderate | Good | Moderate | Poor |
| **Polyurethane Resin (PUR)** | Good | Good | Good | Good | Good |
| **Bitumen** | Good | Good | Poor | Poor | Moderate |
| **Latex** | Good | Moderate | Moderate | Poor | Good |

Given the environmental sensitivity of the area, it is unlikely that cementitious, bitumous or latex products will be suitable. PUR are likely the more appropriate grout type product, with potable water compatibility.

### 7.5.2 Product Approvals

Whichever product is selected, it will likely require approval for application from key stakeholders. As discussed above, there is a precedent for use of PUR in environmentally sensitive areas.

### 7.5.3 Product Application

Product application will be by an appropriately trained and certified application specialist, approved to use the chosen product by the product supplier. We note that the relationship between product supplier and applicator will likely be kept separate; for example, if the supplier is also the applicator of the product being used, there is neither incentive nor accountability for the works to be undertaken in a manner that uses the appropriate volume of product to seal the rock mass.

The application (or constructability) of different grout products is determined by a number of limiting factors, including:

a) Ground Conditions.

b) Accessibility.

c) Environmental Constraints / Compliance.

d) Timing.

e) Experience of Applicator.

Product application design will consider these factors, as well as the most effective treatment application configuration, including:

a) Shallow pre-treatment grouting.

b) Shallow pattern grouting.

c) Shallow to deep 'curtain' approach.

d) Surface aesthetic filling.

With regard to surface aesthetic filling, it is likely that in some stream bed, pool and bar locations, the appearance of water flowing over rather than through the rock mass can be improved by sealing all surface cracking.

## 7.6 Rehabilitation Plans – Site Specific

Following Rehabilitation Design, Tahmoor Colliery will prepare site specific rehabilitation plans for discrete sites, in consultation with Department of Resources and Geoscience and other stakeholders, The Plans will include specific details relating to:

a) Access.

b) Plant and Equipment Type.

c) Treatment Layout Plan.

d) Site Specific Erosion and Sediment Control Measures.

## 7.7 Environmental Management

As part of obligations under the CMAP process, Tahmoor Colliery will prepare a suitable Sediment and Erosion Control Plan to accompany all rehabilitation plans. The Sediment and Erosion Control Plan will consider:

a) Environmental Design Criteria.

b) Site Specific Activity Based Control Measures.

c) Buffer Zones.

d) Maintenance & Inspection Protocols.

## 7.8 Construction Documentation

In addition to administrative controls covered in existing environmental documentation (e.g. Sediment and Erosion Control Plan), Tahmoor Colliery consider appropriate planning, supervision, quality control and assurance are required to carefully apply grouting products to the natural environment.

As such, the rehabilitation campaigns should be treated as formal construction projects, deeming the consideration of:

a) A robust Project Works Schedule, to manage program and budgets.

b) An overarching Project Construction Safety and Environmental Management Plan (CSEMP) for the proposed works, with task specific environment and safety plans.

c) Risk workshops for key tasks and change management.

d) A Project / Site Manager to manage and co-ordinate site works, including:

   i. Preparation of a daily project works diary to document construction works, materials, safety and environmental learnings and conformance with the CSEMP and relevant sections of the EMP.

   ii. Oversight of the implementation of design requirements and performance criteria.

   iii. Preparation of weekly reporting, including cost tracking.

   iv. Quality Control and Assurance protocols, particularly in relation to Verification of Works, which might include Caliper, ATV / OTV and Packer Testing to inform the ongoing rehabilitation design, anticipated material volumes, schedule and efficacy of the works.

## 7.9 Reporting

Following completion of rehabilitation works at any discrete site, Tahmoor Colliery will provide a completion report to key Government Agencies, demonstrating the rehabilitation criteria has been met.

The water level recession rates, ecosystem and aesthetic performance indicators will be considered to have been met if data analysis indicates there is not a statistically significant change in conditions after rehabilitation, compared to conditions prior to the triggering of rehabilitation.

The completion report will likely include:

a) Summary of works executed.

b) Permeability test results.

c) Demonstration of crack infilling.

d) Monitoring results.

e) Overall summary of hydrological performance.

# 8 Trial Rehabilitation - Site 23

## 8.1.1 Location

The pool at Site 23 is located at the downstream end of the section of Myrtle Creek and affected by mine subsidence (**Figure 55**, **Figure 56** and **Figure 57**).


***Figure 59 Myrtle Creek Site 23 – downstream***


***Figure 60 Myrtle Creek Site 23 – upstream***


*Figure 61 Myrtle Creek CMAP Trial Project Location – distance*

## 8.1.2 Impacts at Site 23 during mining

The first subsidence impacts at this site comprised drying out of the pool, along with rock bar and pool cracking in mid-April 2013, during the extraction of Longwall 27. This occurred before the pool was undermined by Longwall 28, which occurred between mid-May and early June 2014.

Significant cracking of the rock bar and pool base was observed, however a constant inflow of overland runoff (and unseen underflow) has been observed at all times from the upstream pool (Site 22), which has not been affected by subsidence at any stage.

The pool level at Site 23 subsequently rose and fell depending on rainfall patterns and inflow from Site 22. Monitoring noted that the pool was often totally dry, and occasionally full or partially full for a few days to weeks.

There was no observable change to water quality in the pool, however the downstream pool (Site 24) became very ferruginous at the time that Site 23 went dry.

The below **Figure 62** shows a plan of the Pool 23 rock bar and indicative drill holes in the Myrtle Creek CMAP Trial Project.

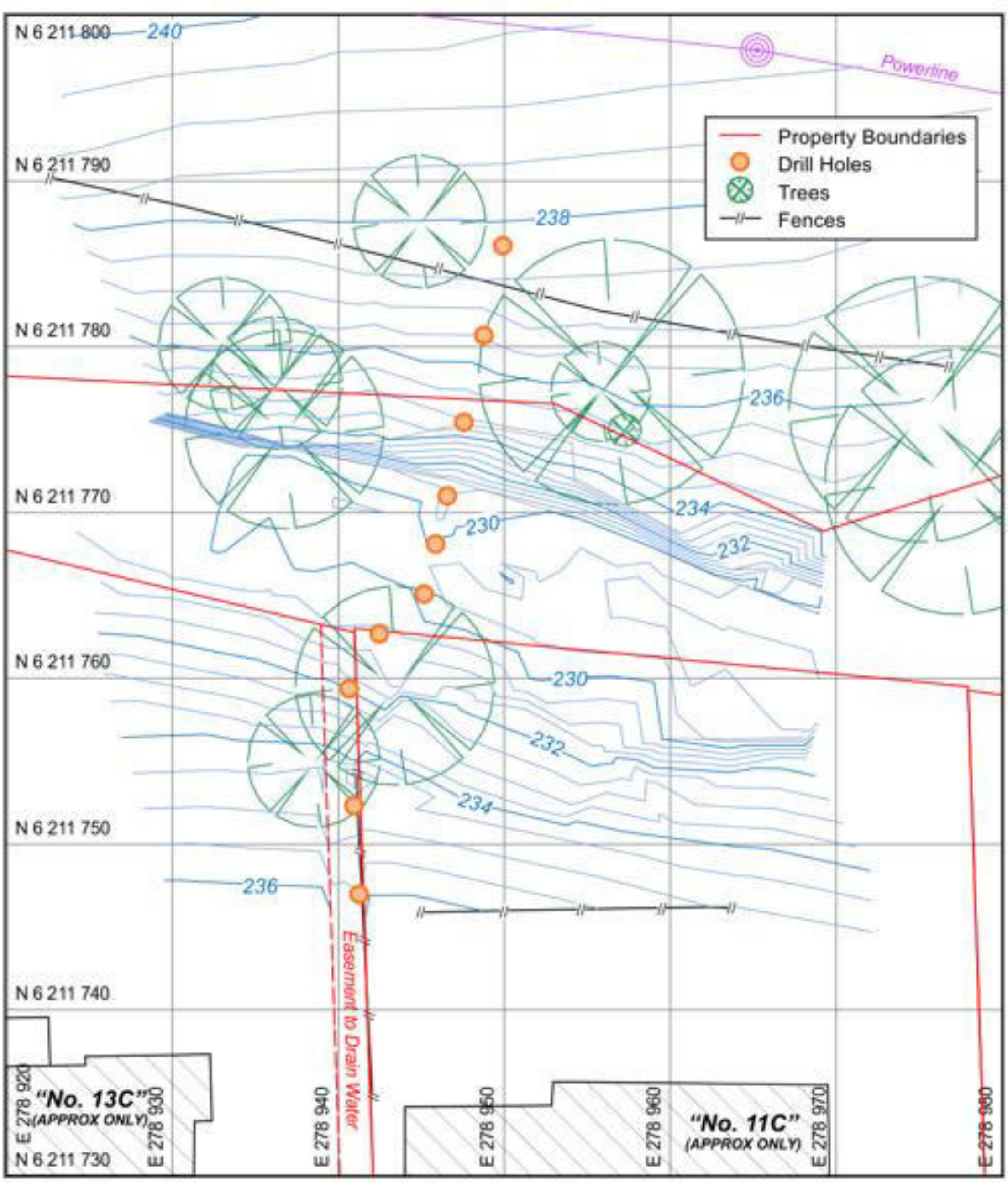


***Figure 62 Myrtle Creek Site 23 – rock bar and proposed drill holes***

The rock bar is located in an area where the banks are approximately up to 8m above the creek bed. The northern bank is vertical near the creek and approximately 5m high along with a 3m sloping riparian zone with a small corridor of bushland separating the creek from some open farmland which has good access.

The southern bank is covered by some rock debris that leads up to a grassy slope and the back of several residential properties as shown in below **Figure 63**. The boundary fence is approximately 5m from the end of the rock bar and the nearest houses are located 30m from the rock bar. The northern bank is also covered by some rock debris and small trees leading up to open grassland as shown in below **Figure 64**. Selected photographs of Site 23 are show on the following pages.

***Figure 63 Myrtle Creek Site 23 – southern bank***

***Figure 64 Myrtle Creek Site23 – northern bank***

## 8.1.3 Access

Site access for remediation works is possible from both sides of the creek, but will require access agreements with landowners. As **Figure 63** demonstrates, the residential dwellings and steep / vertical banks on the southern bank will provide limited opportunity for drill rig access.

Although the northern bank is most practical as a staging area for some of the works, a power line located some distance from the edge of the creek is expected to limit crane options for lifting a drill rig and other equipment down into the creek.

It would be possible to use the open field to the north of Site 23 as a staging area and drive the drill rig into the upper section of Site 23 during dry periods and from there drive to the Site 23 rock bar, however some track preparation, restricted clearing of shrubs and management of small (<1m step downs on rock shelves would be required.

In the event of heavy rain and associated stream flow / flooding, the drill rig could be driven out of the dry pool and up onto the northern bank before stream flow commences, but would require some earthworks or artificial ramp and would involve cooperation from one or more of the landowners on the creek bank.

***Figure 65 Myrtle Creek Site 23 – pool full***

*Figure 66 Myrtle Creek Site 23 – pool dry*

A platform of timber and rubber matting is likely to be required in the base of the creek to allow the drill rig to move around without causing damage to the sandstone surfaces.

Drilling of holes on the northern bank may require the removal of some vegetation for access (the area will be assessed prior to any work). There should be sufficient flexibility in terms of borehole location to avoid the need to remove large trees.

### 8.1.4 Proposed Works

The first proposed site to be characterised is Site 23. This proposal may be modified if the hydrological assessment indicates that a more suitable trial site is evident. It is not possible to estimate the number of boreholes that will be required to characterise the fracture network. Approval for at least 30 boreholes will be sought. An indicative drill-hole pattern is shown in **Figure 62**.

The primary objectives of the drilling are:

a) To determine the void profile with depth. This means quantifying the number and opening width of the fractures.

b) Evaluation of fracture connectedness. This important to assess the potential drill hole spacing required for injection.

c) Determine the lateral extent (and depth) of fracturing beyond the creek boundaries. This will be subject to access requirements, approvals, and land holder agreement.

### 8.1.5 Investigation Scope

Mobilise personnel, drilling and testing equipment to the Site 23 work site to undertake intrusive investigation, including:

a) Rock coring of up to 30 NQ boreholes to nominal depth of 20 m, or advanced 5 m below the fracture zone.

b) Geotechnical logging of rock core (lithology and joint characteristics).

c) Geophysical logging of boreholes including calliper logging, acoustic and ATV / OTV of boreholes to record fracture aperture and orientation.

d) Packer testing from the surface in 5 m intervals within borehole to determine hydraulic conductivity of rock mass.

As outlined in **Section 7** of this report, the primary strategy is to fill the mining induced fracture network evident within the Site 23 rock bar such that the permeability of the rock bar is restored to pre-mining levels as far as practicable. Streams incised within the Hawkesbury Sandstone typically contain existing fractures associated with the natural erosion of the stream bed. The process of buckling, uplift and erosion is a continuous process over time. It is not possible to know the pre-mining extent of fracturing however given the monitoring data available for Pool 23, it would be expected that the pool holding capacity at Site 23 would be restored.

The site characterisation results and on-going feedback inherent in the PUR injection process will provide continual information to direct the injection program. The location of each drill hole and the depth and quantity of injected material will be recorded.

## 8.1.6 Completion Criteria

**Section 8.1** of this CMAP outlined the Myrtle Creek CMAP Trial Project Objectives. In the absence of further mining impacts, some of the potential remediation objectives envisaged in the Longwall 27-30 EMP do not require restoration. These include:

a) Restoration of the ecological value.

b) Restoration of creek or catchment yield.

The project completion criteria are designed to provide a quantitative means to assess the pre-mining and post restoration aspects that relate to the functioning of the creek. The completion criteria are:

a) Reduction in pool water level recession rates.

b) Measurement of the extent of fracture in-filling.

c) Measurement of reduction in rock mass permeability.

### 8.1.6.2 Restoration of Pool Holding Capacity

Myrtle Creek is recognised as an ephemeral stream based on the hydrological assessment. However whilst flow is not continuous, pools are generally expected to retain water (unless unusual climatic conditions are evident (e.g. drought).

The completion criteria in relation to pool holding capacity at Site 23 is that the recession rate within pool 23 will be rehabilitated to pre-mining conditions as far as practicable.

### 8.1.6.3 Fracture Filling Criteria

A quantitative measure of the fracture apertures (void spaces) will be obtained by borehole Caliper and recorded by televiewer prior to the commencement of grout injection. The data will include the location and aperture size at least 5 locations across the rock bar at Site 23.

Following grout injection, the same sites will be re-drilled and repeat measurement of the fracture profile will be conducted ( or as near as practicable).

The completion criteria in relation to fracture filling is that at least 95% of all fractures across the Site 23 rock bar will be filled.

### 8.1.6.4 Rock Mass Permeability

A quantitative measure of rock mass permeability will be obtained by packer testing. At least 5 drill holes at a minimum of 3 depths will be measured prior to grout injection. The holes will be located across the Site 23 rock bar.

Following grout injection, the same sites will be re-drilled and packer tests conducted at the same locations and the same depths as prior to grouting (or as near as practicable).

The completion criteria in relation to permeability is that a reduction in permeability of at least 3 orders of magnitude will be obtained. In addition, the permeability of the rock bar retaining the pool at Site 23.

## 8.2 Limitations

As remediation efforts move upstream, flow decreases and the benefits of intervention are likely to diminish while the effort involved is likely to increase. Part of the strategy will involve determining an acceptable balance between beneficial outcomes and remediation effort, collateral impact and cost.

This component of the strategy is beyond the scope of this Report and is not considered further.

No amount of remediation will be able to maintain connected water flow along the full length of the subsidence affected reach of Myrtle Creek. The upstream extent at which water is maintained permanently at the surface in a natural creek is a function of many factors, but primarily the quantity of flow in the creek. Flow diminishes in an upstream direction toward the catchment headwaters.

Flow is also a function of rainfall runoff and catchment characteristics.

Factors that affect the rate and quantity of rainfall runoff reporting to the creek include relative proportion of natural bushland to urban / rural development and the number of farm dams diverting runoff to storage. This temporal and spatial variation of flow means that the upstream location where water is apparent on the surface is ever-changing as is the length of time that upstream pools remain filled after rainfall.

Flow in natural creek systems involves surface flow and sub-surface flow. In downstream sections of a creek system, sub-surface flow may only be a small proportion of the total flow, but as the flow volume diminishes upstream toward the headwaters, a greater proportion of the flow occurs as sub-surface flow.

Mining-induced subsidence movements have the effect of increasing the lateral connectivity through sub-surface fractures in the stream bed.

A greater quantity of the total stream flow can then occur as sub-surface flow and surface flow may not develop until further downstream when either the flow rate increases sufficiently or mining impacts are no longer present.

## 8.3 Reporting

During the execution of the Myrtle Creek CMAP Trial Project, weekly monitoring and reporting will be prepared by Tahmoor Colliery and forwarded on request to key Government Agencies.

On completion of the Myrtle Creek CMAP Trial Project, a Completion Report will be prepared and will outline the following:

a) Activities conducted during the works.

b) Results of the investigation.

c) Materials used.

d) Success of the drilling and grouting methods.

e) Unforeseen issues that affected the effective use of drilling / grouting / site management and environmental controls.

f) Effectiveness of Site 23 pool flow / standing water restoration.

g) Recommendations for and location of future pool rehabilitation works.

The deficiencies of Myrtle Creek CMAP Trial Project creek remediation and the recommendations for future CMAPs will be prepared in consultation with key Government Agencies.

# 9 Risk Management

## 9.1 Key Risks

The key risks identified for the Project can be divided into two categories: operational risks and risks to achieving the project objectives.

Risks associated with not achieving project objectives include loss of corporate credibility, increased costs, regulatory barriers and implications for mining license.

Operational risks include loss of equipment due to flooding, downstream pollution and unacceptable collateral impacts.

### 9.1.2 Risks to Achieving Project Objectives

Key risks associated with ability to achieve the overall project objectives include ability to achieve an effective outcome at the low flow rates, the high costs of remediation and potential regulatory approvals.

#### 9.1.2.2 Low Stream Flows

A key risk associated with meeting the Project objectives is that the flow rates in Myrtle Creek may be too low for fracture filling strategies to be effective.

This risk will increase upstream as the base flow in the creek diminishes.

Locations where fracture filling has been effective are on creeks where the based flow rate is in the range 1-4ML/day. This amount of flow means that the sub-surface flow of the order of 0.5ML/day can still occur at the same time there is significant surface flow. When the flow rate is smaller at 0.3ML/day total flow, the effectiveness of the filling needs to be greater in order to return flow to the surface.

#### 9.1.2.3 Costs

The first task is to determine the depth, nature and lateral extent of the fracture network below the rock bar at Site 23 and its lateral extent into the creeks banks. The outcome will determine the cost associated with grouting.

Tahmoor Colliery will seek to reduce costs as part of normal business activities and will seek cost reduction through continuous improvement by efficiency gains. Even so, the cost of effective remediation may become prohibitive compared to the outcomes that are able to be achieved.

This high cost would be a risk to being able to achieve the project objectives, with the risk likely to increase upstream as the base flow in the creeks diminishes and in areas where the flow is not controlled by rock bars so that the entire section of creek needs to be treated.

#### 9.1.2.4 Regulatory Issues

Working in the bed of a waterway involves gaining approval from a number of government agencies. This may be a risk to achieving the project objectives if regulators impose conditions that are either too costly and / or difficult to comply with.

### 9.1.3 Operational Risks

Operational risks associated with drilling and pollution risk are expected to be controllable through design of appropriate management systems and with suitable approvals in place.

#### 9.1.3.2 Drill Rig Access

Access options to allow a drill rig into the creek bed could involve tramming a drill rig through partially vegetated and slightly sloping land or lifting it over the trees on the north bank while avoiding the high voltage power lines.

Access through residential properties on the south bank is unlikely to be viable due to its highly built up, fenced and landscaped nature.

There are risks associated with all these options but the most suitable and practical is considered to be a mobile drill rig and ramp access to the bed of the creek. This approach would enable the drill rig to be moved out of the creek bed in anticipation of flood conditions.

Moving or temporarily decommissioning the power line would give greater flexibility for crane operations, but may not be practical for moving the drill rig out of the creek channel in anticipation of flood conditions.

#### 9.1.3.3 Pollution Risk Management

The risk of contamination of the downstream section of the waterway through dilution and migration of grout fill material and migration of drilling sediment is considered to be a risk that needs to be managed. Some government approvals (covered in project risks) may be necessary.

This potential would be reduced if the sub-surface flows are managed by pumping from an upstream well either around the rock bar to a discharge point further downstream or into a temporary storage that can be monitored, treated if necessary should contamination occur and then separately discharged if required.

Drilling multiple holes is expected to cause clay-rich sediments to enter the water. The upstream well point may allow this to be managed but some discolouration is expected to occur downstream.

#### 9.1.3.4 Public Safety

Tahmoor Colliery take the management of Public Safety seriously and will be managed accordingly. Training for the Project team is outlined in **Section 11.3**, and the inductions will include making the Project team aware of ensuring that the public do not enter the work site at any time.

All work areas will be clearly demarcated and appropriate signage will be installed advising the Public not to enter these areas. Signage will be erected at the site with a 24 hour number to call Tahmoor Colliery Control and 000 in the event of an emergency if required.

#### 9.1.3.5 Flood Conditions

In the event of a storm or flood, all equipment will be removed from the creek and the Project will not be able to operate. During consultation with key Government Agencies the discussion regarding the location of equipment will be determined during out of operating hours and in the event of a storm or flood.

## 9.2 Timeframes for Implementation

### 9.2.1 Myrtle Creek

Due to the complex and unique nature of the remediation activities, **Section 3** outlines the approvals and document preparation that is required prior to the start of any planned Project works. The approvals also incorporate consultation with key Government Agencies including Wollondilly Shire Council. Execution of these approvals will commence on Approval of this Management Plan.

Upon granting of all relevant approvals, a period of relatively dry weather which translates to low flow conditions in Myrtle Creek will be required to implement the approved Project works.

On completion of these works the effectiveness will be assessed for the implementation of Stage 2.

The first stage will assist Tahmoor Colliery in determining the effectiveness for future stages, confirm timeframes for future remediation and assist the Project team to determine the most effective equipment / tools and resource structure to achieve the most realistic outcomes achievable.

Timeframes outlined in **Table 14** are indicative and may vary due to approvals or Project delays.

***Table 14 CMAP Stage 1 timeframes for implementation***

| Task or Milestone | Government Agency | Estimated Date of Completion |
|---|---|---|
| Submit Revision B CMAP for Approval | Dept of Industry | 16/06/2017 |
| Approval of CMAP | Dept of Industry | 11/08/2017 |
| Consultation during preparation of *Erosion and Sediment Control Plan for Myrtle Creek CMAP Trial Project* | DPI-Water | 18/08/2017 |
| | Wollondilly Shire Council | 18/08/2017 |
| | Dept Planning & Environment | 18/08/2017 |
| Consultation during preparation of Part 7 Fisheries Permit for *Myrtle Creek CMAP Trial Project* | NSW Fisheries | 18/08/2017 |
| Consultation regarding variation to EPL 3189 for *Myrtle Creek CMAP Trial Project* | EPA | August 2017 |
| Submit *Erosion and Sediment Control Plan* for *Myrtle Creek CMAP Trial Project* | Dept Planning & Environment | October 2017 |
| Submit Part 7 Fisheries Permit for *Myrtle Creek CMAP Trial Project* | NSW Fisheries | August 2017 |
| Approval of *Erosion and Sediment Control Plan* for *Myrtle Creek CMAP Trial Project* | Dept Planning & Environment | December 2017 |
| Approval of Part 7 Fisheries Permit for *Myrtle Creek CMAP Trial Project* | NSW Fisheries | December 2017 |
| Consultation during preparation of *Site23 Rehabilitation Plan* | Dept of Industry | January 2018 |
| Consultation during the preparation of *Myrtle Creek CMAP Trial Project*<br>- Preparation of document will begin on receipt on required Project Approvals to capture consultation requirements from Government Agencies | Dept of Industry | January 2018 |
| | OEH | January 2018 |
| | Wollondilly Shire Council | January 2018 |
| | DPI-Water | January 2018 |
| Submit *Myrtle Creek CMAP Trial Project* for remediation of rock bar downstream of Site 23 Myrtle Creek | Dept of Industry | April 2018 |
| Approval of *Myrtle Creek CMAP Trial Project* for remediation of rock bar downstream of Site 23 Myrtle Creek | Dept of Industry | June2018 |
| Execution of Myrtle Creek CMAP Trial Project | Tahmoor Collier | On receipt of approval and weather pending |

| Task or Milestone | Government Agency | Estimated Date of Completion |
|---|---|---|
| Assessment of outcomes and reporting to key stakeholders | Key Government Agencies | To be confirmed following outcomes of *Myrtle Creek CMAP Trial Project Site 23* |
| Preparation of *Myrtle Creek CMAP Trial Project Stage 2* | Tahmoor Colliery | To be confirmed following outcomes of *Myrtle Creek CMAP Trial Project Site 23* |

### 9.2.2 Redbank Creek

On completion of subsidence impacts in Redbank Creek a CMAP will be prepared in consultation with key stakeholders.

# 10 Consultation and Communication Plan

## 10.1 Identification of Key Stakeholders

Tahmoor Colliery is committed to adequately consulting with all key stakeholders regarding the implementation of the Myrtle Creek CMAP Trial Project. The table below outlines an overview of key external stakeholders that have been identified by Tahmoor Colliery and the likely consultation and engagement methods to be employed throughout the Project.

***Table 15 Myrtle Creek CMAP Trial Project Consultation and Communication Plan***

| Government Agency | Consultation | Document |
|---|---|---|
| **Division of Resources and Geoscience - Resource Regulator** | - Approval of CMAP | CMAP |
| **Division of Resources and Geoscience - Water** | - Consultation during the development of the Plan | Erosion and Sediment Control Plan |
| **Wollondilly Shire Council** | - Consultation during the development of the Plan | |
| **Department of Planning** | - Consultation during the development of the Plan<br>- Approval of the Plan prior to execution of Myrtle Creek CMAP Trial Project | |
| **NSW Fisheries** | - Consultation during the development of the Permit<br>- Approval of the Permit prior to execution of Myrtle Creek CMAP Trial Project | Part 7 Permit |
| **Environment Protection Authority** | - Consultation regarding a variation to EPL 1389<br>- If determined variation is required approval from EPA prior to execution of Myrtle Creek CMAP Trial Project | EPL 1389 |
| **Residents** | - Consultation with residents when all approval documents received<br>- Ongoing consultation with residents throughout the Project | Project Newsletter |
| **Tahmoor Colliery Community Consultative Committee (TCCCC)** | - Consultation has been ongoing with the TCCCC providing updates at quarterly meetings<br>- Continue to provide updates throughout the Myrtle Creek CMAP Trial Project | Project Newsletter and TCCCC Presentation |

Prior to the execution of the Myrtle Creek CMAP Trial Project, a comprehensive 'Stakeholder Engagement Program' will be developed in accordance with *Glencore Coal Assets Australia Community and Stakeholder Engagement.*

As outlined in **Figure 61**, the proximity and density of residential dwellings on the southern bank highlights the importance of consultation with neighbouring residents throughout the Project.

## 10.2 Project Newsletter

Crucial to the success of managing the community consultation aspects of the Project is ensuring that ongoing, transparent and two way communication is adopted between the Project team and the stakeholders. The key residents that have been identified will be kept informed with a Project Newsletter. The Newsletter will be distributed on a periodic basis via email and hand delivered.

## 10.3 Enquiry Management

Tahmoor Colliery has a 24 hour community phone line (1800 154 415) for community enquiries. This phone line will be utilised to manage all enquiries relating to the Project. They will be recorded in a Stakeholder database.

Tahmoor Colliery has an enquiry email on the Tahmoor Colliery website. The Project team will be responsible for responding to all email enquiries. A fact sheet will be provided to the Project Team enabling any frequently asked questions to be addressed immediately. An email response will be sent as soon as possible. This should thank them for making the enquiry and detailing what response has been initiated.

# 11 Management

The Myrtle Creek CMAP Trial Project will be managed in accordance with the Tahmoor Colliery Environmental Management System (EMS) and appropriate Approval Conditions. All approved plans and relevant documents are available on the Tahmoor Colliery website (www.tahmoorcoal.com.au).

## 11.2 Training and Awareness

A site specific induction / training package will be developed outlining the key environmental / safety hazards and controls identified in the risk assessment and Myrtle Creek CMAP Trial Project as well as providing basic environmental awareness information. It will be a site specific requirement that any consultant, contractor or employee working on the Myrtle Creek CMAP Trial Project will be inducted prior to any works commencing. Regular tool box talks will be provided to ensure that all environmental approvals are adhered to and reporting is captured.

## 11.3 Roles & Responsibilities

Tahmoor Colliery will be responsible for the coordination of the day to day activities associated with the implementation of the Myrtle Creek CMAP Trial Project. The role and function of key personnel responsible for the development and implementation of this Plan are outlined below.

*Table 16 Accountabilities for Tahmoor Colliery*

| Role | Accountabilities for this document |
|---|---|
| **Operations Manager** | Ensuring that the required resources are made available to the Project team including but not limited to equipment and Consultants. |
| **Manager Environment and Community** | Authorise the documentation and any amendments. |
| **Approvals and Community Coordinator** | a) Preparation and supervision of required documentation.<br>b) Consultation with key Government Agencies and stakeholders.<br>c) Management of consultation throughout Project.<br>d) Plan implementation.<br>e) Address any non-conformances.<br>f) Ensure all Contractors and Consultants are inducted.<br>g) Manage Project reporting.<br>h) Preparation of Project Newsletter.<br>i) Undertake regular review.<br>j) Interim and completion report preparation. |
| **Environment Coordinator** | a) Assist with CMAP preparation and supervision.<br>b) Implementation of environmental controls prior and during Project.<br>c) Plan implementation.<br>d) Management of consultation throughout Project.<br>e) Assist in preparation of Project Newsletter. |

The following technical experts have been engaged by Tahmoor Colliery to provide expert opinion as requested to the satisfaction of the Manager Environment and Community and conduct the roles assigned to them in a competent and timely manner.

*Table 17 Accountabilities for Technical Experts*

| Role | Accountabilities for this document |
|---|---|
| **Project Manager**<br><br>**Dr Greg Tarrant**<br>***Tarrant Geomechanics*** | a) Project Manage Myrtle Creek CMAP Trial Project.<br>b) Oversee remediation activities and undertake regular inspections of work area.<br>c) Undertake regular review.<br>d) Manage costs.<br>e) Provide regular toolbox talks at Myrtle Creek CMAP Trial Project work site.<br>f) Develop drill and grout plan.<br>g) Interim and completion report preparation. |
| **Dr Chris Meikle**<br>***Cardno*** | a) Project Implementation / Design<br>b) Ensure remediation activities undertaken in accordance with required approval documents.<br>c) Develop drill and grout plan.<br>d) Site Characterisation Management.<br>e) Hydrological Assessment.<br>f) Grout Options Analysis.<br>g) Coordination of drill crew. |
| **Bruce Blunden**<br>***Niche*** | a) Preparation of required approvals.<br>b) Preparation of Sedimentation & Erosion Management Plan.<br>c) Consultation with Government Agencies. |
| **Andrew Dawkins**<br>***GeoTerra*** | a) Pool mapping.<br>b) Creek chemical / physical monitoring.<br>c) Regular site inspections. |

# 12 Documents Reviewed

The below documents were reviewed during the development of this Management Plan.

***Table 18 Documents referenced during development of CMAP***


| Documents Reviewed |
|---|
| ACARP 2009. Damage Criteria and Practical Solutions for Protecting River Channels. Ken Mills, SCT Report ACA2387. May 2009. |
| ACARP 2001. Research into the Impacts of Mine Subsidence on the Strata and Hydrology of River Valleys and Development of Management Guidelines for Undermining Cliffs and River Systems. Waddington, A.A. and Kay, D.R., Final Report on ACARP Research Projects Nos. C8005. March 2001. |
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| GeoTerra 2014. Tahmoor Coal Pty Ltd – Tahmoor Colliery Longwall Panels 31 to 37 Streams, Dams & Groundwater Assessment Tahmoor, NSW, Revision A. December, 2014. |
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| Hydrometric Consulting Services 2017. “Time weighted stream discharge duration curve” Email attachment from A. Dawkins. September, 2017. |
| Krogh 2012. Management of Longwall Coal Mining Impacts in Sydney’s Southern Drinking Water Catchments. Australasian Journal of Environmental Management Vol 14, Issue 3, pp155-165. |
| Mills, K. W. and Huuskes, W. The effects of mining subsidence on rock bars in the Waratah Rivulet at Metropolitan Colliery. The Proceedings of the 6th Triennial Conference on Mine Subsidence. pp.47–63. |
| MSEC 2006. The Prediction of Subsidence Parameters and the Assessment of Mine subsidence Impacts on Surface and Sub-surface Features due to Mining Longwalls 24 to 26 at Tahmoor Colliery in Support of an SMP Application, Revision C. March, 2006. |
| MSEC 2009. Tahmoor Colliery Longwalls 27 to 30 Report on The Prediction of Subsidence Parameters and the Assessment of Mine Subsidence Impacts on Natural Features and Items of Surface Infrastructure Due to Mining Longwalls 27 to 30 at Tahmoor Colliery in Support of the SMP Application. Revision B. July, 2009. |
| MSEC 2011. Xstrata Coal: Tahmoor Colliery Longwall 25 End of Panel Subsidence Monitoring Report for Tahmoor Longwall 25, Revision A. May, 2011. |
| MSEC 2013. Xstrata Coal: Tahmoor Colliery Longwall 26 End of Panel Subsidence Monitoring Report for Tahmoor Longwall 26, Revision A. January, 2013. |

| Documents Reviewed |
|---|
| MSEC 2014. Glencore: Tahmoor Colliery Longwall 27 End of Panel Subsidence Monitoring Report for Tahmoor Longwall 27, Revision A. August, 2014. |
| MSEC 2015. Glencore: Tahmoor Colliery Longwall 28 End of Panel Subsidence Monitoring Report for Tahmoor Longwall 28, Revision A. September, 2015. |
| MSEC 2016. Glencore: Tahmoor Colliery Longwall 29 End of Panel Subsidence Monitoring Report for Tahmoor Longwall 29, Revision A. August, 2016. |
| MSEC 2014. Glencore: Tahmoor Colliery Longwalls 31 to 37 Subsidence Predictions and Impact Assessments for Natural and Built Features in Support of the SMP Application Volume 1, Revision A. December, 2014. |
| MSEC 2014. Glencore: Tahmoor Colliery Longwalls 31 to 37 Subsidence Predictions and Impact Assessments for Natural and Built Features in Support of the SMP Application Volume 2, Revision A. December, 2014. |
| Niche 2014. Tahmoor North Longwalls 31 to 37 Subsidence Management Plan – Aboriginal and European Heritage Assessment. December, 2014. |
| Niche 2014. Tahmoor North Longwalls 31 to 37 Subsidence Management Plan - Aquatic Ecology Assessment. December, 2014. |
| Niche 2014. Tahmoor North Longwalls 31 to 37 Subsidence Management Plan - Terrestrial Ecology Assessment. December, 2014. |
| South32: 2015. Josh Carlon, Kim Vaux, Gary Brassington - Dendrobium Area 3B: WC21 Rehabilitation Plan. December, 2015. |
| WRM 2014. Tahmoor Coal Flood Impact Assessment: LW31-37. December, 2014. |
| Xstrata Coal 2013. Xstrata Coal Sustainable Development Plan: Grout Remediation Plan West Wallsend Colliery. October 2013. |

# 13 Control and Revision History

| Property | Value | Details |
|---|---|---|
| Approved By | Ian Sheppard | June 2017 |
| Document Owner | Belinda Treverrow | Development of document |

# 14 Appendices

## A.1 Tahmoor Colliery Longwalls 27-30 Environmental Management Plan – Trigger Action Response Plan

| Feature | Monitoring | | | Management | |
|---|---|---|---|---|---|
| | Prior to Mining | During Mining | Post Mining | Trigger | Action |
| **General Stream Sites**<br><br>**MYC1,2,3,4**<br><br>**RC1,2,3** | Observations every month for at least two months prior to mining using photo points | Observations every week during active undermining of 3rd order streams using photo points | Observations every 2 months for an agreed period (minimum 1 yr) after mining is completed in LW27-30 using photo points | **NORMAL**<br><br>No observable mining induced change<br><br>**WITHIN PREDICTIONS**<br><br>No observable change to stream bed or bank; erosion turbidity iron staining algal growth vegetation compared to baseline conditions<br><br>**EXCEEDS PREDICTIONS**<br><br>Observable increase in stream bed or bank; erosion turbidity iron staining algal growth vegetation compared to pre mining conditions | Continue monitoring program, discuss in end of panel report or AEMR as required.<br><br>Ongoing review of stream condition.<br><br>Continue monitoring program, discuss in end of panel report or AEMR as required.<br><br>Ongoing review of stream condition<br><br>Immediately inform NOW and DRE Director Environmental Sustainability and Land Use, Principal Subsidence Engineer<br><br>Notify technical specialists immediately<br><br>Site visit with stakeholders within 1 mth<br><br>Record photographically immediately<br><br>Review monitoring program within 2 |

| Feature | Monitoring | | | Management | |
|---|---|---|---|---|---|
| | Prior to Mining | During Mining | Post Mining | Trigger | Action |
| | | | | | weeks and review accordingly<br><br>Inform NOW and DRE of investigation results<br><br>Prepare and implement a site mitigation/action plan<br><br>within 1 mth (pending stakeholder availability) and seek approvals from key agencies if required<br><br>Complete works asap<br><br>Additional post works monitoring and reporting within 1 mth as required<br><br>Discuss in EoP or AEMR reports as required |

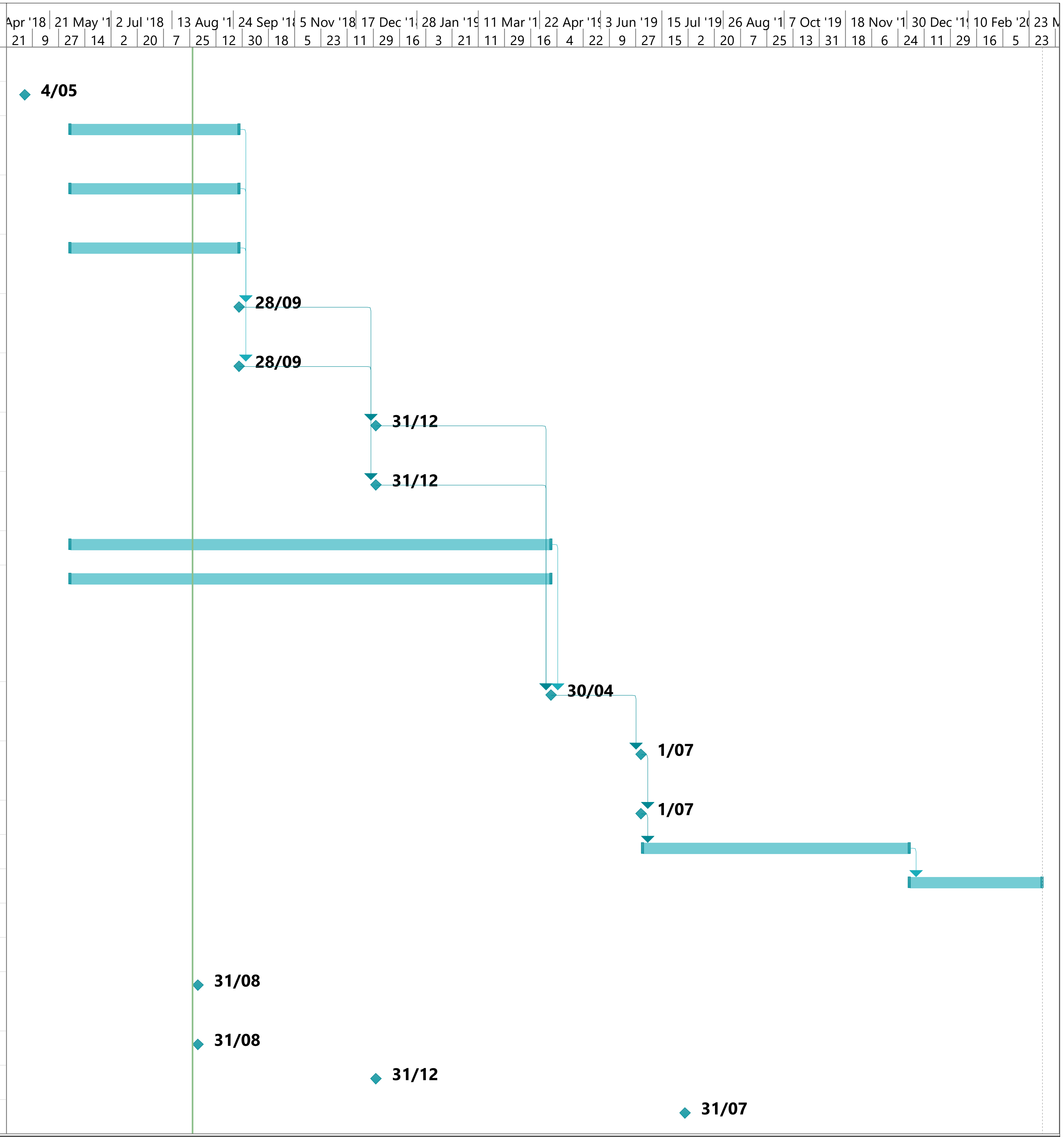
| Feature | Monitoring | | | Management | |
|---|---|---|---|---|---|
| | Prior to Mining | During Mining | Post Mining | Trigger | Action |
| **Stream Flow / Water Level**<br><br>**Sites**<br><br>**M1 - M6**<br><br>**R1-R11** | Minimum continuous 6 hourly, with 2 monthly downloads Minimum continuous 2 hourly, with monthly downloads when longwall is < 250m from monitoring site | Minimum continuous hourly with weekly downloads for 2 month before / after active mining within 100m of a 3rd order or higher channel in a relevant actively undermined stream reach | Minimum continuous 6 hourly with downloads every two months for agreed period (minimum 1 yr) after mining is completed in LW27 - 30 | **NORMAL**<br><br>No observable mining induced change<br><br>**WITHIN PREDICTIONS (< 2mths) -** within baseline variability or temporary reduction over < 2mth period for pool levels and stream flow, considering rainfall / runoff variability.<br><br>**WITHIN PREDICTIONS (>2** | Continue monitoring program, discuss in end of panel report or AEMR as required.<br><br>Ongoing review of stream flow / level data<br><br>Continue monitoring program, discuss in end of panel report or AEMR as required.<br><br>Ongoing review of water pressure data |

| Feature | Monitoring | | | Management | |
|---|---|---|---|---|---|
| | Prior to Mining | During Mining | Post Mining | Trigger | Action |
| | | | | **mths)** fracturing of bedrock in directly undermined channels Pool level / flow decline <20% during mining compared to baseline for > 2 mths | Continue monitoring program, review monitoring frequency, discuss in end of panel report or AEMR as required. |
| | | | | **EXCEEDS PREDICTIONS** fracturing of bedrock in stream reach directly or not directly undermined re-direction of surface water flows and pool level / flow decline >20% during mining compared to baseline for >2mths, considering rainfall / runoff variability | Ongoing review of water pressure data<br><br>Immediately inform NOW and DRE Director<br><br>Environmental Sustainability and Land Use, Principal Subsidence Engineer<br><br>Notify technical specialists immediately<br><br>Site visit with stakeholders within 1 mth<br><br>Record photographically immediately<br><br>Review monitoring program within 2 weeks and review accordingly<br><br>Inform NOW and DRE of investigation results<br><br>Prepare and implement a site mitigation/action plan within 1 mth (pending stakeholder availability) and seek approvals from key agencies if required |

| Feature | Monitoring | | | Management | |
|---|---|---|---|---|---|
| | Prior to Mining | During Mining | Post Mining | Trigger | Action |
| | | | | | Complete works asap<br><br>Additional post works monitoring and reporting within 1 mth as required<br><br>Discuss in EoP or AEMR reports as required |

# Appendix 7 – CMAP Schedule

| ID | Task Name | Duration | Start |
|---|---|---|---|
| 1 | Submit Revision B CMAP for Approval | 0 days | Fri 16/06/17 |
| 2 | Approval of CMAP | 0 days | Fri 4/05/18 |
| 3 | Consultation during preparation of Erosion and Sediment Control Plan for Myrtle Creek CMAP Trial Project | 84 days | Mon 4/06/18 |
| 4 | Consultation during preparation of Part 7 Fisheries Permit for Myrtle Creek CMAP Trial Project | 84 days | Mon 4/06/18 |
| 5 | Consultation regarding variation to EPL 1389 for Myrtle Creek CMAP Trial Project | 84 days | Mon 4/06/18 |
| 6 | Submit Erosion and Sediment Control Plan for Myrtle Creek CMAP Trial Project | 0 days | Fri 28/09/18 |
| 7 | Submit Part 7 Fisheries Permit for Myrtle Creek CMAP Trial Project | 0 days | Fri 28/09/18 |
| 8 | Approval of Erosion and Sediment Control Plan for Myrtle Creek CMAP Trial Project | 0 days | Mon 31/12/18 |
| 9 | Approval of Part 7 Fisheries Permit for Myrtle Creek CMAP Trial Project | 0 days | Mon 31/12/18 |
| 10 | Consultation during preparation of Site23 Rehabilitation Plan | 236 days | Mon 4/06/18 |
| 11 | Consultation during the preparation of Myrtle Creek CMAP Trial Project Preparation of document will begin on receipt on required Project Approvals to capture consultation requirements from Government Agencies | 236 days | Mon 4/06/18 |
| 12 | **Submit Myrtle Creek CMAP Trial Project for remediation of rock bar downstream of Site 23 Myrtle Creek** | 0 days | Tue 30/04/19 |
| 13 | Approval of Myrtle Creek CMAP Trial Project for remediation of rock bar downstream of Site 23 Myrtle Creek | 0 days | Mon 1/07/19 |
| 14 | Execution of Myrtle Creek CMAP Trial Project | 0 days | Mon 1/07/19 |
| 15 | Assessment of outcomes and reporting to key stakeholders | 131 days | Tue 2/07/19 |
| 16 | Preparation of Myrtle Creek CMAP Trial Project Stage 2 | 65 days | Wed 1/01/20 |
| 17 | | | |
| 18 | | | |
| 19 | The MOP to be updated with the requirements of CMAP Rev B | 0 days | Fri 31/08/18 |
| 20 | Updated timeline for the implementation of the CMAP | 0 days | Fri 31/08/18 |
| 21 | Plan and Draft a CMAP for Redbank Creek | 0 days | Mon 31/12/18 |
| 22 | Update the MOP with Redbank Creek CMAP Requirements | 0 days | Wed 31/07/19 |




Project: CMAP Update.mpp
Date: Mon 27/08/18

| | | | | |
|---|---|---|---|---|
| Task | Project Summary | Manual Task | Start-only | Deadline |
| Split | Inactive Task | Duration-only | Finish-only | Progress |
| Milestone | Inactive Milestone | Manual Summary Rollup | External Tasks | Manual Progress |
| Summary | Inactive Summary | Manual Summary | External Milestone | |

# Appendix 8 – Resource Regulator Correspondence

28 August 2018

Mr Greg Kininmonth
Manager Environmental Operations (Southern)
Compliance Operations
Resource Regulator
Level 1 Block H
84 Crown Street Wollongong NSW 2500

Dear Sir,

**CCL716 Inspection Outcome**

**ESU-INSP-2018-0171**

**DOC18/394264**

We refer to your inspection of the Tahmoor Coking Coal Operations (**TCCO**) mine on 28 May 2018 and the following Inspection Report (Ref: ESU-INSP-2018-0171, DOC18/394264) dated 15 June 2018.

The Inspection Report contained the following two Corrective Actions:

- **Corrective Action 1**: Review stabilisation options for the contour drains to provide cover over exposed coal wash and ensure long-term stability of the contour drains.
- **Corrective Action 2**: Review the process for checking topsoil depth of the REA and update the relevant procedures/plans as necessary. This updated process should include details of the record keeping requirements.

The Inspection Report requires correspondence regarding the measures to respond to these two Corrective Actions by 30 August 2018.

**Corrective Action 1**

Additional works were conducted on the contour drains during May and June 2018. These works were undertaken by NSW Soil Conservation Service (**SCS**) and included construction and maintenance works to outlet drains including contouring and topsoiling.

This work also included covering any patches of coal rejects exposed within the drains and additional rock gabion erosion control works.

Additionally, the drains are proposed to be hydromulched during the 2018 spring growth season, anticipated during September/October 2018, as an added erosion protection measure.

A selection of photographs outlining the works completed on the contour drains to ensure that no reject material is exposed and additional erosion controls are attached as **Attachment 1** to this covering letter.

**Corrective Action 2**

The following TCCO procedure has been revised and updated to incorporate a process for checking topsoil depth at the REA and record keeping requirements:

*Rehabilitation and Topsoil Management Procedure, Document Number: TAHUG-502308417-2435*

Section 8.1.3 has been added to the Procedure detailing soil depth management.

A copy of the revised and updated Procedure is attached as **Attachment 2** to this covering letter.

If you would like any further information on this matter please contact Ron Bush on 0437 266 998 or ron.bush@glencore.com.au

Yours sincerely,

Ron Bush
Environment and Community Manager
Tahmoor Coking Coal Operations
SIMEC Mining


Tahmoor Coal Mine
REA Drains 28 August 2018

**Tahmoor Coal Mine**
**REA Drains 28 August 2018**

Tahmoor Coal Mine
REA Drains 28 August 2018

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**REA Drains 28 August 2018**

**Tahmoor Coal Mine**
**REA Drains 28 August 2018**

# Appendix 9 – Longwall 32 Environmental Management Plan

SIMEC

MEMBER OF GFG ALLIANCE

Tahmoor Coal Pty Ltd

# LONGWALL 32

## Environmental Management Plan

04 May 2019

simecgfg.com

Tahmoor Coal Pty Ltd

# LONGWALL 32

## Environmental Management Plan

## 04 May 2019

simecgfg.com

Document Control

| | |
|---|---|
| **PUBLICATION DATE:** | 04 May 2019 |
| **PREPARED BY:** | **Ron Bush**<br>**Environment and Community Manager**<br>**Tahmoor Coking Coal Operations – SIMEC Mining** |
| **VERSION NUMBER:** | **Rev 2** |
| **COMMENTS:** | **Final** |

simecgfg.com

# Table of Contents

# 1 Introduction

## 1.1 Overview

The Tahmoor Coal Mine (**Tahmoor Mine**) has been operated by Tahmoor Coal Pty Ltd (**Tahmoor Coal**) since the mine commenced in 1979 and via longwall mining methods since 1987.

Tahmoor Coal, trading as Tahmoor Coking Coal Operations (**TCCO**) is a subsidiary within the SIMEC Mining Division (**SIMEC**) of the GFG Alliance (**GFG**).

This Environmental Management Plan (**EMP**) provides detailed information about how the risks associated with mining Longwall 32 (**LW32**) beneath environmental significant and natural features and how the subsidence impacts on surface and groundwater, flora and fauna and archaeological sites will be managed by TCCO.

## 1.2 Objectives

The objectives of this EMP are to establish procedures to measure, control, mitigate and repair potential impacts that might occur to environmental significant and natural features and how the subsidence impacts on surface and groundwater, flora and fauna and archaeological sites.

The objectives of the EMP have been developed to:

- Ensure the safe and serviceable operation of environmental significant and natural features.
- Ensure that public and workplace safety is paramount. Ensure that the health and safety of people who may be present on public or private property are not put at risk due to mine subsidence;
- Provide a detailed monitoring program for environmental significant and natural features;
- Monitor ground movements and the condition of environmental significant and natural features during mining;
- Provide trigger levels for subsidence impacts that require action and responses;
- Provide procedures to be followed for subsidence impacts that require actions from monitoring showing an exceedance of trigger levels;
- Initiate action to mitigate or remediate and /or compensate potential significant impacts that are expected to occur on the surface;
- Provide a plan of action in the event that the impacts of mine subsidence are greater than those that are predicted;
- Establish a clearly defined decision-making process to ensure timely implementation of risk control measures;
- Provide a forum to report, notify, discuss and record subsidence impacts;
- Establish lines of communication and emergency contacts;
- Consider contingency planning; and
- Outline annual reporting procedures.

## 1.3 Scope

The EMP is to be used to protect and monitor the condition of environmental significant and natural features identified to be at risk due to mine subsidence.

The potential environmental significant and natural features at risk are:

- Surface water, including quality and quantity and dams;
- Groundwater including quality and quantity;
- Ecology including flora and fauna;
- Aboriginal cultural heritage including archaeological sites;
- European heritage;
- Fluvial geomorphology including rock bars and pools; and
- Steep slopes.

The EMP only covers the environmental significant and natural features that is located within the limit of subsidence, which defines the extent of land that may be affected by mine subsidence as a result of mining LW32 only.

The EMP does not include other environmental significant and natural features, which lie outside the extent of this area.

# 2 SMP Approval

## 2.1 SMP Approval

TCCO received Subsidence Management Plan (**SMP**) Approval (**SMP Approval**) for LW32 on the on 14 September 2018 for the initial 1,100 metres.

TCCO submitted an application to the Division of Resources and Geosciences of the Department of Planning and Environment (**DPE-DRG**) on 3 March 2019 for the extension of the LW32 SMP Approval to enable the full extraction of the LW32 from 1,100 metres to 2,378 metres.

## 2.2 SMP Condition 12

Condition 12 of the LW32 SMP Approval requires an EMP to be prepared.

Condition 12 states the following:

> *12. The Leaseholder must submit to the Director Compliance Operations for approval an Environmental Management Plan (EMP) for the panels which are the subject of this Approval. The EMP is to be incorporated as an appendix to the Leaseholders Mining Operations Plan.*
>
> *This plan must address subsidence impacts on:*
>
> > *a) surface and groundwater (quality and quantity);*
> >
> > *b) flora and fauna;*
> >
> > *c) archaeological sites; and*
> >
> > *d) any other significant environmental features that may be effected by subsidence resulting from the proposed longwall extraction.*
>
> *The leaseholder must not operate beyond chainage 1,100m of Longwall 32 other than in accordance with an EMP approved by the Director Compliance Operations as an appendix*

*to the Leaseholders Mining Operations Plan. This plan must address subsidence impacts above and must include:*

*a) a detailed monitoring program;*

*b) trigger levels for subsidence impacts that require actions and responses;*

*c) the procedures that would be followed in the event that the monitoring indicates an exceedance of trigger levels;*

*d) measures to mitigate, remediate and/or compensate any identified impacts;*

*e) a protocol for the notification of identified exceedances of the trigger levels;*

*f) a contingency plan; and*

*g) annual reporting procedures*

*This plan must be prepared in consultation with relevant landholders and government agencies.*

*The Leaseholder must not cause subsidence impacts prior to the Environmental Management Plan being approved.*

*Note: The plan should be submitted to the Director Compliance Operations at least 30 days prior to the expected commencement of operations beyond chainage 1,100m so as to enable sufficient time for the assessment of the plan. The Director may require the provision of further information to assist in the assessment of the plan or a resubmission of the plan if it is considered inadequate. Complex issues or the need for additional information or a resubmission of the plan may require a longer assessment period.*

# 3 Enviromental Conditions

## 3.1 Regional Catchment

The Nepean River rises in the Great Dividing Range to the west of Picton. Its headwaters also lie in the coastal ranges to the east of Picton. Flows in the upper reaches of the Nepean River are highly regulated by the Upper Nepean Water Supply Scheme, operated by WaterNSW that incorporates four major water supply dams on the Cataract, Cordeaux, Avon and Nepean Rivers. Releases from the Cordeaux, Avon and Nepean Dams are made to enable withdrawal for water supply purposes from the Pheasant's Nest Weir located further downstream on the Nepean River.

The Nepean Dam is situated some 18 km upstream of the Bargo River confluence, while the Pheasant's Nest Weir is located approximately 7 km upstream of the confluence. Flows in the Nepean River near and downstream of the Project Area (downstream of the Peasant's Nest Weir) are not part of a WaterNSW Drinking Water Catchment Area.

Further downstream, the Nepean River has been extensively modified by the construction of a series of in-stream weirs which have created a series of pondages, such as the Maldon Weir. Ponding behind the Maldon Weir does not affect water levels far upstream.

The Nepean River flows into the Warragamba River near Wallacia downstream of which it is referred to as the Hawkesbury-Nepean River. The Hawkesbury- Nepean catchment is one of the largest coastal catchments in NSW with an area of some 21,400 km$^2$ at its mouth in Broken Bay on the northern side of the Sydney Metropolitan area.

Stonequarry Creek, Cedar Creek, Matthews Creek and Redbank Creek, which all traverse the local area, are tributaries of the Nepean River.

## 3.2 Redbank Creek Catchment

Redbank Creek is a stream with 3rd order or higher channel, whilst its tributaries are streams with 1st or 2nd order channels.

The topography in the vicinity of Redbank Creek is varied, ranging from gently undulating plateaux, ridges and low hills in the upland areas, to a rugged landscape of deeply dissected valleys and gorges in Hawkesbury Sandstone.

Redbank Creek flows roughly west to east through the township of Thirlmere before joining Stonequarry Creek just south of Picton, approximately 2.5 km upstream of the junction with the Nepean River. The Redbank Creek total catchment covers an area of approximately 8 km$^2$ and incorporates areas of both Thirlmere and Picton townships. The remainder of the catchment is undeveloped or agricultural land or mixed industrial/residential urban area.

Redbank Creeks contain a sequence of clay /sand based alluvial pools, exposed sandstone rock bars and creek beds, boulder fields and gravel / cobble riffles, with varying degrees and types of riparian and stream bed vegetative cover.

Flooding in Redbank Creek is typically contained in the creek channel with the exception of overbank flow located in the north-eastern extent of the hydraulic model downstream of the Antill Street culvert and in the vicinity of the Argyle Street Bridge. Depths in these areas range between 0.2 m and 1.0 m. Depths in the creek channel are significant in places with flood depths in excess of 4.0 m located downstream of the Argyle Street bridge.

Stream velocities in Redbank Creek are high (point velocities greater than 2.5 m/s) during the 1% the AEP design event. The velocities in the overbank flow path downstream of Antill Street and in the vicinity of the Argyle Street Bridge are slightly lower (less than 2.0 m/s).

Mapped pools along Redbank Creek are shown on **Figure 1**.

TCCO established gauging stations along Redbank Creek at 11 sites, as shown on **Figure 2**, and has undertaken a flow gauging program to develop flow ratings for each station. A baseline water quality monitoring program has also been undertaken at each gauging station, such that gauging station sites are paired with water quality monitoring sites.

In terms of gauging stations locations, the sites are categorised as the following:

- Control site (R1 and R11): a site which is to provide control data against which future subsidence impacts can be compared; or
- Baseline/impact site (R2 to R10): a site which is to be used to compare conditions before, during and after subsidence.

TCCO has nine (9) piezometers (P1 to P9) where regular manual and data logger based standing water level monitoring has been conducted since June 2004 for some locations, as shown on **Figure 3**.

## 3.3 Rainfall

Regional rainfall monitoring stations in the vicinity of the Redbank Creek have varying periods of record, as outlined on **Table 1**. The Buxton and Picton stations are the closest BoM stations with long term records without significant gaps in the data record.

| BoM Station Number | Station Name | Year of Establishment & Closure | Percent Complete Record | Latitude (degrees south) | Longitude (degrees east) | Elevation (m AHD*) | Distance from Pit Top (km) |
|---|---|---|---|---|---|---|---|
| 068166 | Buxton | 1967 - Open | 92% | 34.24 | 150.52 | 420 | 5.5 |
| 068052 | Picton | 1880 - Open | 91% | 34.17 | 150.61 | 165 | 9.3 |
| 068016 | Cataract Dam | 1904 - 2013 | 93% | 34.26 | 150.81 | 340 | 21.3 |
| 068159 | Wedderburn | 1964 - Open | 62% | 34.17 | 150.81 | 250 | 23.1 |
| 068122 | Cawdor | 1962 - Open | 88% | 34.1 | 150.64 | 132 | 17.6 |
| 068216 | Menangle Bridge | 1963 - Open | 94% | 34.12 | 150.74 | - | 20.7 |
| 068200 | Douglas Park | 1974 - Open | 98% | 34.21 | 150.71 | 165 | 12.9 |

* Australian Height Datum. The existing Tahmoor pit top is at approximately 290m AHD.

***Table 1: Summary of Regional Rainfall Monitoring Stations***

Monthly long-term average rainfalls for the BoM stations and the record obtained for the Project site from the SILO Data Drill are summarised in **Table 2**. A comparison of monthly average rainfall totals from the Data Drill and local BoM rainfall data sites indicates that the Data Drill data are similar to nearby BoM station records.

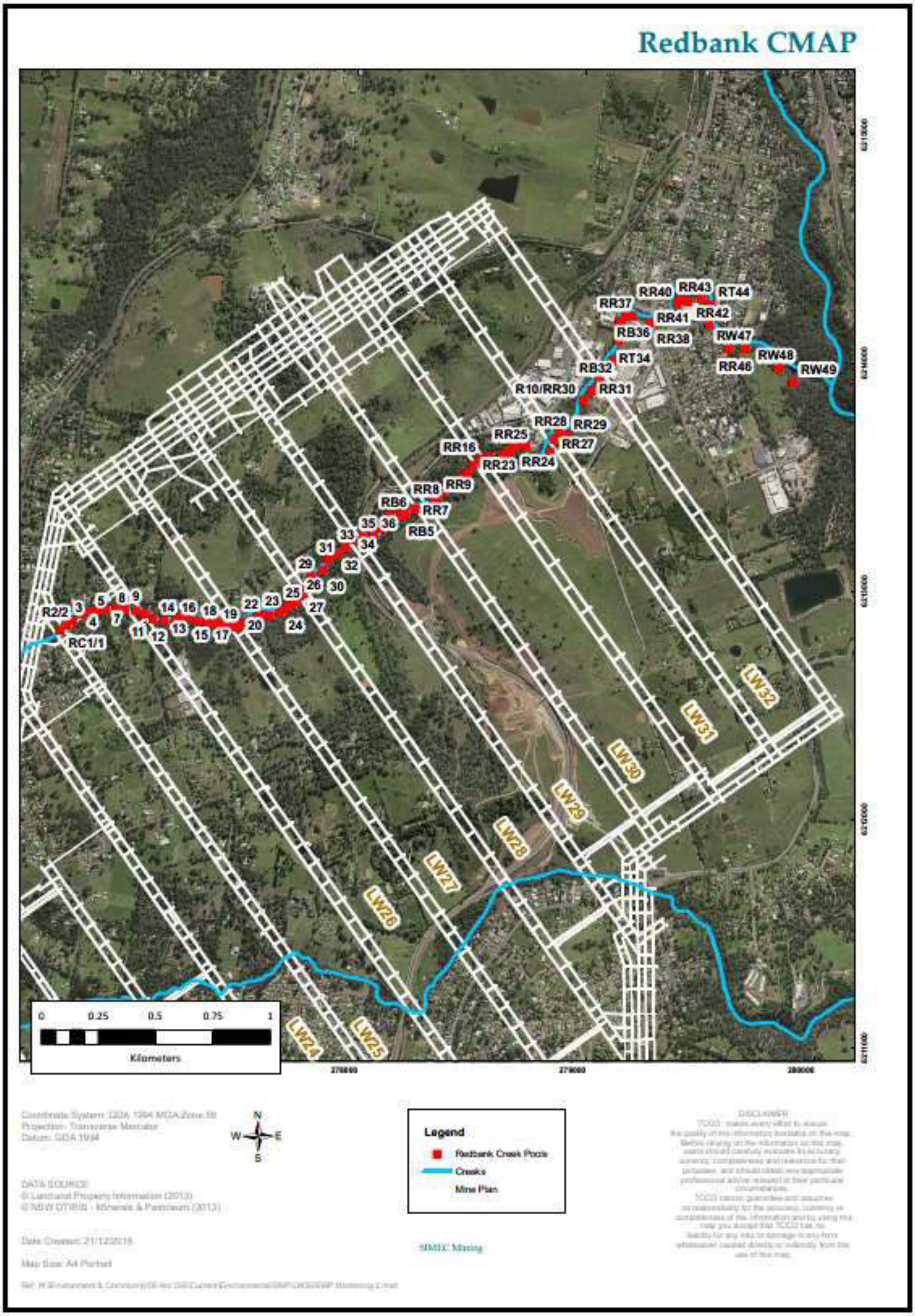


*Figure 1: Redbank Creek Pools*



SIMEC


*Figure 2: Redbank Creek Monitoring Gauge Stations*


*Figure 3: Redbank Creek Groundwater Monitoring Bores*

| Data Source | Data Drill for Project Site | Picton Council Depot | Buxton | Douglas Park |
|---|---|---|---|---|
| *Number of Years of Record* | 129 | 116 | 51 | 44 |
| *BoM Station Number* | - | 068052 | 068166 | 068200 |
| | Rainfall (mm) | Rainfall (mm) | Rainfall (mm) | Rainfall (mm) |
| January | 89.5 | 87 | 92.2 | 69.6 |
| February | 95.4 | 89.9 | 125.5 | 88.1 |
| March | 89.3 | 89.3 | 82.2 | 85.4 |
| April | 74.5 | 69.6 | 74 | 64.2 |
| May | 64.0 | 55.8 | 51.6 | 57.4 |
| June | 77.9 | 67.6 | 67.3 | 70.8 |
| July | 55.1 | 49.4 | 35.8 | 41 |
| August | 50.0 | 44.8 | 51.2 | 43.8 |
| September | 47.0 | 43.7 | 44.4 | 41.2 |
| October | 60.4 | 62.7 | 62 | 54.9 |
| November | 70.0 | 71.6 | 90.2 | 72.3 |
| December | 72.1 | 70.1 | 78 | 57.1 |
| Annual Average | 845.2 | 805 | 858.8 | 758.6 |

***Table 2: Summary of Mean Rainfall Statistics***

Rainfall data for the Picton Council Depot BoM station is shown on **Figure 4**.

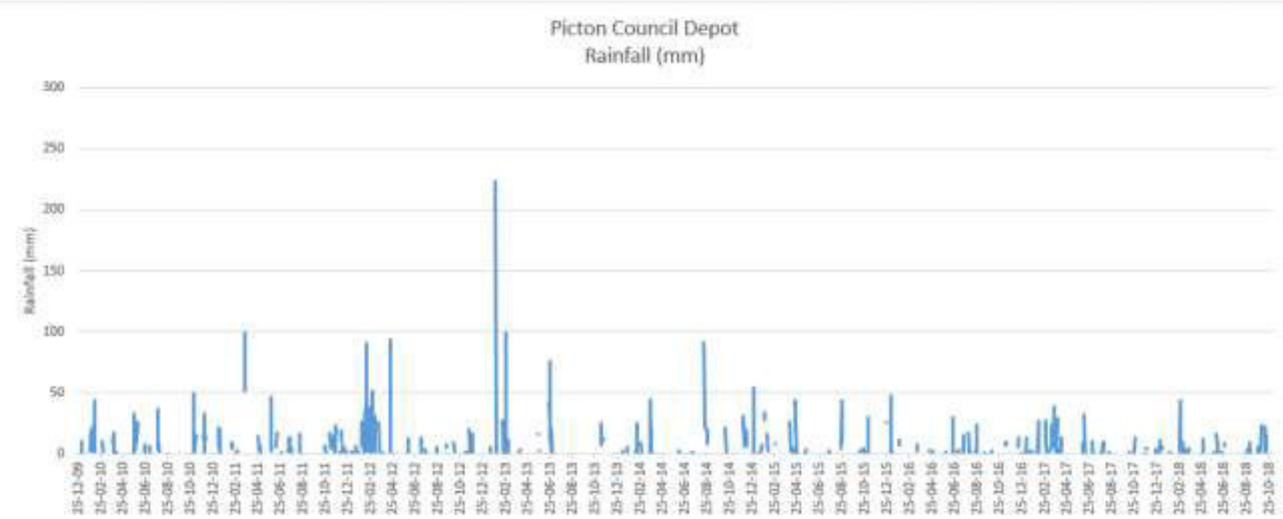


***Figure 4: Picton Council Depot BoM Station Rainfall***

The probability of low rainfall has been assessed using the Data Drill data suite, which shows, in **Figure 5**, the probability of low rainfall periods as the percentage of time that the total rainfall for different numbers of consecutive day periods has been less than or equal to the amount shown.

There is a 50% chance that 20mm of rainfall or less will fall in any 30 day period. There is also a 30% chance that 5mm or less will fall in any 10 day period. This indicates that the area in the vicinity of Redbank Creek has a relatively low probability of persistent dry/low rainfall.

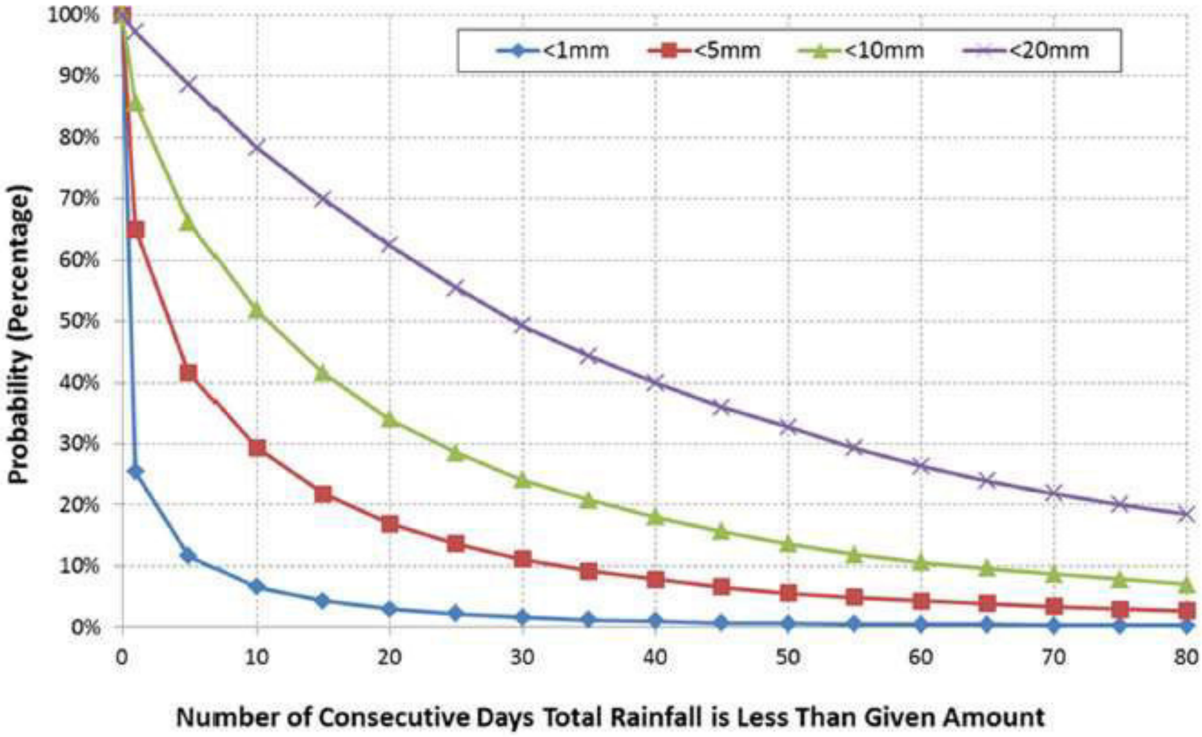


*Figure 5: Low Rainfall Persistence Characteristics*

## 3.4 Evaporation

The closest BoM climate station with pan evaporation (**PE**) data is Prospect Reservoir (0670191), which is located about 40 km to the northeast of Redbank Creek. Mean annual pan evaporation at Prospect is 1,314 mm.

Pan evaporation data was obtained from the SILO Data Drill for the site location and monthly estimates of point potential evapotranspiration2 were also taken from BoM mapping. A summary of monthly average Data Drill estimated pan evaporation and average monthly point potential evapotranspiration from BoM mapping are presented in **Table 3** along with the average monthly rainfall derived from the nearest Data Drill point.

The average site evaporation from the SILO Data Drill is consistently lower than the point potential evapotranspiration taken from the Climatic Atlas of Australia. Average evaporation exceeds average rainfall in all months except June when there is an average excess of rainfall. The greatest evaporation deficit occurs in June and the greatest excess occurs in December.

| Month | Average Evaporation Data Drill | Climate Atlas of Australia (Point Potential Evapotranspiration) | Average Data Drill Rainfall |
|---|---|---|---|
| January | 177.7 | 195 | 89.5 |
| February | 154.7 | 160 | 95.4 |
| March | 127.7 | 150 | 89.3 |
| April | 94.9 | 105 | 74.5 |
| May | 65.0 | 75 | 64.0 |
| June | 55.7 | 60 | 77.9 |
| July | 56.3 | 60 | 55.1 |
| August | 79.8 | 90 | 50.0 |
| September | 107.3 | 120 | 47.0 |
| October | 133.0 | 160 | 60.4 |
| November | 162.2 | 180 | 70.0 |
| December | 181.6 | 195 | 72.1 |
| Annual Average | 1,368 | 1,500 | 845.2 |

*Table 3: Summary of Average Rainfall and Evaporation (mm)*

# 4 Subsidence Processes

## 4.1 Definition of Active Subsidence Zone

As a longwall progresses, subsidence begins to develop at a point in front of the longwall face and continues to develop after the longwall passes. The majority of subsidence movement typically occurs within an area 150 metres in front of the longwall face to an area 450 metres behind the longwall face.

This is termed the *"active subsidence zone"* for the purposes of this EMP, where surface monitoring is generally conducted. The active subsidence zone for each longwall is defined by the area bounded by the predicted 20 mm subsidence contour for the active longwall and a distance of 150 metres in front and 450 metres behind the active longwall face, as shown by **Figure 6**.

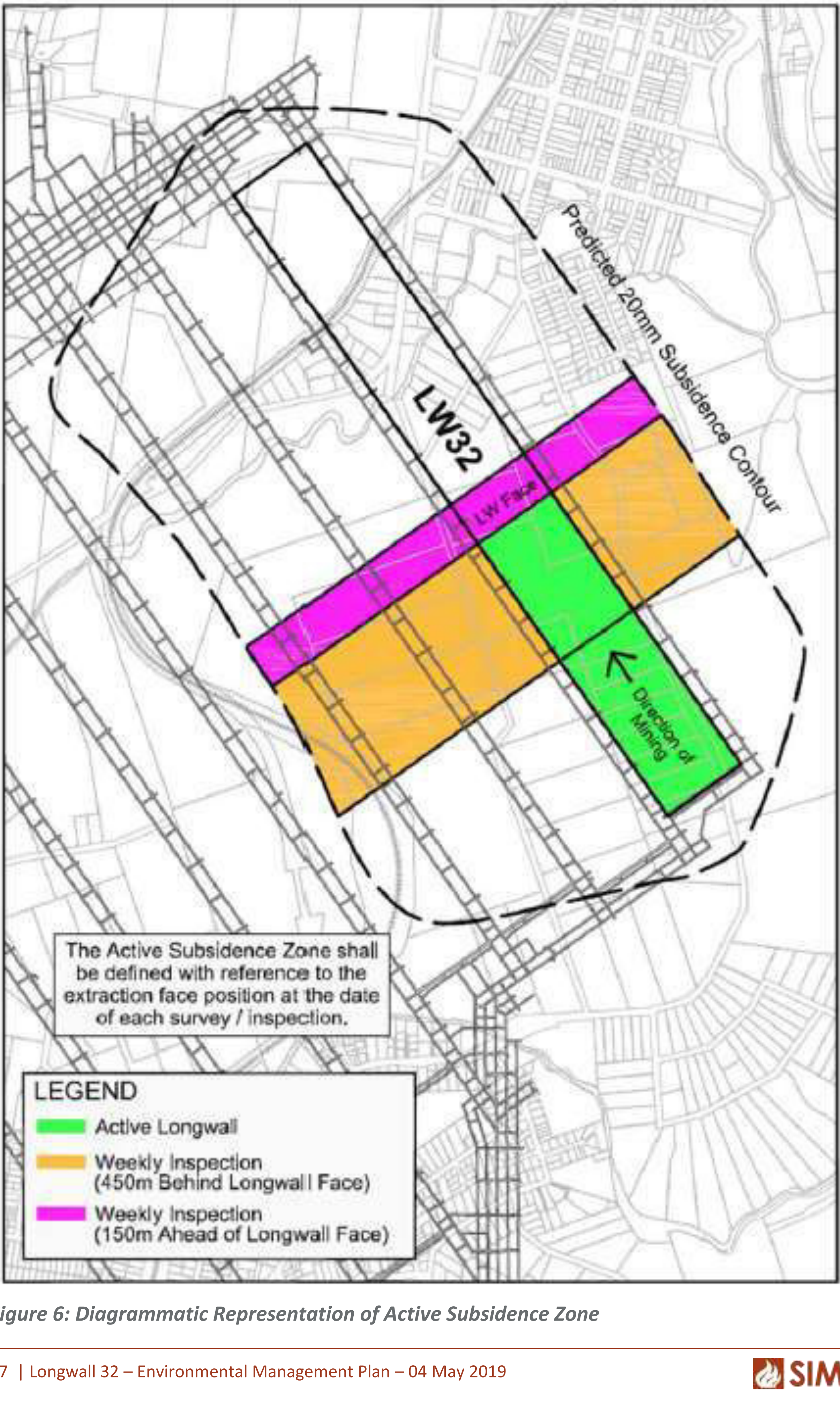


***Figure 6: Diagrammatic Representation of Active Subsidence Zone***

## 4.2 Subsidence Mechanisms

Following the Southern Coalfield Inquiry in 2008, it has become common practice in NSW to differentiate between subsidence effects, subsidence impacts and the resulting environmental consequences.

- **Subsidence Effect** - the nature of mining-induced deformation of the ground mass. This includes all mining-induced ground movements such as vertical and horizontal displacements and their expression as ground curvatures, strains and tilts.
- **Subsidence Impact** - any physical change caused by subsidence effects to the fabric of the ground, the ground surface, or a structure. In the natural environment these impacts are principally tensile and shear cracking of the rock mass, localised buckling of the strata and changes in ground profile.
- **Environmental Consequence** - any change caused by a subsidence impact to the amenity, function or risk profile of a natural or constructed feature. Some consequences may give rise to secondary consequences. Environmental consequences of subsidence could include the redirection of surface water to the subsurface through mining-induced fractures may be a primary consequence for water inflow and result in secondary consequences for surface ecology. Additionally, could also include loss of stream flow, loss of vegetation and faunal habitat, erosion, scouring, ponding and development of iron staining.

### 4.2.1 Subsidence Effects

The term subsidence effects to describe subsidence itself, that is, deformation of the ground mass caused by mining, including all mining-induced ground movements such as vertical and horizontal displacements and curvature as measured by tilts and strains.

Maximum subsidence varies and is directly dependent on a number of factors, including:

- Depth of cover;
- Panel width;
- Pillar width;
- Panel width to depth ratio;
- Seam thickness extracted;
- Proximity of adjacent previously mined panels in current seam; and
- Proximity of adjacent previously mined panels in other seams under multi-seam conditions.

The overburden is usually comprised of near-horizontally bedded strata. Sag results in each stratum being ‘stretched’ and placed into tension. Because rock is very weak when under tension, this is conductive to the opening up of existing geological joints and the formation of fresh near vertical fractures. In the process of sagging, shearing also occurs along the bedding planes between and within the various strata. Fresh near-horizontal fractures may also be formed. These sliding surfaces can develop into open cracks, which may become quite wide if the lower bed of rock sags more than the adjacent upper bed. Hence, a well developed and connected vertical and horizontal fracture network is likely to exist in the rock mass immediately overlying the caved material in a goaf. This network defines the fractured zone.

The caved material bulks and occupies a greater volume when it falls. A point is reached where, with increasing excavation width (W), the roof fall will choke itself off and act as a cushion to the overlying strata. It is known from theoretical calculations and field measurements that this caving height typically ranges from 3 to 10 times the mining height, depending on the nature of the roof strata. Highly-laminated strata tend to fall like a deck of cards and so have a low bulking factor, resulting in the caved zone extending to a considerable height. Falls comprising blocky material, such as sandstone, tend to bulk up and choke off quickly. The caving height defines the limit of the caved zone shown on **Figure 7**.

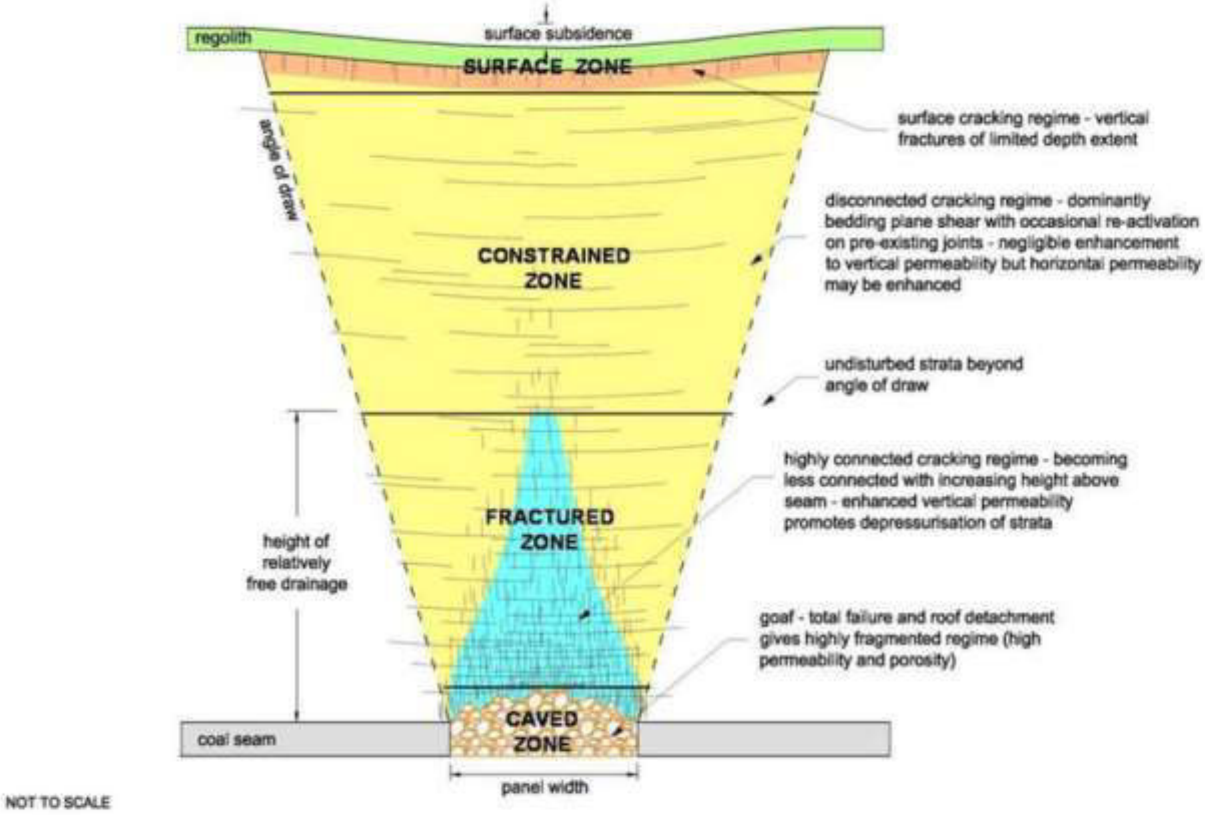


*Figure 7: Conceptual Model of Caving and Fracturing*

The lateral extent of sag increases with distance above the excavation. This results in a decreasing rate of deflection, or curvature, in the upper strata and a corresponding reduction in shear and tensile stresses. Given sufficient depth, a point is reached where the tensile stresses become too low in the upper strata to cause joints to open or new vertical fractures to develop on a regular or continuous basis. Horizontal fracture planes may still be activated as a result of sagging strata sliding past each other but the magnitude of these displacements also reduces as curvature decreases. The zone in which this behaviour occurs is referred to as the constrained zone. It is characterised by strata which have not suffered significant alteration of their physical properties, and therefore there is negligible change in vertical permeability and only a slight increase in horizontal permeability. The surface zone lies above the constrained zone.

The surface above coal mine workings usually subsides in the form of a subsidence trough, taking on a saucer-shaped appearance. The angle of draw is a subsidence engineering term used to define the limits of the subsidence trough. It is the angle between two lines drawn from the edge of the mine workings, one a vertical line and the other a line to the limit of vertical displacement on the surface. Because surface movements can also be caused by natural effects such as seasonal variations or drought leading to swelling or shrinkage of near-surface soil and sediment, it can be very difficult to identify where vertical movement due to mining ceases. It is standard practice to specify a limiting value for vertical displacement which might be attributable to mining and this value is usually 20 mm of vertical subsidence.

Curvature in an outwards direction results in the ground ‘stretching’ or ‘hogging’ and is referred to as convex curvature. Curvature in an inwards direction causes the ground to sag and move closer together and is referred to as concave curvature.

Features of curvature include:

- Curvature results in points on the surface moving in both a vertical direction and a horizontal direction as they subside into a subsidence trough;
- Curvature changes the slope, or horizontal level, of the surface which, in turn, changes the tilt, or vertical level, of surface features;
- Convex curvature induces tension on the surface;
- Concave curvature induces compression on the surface;
- Bending is induced in long features located on curvature surfaces; and
- Near-surface strata may shear along bedding planes and fresh fracture surfaces as they bend and subside into the subsidence trough.

As mining approaches a site, the site will begin to tilt towards the excavation. Maximum tilt occurs at the point of inflection between concave and convex curvature. The amount of horizontal extension or compression induced over a given distance on the surface is expressed in terms of strain, as shown on **Figure 8**.

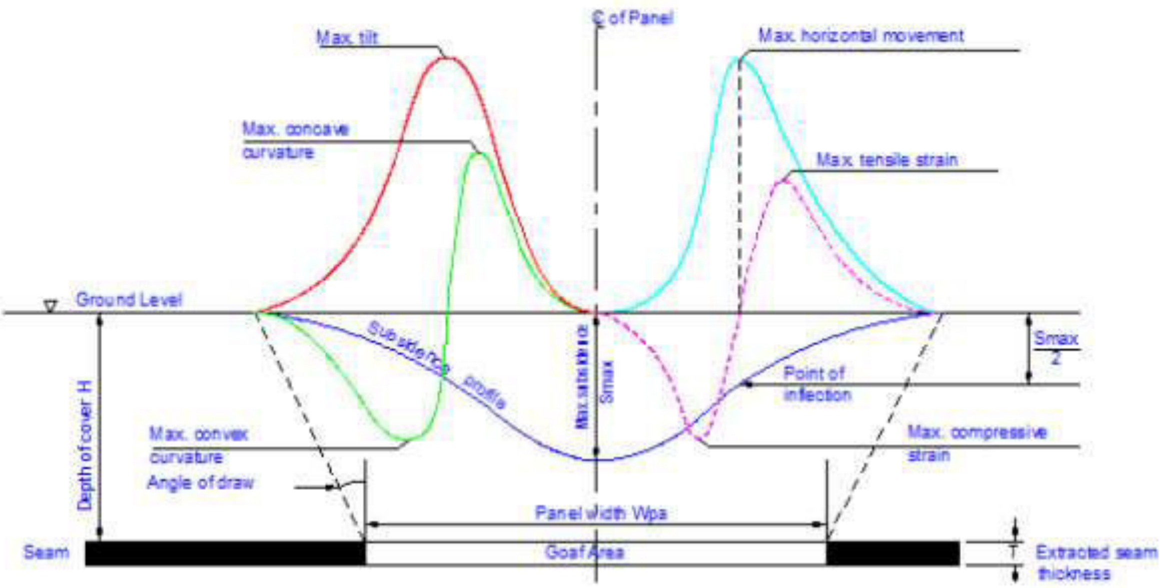


*Figure 8: Subsidence Parameters*

Strain is also expressed in terms of mm/m, that is, millimetres of stretch or millimetres of shortening per metre of distance. As the edge of an excavation is approached from the solid side, tensile strain begins to increase and builds up to a maximum value which usually occurs over the excavation. From that point, there is a graduation from the point of maximum tensile strain, through a point of zero strain, to a point of maximum compressive strain. Surface strain changes from tensile to compressive at the point of inflection.

The near surface rocks over coal mine workings are usually comprised of laminated strata. In order for the strata to sag and subside, the individual strata have to slide past each other, as shown in **Figure 9**. This shear movement may or may not significantly enhance horizontal permeability. Additionally, when one face of a stratum is subjected to tension, its opposite face is subjected to compression. Because rocks have very low tensile strength (rocks are typically 10 to 30 times weaker in tension than compression), surfaces in tension are susceptible to fracturing and to the opening of pre-mining fractures.

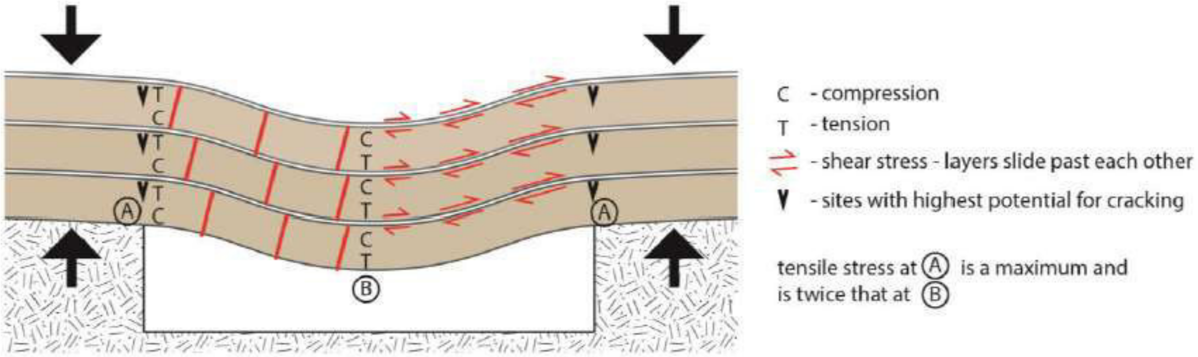


*Figure 9: Shear Diagrammatic Representation*

### 4.2.2 Subsidence Impacts

The term subsidence impacts is then used to describe the physical changes to the ground and its surface caused by these subsidence effects.

These impacts are principally tensile and shear cracking of the rock mass and localised buckling of strata caused by valley closure and upsidence but also include subsidence depressions or troughs.

The environmental consequences of these impacts include:

- Loss of surface flows to the subsurface;
- Loss of standing pools;
- Water quality impacts;
- Development of iron bacterial mats;
- Cliff falls and rock falls;
- Damage to Aboriginal heritage sites; and
- Impacts on aquatic ecology and ponding.

## 4.3 Valley Closure

### 4.3.1 Valley Closure Mechanics

As erosion has taken place over geologic time, the vertical (loading) stresses have been relieved but a component of the horizontal stress remains locked in the seams and surrounding strata. Tectonic processes associated with the movement of continental plates may have imprinted additional horizontal stresses, which are often strongly directional. Therefore, it is not uncommon in coalfield strata for the horizontal stress in at least one direction to be up to three times greater than the vertical stress.

Steep, incised topography interrupts the transmission of horizontal stress, causing it to be redirected from the hills and into the floor of the valleys or gorges. This can lead to overstressing of valley floors, with the near-surface rock strata uplifting under the effects of bending and buckling. The valley is deepened which, in turn, causes an increase in the horizontal stress redirected into the floor of the valley. This very slow, self-perpetuating natural process is referred to as valley bulging.

Mining causes further disruptions to this natural regional horizontal stress system because:

- Causes a void which then redirects horizontal stress into the roof and floor of the void. The effective height of the void is increased if fracturing and/or caving of the undermined strata occur. If a constrained zone exists above the mine workings, some of the horizontal stress will be redistributed through this zone. This increases the horizontal stress acting across the valley floor; and

- Removes or reduces the resistance to horizontal movement in the zone comprised of caved and fractured material, thereby permitting the surrounding rock mass to relax and to move towards the excavation.

When mining-induced fractures are created within the overburden strata more generally during the incremental vertical subsidence that is characteristic of longwall mining, the volume occupied by the fractures is additional to the original volume of the rock strata so there is an overall increase in volume called dilation. Mining-induced horizontal compression across the creek channel is generated by dilation (volume increase) of the overburden strata located to either side of the channel.

The dilation of the strata on either side of a topographic low point, such as creek channels, becomes concentrated at these topographic low points because there is freedom for the valley sides to move toward the valley and the confining pressures provided by the overburden strata to either side are not present at the creek line, as shown on **Figure 10.**

Two responses arising from these mining-related stress behaviours are:

- Valley closure, whereby the two sides of a valley move horizontally towards the valley centreline; and
- Uplift of the valley floor, as a result of valley bulging and buckling and shearing of the valley floor and near surface strata.

The ground movements that occur around excavations in steeply incised terrain in a high horizontal stress environment are complex and it is difficult to identify the individual contribution of the various components to these movements, which include:

- Conventional subsidence movements;
- Elastic ground movements associated with redistribution of horizontal stress on a regional
- basis;
- Movements associated with localised buckling and shear failure; and
- Gravity-induced downhill slippage.

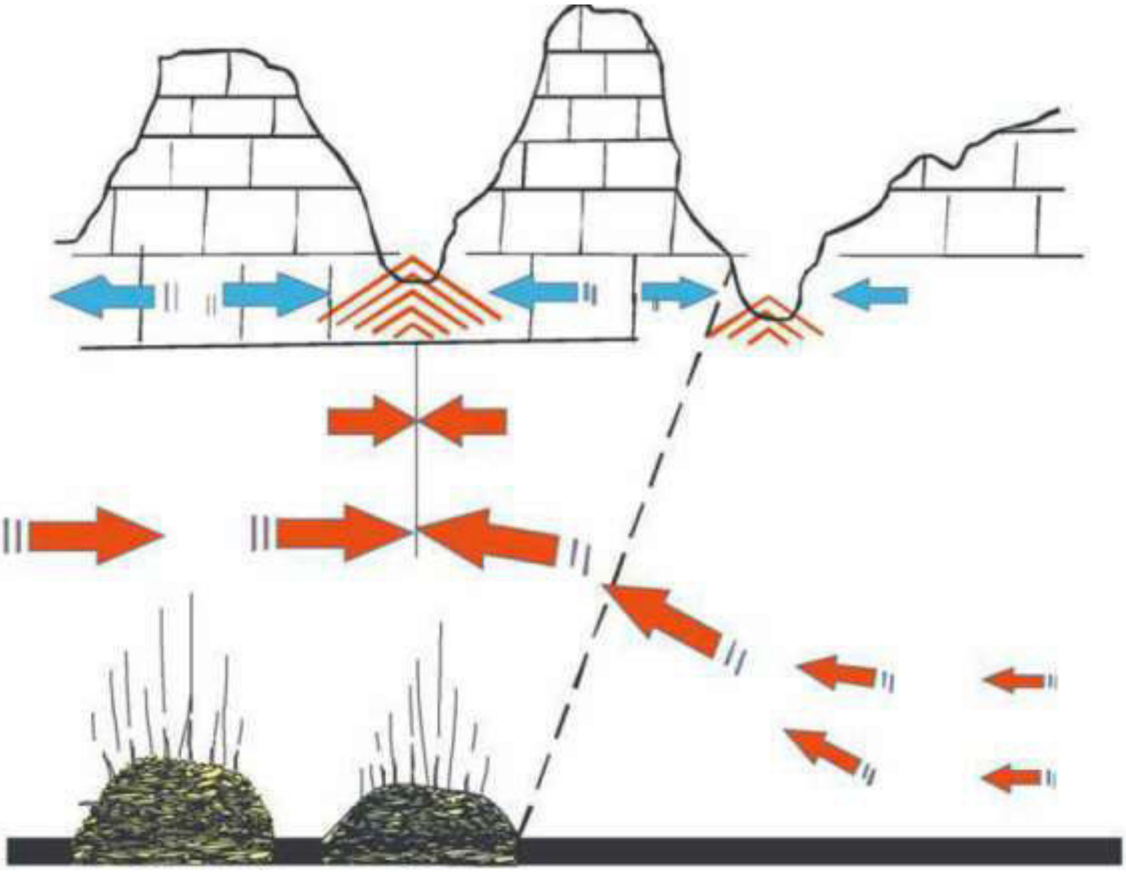

*Figure 10: Valley Closure Conceptualisation*

### 4.3.2 Valley Closure Impacts

Buckling and shear in the near-surface strata, which leads to upsidence, can also generate an extensive network of fractures and voids in the valley floor. Ground movements due to conventional subsidence can also contribute to the formation of this network if the upsidence occurs within the angle of draw of the mine workings. The main fracture network extends to a depth of about 12 metres and bed separation extends to a depth of some 20 metres, as shown on **Figure 11**.

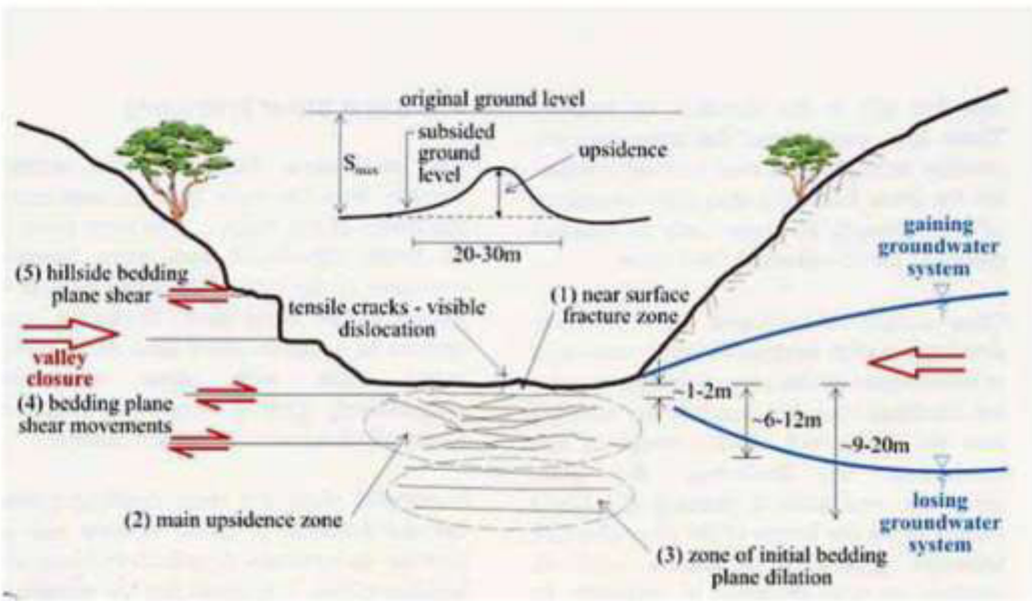


*Figure 11: Mechanisms of Valley Closure and Upsidence*

### 4.3.3 Valley Closure Consequences

The process of valley closure occurs naturally as valleys are cut down into the host rock by the erosive action of the creek. The interaction of vertical stress relief and diurnal and annual temperature variations causes rock close to the surface to become overloaded and fractured. Generally, the rates of natural processes are slow enough that sufficient sediment is deposited within the fracture network to maintain a high proportion of the total flow as surface flow.

However, subsidence effects can enhance the impacts of valley closure once compression movements increase sufficiently, fresh fractures are created within the sandstone strata in the bed of the creek and existing fractures that may have become sealed with sediment over time are remobilised. Open fractures within the near surface strata provide an alternative pathway for surface flow. Flow that previously flowed on the surface can now flow through this sub-surface fracture network, at least during periods of low flow.

Mining-induced surface flow diversion into subterranean flows occurs where there is an upwards thrust of bedrock, resulting in fracturing of the rock and redirection of surface water through the dilated strata beneath it. The water reappears downstream of the fractured zone as the water is only redirected below the river bed for the extent of the subsidence induced fracturing, as outlined on **Figure 12**.

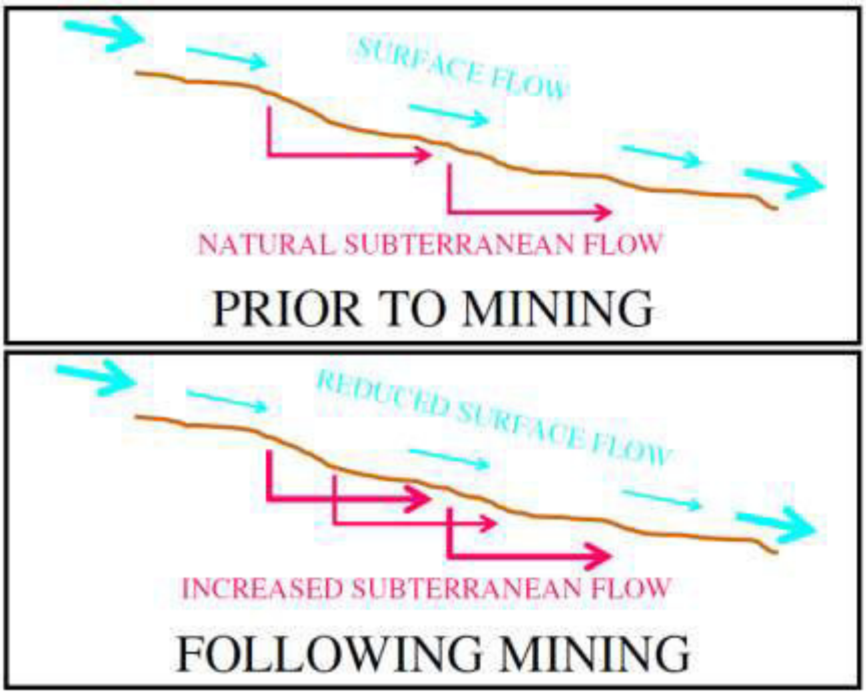


***Figure 12: Diagrammatic Representation of Subterranean Flows***

During periods of high flow such as immediately after heavy rain, frictional resistance requires an increase in head to drive the additional flow through the sub-surface fracture network. With sufficient flow, as occurs after heavy rain, this head increases to reach the surface and gives the appearance that flow has returned to the surface.

As the flow reduces again, the fracture network becomes able to accommodate all the flow without the need for the hydraulic gradient to rise above the surface. Although water is still flowing in the creek system, the surface pools appear to have dried out.

The fracture network is generally a zone of intense fracturing below the creek bed. This zone is typically evident to a depth of less than 6 metres, but has been observed to range up to about 12 to 20 metres below the surface. The intense fracturing is evident as open fractures of up to several hundred millimetres wide. These develop as low angle conjugate fractures to form wedges that lift the surface causing localised upward movement or upsidence directly above the zone of intense fracturing.

A basal shear plane extends outward from the base of the zone of intense fracturing on either side of the river channel. Shear on this basal plane enables horizontal movement of the valley sides inward toward the creek to generate the zone of intense fracturing. Measurements at various sites indicate that basal shear planes are likely to follow bedding and may extend hundreds of metres either side of the valley. They may be formed as part of natural valley forming processes and are then remobilised by the dilation associated with mining subsidence.

Depending on the magnitude of valley closure, both the zone of intense fracturing and the basal shear plane have potential to be hydraulically conductive. At low flows, all the flow in the creek can flow through these fracture networks without appearing on the surface.

Mining-induced surface flow diversion due to rockbar leakage occurs in a similar manner to the above mechanism, except that the rockbar is elevated above the rest of the river bed and the general water table. The rate of leakage is dependent, among other things, on the extent of horizontal fracturing within the depth of the rock bar and the water level. The rockbar leaks at a higher rate when the pool is full as there is access to all drainage paths and the water pressure is at its highest. However, as the pool level falls, the drainage rate reduces as the water pressure falls and access is restricted to drainage paths near the base of the rockbar, as outlined on **Figure 13**.

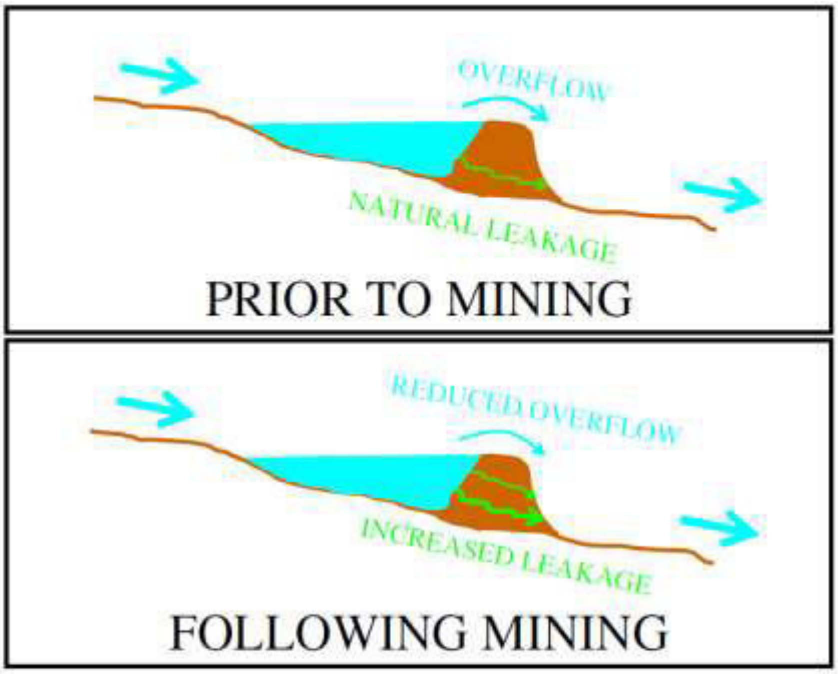


***Figure 13: Diagrammatic Representation of Rockbar Leakage***

# 5 Longwall 32 Mining Parameters

## 5.1 Background

Tahmoor Mine is located approximately 80 km south-west of Sydney in the township of Tahmoor NSW.

TCCO has previously mined 31 longwalls to the north and west of the mine’s current location.

TCCO is currently mining LW32.

LW32 is a continuation of a series of longwalls that extend into the Tahmoor North Lease area, which began with Longwall 22. The longwall panels are located between the Bargo River in the south-east, the township of Thirlmere in the west and Picton in the north.

LW32 is located beneath the rural area between Tahmoor, Thirlmere and Picton, including part of the South Picton industrial area.

**Table 4** provides a summary of the dimensions of LW32.

| Longwall | Overall void length including the installation heading (m) | Overall void width including the first workings (m) | Overall tailgate chain pillar width (m) |
|---|---|---|---|
| Longwall 32 | 2,378 | 283 | 39 |

***Table 4: Longwall 32 Dimensions***

## 5.2 Mining Schedule

LW32 is planned to extract coal working northwest from the south-eastern end.

The EMP covers longwall mining until completion of mining in LW32 and for sufficient time thereafter to allow for completion of subsidence effects.

**Table 5** outlines the current schedule of mining.

| Longwall | Start Date | Completion Date |
|---|---|---|
| Longwall 32 | October 2018 | October 2019 |

***Table 5: Longwall 32 Mining Schedule***

# 6 Longwall 32 Subsidence Parameters

## 6.1 Longwall 32 Subsidence Predictions

Predicted mining-induced conventional subsidence movements were outlined within TCCO’s SMP Approval application for Longwalls 31 to 37, and includes predictions due to the extraction of LW32.

A summary of the maximum predicted incremental subsidence parameters due to the extraction of LW32 only and the maximum predicted total conventional subsidence parameters due to the extraction of Longwalls 22 to 32, are provided in **Table 6**.

| Longwall | Maximum Predicted Subsidence (mm) | Maximum Predicted Tilt (mm/m) | Maximum Predicted Hogging Curvature (1/km) | Maximum Predicted Sagging Curvature (1/km) |
|---|---|---|---|---|
| Increment due to LW32 only | 700 | 5.5 | 0.06 | 0.12 |
| Total after extraction of LWs 22 to 32 | 1,225 | 6.0 | 0.09 | 0.13 |

*Table 6: Incremental and Maximum Predicted Conventional Subsidence Parameters for LW32*

The values provided in the above table are the maximum predicted conventional subsidence parameters which occur within the general longwall mining area, including the predicted movements resulting from the extraction of Longwalls 22 to 32.

The location of the maximum predicted total subsidence is not directly above LW32. Predicted maximum total subsidence directly above LW32 is approximately 800 mm.

## 6.2 Observed Subsidence Longwalls 22 to 31

The extraction of longwalls at Tahmoor Mine has generally resulted in mine subsidence movements that are typical of those observed above other coal mines located within the Southern Coalfield of NSW at comparable depths of cover.

However, observed subsidence was greater than the predicted values over Longwalls 24A and the southern parts of Longwalls 25 to 27, likely to be associated with proximity to the Nepean Fault geological structure.

Monitoring during the mining of Longwalls 28 to 31 has found that subsidence behaviour has returned to normal levels, as shown on **Figure 14**.

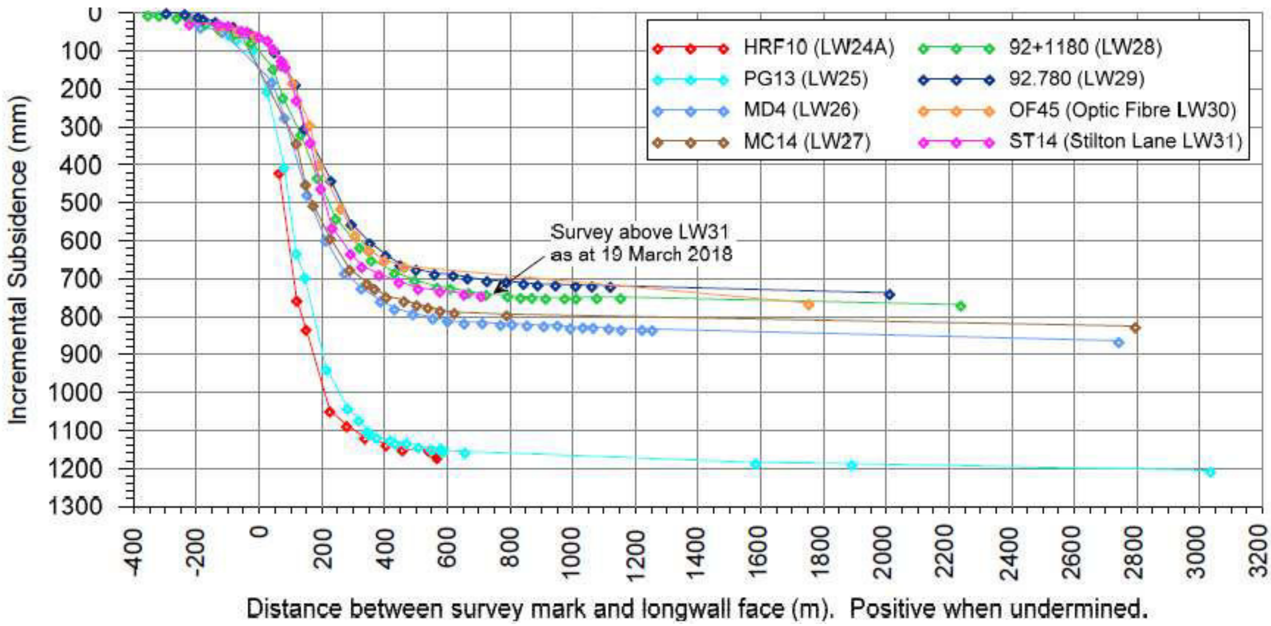


*Figure 14: Observed Development of Subsidence Above Centrelines of Longwalls 24A to 31*

## 6.3 Predicted Strain

The prediction of strain is more difficult than the predictions of subsidence, tilt and curvature. The reason for this is that strain is affected by many factors, including curvature and horizontal movement, as well as local variations in the near surface geology, the locations of pre-existing natural joints at bedrock, and the depth of bedrock. Survey tolerance can also represent a substantial portion of the measured strain, where the strains are of a low order of magnitude. The profiles of observed strain, therefore, can be irregular even when the profiles of observed subsidence, tilt and curvature are relatively smooth.

For features that are in discrete locations, such as archaeological sites, it is appropriate to assess the frequency of the observed maximum strains for individual survey bays.

### 6.3.1 Predictions of Strain Above Goaf

The survey database has been analysed to extract the maximum tensile and compressive strains that have been measured at any time during the extraction of Longwalls 22 to 28 at Tahmoor Mine, for survey bays that were located directly above goaf or the chain pillars that are located between the extracted longwalls, which has been referred to as "*above goaf*".

The histogram of the maximum observed total tensile and compressive strains measured in survey bays above goaf at Tahmoor Mine is outlined in **Figure 15**.

The 95 % confidence levels for the maximum total strains that the individual survey bays above goaf experienced at any time during mining are 0.9 mm/m tensile and 1.8 mm/m compressive. The 99 % confidence levels for the maximum total strains that the individual survey bays above goaf experienced at any time during mining are 1.5 mm/m tensile and 3.5 mm/m compressive.

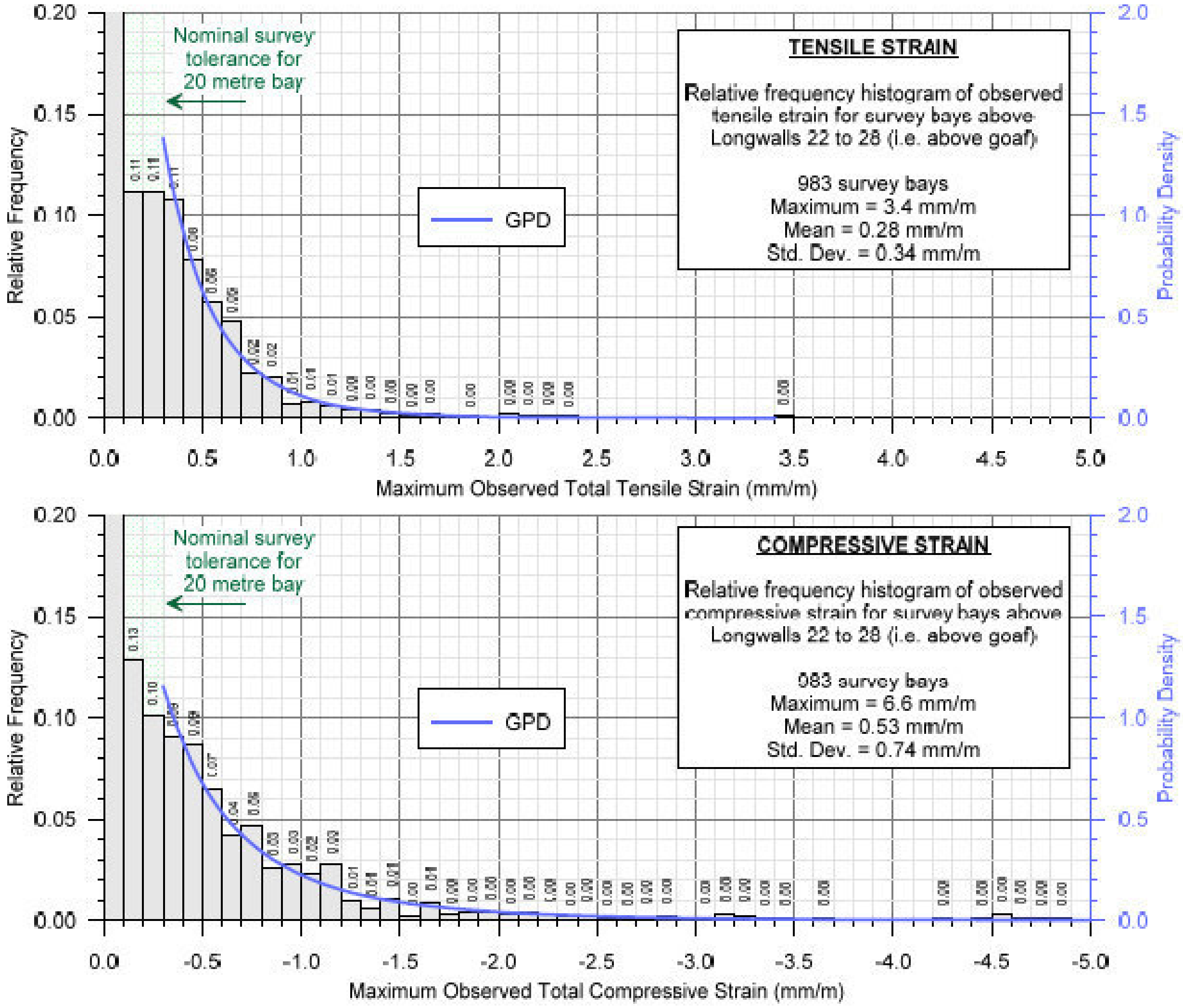


*Figure 15: Distributions of Maximum Tensile and Compressive Strains above Goaf*

## 6.3.2 Predictions of Strain Above Solid Coal

The survey database has also been analysed to extract the maximum tensile and compressive strains that have been measured at any time during the extraction of Longwalls 22 to 28 at Tahmoor Mine, for survey bays that were located outside and within 200 metres of the nearest longwall goaf edge, which has been referred to as "*above solid coal*".

The histogram of the maximum observed tensile and compressive strains measured in survey bays above solid coal at Tahmoor Mine is outlined in **Figure 16**.

The 95 % confidence levels for the maximum total strains that the individual survey bays above solid coal experienced at any time during mining are 0.6 mm/m tensile and 0.5 mm/m compressive. The 99 % confidence levels for the maximum total strains that the individual survey bays above solid coal experienced at any time during mining are 1.1 mm/m tensile and 0.9 mm/m compressive.

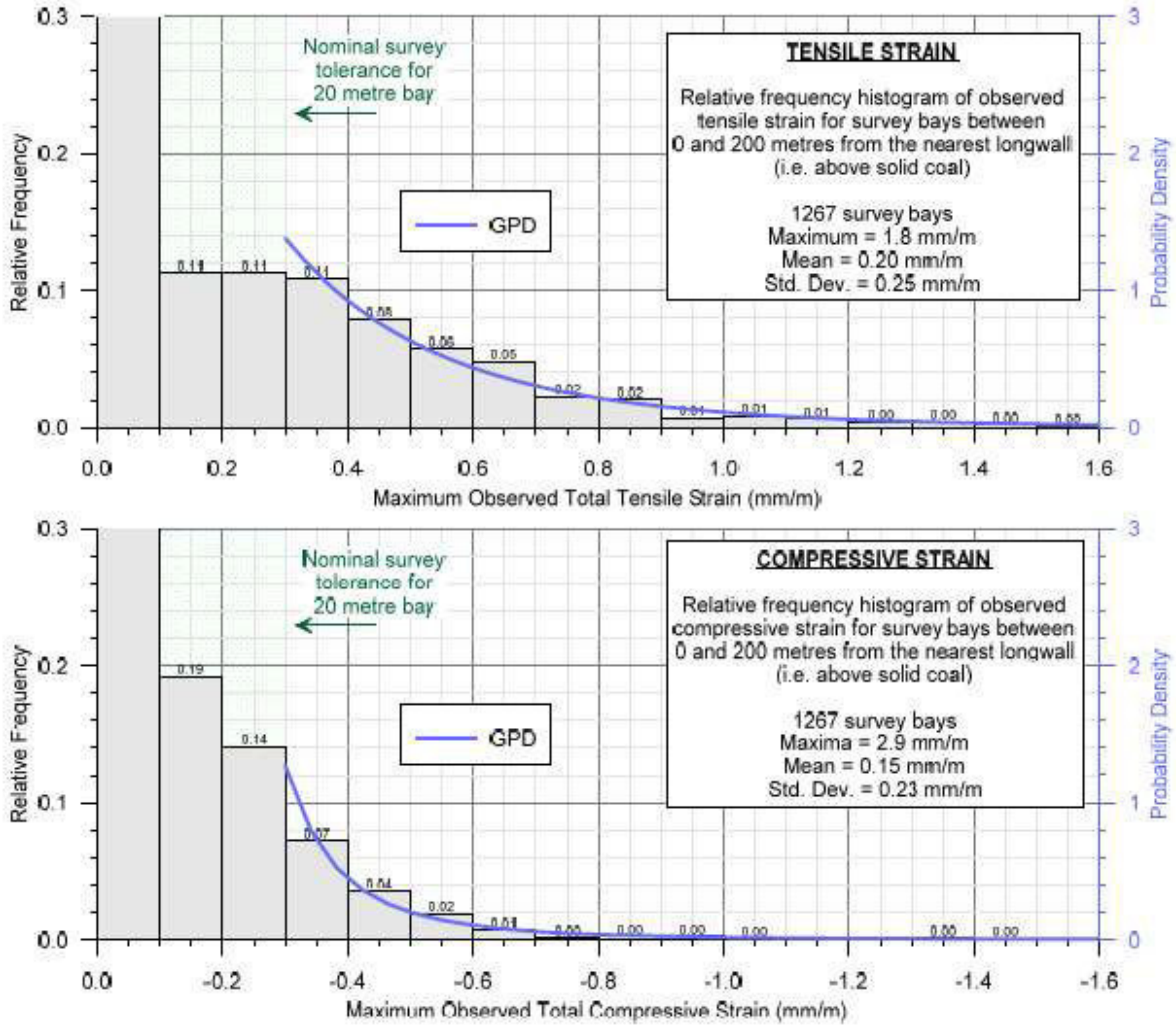


*Figure 16: Distributions of Measured Maximum Tensile and Compressive Strains Above Solid Coal*

## 6.4 Redbank Creek Valley Closure

A summary of the maximum predicted values of total subsidence, upsidence and closure along these creeks, after the extraction of each of the proposed longwalls, is provided in **Table 7**.

The predicted subsidence movements are the maximum values which occur along the stream, including the predicted movements resulting from the extraction of Longwalls 22 to 30. The predicted upsidence and closure movements are the maximum values which occur within the predicted limits of 20 mm additional upsidence and 20 mm additional closure, due to the extraction of Longwalls 31 to 32, but also include the predicted movements resulting from the extraction of Longwalls 22 to 30.

| Longwall | Maximum Predicted Total Subsidence (mm) | Maximum Predicted Total Upsidence (mm) | Maximum Predicted Total Closure (mm) |
|---|---|---|---|
| After LW30 | 1,250 | 500 | 500 |
| After LW31 | 1,250 | 525 | 575 |
| After LW32 | 1,250 | 575 | 625 |

*Table 7: Maximum Predicted Total Subsidence, Upsidence and Closure*

# 7 Risk Management

## 7.1 General

The method of assessing potential mine subsidence impacts in this EMP is consistent with the Australian/New Zealand Standard for Risk Management (**AS/NZS 4360:1999 – Risk Management**).

The Standard defines the terms used in the risk management process, which includes the identification, analysis, assessment, treatment and monitoring of potential mine subsidence impacts. In this context:-

## 7.2 Consequence

AS/NZS 4360:1999 defines consequence as:

> *The outcome of an event expressed qualitatively or quantitatively, being a loss, injury, disadvantage or gain. There may be a range of possible outcomes associated with an event.*

The consequences of a hazard are rated from very slight to very severe.

## 7.3 Likelihood

AS/NZS 4360:1999 defines likelihood as:

> *Used as a qualitative description of probability or frequency.*

The likelihood can range from very rare to almost certain.

## 7.4 Hazard

AS/NZS 4360:1999 defines hazard as:

> *A source of potential harm or a situation with a potential to cause loss.*

## 7.5 Method of Assessment

The method of assessing potential mine subsidence impacts combines the likelihood of an impact occurring with the consequence of the impact occurring.

In this EMP, the likelihood and consequence are combined using the SIMEC Mining Risk Matrix to determine an estimated level of risk for particular events or situations.

## 7.6 Risk Assessment

A risk assessment for LW32 was conducted on 24 May 2018 that considered the natural features outlined within this EMP.

# 8 Potential Subsidence Impacts

## 8.1 Surface Water

### 8.1.1 Redbank Creek

Redbank Creek will be directly mined beneath by Longwall 32.

Redbank Creek flows over predominantly Hawkesbury Sandstone bedrock with natural iron hydroxide containing seepage flowing into the creek, resulting in red colouration of the banks and pools.

The main channel of Redbank Creek within the Longwall 32 active subsidence zone is developed principally for industrial use on both the northern and southern banks, with lesser semi-rural residential development on the southern bank. Agricultural land on the southern bank is used for mainly cattle and horse grazing.

The stream bed and banks are generally well vegetated with predominantly native vegetation intermixed with weeds, and do not show significant erosion or bank instability.

Redbank Creek flows above Longwalls 32 and towards the north-east, where it joins Stonequarry Creek approximately 830 metres (m) east of proposed Longwall 32, it then drains to the Nepean River. The creek falls approximately 30 metres over a total length of approximately 2,300m, with an inferred average gradient of 13mm/m.

There are a number of channel constraints, including rockbars, boulders and rock shelves, which form standing pools along the alignment of the creek. Natural iron seepage flows into the creek, resulting in red colouration of the banks and pools.

The pools along the streams have flow controlling features along their alignments that include rockbars, boulders, tree roots and gravel.

Redbank Creek is the primary watercourse that will experience subsidence impacts due to the extraction of Longwall 32. A tributary to Redbank Creek was mined directly beneath by Longwall 31 and is located to the southern side of Longwall 32. The tributary is located within pasture land.

It is expected that fracturing could develop along the sections of Redbank Creek located directly above Longwall 32, as experienced along Redbank Creek during the mining of previous longwalls. In some locations along Redbank Creek, the surface water flows will be diverted into the dilated strata beneath the beds, which could result in the partial or complete loss of surface water flows and the drainage of pools. It is unlikely that there would be any net loss of water from the catchment, as the depth of buckling and dilation resulting from longwall mining is generally less than 10 metres to 15 metres, with the diverted flows expected to re-emerge further downstream.

### 8.1.2 Fluvial Geomorphology

#### 8.1.2.1 Change of Grade Impacting Pool Levels

No reversal of flow, increased levels of ponding or increased levels of scouring have been observed in Redbank Creek during the mining of Longwalls 22 to 31. This is because the mining induced tilts are significantly smaller than the natural creek gradients. A similar outcome is expected to occur along Redbank Creeks due to mining Longwall 32.

The maximum predicted changes in grade along the alignments of Redbank Creek is 6 mm/m (i.e. 0.6 %). The natural grade along the alignment of Redbank Creek varies between 5 mm/m and 40 mm/m, with an average natural grade of 15 mm/m.

The predicted systematic tilts along the alignments of the creek is small compared to the existing natural grades and are unlikely, therefore, to result in any significant increases in the levels of ponding, flooding or scouring.

The creek has highly variable perennial stream flow over Longwall 32 and partially serves as drainage conduit for runoff from the industrial, urban and rural areas within the creek catchment in Thirlmere.

As a result of the generally moderate flow and low gradient, it is assessed that the small changes in grade imposed by subsidence will have an insignificant effect on the aquatic habitat of Redbank Creek over Longwall 32.

#### 8.1.2.2 Creek Bed Fracturing

Overall, there have been adverse effects on pool depth and longevity, connected stream flow and water quality in Redbank Creek over the subsided longwalls after extraction of Longwalls 25 to 31.

Regular visual inspections have identified subsidence related cracking of numerous sandstone rockbars and rock shelves in Redbank Creek above Longwalls 26 to 31, which has affected pool water levels and pool longevity upstream of the affected rockbars, as well as generating disconnected stream flow.

In addition, new ferruginous springs have been generated, reduced or relocated downstream, which sequentially change location downstream as the longwalls advance down the gradient of the creek.

It is possible that additional fracturing may occur in the creek bed as a result of mining Longwall 32 with similar associated effects on pools and stream flow over Longwall 32.

Some subsidence related fractures may not be visible, however, due to sediment and vegetation cover within and on the banks of the creek.

#### 8.1.2.3 Surface Water Flow Diversion

As stream bed fracturing and surface flow diversions have been observed over Longwalls 25 to 31, sandstone stream bed fracturing and surface water flow diversion are possible within Redbank Creeks over and downstream of Longwall 32.

Compressive strains due to closure are expected to be sufficient to potentially cause the underlying strata to dilate and buckle and induce cracking in the stream bed at some locations which could lead to additional diversion of water from the creek bed into dilated strata beneath it.

It is unlikely, however, based on previous observations over Longwalls 25 to 31 that there will be any net loss of water from the catchment since re-directed flow has previously emerged further downstream.

If significant stream bed fracturing occurs, it is possible that partial or complete loss of pool standing water levels and connected stream flow may occur in some stream reaches if the rate of diversion exceeds upstream inflow.

In times of heavy rainfall, the majority of runoff flows on / in the creek bed, in addition to the diverted flow within subsidence related dilated strata below the creek bed. In times of low flow, however, some or all of the stream flow is diverted into the dilated / fractured strata below the creek bed, with no overland flow which affects the quantity and quality of observable water flowing in the creek.

Sediments in some sections of the creek cover the sandstone bedrock and any fractures that occur are unlikely to be visible.

Bedrock is exposed in some sections of the creek and fractures may be visible in these locations, including in pools with controlling rockbars where fracturing and surface water flow diversion may occur through the rockbars.

#### 8.1.2.4 Bed, Bank Erosion and Bed Load Movement

Cracking of creek beds and banks can create new surface water conduits and therefore subsidence may induce minor bed or bank erosion. The potential for creek bed and bank erosion of sediments, however, is considered to be unlikely as the majority of cracking is observed within exposed sandstone in the creek bed and pool sides.

Dislocation of fractured/dilated sandstone sheets from subsided sections of the creek has been observed over Longwalls 26 to 30, and it is possible that dislocation of rock sheets could occur to the creek bed during subsidence of LW32.

If erosion occurs in the creek, it may cause a minor increase in potential bed load movement and require remediation.

### 8.1.3 Stream Water Quality

Within Redbank Creek pre-mining ferruginous seeps were observed over Longwalls 25 to 31 prior to these locations being undermined.

If stream water quality changes through the development of a new or change to an existing ferruginous spring the effect will be localised around the point of discharge and may result in potential increase in salinity.

The water quality in the creek is highly variable and depends on the amount of flow in the creek at any one time.

### 8.1.4 Dams

A number of dams are located directly above or adjacent to Longwall 32.

The mining induced tilts are predicted to result in changes in freeboard up to a maximum of 200 mm, which is unlikely to result in any significant reductions in the capacities of the farm dams.

Subsidence impacts could result in cracking or deformations in the dam bases or walls. TCCO's experience of mining directly beneath farm dams indicates that the likelihood of adverse impacts on the dams is very low.

TCCO has developed subsidence management plans for managing the potential impacts on farm dams during the mining of Longwalls 22 to 31.

A Built Features Management Plan has been prepared and implemented, which includes visual inspections of farm dams.

If impacts occur to the dams, TCCO will supply water to the landowner on a temporary basis until the dam is repaired.

## 8.2 Groundwater

### 8.2.1 Groundwater Quantity

TCCO experience with aquifer interconnection has been that hydraulic connection of surface water or alluvial groundwater systems to the mine workings have a very low likelihood at mining depths of cover greater than 150 metres.

A temporary lowering of the regional piezometric surface over the subsidence area due to horizontal dilation of strata could occur due to the increase in secondary porosity and permeability. This effect would be most notable directly over the area of greatest subsidence and dilation, and will dissipate laterally out to the edge of the subsidence zone.

Based on similar observations within the Longwall 22 to 31 mining area, groundwater levels may reduce by up to 15 metres, and may stay at that reduced level until maximum subsidence develops at a specific location. The duration of the reduced groundwater levels depends on the time required to develop maximum subsidence, the time for subsidence effects to migrate away from a location as mining advances and the length of time required to recharge the secondary voids.

On the basis that the pre-mining circumstances of rainfall recharge and bore pumping remain the same, and based on observation of groundwater levels over Longwalls 22 to 31, it is anticipated that groundwater levels generally recover over a few months to a year or so as the secondary void space is recharged by rainfall infiltration.

### 8.2.2 Groundwater Quality

It is possible that groundwater seepage may discharge in the streams in addition to the non-mining induced springs observed in Redbank Creek. If an adverse change in stream water quality occurs through development of an isolated new or change to an existing ferruginous spring, it is anticipated that due to the ephemeral nature of the streams and the generally low flow volumes in the creeks, the effect will be localised around the point of discharge and will not adversely affect the overall water quality.

The local groundwater bores are currently used for domestic garden supply, with the water quality being suitable for selected livestock and limited irrigation use, but not potable water.

No adverse changes to groundwater quality of subsided bores or piezometers have been observed during the mining of Longwalls 25 to 31, apart from minor increases in dissolved iron.

### 8.2.3 Wells and Bores

It is possible that the groundwater bores will experience impacts as the result of the proposed mining, particularly those located directly above the proposed longwalls. Impacts would include lowering of the piezometric surface, blockage of the bore due to differential horizontal displacements at different horizons within the strata and changes to groundwater quality.

One groundwater bores (GW105813) is located directly above LW32. TCCO have completed a pre-mining bore census that records pre-mining level, quality, yield and flow from the bore.

Near surface ground water levels may be affected by mine subsidence. If impacts occur to the bores, TCCO would supply water to the landowner on a temporary basis, until the bore returns to operation, or is reinstated or replaced by the Subsidence Advisory NSW.

## 8.3 Ecology

### 8.3.1 Flora

No Critical Habitat has been declared for any ecological values within the LW32 active subsidence zone of Longwall 32 and no Critical Habitat will be impacted.

Vegetation along the banks of Redbank Creek has been mapped as Cumberland Shale Sandstone Transition Forest, with the vegetation along the upper banks of the creek containing diagnostic overstorey species: *Eucalyptus crebra*, *Eucalyptus punctata* and *Angophora floribunda*, and understorey species consisting of *Acacia parramattensis*, *Sigesbeckia orientalis*, and *Indigofera australis*.

The majority of vegetation within the active subsidence zone of LW32 would not be impacted by subsidence due to underground mining but impacts may potentially occur for riparian vegetation. Riparian vegetation potentially impacted by subsidence is generally not mapped as discrete vegetation communities, rather these areas display structural and floristic variation within their composite community in response to more frequent contact with the local water table. As such, it would be hard to distinguish impacts to truly riparian vegetation and the intergrade between riparian and woodland communities.

Vegetation which occurs on undulating lands or on ridgelines is unlikely to be impacted by subsidence.

### 8.3.2 Fauna

The Cumberland Plain Land Snail has been previously recorded to the immediate west of LW32 at Innes Street, Thirlmere. The species is likely to occupy areas of Cumberland Plain Woodland within the locality.

Fauna that occur within LW32 is unlikely to be impacted by subsidence.

### 8.3.3 Aquatic Ecology

Aquatic habitat for LW32 consists predominately of Redbank Creek pools with little to no riffles present, with most sites having moderate to high quality riparian and channel health. The stream is controlled by the sandstone geology with bedrock a common component of the stream morphology. There was very little cobble/boulder habitat and stream benthos is dominated by finer sand/silt sized sediment where bedrock did not occur.

Macrophyte occurrence varies between sites within Redbank Creek, as shown on **Figure 17** and outlined within the RCE inventory scores in **Table 8**. An RCE score below 20 indicates that the stream is in very poor condition. RCE Scores of 20-40 indicate a stream is in moderate condition and greater than 40 indicates a stream is considered to be in good condition with potential for higher biodiversity values.

| Stream | Redbank Creek | | |
|---|---|---|---|
| Site | 1 | 2 | 3 |
| RCE Score | 35 | 38 | 39 |

*Table 8: Redbank Creek – RCE Inventory Scores*

- **Site 1 Redbank Creek - Down Stream**

  The site is located immediately downstream of LW32. The stream is in a moderate condition (RCE score 35) however there were high levels of disturbance including bank erosion, sedimentation and weeds. Canopy vegetation was dominated by weeds including Large Leaf Privet, Small Leaf Privet. *Eucalyptus tereticornis* was also present. The dominant midstorey species was Turkey Rhubarb and ground cover dominated by *Tradescantia spp*., *Commelina cyanea*, and *Microleana stipoides*. The vegetation provided moderate shading of the stream.

  This stream at the location was mostly shallow (<1m depth) with 2m modal width. The benthic substrate of the stream contained some gravel but was dominated by finer sized sediment including sand and silt. There were few macrophytes present at this site (approximately<3% of the reach contained macrophytes) with the distribution of the macrophytes being confined to the stream edge. There are pools present, however there is commonly little flow.

- **Site 2 Redbank Creek – LW32**

  The site is located over the proposed LW32. The stream is in a moderate condition (RCE 38) but shows high levels of disturbance including sedimentation, and dominance of weeds in the riparian vegetation. Canopy vegetation was dominated by weeds Large Leaf Privet and Small Leaf Privet. *Eucalyptus moluccana* and *Angophora floribunda* also occurred. Weedy shrubs dominated the mid-storey including Large and Small Leaf Privet and Lantana

(*Lantana camara*). Ground cover was dominated by weeds Wandering Jew (*Tradescantia spp*.), Panic Veldt Grass (*Erharta erecta*), as well as native species *Microleana stipoides*. The vegetation provided moderate shading of the stream.

- **Site 3 Redbank Creek – Upstream LW31**

  The site is located on the left bank of Redbank Creek and over Longwall 31. The stream was in moderate condition (RCE 39) however showed high levels of disturbance including rubbish, and dominance of weeds. Canopy vegetation was dominated *Backhousia myrhfolia*, and weeds including Large and Small Leaf Privet. The mid-storey was dominated by Bursaria spinulosa and the ground cover by *Lomandra longifolia, Microleana stipodes, Commelina cyanea* as well as the weed Wandering Jew (Tradescantia spp.). The vegetation provided moderate shading of the stream.

  This stream is shallow (<1m depth) with 2.5m modal width. The stream substrate consists of bedrock, sand and silt. There are no macrophytes observed at this site. There are pools present, however there was little flow.

Results of macroinvertebrates at these sampling sites within Redbank Creek are presented in **Table 9**, which shows that 39 different taxa are found in Redbank Creek, with the number of taxa ranging from 9-17 between the sites.

Redbank Creek scored low SIGNAL values indicating that sites are severely polluted as they contain pollution tolerant macroinvertebrate families. This indicates that there are more pollution sensitive invertebrates at these sites and the presence of these fauna infer that these streams are unlikely to be severely affected by pollution. One family in particular, Leptophlebiidae (SIGNAL 8) was notably absent from all Redbank Creek sites. The family is common among the ephemeral/semi-permanent streams in the area and its absence may show that Redbank Creek is under natural or anthropogenic stress.

| Stream | Redbank Creek | | |
|---|---|---|---|
| **Site** | **1** | **2** | **3** |
| No of taxa | 9 | 16 | 10 |
| OE 50) | 0.68 | 0.78 | 0.53 |
| Signal | 3.44 | 3.44 | 4 |
| Band | B | B | B |

***Table 9: Redbank Creek – AUSRIVAS Results***

Water quality sampling for aquatic ecology, as shown on **Table 10**, found that temperature varies seasonally whilst conductivity ranged between 212-2,003 µ/cm. Sites in Redbank Creek had raised electrical conductivity. Turbidity was low.

Considering the sampling was conducted after a moderate rainfall event this result is not considered environmentally significant. Dissolved oxygen ranged between 61 – 90.1% saturation, with most sites falling outside of ANZECC trigger values. Lower dissolved oxygen however is a characteristic of the non-flowing semi-permanent/ephemeral groundwater baseflow dependent ecosystems in the region so these values are not considered environmentally significant. The pH range was generally low (3.88—7.02) and was exceeded at all three sites.

| Stream | Redbank Creek | | |
|---|---|---|---|
| Site | 1 | 2 | 3 |
| Temperature (ºC) | 13 | 13.05 | 12.34 |
| Electrical conductivity (µS/cm) ANZECC | 1,521 | 1,478 | 2,003 |
| Turbidity (NTU) | 10 | 150 | 12 |
| Dissolved (oxygen saturation) | 71 | 77.6 | 84.7 |
| pH | 6.4 | 6.14 | 3.88 |
| Alkalinity (mg CaCa3/L) | 15 | 15 | 0 |
| Oxygen reduction potential (mV) | 270 | 146 | 370 |

*Table 10: Redbank Creek – Water Quality*

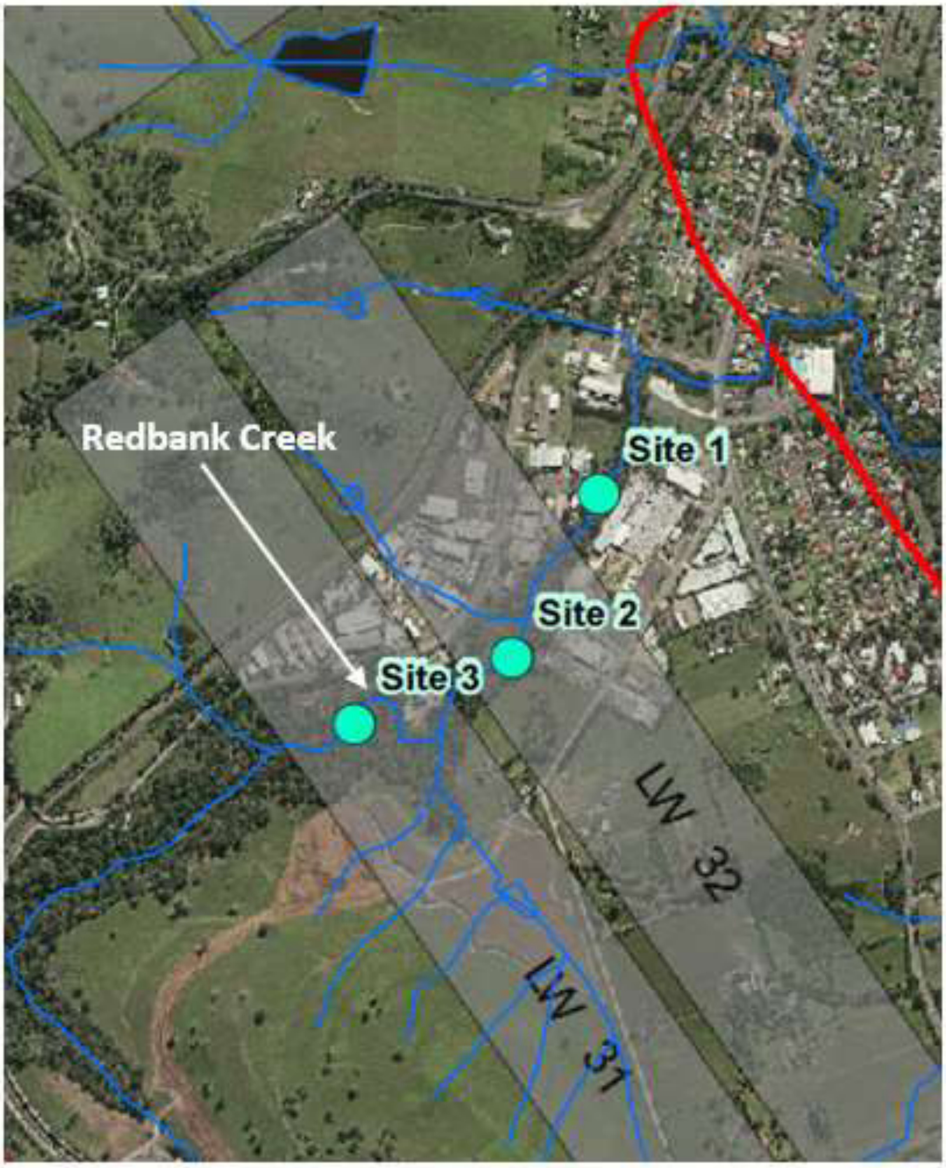


*Figure 17: Redbank Creek – Aquatic Ecology Sites*

### 8.3.4 Key Fish Habitat

Redbank Creek is mapped as *'key fish habitat'* and is classed as having TYPE 1 highly sensitive and TYPE 2 moderately sensitive aquatic habitat.

Redbank Creek is classed as TYPE 2 fish passage and has moderate key fish habitat.

It is possible that there will be a net reduction in key fish habitat as a result of localised flow diversion and draining of pools. Stream connectivity and hence fish passage will be accessible in periods of higher flow.

## 8.4 Aboriginal Cultural Heritage

Two archaeological sites are located directly above LW32, as shown on **Figure 18**.

The sites comprise an open camp site and a grinding groove site.

The open camp site is unlikely to experience adverse subsidence impacts resulting from the proposed LW32 mining. It is possible that fracturing could occur in the vicinity of the grinding groove site as a result of the proposed LW32 mining.

TCCO has submitted a Section 90 application to OEH.

| Site Number and Name | Site Type | Archaeological Significance | Potential For Impact | Recommendations |
|---|---|---|---|---|
| 52-2-2082<br>Redbank Creek 4 | Grinding Groove Site | Low | Moderate | S90 Consent to Disturb from OEH<br>ACHMP prepared which details monitoring by an archaeologist and Aboriginal Stakeholders |

***Table 11: Aboriginal Cultural Heritage***


*Figure 1: Aboriginal Archaeological Sites*

## 8.5 European Heritage

Koorana House is located directly above proposed LW32 and Mill Hill located beyond the finishing end of proposed LW32, as shown on **Figure 19**.

The heritage properties could experience subsidence impacts, but are expected to remain safe, serviceable and repairable. TCCO has identified, investigated and analysed mine subsidence hazards at the properties in a systematic manner, with inspections and investigations by a structural engineer, and a heritage consultant.

TCCO has developed and implemented Property Subsidence Management Plan (**PSMP**) for the mining of LW32 in consultation with the owners of each heritage property.

The PSMPs includes ground surveys and visual inspections.

The Fairley Residence, as shown on **Figure 19**, on Argyle Street is located approximately 400 metres to the side of LW32 and is expected to experience minor subsidence movements during the extraction of proposed LW32. A PSMP for Fairley House has been developed and implemented with the property owner.

| Site Name | Structure Type | Heritage Significance | Potential Impact | Recommendations |
|---|---|---|---|---|
| Koorana Homestead Complex<br>2240 Remembrance Drive, Tahmoor | - Main federation style house<br>- Stables<br>- Cottage<br>- 3 brick wells | Local | Low | Specific Statement of Heritage Impact and Property Subsidence Management Plan developed in consultation with property owner and submitted to Wollondilly Shire Council prior to subsidence. |
| Mill Hill<br>Millers House and Archaeological Relics<br>675 Thirlmere Way, Picton | - Federation style weatherboard house<br>- small cottage<br>- brick well<br>- possible archaeological remains of windmill | Local | Low | Specific Statement of Heritage Impact and Property Subsidence Management Plan developed in consultation with property owner and submitted to Wollondilly Shire Council prior to subsidence. |

*Table 12: European Historical Heritage*

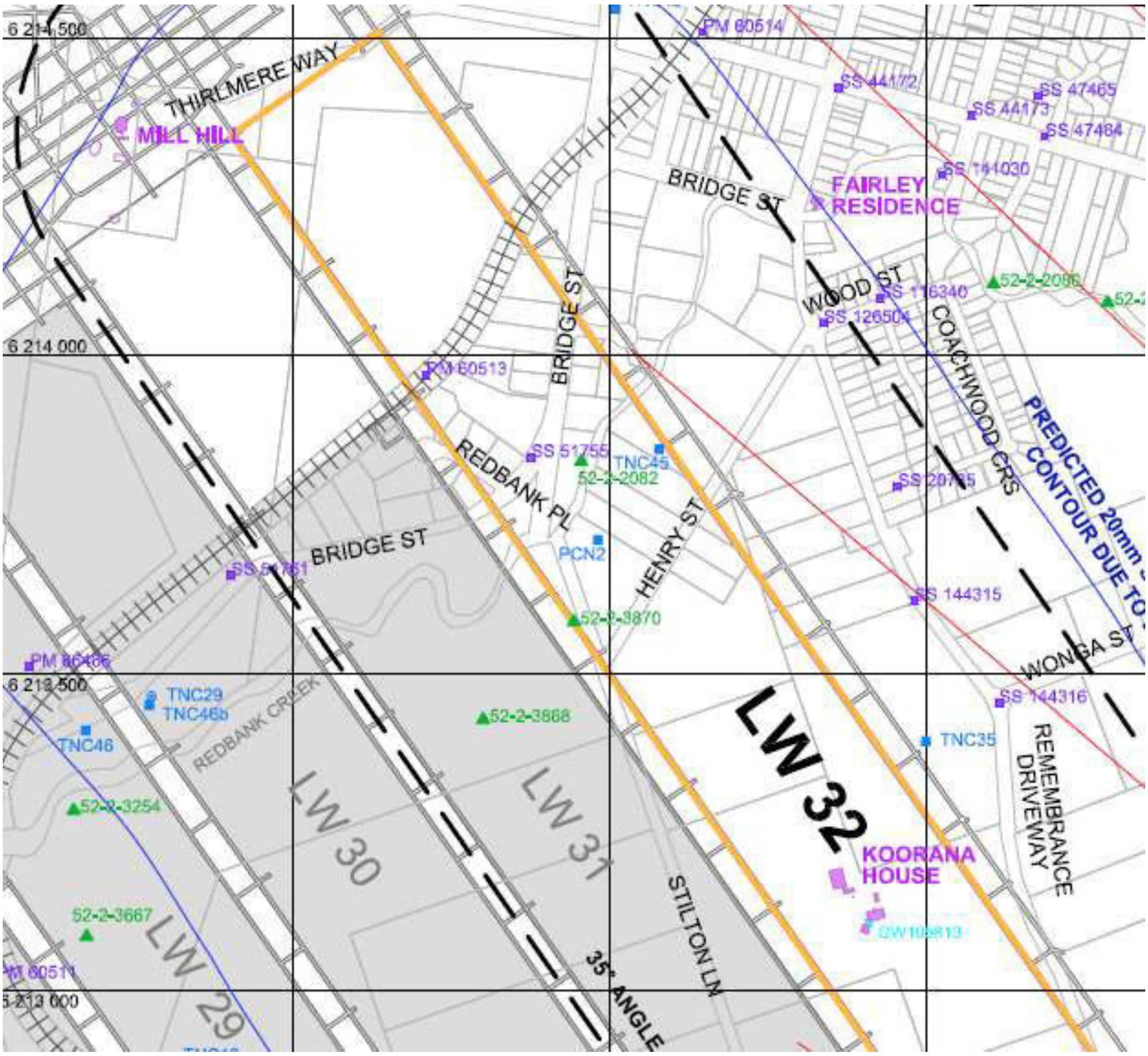


*Figure 19: European Heritage Sites*

## 8.6 Steep Slopes

The locations of the steep slopes are shown on **Figure 20**.

A steep slope is defined as *"an area of land having a natural gradient greater than 1 in 3 (i.e. a grade of 33 %, or an angle to the horizontal of 18°)"*.

Slopes with grades greater than 1 in 3 have been identified on the slopes of Redbank Range within LW32.

There are no identified cliffs located within LW32.

As shown on **Figure 20**, natural steep slopes exist directly above and adjacent to LW32 along the banks of Redbank Creek and along the sides of ridges, such as the Redbank Range and alongside Thirlmere Way. Some structures are located on or near steep slopes, with no impacts observed during the mining of Longwall 31.

Tension cracks could develop at the tops and along the sides of the steep slopes and compression ridges could develop at the bases of these slopes. Localised natural slope slippage has been observed along the Redbank Range and it is possible, therefore, that further localised slope slippages could develop along the ridges that may be attributable to either natural causes, mine subsidence, or both.

Experience indicates that the probability of large scale slope slippage due to the proposed mining is extremely low due to the significant depth of cover beneath the ridges. No large-scale mining-induced slope failures have been observed in the NSW Southern Coalfield at depths of cover exceeding 400 metres.

While the risk is extremely low, some risk remains and attention must therefore be paid to any structures or roads that may be located in the vicinity of steep slopes.

TCCO has developed the Built Features SMP for managing the potential impacts on steep slopes during the mining of LW32. A geotechnical engineering inspection and assessment has been undertaken for steep slopes located near structures. The Built Features Management Plan includes ground surveys and visual inspections of structures near steep slopes.

A geotechnical engineering inspection has been undertaken in relation to the steep slopes that are located to the side of Thirlmere Way, which runs along the top of a ridge near the finishing ends of Longwalls 31 and 32. Whilst no concerns were raised from the inspection, specific management strategies have been developed for Thirlmere Way in consultation with Wollondilly Shire Council and survey pegs have been installed. TCCO has developed the Council Infrastructure SMP in consultation with Wollondilly Shire Council.

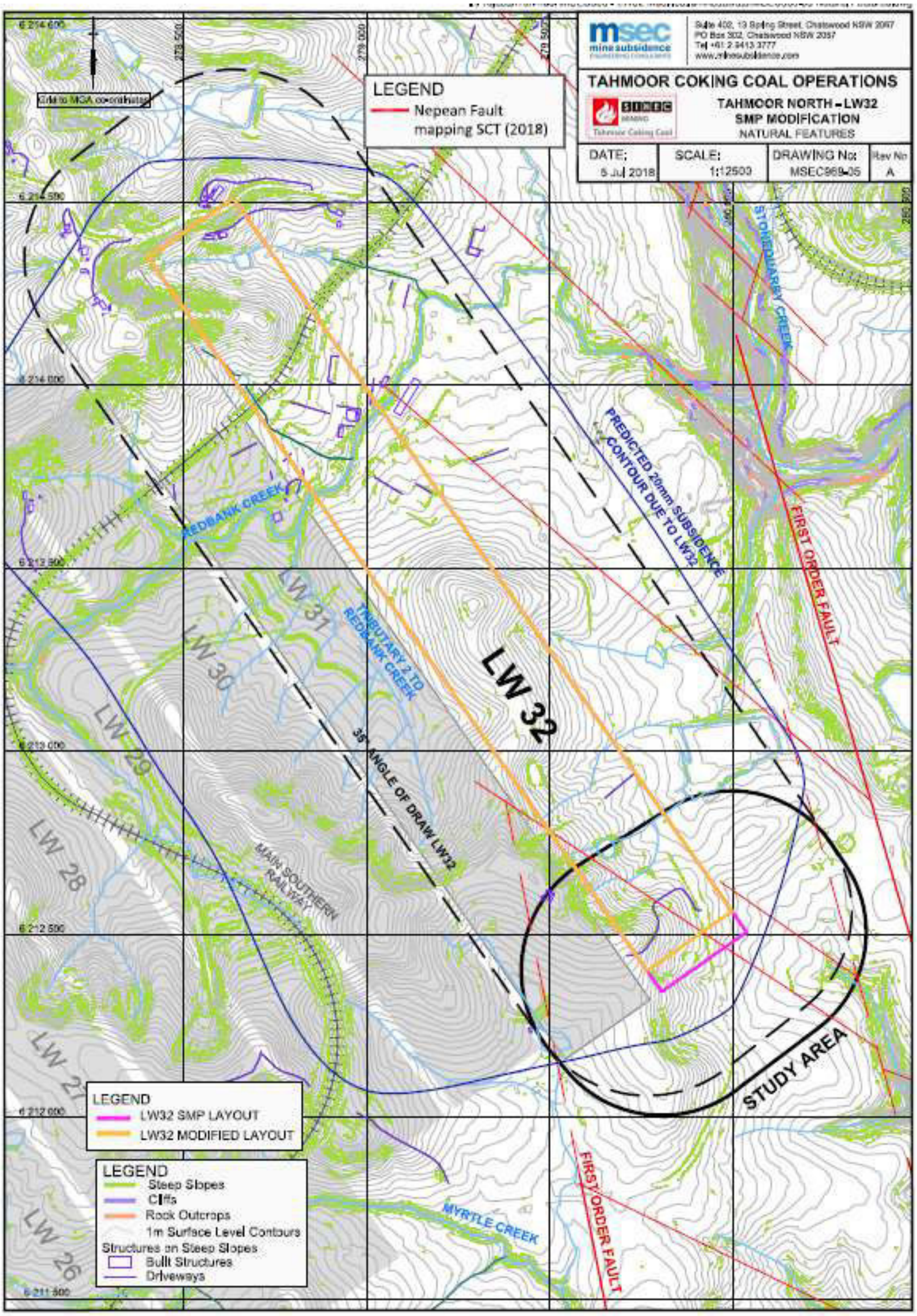


*Figure 20: LW32 – Steep Slopes*

# 9 Monitoring Program

A detailed monitoring plan is outlined within **Appendix 1**.

# 10 Subsidence Impact Response

## 10.1 Trigger Action Response Plan

Trigger, Action, Response Plans (**TARPs**) are a common management tool used to manage risk in many industries, including the underground coal mining industry in NSW.

TARPs involve a set of clear and quantifiable triggers. When any one monitoring trigger is met, it automatically leads to a pre-defined management action and to any pre-agreed mitigatory or remedial response. Once a subsidence impact or environmental consequence is identified, it triggers a series of actions according to the level or significance of the impact. TARP triggers are typically sequential, so that, subsidence impacts or environmental consequences may initially be reported as Level 1 and later progress to Level 2 and maybe Level 3 if successive triggers are exceeded.

The TARP system provides a simple, transparent and useable reference of the monitoring of environmental performance and the implementation of management and/or contingency measures. It provides a transparent method to monitor the environmental performance and, where required, implement management and/or contingency measures where the components of the proposed monitoring will serve to alert the mine if an abnormal problem does, or potentially may, exist.

The TARP is designed with consideration of baseline conditions and predicted subsidence impacts and comprises the following:

- Trigger levels from monitoring to assess performance; and
- Triggers that flag implementation of contingency measures.

The TARP is designed to identify, assess and respond to impacts, including impacts greater than predicted, in the proposed mining area.

The TARP outlines what actions will be taken in the case where exceedance of the approved impact assessment criteria occur.

Site specific mitigation, or corrective management action plans (**CMAP**), can be required, and may include:

- Description of the impact to be managed;
- Results of the investigations;
- Aims and objectives for the Plan;
- Specific actions required to mitigate/manage the issue;
- Timeframes for implementation;
- Roles and responsibilities;
- Identification of and gaining appropriate approvals from key government agencies; and
- Providing a consultation and communication plan.

The proposed triggers are based on baseline monitoring and predicted subsidence impacts, with monitoring changes and/or specific triggers continuing to be developed as monitoring matures and is refined.

Where a trigger is exceeded, the cause and effect can be investigated and a CMAP can be developed if the cause is directly related to mining.

Refined triggers can be proposed within End of Panel (**EOP**) reports or TCCO Annual Environmental Management Report (**AEMR**).

## 10.2 Trigger Levels

The proposed triggers are based on baseline monitoring and anticipated subsidence effects are outlined in **Appendix 2**, with monitoring changes and/or specific triggers continuing to be developed as monitoring matures and refined.

Where a trigger is exceeded, the cause and effect can be investigated and a CMAP developed if the cause is directly related to mining.

## 10.3 Trigger Level Exceedances

The TARP, contained within **Appendix 2,** outlines what actions will be taken in the case if exceedances of the impact assessment criteria occur.

Site specific mitigation or CMAP are required, and can include:

- Notification to stakeholders;
- Description of the impact to be managed;
- Results of the investigations;
- Aims and objections for the plan;
- Specific actions required to mitigate/manage the issue;
- Timeframes for implementation;
- Roles and responsibilities;
- Identification of and gaining approvals from government agencies; and
- Providing a consultation and communication plan.

The mitigation or remediation plans will outline methods to ensure that ongoing impacts reduce to levels below the impact assessment criteria as quickly as possible.

## 10.4 Mitigation and Remediation Measures

The TARP, contained within **Appendix 2**, outlines mitigation and remediation measures.

## 10.5 Exceedances Notification

The TARP, contained within Appendix A, contains actions if the trigger values exceed predictions that require TCCO to notify the following stakeholders:

- Resources Regulator - Principal Subsidence Engineer;
- Resources Regulator - Director Compliance Operations;
- Subsidence Advisory NSW;
- Department of Industry – Water; and
- Other relevant government stakeholders, such as OEH or Wollondilly Shire Council.

Condition 14 of the SMP Approval has additional requirements for reporting and states the following:

***Incident and Ongoing Management Reporting***

*14. The Leaseholder must, within 24 hours of becoming aware of the occurrence, notify:*

*a) the Principal Subsidence Engineer;*

*b) Director Compliance Operations;*

*c) SA;*

*d) NSWOW;*

*e) other relevant stakeholders and any Government Agency with a regulatory role if they request such notification, of the following:*

*i. Any significant unpredicted and/or higher-than-predicted subsidence and/or abnormalities in the development of subsidence;*

*ii. Any exceedance of predicted impacts on groundwater resources and/or the natural environment that may have been caused (whether partly or wholly) by subsidence;*

*iii. Any observed subsidence impacts adverse to the serviceability and/or safety of infrastructure and other built structures that may be affected by longwall mining;*

*iv. Any significant subsidence-induced cracking and/or ground deformations observed in any surface areas within the SMP application area;*

*v. Any buildings, structure and infrastructure, which have become or likely to become hazardous as a result of subsidence, and*

*vi. Development of instability and/or falls of rocks within any areas with cliff formation and/or steep slopes that may have been affected by subsidence.*

*f) the operators of infrastructure affected by subsidence.*

*Note: Under Condition 11, the Leaseholder can be directed to, among other things, prepare a report on an incident reported under this condition. A report on the details of the incident, including likely or known causes, response action and proposed response measures will generally be required for incidents that involve material property or environmental damage or have the potential to cause such damage.*

## 10.6 Contingency Plan

In the event that LW32 triggers are considered to have been exceeded, or are likely to be exceeded, TCCO will implement a Contingency Plan to manage any unpredicted impacts and their consequences.

The Contingency Plan would involve the following actions:

- Capture record of the exceedance immediately;
- Notify relevant stakeholders as soon as practicable;
- Notify relevant agencies and specialists as soon as practicable;
- Conduct site visits with stakeholders as required;
- Contract specialists to investigate and report on identified impacts;
- Provide incident report to relevant agencies within seven days;
- Undertake a condition assessment to record impacts within 14 days;
- Establish weekly monitoring frequency until any unstable area/s are stabilised;
- Monthly updates from specialists on investigation process;
- Inform relevant agencies and stakeholders of results of investigation within 1 week of completion;

- Develop site Corrective Management Actions (**CMA**) in consultation with key stakeholders if required within 1 month, (pending stakeholder availability) and seek approvals;
- Implement CMA as agreed with stakeholders following approvals;
- Conduct initial follow up monitoring and reporting within two months of CMA completion;
- Review management and implementation controls for the CMAP within three months; and
- Report results in regular reporting e.g. AEMR.

## 10.7 Reporting

### 10.7.1 Longwall 32 Status Report

Condition 15 of the SMP Approval requires a Subsidence Management Status Report be updated at least every 14 days and states the following:

> ***Status Report***
>
> *15. The Leaseholder must prepare and maintain a Subsidence Management Status Report which must include but not be limited to:*
>
> *a) the current face position of the panel being extracted;*
>
> *b) a summary of any subsidence management actions undertaken by the Leaseholder;*
>
> *c) a summary of any comments, advice and feedback from consultation with stakeholders in relation to the implementation of this Approval (including the preparation, implementation and review of plans, programs, reports or strategies required by this approval) undertaken or received and a summary of the Leaseholder's response to the comments, advice and feedback given by the stakeholders;*
>
> *d) a summary of the observed and/or reported subsidence impacts, incidents, service difficulties, community complaints, and any other relevant information reported to the Leaseholder and a summary of the Leaseholder's response to these impacts, incidents, service difficulties and complaints;*
>
> *e) a summary of subsidence development based on monitoring information compared with any defined triggers and/or the predicted subsidence to facilitate early detection of potential subsidence impacts;*
>
> *f) a summary of the adequacy, quality and effectiveness of the implemented management processes based on the monitoring and consultation information summarised above; and*
>
> *g) a statement regarding any additional and/or outstanding management actions to be undertaken or the need for early responses or emergency procedures to ensure adequate management of any potential subsidence impacts due to longwall mining.*
>
> *The Subsidence Management Status Report must be updated at least every 14 days to reflect any changes in the information required to be included in the Report. The Status Report (as updated from time to time) must be provided, upon request, to SA, the Director of Compliance Operations, the Principal Subsidence Engineer, owners/operators of any infrastructure within the application area and any other relevant government agencies.*

TCCO's subsidence consultant MSEC prepares a weekly LW32 Subsidence Status Report that is distributed to a range of stakeholders, including:

- Resources Regulator;
- Subsidence Advisory NSW;
- OEH; and
- Wollondilly Shire Council.

### 10.7.2 Monthly Longwall Report Newsletter

TCCO produce a Monthly Longwall Report Newsletter that outlines the monthly longwall status and is distributed to key stakeholders during the extraction of LW32 and includes the following information:

- Monitoring period;
- Current length of extraction;
- Distance travelled by longwall since previous report;
- Distance to completion of longwall;
- Summary of observed ground movements;
- Have any triggers been reached; and
- Monitoring results for natural features outlined in this Management Plan.

### 10.7.3 End of Panel Report

A LW32 End of Panel (**EOP**) Report will be prepared that will include:

- A summary of the subsidence and environmental monitoring results for the year;
- An analysis of the monitoring results against the relevant impact assessment criteria;
- Monitoring results from previous panels;
- Assessment against subsidence predictions;
- Identification of any trends in the monitoring results; and
- Description of actions taken to ensure management of any potential or actual subsidence impacts due to mining.

The EOP Report will be submitted with the TCCO Annual Review required as a condition of the development consent and the SMP Approval.

### 10.7.4 Annual Report

Condition 16 of the SMP Approval requires an Annual Report be prepared and states the following:

> ***Annual Report***
>
> *16.*
>
> *a) The Leaseholder shall prepare an annual report. This report shall be submitted to the Secretary within twelve months of the date of this approval and annually thereafter. The annual report must:*
>
> *b) include a summary of the subsidence and environmental monitoring results for the year;*
>
> *c) include an analysis of these monitoring results against the relevant;*

- *impact assessment criteria;*
- *monitoring results from previous panels; and*
- *predictions in the SMP;*

*d) identify any trends in the monitoring results over the life of the activity; and*

*e) describe what actions were taken to ensure adequate management of any potential or actual subsidence impacts due to mining.*

*Note: The requirement of this condition may be satisfied via an Annual Review prepared under conditions of development consent or project approval.*

TCCO produces an Annual Review, which is a requirement of conditions of the development consent and the SMP Approval.

# 11 Plan Administration

## 11.1 Consultation

A crucial aspect to the success of managing the consultation aspects of the implementation of the LW32 EMP is ensuring that ongoing, transparent and two way communication is adopted between TCCO and relevant stakeholders with an ongoing interest in the successful implementation of the LW32 EMP.

Stakeholders that have been consulted in the preparation of this LW32 EMP are outlined on **Table 13**.

| Stakeholder | Form of Consultation | Date |
|---|---|---|
| Wollondilly Shire Council | Meeting and presentation | 22 March 2019 |
| OEH | Meeting and presentation | 21 March 2019 |
| Department of Industry - Water | Email | 21 March 2019 |
| OEH | AHIP Application | 24 October 2018 |

***Table 13: EMP Stakeholder Consultation***

## 11.2 Enquiry Management

TCCO has a 24 hour community phone line (**1800 154 415**) for community enquiries. This phone line will be utilised to manage all enquiries relating to the LW32 EMP. They will be recorded in the TCCO Environment & Community Stakeholder database, administered by the TCCO Community Coordinator.

TCCO has an enquiry email (tahmoorenquiries@simecgfg.com) and a TCCO website (http://www.simec.com/mining/tahmoor-coking-coal-operations/).

The TCCO Community Coordinator and/or the TCCO Environment Coordinator and/or the Environment Projects Coordinator will be responsible for responding to all email enquiries. An email response will be sent as soon as possible to all email enquiries.

## 11.3 Roles and Responsibilities

All statutory obligations applicable to the LW32 EMP are identified and managed via the TCCO CMO compliance management system administered by the TCCO Compliance Coordinator.

The overall responsibility for the implementation of the LW32 EMP resides with the TCCO Environment & Community Manager.

The responsibilities of the following TCCO staff related to the management and implementation of the LW32 EMP are outlined on **Table 14**.

| Role | Redbank Creek EMP Accountabilities |
|---|---|
| General Manager | • Ensure that LW32 EMP implementation is managed and adequately resourced so that works can be completed in a manner that is safe and in compliance with the requirements of the LW32 EMP. |
| Environment and Community Manager | • Ensure sufficient resource allocation for the implementation of the LW32 EMP.<br>• Ensure LW32 EMP implementation works are planned and budgeted within the TCCO LOM and budget planning process.<br>• Ensure all internal and external reporting, reviews, audits, non-conformances and improvement requirements are met, including incident reporting.<br>• Proactively engage government and community stakeholders as required.<br>• Review and approve internal and external reports e.g. Annual Report.<br>• Ensure effective management of all community complaints.<br>• Review, approve and endorse any LW32 EMP amendments to DPE-RR (Environment) for approval. |
| Community Coordinator | • Coordinate ongoing stakeholder consultation.<br>• Preparation and distribution of the TCCO monthly newsletters. |
| Environment Coordinator | • LW32 EMP implementation.<br>• Implementation of Contingency Plan (if required).<br>• Preparation and management of LW32 EMP reporting, audits and reviews for review and approval by the TCCO Environment & Community Manager.<br>• Assist with the preparation and ongoing management of the Stakeholder and Consultation Plan, stakeholder consultation and Contingency Plan.<br>• Assist in preparation and distribution of TCCO monthly newsletters.<br>• Identification and reporting of any incidents, non-conformances identified during the implementation of the LW32 EMP. |
| Environment Projects Coordinator | • LW32 EMP implementation.<br>• Implementation of Contingency Plan (if required).<br>• Preparation and management of LW32 EMP reporting, audits and reviews for review and approval by the TCCO Environment & Community Manager.<br>• Assist with the preparation and ongoing management of the Stakeholder and Consultation Plan, stakeholder consultation and Contingency Plan.<br>• Assist in preparation and distribution of TCCO monthly newsletters.<br>• Identification and reporting of any incidents, non-conformances identified during the implementation of the LW32 EMP. |
| Compliance Coordinator | • Administration of the TCCO CMO compliance management system.<br>• Administration of the TCCO document control system. |
| Training Coordinator | • Administration of TCCO training records |

***Table 14: LW32 EMP Roles and Responsibilities***

# 11.4 Incidents, Compliants, Non-Conformances & Corrective Actions

## 11.4.1 Incidents

TCCO will notify the NSW Resources Regulator and any other relevant agencies of any incident associated with the implementation of the LW32 EMP as soon as practicable after TCCO confirms the incident.

TCCO will provide the NSW Resources Regulator and any relevant agencies with a detailed report on the incident within seven days of confirmation of any event.

## 11.4.2 Compliants

To ensure any community complaints related to the LW32 EMP are addressed in a timely and satisfactory manner, TCCO will:

- Provide a readily accessible contact point through a 24 hour toll-free Community Call Line (**1800 154 415**) or TCCO enquiries email (tahmoorenquiries@simecgfg.com);
- The number will be displayed prominently on work sites in a position visible by the public as well as on publications provided to the local community, such as TCCO newsletters;
- Respond to complaints in accordance with the TCCO Community Complaints Procedure;
- Maintain good relations and communication lines between the community and TCCO staff; and
- Keep a register of any complaints, including the details of the complaint.

## 11.4.3 Non-Conformance Protocol

The requirement to comply with all approvals, plans and procedures is the responsibility of all personnel (staff and contractors) employed for or in association with the LW32 EMP. Regular inspections, internal audits and initiation of any remediation/rectification work in relation to the LW32 EMP will be undertaken by the TCCO Environment & Community Manager.

Non-conformities, corrective actions and preventative actions are managed in accordance with the TCCO Non-Conformance, Preventative and Corrective Action Procedure. This procedure details the processes to be utilized with respect to the identification of non-conformances, the application of appropriate corrective actions(s) to address non-conformances and the establishment of preventative actions to avoid non-conformances. The key elements of the process include:

- Identification of non-conformance and/or non-compliances;
- Recording of non-conformance and/or non-compliance;
- Evaluation of the non-conformance and/or non-compliance to determine specific corrective and preventative actions;
- Corrective and preventative actions to be assigned to the responsible person; and
- Management review of corrective actions to ensure the status and effectiveness of the actions.

The LW32 EMP will be administered in accordance with the requirements of the TCCO Environmental Management System (**EMS**) and all relevant Development Consent Conditions. An Annual Review will be undertaken to assess the LW32 EMP compliance with all conditions of the relevant Development Consent, mining leases and all other approvals and licenses.

### 11.4.4 Corrective Action

Non-conformances relating to the content of this LW32 EMP will be identified through the following methods:

- Weekly inspections:
- Monitoring and surveys:
- Reporting;
- Incident and hazard reporting; and
- Reviews and audits.

The TCCO Environment & Community Manager and/or other delegated TCCO senior Manager or TCCO Compliance Coordinator will investigate all non-conformances identified, and ensure corrective actions are defined, implemented and monitored.

Identifying and tracking of remedial corrective action will via the TCCO CMO compliance management system administered by the TCCO Compliance Coordinator.

Corrective action processes and/or investigations will be undertaken and recorded. Investigations will determine cause, corrective action, and action to prevent reoccurrence. Action plans will be developed and responsibilities defined and assigned. Results and action undertaken will be communicated back to the relevant stakeholders and recorded within CMO by the TCCO Compliance Coordinator.

## 11.5 Document Control

### 11.5.1 Document Control

The LW32 EMP, including all associated ancillary management plans, reports, monitoring, procedures and other documents, are subject to the TCCO document and record control system administered by the TCCO Compliance Coordinator.

The controlled document of this LW32 EMP is that document appearing on the TCCO electronic intranet.

### 11.5.2 Record Keeping

Records will be retained at the mine for a period of 7 years from the date the record was made.

Records related to the LW32 EMP include:

- Risk assessments;
- Reports and monitoring;
- Events;
- Non-conformances- corrective action;
- Audits; and
- Reviews.

## 11.6 Audit

Audits of the LW32 EMP will be conducted by the TCCO Environment & Community Manager and/or other delegated TCCO senior Manager or TCCO Compliance Coordinator on an as required basis but with at least one audit conducted annually. Audits will be conducted in consultation with the relevant TCCO staff and will focus on the content and implementation of the LW32 EMP.

Audits on the content will consist of a determination of understanding of the LW32 EMP by the individual's allocated responsibility under the LW32 EMP.

Audits on the implementation shall consist of reviews of the safe working procedures and risk assessments developed to ensure safe operation of the LW32 EMP. These audits may also involve discussions with personnel involved in the management of works to determine understanding and compliance.

Should an audit of the LW32 EMP determine that a deficiency is evident in the content or implementation; a corrective action must be developed and implemented.  Actions will be assigned to a nominated individual and tracked in CMO administered by the TCCO Compliance Coordinator.

Any changes LW32 EMP are to be managed and communicated to all personnel in line with the TCCO Change Management Process administered by the TCCO Compliance Coordinator.

## 11.7 Change Management

Full details of the document history are recorded in the document control register, by version is outlined on **Table 15**.

| Version | Date Reviewed | Reviewer | Change Summary |
|---|---|---|---|
| 1.0 | 10/03/2019 | Ron Bush | New document |
| 2.0 | 04/05/2019 | Ron Bush | Changes to Monitoring Plan and reference to Redbank Creek CMAP following feedback from Resource Regulator review of Version 1. |

***Table 15: LW32 EMP Document Control Register***

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# APPENDIX 1

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| Feature | Monitoring | | |
|---|---|---|---|
| | **Prior to Mining** | **During Mining** | **Post Mining** |
| **Rainfall Sites TCCO Pit Top Met Station and Picton Council Met Station** | Continuous daily rainfall monitoring for at least two months prior to mining | Continuous daily rainfall monitoring | Continuous daily rainfall monitoring for minimum of 12 months post mining |
| **Groundwater Quality Bore P10** | Field water quality (EC, pH) monthly<br><br>Laboratory analysis monthly for TDS, Na, K, Ca, Mg, F, Cl, SO4, HCO3, NO3, Total N, Total P, Cu, Pb, Zn, Ni, Fe, Mn, As, Se, Cd, (filtered) | 400 metres before and after LW32 face<br><br>Field water quality (EC, pH) weekly<br><br>Laboratory analysis weekly for TDS, Na, K, Ca, Mg, F, Cl, SO4, HCO3, NO3, Total N, Total P, Cu, Pb, Zn, Ni, Fe, Mn, As, Se, Cd, (filtered) | Field water quality (EC, pH) bi-monthly for a minimum period of 12 months after LW32 completed<br><br>Laboratory analysis bi-monthly for a minimum period of 12 months after LW32 completed for TDS, Na, K, Ca, Mg, F, Cl, SO4, HCO3, NO3, Total N, Total P, Cu, Pb, Zn, Ni, Fe, Mn, As, Se, Cd, (filtered) |
| **Groundwater Quality Bores P1, P2, P3, P4, P5, P6, P7, P8, P9 and P11** | Field water quality (EC, pH) bi-monthly<br><br>Laboratory analysis bi-monthly for TDS, Na, K, Ca, Mg, F, Cl, SO4, HCO3, NO3, Total N, Total P, Cu, Pb, Zn, Ni, Fe, Mn, As, Se, Cd, (filtered) | Field water quality (EC, pH) bi-monthly<br><br>Laboratory analysis bi-monthly for TDS, Na, K, Ca, Mg, F, Cl, SO4, HCO3, NO3, Total N, Total P, Cu, Pb, Zn, Ni, Fe, Mn, As, Se, Cd, (filtered) | Field water quality (EC, pH) bi-monthly for a minimum period of 12 months after LW32 completed<br><br>Laboratory analysis bi-monthly for a minimum period of 12 months after LW32 completed for TDS, Na, K, Ca, Mg, F, Cl, SO4, HCO3, NO3, Total N, Total P, Cu, Pb, Zn, Ni, Fe, Mn, As, Se, Cd, (filtered) |
| **Groundwater Levels Bore P10** | Minimum continuous 24-hourly readings with monthly logger download and dip meter | 400 metres before and after LW32 face<br><br>Minimum continuous 24-hourly readings with weekly logger download and dip meter | Minimum continuous 24-hourly readings with monthly logger download and dip meter for a minimum period of 12 months after LW32 completed |

| | Prior to Mining | During Mining | Post Mining |
|---|---|---|---|
| **Groundwater Levels Bores P1, P2, P3, P4, P5, P6, P7, P8, P9 and P11** | Minimum continuous 24-hourly readings with bi-monthly logger download and dip meter | 400 metres before and after LW32 face<br><br>Minimum continuous 24-hourly readings with bi-monthly logger download and dip meter | Minimum continuous 24-hourly readings with bi-monthly logger download and dip meter for a minimum period of 12 months after LW32 completed |
| **Groundwater Pressures VWPs TNC37, 40, 43** | Minimum continuous 24-hourly readings<br>Bi- monthly logger download | Minimum continuous 24-hourly readings<br>Bi-monthly logger download | Minimum continuous 24-hourly for a minimum period of 12 months after LW32 completed<br>Bi- monthly logger download for a minimum period of 12 months after LW32 completed |
| **Groundwater Quality (no SWL due to pump installation) GW105813** | Field water quality (EC, pH) 1 month before active subsidence period<br><br>Laboratory analysis for TDS, Na, K, Ca, Mg, F, Cl, SO4, HCO3, NO3, Total N, Total P, Cu, Pb, Zn, Ni, Fe, Mn, As, Se, Cd, (filtered) 1 month before active subsidence period<br><br>Bore flow test 1 month before active subsidence period | 400 metres before and after LW32 face<br><br>Field water quality (EC, pH) sample during active subsidence period<br><br>Laboratory analysis for TDS, Na, K, Ca, Mg, F, Cl, SO4, HCO3, NO3, Total N, Total P, Cu, Pb, Zn, Ni, Fe, Mn, As, Se, Cd, (filtered) sample during active subsidence period<br><br>Bore flow test during active subsidence period | Field water quality (EC, pH) 6- monthly after active subsidence period<br><br>Laboratory analysis for TDS, Na, K, Ca, Mg, F, Cl, SO4, HCO3, NO3, Total N, Total P, Cu, Pb, Zn, Ni, Fe, Mn, As, Se, Cd, (filtered) 6- monthly after active subsidence period<br><br>Bore flow test 6- monthly after active subsidence period |

| | Prior to Mining | During Mining | Post Mining |
|---|---|---|---|
| **Stream Water Quality Sites**<br>**RC1, RC2, RC3, RC4, RC5 and RC6** | Monthly manual field analysis (EC, pH, DO, ORP, temp)<br><br>Monthly Laboratory Analysis of TDS, Na, K, Ca, Mg, F, Cl, SO4, HCO3, NO3, Total N, Total P, Cu, Pb, Zn, Ni, Fe, Mn, As, Li, Ba,<br>(filtered) DOC, Tot. Alkalinity<br><br>Monthly observation of iron hydroxide staining using photo points | Monthly manual field analysis (EC, pH, DO, ORP, temp)<br><br>Monthly Laboratory Analysis of TDS, Na, K, Ca, Mg, F, Cl, SO4, HCO3, NO3, Total N, Total P, Cu, Pb, Zn, Ni, Fe, Mn, As, Li, Ba,<br>(filtered) DOC, Tot. Alkalinity<br><br>Monthly observation of iron hydroxide staining using photo points | Monthly manual field analysis (EC, pH, DO, ORP, temp) for a minimum period of 12 months after LW32 completed<br><br>Monthly Laboratory Analysis of TDS, Na, K, Ca, Mg, F, Cl, SO4, HCO3, NO3, Total N, Total P, Cu, Pb, Zn, Ni, Fe, Mn, As, Li, Ba,<br>(filtered) DOC, Tot. Alkalinity for a minimum period of 12 months after LW32 completed<br><br>Monthly observation of iron hydroxide staining using photo points for a minimum period of 12 months after LW32 |
| **Stream Flow/Water Level Sites**<br>**R1- R11** | Minimum continuous 24-hourly, with monthly downloads. | Minimum continuous 24-hourly, with monthly downloads | Minimum continuous 24-hourly, with monthly downloads for minimum of 12 months post mining. |
| **Stream Flow/Water Level Sites**<br>**RC1, RC2 and RC3** | Minimum continuous 24-hourly, with monthly downloads. | Minimum continuous 24-hourly, with monthly downloads | Minimum continuous 24-hourly, with monthly downloads for minimum of 12 months post mining or until remediation works have been completed to the satisfaction of the Resources Regulator. |
| **General Stream Sites**<br>**RC1,2,3**<br>**R1- R11** | Observations every month for at least two months prior to mining using photo points. | 400 metres before and after LW32 face<br><br>Observations weekly during active subsidence period using photo points | Observations every month for a minimum period of 12 months after LW32 |
| **Aquatic Ecology** | Aquatic ecology monitoring during Autumn and Spring seasons for a minimum of 12 months prior to mining. | Aquatic ecology monitoring during Autumn and Spring seasons during active subsidence period. | EOP observations and report by Aquatic Ecology consultant. |
| **Private Dams** | Dam wall integrity and water level observation every month for at least two months prior to mining using photo points. | Dam wall integrity and water level observation every week during active subsidence period by TCCO’s Subsidence & Building Inspector using photo points. | Dam wall integrity and water level observation 3-monthly for minimum of 12 months after LW32 using photo points. |

| | Prior to Mining | During Mining | Post Mining |
|---|---|---|---|
| **Steep Slopes** | Observations every month for at least two months prior to mining using photo points. | Observation every week during active subsidence period by TCCO's Subsidence & Building Inspector using photo points. | Observation 3-monthly for minimum of 12 months after LW32 using photo points. |
| **Aboriginal Archaeology Sites** | Baseline archival recording at least two months prior to mining | Observations weekly during active subsidence period | EOP observations and report by Heritage consultant |
| **Heritage Properties**<br>**Koorana House**<br>**Mill Hill**<br>**Fairley House** | Preparation of Heritage Impact Statement and Property Subsidence Management Plan prepared by specialist consultants including heritage consultant, structural engineer and subsidence engineer at least two months prior to mining. | Observations weekly during active subsidence period by TCCO's Subsidence & Building Inspector | EOP observations and report by Heritage consultant |

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# APPENDIX 2

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| Feature | Management | |
|---|---|---|
| **Groundwater Quality Bore P10** | **Trigger** | **Action** |
| | **NORMAL** | **NORMAL** |
| | No observable mining induced change | Continue monitoring program, report in EOP report and AEMR. Ongoing review of water quality data |
| | **WITHIN PREDICTION** | **WITHIN PREDICTION** |
| | Short term increase (< 3 months) in salinity or reduction in pH outside of baseline variability, with the effect not persisting after a significant rainfall recharge event | Continue monitoring program, report in EOP report and AEMR. Ongoing review of water quality data |
| | **EXCEEDS PREDICTION** | **EXCEEDS PREDICTION** |
| | Increase in salinity or reduction in pH outside of baseline variability with the effect persisting for greater than 3 months or after a significant rainfall recharge event | Notify within 48 hours NSW Resources Regulator – Director Compliance Operations and Principal Subsidence Engineer, Subsidence Advisory NSW, Wollondilly Shire Council, DI-Water and OEH of exceedance.<br><br>Provide written Status Report to NSW Resources Regulator – Director Compliance Operations within 4 weeks of notification reviewing requirement, need and potential cost/benefit of preparation and implementation of a corrective action management plan.<br><br>Investigate the potential source/s of any water quality trigger exceedance<br><br>Report notification in EOP report and AEMR. |

| Groundwater Quality Bores P1, P2, P3, P4, P5, P6, P7, P8, P9 and P11 | Trigger | Action |
|---|---|---|
| | **NORMAL** | **NORMAL** |
| | No observable mining induced change | Continue monitoring program, report in EOP report and AEMR.<br>Ongoing review of water quality data |
| | **WITHIN PREDICTION** | **WITHIN PREDICTION** |
| | Short term increase (< 3 months) in salinity or reduction in pH outside of baseline variability, with the effect not persisting after a significant rainfall recharge event | Continue monitoring program, report in EOP report and AEMR.<br>Ongoing review of water quality data |
| | **EXCEEDS PREDICTION** | **EXCEEDS PREDICTION** |
| | Increase in salinity or reduction in pH outside of baseline variability with the effect persisting for greater than 3 months or after a significant rainfall recharge event | Notify within 48 hours NSW Resources Regulator – Director Compliance Operations and Principal Subsidence Engineer, Subsidence Advisory NSW, Wollondilly Shire Council, DI-Water and OEH of exceedance.<br><br>Provide written Status Report to NSW Resources Regulator – Director Compliance Operations within 4 weeks of notification reviewing requirement, need and potential cost/benefit of preparation and implementation of a corrective action management plan.<br><br>Investigate the potential source/s of any water quality trigger exceedance<br><br>Report notification in EOP report and AEMR. |

| Groundwater Levels Bore P10 | Trigger | Action |
|---|---|---|
| | **NORMAL** | **NORMAL** |
| | No observable mining induced change | Continue monitoring program, report in EOP report and AEMR.<br>Ongoing review of water level data |
| | **WITHIN PREDICTION** | **WITHIN PREDICTION** |
| | Up to 2m water level reduction | Continue monitoring program, report in EOP report and AEMR.<br>Ongoing review of water level data |
| | **EXCEEDS PREDICTION** | **EXCEEDS PREDICTION** |
| | Greater than 2m water level reduction for a period greater than 3 months<br><br>Water level (for a specific depressurisation event) does not return to within 1m of the pre "event" level (or trend occurring prior to the "event") after 3 months of the "event" | Notify within 48 hours NSW Resources Regulator – Director Compliance Operations and Principal Subsidence Engineer, Subsidence Advisory NSW, Wollondilly Shire Council, DI-Water and OEH of exceedance.<br><br>Provide written Status Report to NSW Resources Regulator – Director Compliance Operations within 4 weeks of notification reviewing requirement, need and potential cost/benefit of preparation and implementation of a corrective action management plan.<br><br>Investigate the potential cause / fate of any water level trigger exceedance<br><br>Report notification in EOP report and AEMR |

| Groundwater Levels Bores P1, P2, P3, P4, P5, P6, P7, P8, P9 and P11 | Trigger | Action |
|---|---|---|
| | **NORMAL** | **NORMAL** |
| | No observable mining induced change | Continue monitoring program, report in EOP report and AEMR.<br>Ongoing review of water level data |
| | **WITHIN PREDICTION** | **WITHIN PREDICTION** |
| | Up to 2m water level reduction for less than 3 months | Continue monitoring program, report in EOP report and AEMR.<br>Ongoing review of water level data |
| | **EXCEEDS PREDICTION** | **EXCEEDS PREDICTION** |
| | Greater than 2m water level reduction for a period greater than 3 months<br><br>Water level (for a specific depressurisation event) does not return to within 1m of the pre “event” level (or trend occurring prior to the “event”) after 3 months of the “event” | Notify within 48 hours NSW Resources Regulator – Director Compliance Operations and Principal Subsidence Engineer, Subsidence Advisory NSW, Wollondilly Shire Council, DI-Water and OEH of exceedance.<br><br>Provide written Status Report to NSW Resources Regulator – Director Compliance Operations within 4 weeks of notification reviewing requirement, need and potential cost/benefit of preparation and implementation of a corrective action management plan.<br><br>Iinvestigate the potential cause / fate of any water level trigger exceedance<br><br>Report notification in EOP report and AEMR |

| Groundwater Pressures VWPs TNC 37, 40, 43 | Trigger | Action |
|---|---|---|
| | **NORMAL** | **NORMAL** |
| | No observable mining induced change in the upper Hawkesbury Sandstone VWP intake | Continue monitoring program, report in EOP report and AEMR. Ongoing review of water pressure data |
| | **WITHIN PREDICTION** | **WITHIN PREDICTION** |
| | Up to 2m water level reduction in the upper Hawkesbury Sandstone VWP intake | Continue monitoring program, report in EOP report and AEMR. Ongoing review of water pressure data |
| | **EXCEEDS PREDICTION** | **EXCEEDS PREDICTION** |
| | Greater than 2m water level reduction in the upper Hawkesbury Sandstone VWP intake for a period greater than 3 months<br><br>Water level (for a specific depressurisation event) does not return to within 1m of the pre "event" level (or trend occurring prior to the "event") after 3 months of the "event" in the upper Hawkesbury Sandstone VWP intake | Notify within 48 hours NSW Resources Regulator – Director Compliance Operations and Principal Subsidence Engineer, Subsidence Advisory NSW, Wollondilly Shire Council, DI-Water and OEH of exceedance.<br><br>Provide written Status Report to NSW Resources Regulator – Director Compliance Operations within 4 weeks of notification reviewing requirement, need and potential cost/benefit of preparation and implementation of a corrective action management plan.<br><br>Investigate the potential cause / fate of any water level trigger exceedance<br><br>Report notification in EOP report and AEMR |

| Groundwater Quality (no SWL due to pump installation) GW | Trigger | Action |
|---|---|---|
| | **NORMAL** | **NORMAL** |
| | No observable mining induced change | Continue monitoring program, report in EOP report and AEMR. Ongoing review of water quality data |
| | **WITHIN PREDICTION** | **WITHIN PREDICTION** |
| | Short term increase (< 3 months) in salinity or reduction in pH outside of baseline variability, with the effect not persisting after a significant rainfall recharge event | Continue monitoring program, report in EOP report and AEMR. Ongoing review of water quality data |
| | **EXCEEDS PREDICTION** | **EXCEEDS PREDICTION** |
| | Increase in salinity or reduction in pH outside of baseline variability with the effect persisting for greater than 3 months or after a significant rainfall recharge event<br><br>Increase of metal suite of analytes outside of baseline variability with the effect persisting for greater than 3 months or after a significant rainfall recharge event | Notify within 48 hours NSW Resources Regulator – Director Compliance Operations and Principal Subsidence Engineer, Subsidence Advisory NSW, Wollondilly Shire Council, DI-Water and OEH of exceedance.<br><br>Provide written Status Report to NSW Resources Regulator – Director Compliance Operations within 4 weeks of notification reviewing requirement, need and potential cost/benefit of preparation and implementation of a corrective action management plan.<br><br>Investigate the potential source/s of any water quality trigger exceedance<br><br>Report notification in EOP report and AEMR. |

| Stream Water Quality Sites RC1, RC2, RC3, RC4, RC5 and RC6 | Trigger | Action |
|---|---|---|
| | **NORMAL** | **NORMAL** |
| | No observable mining induced change | Continue monitoring program, report in EOP report and AEMR.<br>Ongoing review of water quality data |
| | **WITHIN PREDICTION** | **WITHIN PREDICTION** |
| | Short term increase (< 3 months) in salinity or reduction in pH outside of baseline variability<br><br>Increase in stream Fe hydroxide precipitation compared to baseline | Continue monitoring program, report in EOP report and AEMR.<br>Ongoing review of water quality data |
| | **EXCEEDS PREDICTION** | **EXCEEDS PREDICTION** |
| | Significant reduction compared to baseline variability and predicted impacts last over >3 months in water quality at downstream monitoring site compared to baseline and / or significant observable increase in Fe hydroxide precipitate compared to baseline observations | Notify within 48 hours NSW Resources Regulator – Director Compliance Operations and Principal Subsidence Engineer, Subsidence Advisory NSW, Wollondilly Shire Council, DI-Water and OEH of exceedance.<br><br>Site visit within 1 week<br>Record photographically within 1 week<br>Collect laboratory samples within 1 weeks and analyse for standard analytes<br><br>Provide written Status Report to NSW Resources Regulator – Director Compliance Operations within 4 weeks of notification reviewing requirement, need and potential cost/benefit of preparation and implementation of a corrective action management plan.<br><br>Investigate the potential source/s of any water quality trigger exceedance<br><br>Report notification in EOP report and AEMR. |

| Stream Flow/Water Level Sites<br>R1- R11<br>RC1, RC2 and RC3 | Trigger | Action |
|---|---|---|
| | **NORMAL** | **NORMAL** |
| | No observable mining induced change | Continue monitoring program, report in EOP report and AEMR.<br>Ongoing review of water flow and pool level data |
| | **WITHIN PREDICTION** | **WITHIN PREDICTION** |
| | Within baseline variability or temporary reduction over < 3 month period for pool levels and stream flow, considering rainfall / runoff variability.<br><br>Minor fracturing of bedrock in directly undermined channels<br>Pool level / flow decline <20% during mining compared to baseline for > 3 months | Continue monitoring program, report in EOP report and AEMR.<br>Ongoing review of water flow and pool level data |
| | **EXCEEDS PREDICTION** | **EXCEEDS PREDICTION** |
| | Significant fracturing of bedrock in stream reach directly or not directly undermined<br><br>Re-direction of surface water flows through rock fractures<br><br>Pool level / flow decline >20% during mining compared to baseline for > 3 months, considering rainfall / runoff variability | Notify within 48 hours NSW Resources Regulator – Director Compliance Operations and Principal Subsidence Engineer, Subsidence Advisory NSW, Wollondilly Shire Council, DI-Water and OEH of exceedance.<br><br>Site visit within 1 week<br>Record photographically within 1 week<br><br>Provide written Status Report to NSW Resources Regulator – Director Compliance Operations within 4 weeks of notification reviewing requirement, need and potential cost/benefit of preparation and implementation of a corrective action management plan.<br><br>Investigate the potential source/s of any water quality trigger exceedance<br><br>Report notification in EOP report and AEMR. |

| General Stream Sites<br>RC1,2,3<br>R1- R11 | Trigger | Action |
|---|---|---|
| | **NORMAL** | **NORMAL** |
| | No observable mining induced change | Continue monitoring program, report in EOP report and AEMR.<br>Ongoing review of water flow and pool level data |
| | **WITHIN PREDICTION** | **WITHIN PREDICTION** |
| | Minor fracturing of bedrock in directly undermined channels<br><br>Pool level / flow decline <20% during mining compared to baseline for > 3 months | Continue monitoring program, report in EOP report and AEMR.<br>Ongoing review of water flow and pool level data |
| | **EXCEEDS PREDICTION** | **EXCEEDS PREDICTION** |
| | Significant fracturing of bedrock in stream reach directly or not directly undermined<br><br>Re-direction of surface water flows through rock fractures<br><br>Pool level / flow decline >20% during mining compared to baseline for > 3 months, considering rainfall / runoff variability | Notify within 48 hours NSW Resources Regulator – Director Compliance Operations and Principal Subsidence Engineer, Subsidence Advisory NSW, Wollondilly Shire Council, DI-Water and OEH of exceedance.<br><br>Site visit within 1 week<br>Record photographically within 1 week<br><br>Provide written Status Report to NSW Resources Regulator – Director Compliance Operations within 4 weeks of notification reviewing requirement, need and potential cost/benefit of preparation and implementation of a corrective action management plan.<br><br>Investigate the potential source/s of any water quality trigger exceedance<br><br>Report notification in EOP report and AEMR. |

| Aquatic Ecology | Trigger | Action |
|---|---|---|
| | **NORMAL** | **NORMAL** |
| | No change in aquatic habitat compared to baseline observed | Continue monitoring program, report in EOP report and AEMR.<br>Ongoing review of monitoring data |
| | **WITHIN PREDICTION** | **WITHIN PREDICTION** |
| | No change in aquatic habitat compared to baseline observed<br><br>Water flow and quality results within predictions. Observational monitoring within baseline variability. | Continue monitoring program, report in EOP report and AEMR.<br>Ongoing review of monitoring data |
| | **EXCEEDS PREDICTION** | **EXCEEDS PREDICTION** |
| | Water flow and quality results exceed predictions.<br><br>Observational monitoring shows significant change observed in aquatic habitat compared to baseline observed | Notify within 48 hours NSW Resources Regulator – Director Compliance Operations and Principal Subsidence Engineer, Subsidence Advisory NSW, Wollondilly Shire Council, DI-Water and OEH of exceedance.<br><br>Site visit within 1 week<br>Record photographically within 1 week<br><br>Provide written Status Report to NSW Resources Regulator – Director Compliance Operations within 4 weeks of notification reviewing requirement, need and potential cost/benefit of preparation and implementation of a corrective action management plan.<br><br>Investigate the potential source/s of any water quality trigger exceedance<br><br>Report notification in EOP report and AEMR. |

| Private Dams | Trigger | Action |
|---|---|---|
| | **NORMAL** | **NORMAL** |
| | No change in dam wall integrity and water level | Continue monitoring program, report in EOP report and AEMR. |
| | **WITHIN PREDICTION** | **WITHIN PREDICTION** |
| | No change in dam wall integrity and minor changes to water level | Continue monitoring program, report in EOP report and AEMR.<br>Ongoing review of monitoring data |
| | **EXCEEDS PREDICTION** | **EXCEEDS PREDICTION** |
| | Observed changes in dam wall integrity and water levels, development of seepage at dam wall toe | Notify within 48 hours NSW Resources Regulator – Director Compliance Operations and Principal Subsidence Engineer, Subsidence Advisory NSW, Wollondilly Shire Council, DI-Water and OEH of exceedance.<br><br>Notify landowner.<br><br>Site visit within 1 week<br>Record photographically within 1 week<br><br>Provide written Status Report to NSW Resources Regulator – Director Compliance Operations within 4 weeks of notification reviewing requirement, need and potential cost/benefit of preparation and implementation of a corrective action management plan.<br><br>Investigate the potential source/s of any water quality trigger exceedance<br><br>Report notification in EOP report and AEMR. |

| Steep Slopes | Trigger | Action |
|---|---|---|
| | **NORMAL** | **NORMAL** |
| | No observed changes in slopes | Continue monitoring program, report in EOP report and AEMR. |
| | **WITHIN PREDICTION** | **WITHIN PREDICTION** |
| | No observed changes in slopes, minor erosional movement in slopes | Continue monitoring program, report in EOP report and AEMR. |
| | **EXCEEDS PREDICTION** | **EXCEEDS PREDICTION** |
| | Observed changes in slopes with indication of slope movement | Notify within 48 hours NSW Resources Regulator – Director Compliance Operations and Principal Subsidence Engineer, Subsidence Advisory NSW, Wollondilly Shire Council, DI-Water and OEH of exceedance.<br><br>Site visit within 1 week<br>Record photographically within 1 week<br><br>Provide written Status Report to NSW Resources Regulator – Director Compliance Operations within 4 weeks of notification reviewing requirement, need and potential cost/benefit of preparation and implementation of a corrective action management plan.<br><br>Investigate the potential source/s of any water quality trigger exceedance<br><br>Report notification in EOP report and AEMR. |

| Aboriginal Archaeology Sites | Trigger | Action |
|---|---|---|
| | **NORMAL** | **NORMAL** |
| | No observable mining induced change | Continue monitoring program, report in EOP report and AEMR. |
| | **WITHIN PREDICTION** | **WITHIN PREDICTION** |
| | No observable mining induced change<br><br>Rock fracturing within 2 metres of Aboriginal archaeology site | Continue monitoring program, report in EOP report and AEMR. |
| | **EXCEEDS PREDICTION** | **EXCEEDS PREDICTION** |
| | Rock fracturing of Aboriginal archaeology site | Notify within 48 hours NSW Resources Regulator – Director Compliance Operations and Principal Subsidence Engineer, Subsidence Advisory NSW, Wollondilly Shire Council, DI-Water and OEH of exceedance.<br><br>Site visit within 1 week<br>Record photographically within 1 week<br><br>Provide written Status Report to NSW Resources Regulator – Director Compliance Operations within 4 weeks of notification reviewing requirement, need and potential cost/benefit of preparation and implementation of a corrective action management plan.<br><br>Report notification in EOP report and AEMR. |
| **Heritage Properties**<br>• **Koorana House**<br>• **Mill Hill**<br>• **Fairley House** | As per specific Property Subsidence Management Plans for each heritage property | As per specific Property Subsidence Management Plans for each heritage property |