CENTENNIAL

Subsidence Monitoring Program
Longwalls 30 and 31

Mandalong Mine

MEMS-EP-9000-SMP-9080

June 2021

Table of Contents

List of Figures

List of Tables

Appendices

DOCUMENT CONTROL

DOCUMENT DETAILS

Name:	Subsidence Monitoring Program LW30-31
Author:	Phil Enright
Number:	MEMS-EP-9000-SMP-9080
Revision No.:	2
Document Status	Final

APPROVAL DETAILS

Revision No.	Date Sent	Details of Approval	Approved By	Approval Date
0	19/02/2021	Draft for DRE review	Phil Enright Mining Approvals Coordinator	22/03/2021
1	25/03/2021	Final for submission	Phil Enright Mining Approvals Coordinator	25/03/2021
2	25/06/2021	Final addressing DPIE feedback	Phil Enright Mining Approvals Coordinator	25/06/2021

CIRCULATION DETAILS

Name	Department	Circulation Date
Director Resources Assessments	Department of Planning, Industry and Environment (DPIE) – Resource Assessment's	25/03/2021 (Rev. 1)
Director Resources Assessments	Department of Planning, Industry and Environment (DPIE) – Resource Assessment's	25/06/2021 (Rev. 2)

1 BACKGROUND

1.1 Introduction

Mandalong Mine is an existing underground longwall coal mine located on the western side of Lake Macquarie near Morisset, approximately 35 km southwest of Newcastle. Centennial Mandalong Pty Ltd is the operator of the mine and is a wholly owned subsidiary of Centennial Coal Company Pty Limited.

Development Consent for Mandalong Mine (SSD-5144) was approved on 12 October 2015 and permits extraction of 6.5 million tonnes of run-of-mine (ROM) coal per calendar year until 31 December 2040.

An Extraction Plan is required to be developed and approved prior to undertaking secondary extraction. This Extraction Plan, prepared for Longwalls 30-31 (LW30-31), describes the applicable regulatory framework, mine planning, management and monitoring measures to be implemented to protect all surface/subsurface natural and built features in addition to administering public safety measures associated with secondary extraction.

The Subsidence Monitoring Program has been developed in accordance with the current requirements of Condition 6, Schedule 4 of SSD-5144 for the extraction of LW30-LW31, and in accordance with Mining Leases (ML1722 and ML1744) requirements issued under the Mining Act 1992 to extract longwall panels within the West Wallarah Seam.

The Extraction Plan and Subsidence Monitoring Program have been prepared generally in accordance with the Department of Planning & Environment, *Draft Guidelines for the Preparation of Extraction Plans V5* (2015) and the Department of Industry - Resources Regulator, *Managing Risks of Subsidence Guide: WHS (Mines and Petroleum Sites) Legislation* (2017).

The area applicable to this extraction plan is defined in detail in **Section 3.1**

1.2 Project Description

The Extraction Plan area comprises a surface area of approximately 209 hectares. Across the Extraction Plan area the ground surface elevation ranges from 40 m to 240 m. The depth of cover above the West Wallarah Seam in this area ranges from approximately 285 m to 500 m.

The existing surface environment of the Extraction Plan area includes creeks, native bushland, steep slopes and archaeological heritage items.

There are nine private properties, one property owned by Central Coast Council, one owned by Centennial Coal and one Crown Land lot. A small area of Olney State Forest is located at the southern extent of the Extraction Plan Area. Of the nine privately owned properties, four dwellings will be affected by subsidence. Local roads, power lines, telecommunication networks and other associated infrastructure are also included in the area of potential subsidence influence. This infrastructure is managed by the Built Features Management Plan and supporting individual infrastructure management plans developed for Public Roads (Crown), Telstra Communications and Ausgrid Powerlines.

2 Purpose

The purpose of the Subsidence Monitoring Program is to set out the program for monitoring the subsidence effects associated with the secondary extraction by longwall mining in the West Wallarah Seam. The Subsidence Monitoring Program also consolidates the environmental and built features monitoring managed by the Extraction Plan key component plans.

Landscape features on private property are also documented and managed separately by individual Property Subsidence Management Plans (PSMP). Refer to the Extraction Plan LW30-31 document for a detailed summary of the PSMPs.

3 Scope

3.1 Extraction Plan Area

The Public Safety Management Plan applies to the management of risks relating to the development of subsidence from the extraction of LW30-31, located within Centennial Mandalong Mining Leases (ML1722 and ML1744) and the SDD-5144 approved mining area. The Extraction Plan Area is defined by a minimum 26.5^{o} angle of draw or 20mm limit of subsidence at the Upper 95% Confidence Limits from the extents of proposed extraction of LW30-31 (**Figure 1**).

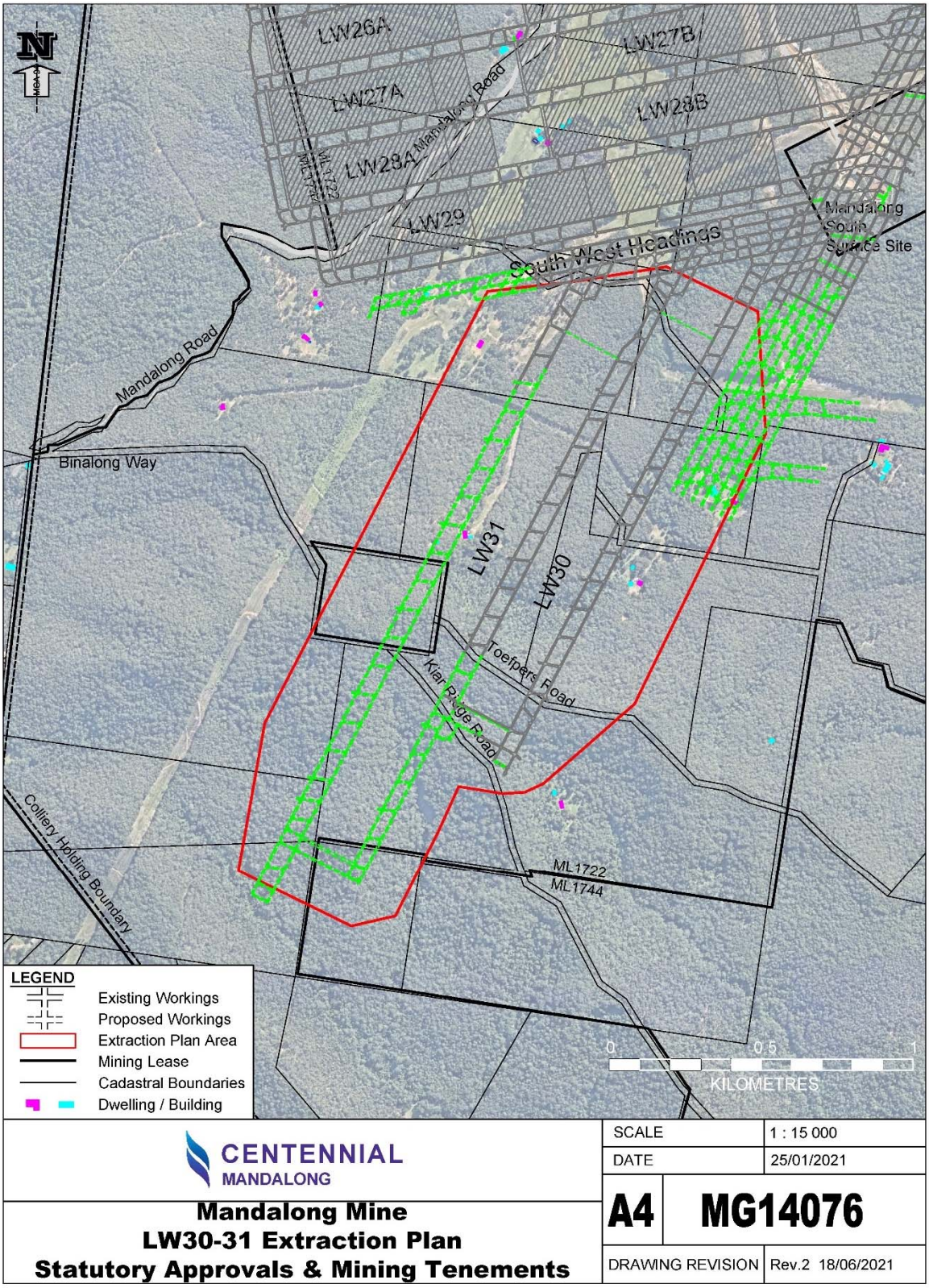


Figure 1 – Extraction Plan Area LW30-31

3.2 Key Component Management Plans

The built and natural features monitored by the Extraction Plan and Key Component Plans are detailed in **Table 1**.

Table 1 – Key Component Management Plans and Features Monitored

Key Component Management Plan (Document No.)	Feature Managed and Monitored
Water Management Plan MEMS-EP-9000-WMP-9010	Surface Water Groundwater Flood Plain
Land Management Plan MEMS-EP-9000-LMP-9020	Steep Slopes and rock outcrops Agricultural Land Erosion
Biodiversity Management Plan MEMS-EP-9000-BMP-9030	Habitat Threatened flora and fauna Endangered Ecological Communities (EEC) Groundwater Dependent Ecosystems (GDE) Aquatic ecosystems Wetlands
Heritage Management Plan MEMS-EP-9000-HMP-9040	Aboriginal Heritage Non-Aboriginal Heritage
Built Features Management Plan MEMS-EP-9000-BFMP-9050 *Public Roads Management Plan - MEMS-EP-9000-BFMP-9051* *Communications Management Plan – MEMS-EP-9000-CMP-9052* *Powerline Management Plan - MEMS-EP-9000-PLMP-9054*	Public Infrastructure, State Survey Marks, unsealed tracks. Public Roads (Crown Roads) Telstra Communications Network Ausgrid Powerlines
Public Safety Management Plan MEMS-EP-9000-PMP-9060	Steep slopes and rock outcrops Public infrastructure Private dwellings
Property Subsidence Management Plans MEMS-EP-9000-PSMP-9070	Private Property Dwellings and built features (sheds, dams, fences, access roads) Flooding Soil Erosion Slope stability Land use and agriculture

4 Consultation and Plan Development

The majority of the extraction plan area is freehold land, comprising of nine private properties, one Centennial, one Central Coast Council property and bordered to the south by Olney State Forest. Crown land is limited to Yambo Trig Reserve, being Lot 175 DP 755271 reserved under R1002616 for Trigonometrical Purposes and various Crown Roads, being Toefpers Road, Kiar Ridge Road and the unnamed roads located in the north east. Landownership is shown in **Figure 2**.

Consultation with the Resource Regulator (RR) for the development of the Subsidence Monitoring Program, Public Safety Management Plan and Built Features Management Plan has been undertaken in accordance with SSD-5144 Schedule 4 Condition 6 (g), (m) and (n).

Ongoing consultation with the RR Mine Safety Officer (Subsidence Engineering) has been undertaken during the preparation of the Extraction Plan. A meeting and site inspection were held with the RR on 23 February 2021 to provide an overview of the Extraction Plan for LW30-31, development of the Built Features Management Plan, supporting infrastructure management plans and the Subsidence Monitoring Program. RR advised that the Extraction Plan documentation would be considered and assessed when the High Risk Activity (HRA) notification process is triggered.

Individual PSMPs have been prepared and developed in consultation with the each of the nine landowners located within the Extraction Plan Area. The full consultation details with private property owners are detailed in Section 3.2 of each PSMP.

Infrastructure owners have been consulted in the development of the Built Features Management Plan and supporting infrastructure management plans, including Public Roads (Crown), Communications (Telstra) and Powerlines (Ausgrid). A full detail of consultation is found in each infrastructure management plan as detailed in **Table 2**.

Table 2 – Location of Consultation in each Infrastructure Management Plan

Infrastructure Management Plan	Summary of Correspondence	Copy of Correspondence
Public Roads Management Plan	Section 4	Appendix 4
Communications Management Plan	Section 4	Appendix 4
Powerline Management Plan	Section 4	Appendix 4
Property Subsidence Management Plans	Section 3.2	

Consultation for the preparation of environmental management plans has been undertaken in accordance with Development Consent requirements with relevant government departments. A summary of the consultation undertaken during the development of the Extraction Plan and sub-plans for LW30-31 is documented in Table 2.3 of the Extraction Plan.

The process for consultation, communication and the provision of information pertaining to this management plan will be managed according to Centennial Mandalong's **HSMC-SC-Information and Communications Arrangements** and **HSMS-SE-6592-Consultation Arrangements**.

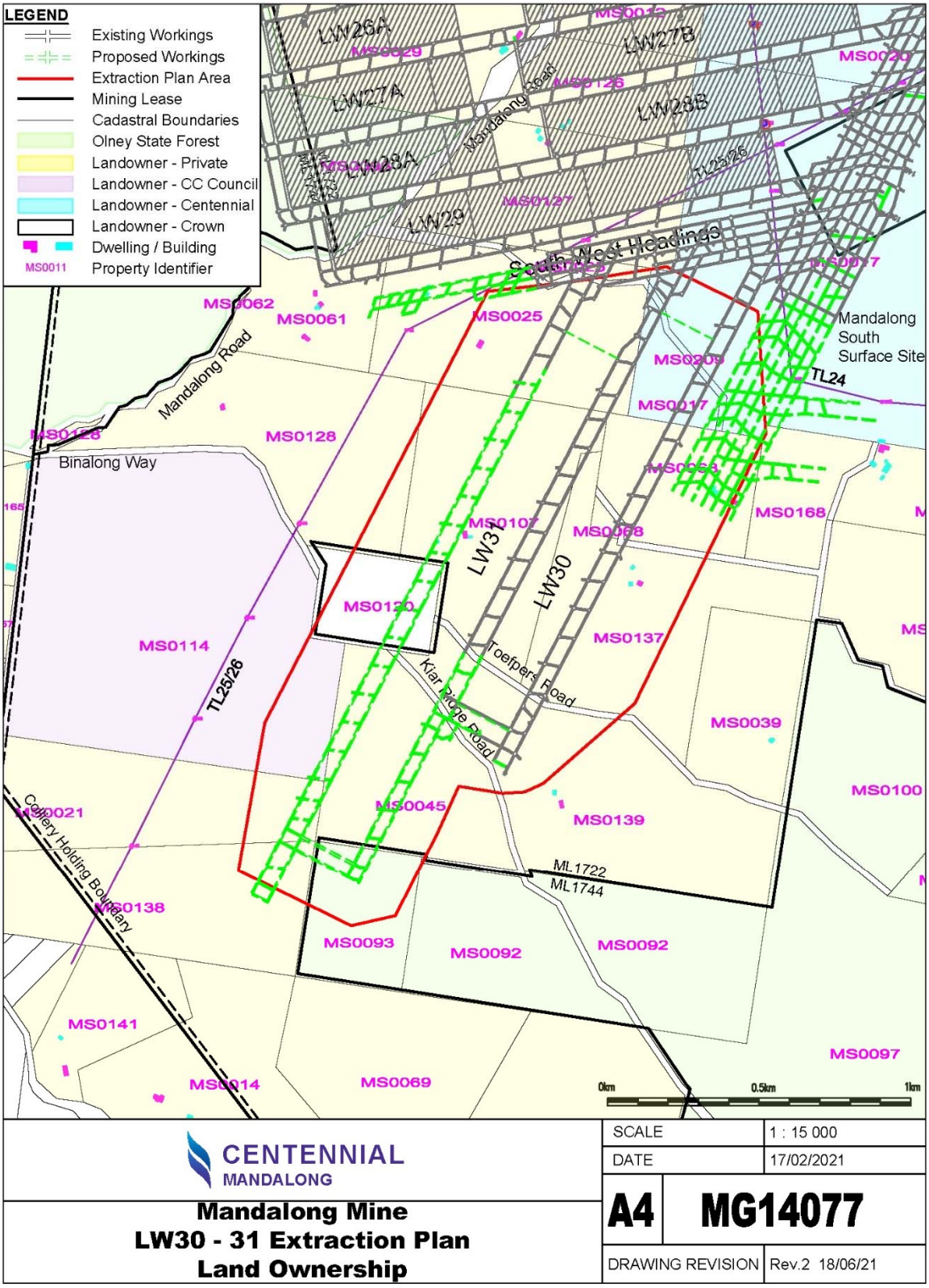


Figure 2 – Land Ownership

5 Regulatory Requirements

Centennial Mandalong operations are conducted in accordance with relevant legislation and requirements of statutory authorities. Legislative and regulatory requirements are generally recognised through the imposition of conditions on the development consent, licences and mining approvals.

5.1 Development Consent

Development Consent SSD-5144 provides a number of conditions relating to the preparation of the Subsidence Monitoring Program. These conditions are summarised in **Table 3** below, together with the notation of the section of this document in which each matter is addressed.

Table 3 - Development Consent Conditions SSD-5144

Consent Condition	Section
Schedule 4 Subsidence **Performance Measures – Natural and Heritage Features** **Condition 1** The Applicant must ensure that the development complies with the performance measures in Table 6, to the satisfaction of the Secretary.	Section 6
Condition 2 The Applicant must assess and manage development-related risks to ensure that there are no exceedances of the performance measures in Table 6. Any exceedance of these performance measures constitutes a breach of this consent and may be subject to penalty or offence provisions under the EP&A Act or EP&A Regulation, notwithstanding actions taken pursuant to condition 3 below. Where any exceedance of these performance measures has occurred, the Applicant must, at the earliest opportunity: (a) take all reasonable and feasible steps to ensure that the exceedance ceases and does not recur; (b) consider all reasonable and feasible options for remediation and submit a report to the Department describing those options and any preferred remediation measures or other course of action; and (c) implement remediation measures as directed by the Secretary, to the satisfaction of the Secretary.	Section 8 Section 9 Section 10 Section 13
Condition 4 The Applicant must ensure that the development does not cause any exceedances of the performance measures in Table 7, to the satisfaction of the Secretary.	Section 6
Extraction Plan **Condition 6** (h) include a Subsidence Monitoring Program, which has been prepared in consultation with RR to: • provide data to assist with the management of the risks associated with conventional and nonconventional subsidence; • validate the subsidence predictions; • analyse the relationship between the predicted and resulting subsidence effects and predicted and resulting impacts under the plan and any ensuing environmental consequences; and • inform the Contingency Plan and adaptive management process;	Section 8 Section 9 Section 10 Section 11

5.2 Mining Leases

The Extraction Plan Area for LW30-31 is associated with two mining leases held by Centennial Mandalong, ML1722 and ML1744. There are no specific conditions that directly relate to subsidence monitoring.

5.3 Extraction Plan Guidelines

The Extraction Plan and Subsidence Monitoring Plan have been prepared generally in accordance with the Department of Planning & Environment, *Draft Guidelines for the Preparation of Extraction Plans V5* (2015). **Table 4** provides a summary of the guideline's requirements for Subsidence Monitoring Programs together with the notation of the section of this document in which each matter is addressed.

Table 4 - Extraction Plan Guideline Requirements for Subsidence Monitoring Programs

Extraction Plan Guideline Requirement – Key Component Plans	Section
5. Subsidence Monitoring Program The key component plans should be followed by a Subsidence Monitoring Program. This program should address two purposes. The first is to set out the program for monitoring the subsidence effects associated with the proposed coal extraction. The second is to summarise and consolidate the various environmental monitoring programs presented in each of the key component plans. These environmental monitoring programs should be directed towards monitoring the subsidence impacts and environmental consequences of mine subsidence.	Section 8
Subsidence Effects Monitoring Program The Subsidence Effects Monitoring Program must provide sufficient information on subsidence effects to fully support implementation of the Extraction Plan. It should have clearly stated objective(s) and address the following: • proposed subsidence monitoring activities (individually specified); • information or subsidence parameters to be obtained from each monitoring activity; • proposed locations and/or extents where each monitoring activity will be undertaken, in particular, the proposed layout and/or locations of instrumentation, monitoring points or inspections (including graphical plans); • proposed timing, frequency and duration of each monitoring activity; • proposed monitoring methods, technologies, industry standards (eg ICSM Standards (SP1) Version 2.0) or Codes of Practice to be applied in undertaking each monitoring activity; • proposed measures and procedures for quality assurance and competence of personnel undertaking monitoring activities; • proposed procedures to record monitoring results; • proposed reporting monitoring results, including the frequency of reporting. The primary recipient of reports is DRE, and required reporting frequency will depend on the significance of features which are subject to risk of subsidence impact and consequence, and the scale of that risk; and • capacity of the program to detect early warning of deviations from the defined performance measures and associated performance indicators.	Section 8 Section 12 Appendix 1

Extraction Plan Guideline Requirement – Key Component Plans	Section
Environmental Monitoring Program Summary The Subsidence Effects Monitoring Program must summarise and consolidate the various monitoring programs presented in each of the key component plans, including the Built Features and Public Safety Management Plans. These environmental monitoring programs should be directed towards monitoring the subsidence impacts and environmental consequences of mine subsidence. It should contain figures showing the monitoring sites for each of the various monitoring programs, as well as a consolidated figure or figures showing all monitoring sites. It should be noted that the purpose of this summary is not to repeat the monitoring programs which are in themselves important elements of each of the key component plans. Instead the purpose is to present a consolidated overview of the six monitoring programs, enabling ready review of the overall monitoring program. As such, clear figures and tabulated information are critical.	Section 8 Section 8.3 Section 8.4

6 Performance Measures and Indicators

6.1 Mine Design

Mandalong Mine is designed to provide reduced levels of subsidence by using sub-critical longwall panels (180m to 200m void width) combined with 43m to 53m wide and nominally 100m long chain pillars that utilise the bridging effect of the overlying massive conglomerate and sandstone strata. This design is proven and provides subsidence impacts below safe, serviceable and repairable (SSR) criteria for dwellings and also minimises the impacts to the flood plain, natural features and built features.

6.2 Subsidence Prediction

Subsidence predictions and potential impacts from the extraction of LW30-31 on surface and subsurface features present within the Extraction Plan Area has been prepared by Ditton Geotechnical Services based on the following methodology:

(i) The development of a geotechnical model of the overburden and immediate roof-pillar-floor system using available borehole log and testing data.

(ii) Prediction of maximum subsidence effect parameters for the proposed longwalls.

(iii) Review of Mandalong Mine's subsidence data and impacts associated with LWs 1-27.

(iv) Prediction of first and final subsidence effect profiles and final contours and assessment of the potential impacts to existing and proposed features or developments.

(v) Prediction of post-mining surface levels.

(vi) Potential surface cracking widths and their general location.

(vii) Prediction of sub-surface heights of continuous and discontinuous fracturing above the proposed longwall panels.

(viii) Potential ponding depth locations.

(ix) Potential surface gradient changes and erosion / slope stability impacts.

(x) Valley Closure and Uplift potential along watercourses.

(xi) Far-field horizontal displacements and strains.

(xii) Predicted impacts and management strategies required for the environment, developments and Aboriginal and European Heritage sites.

Two empirically based prediction models (**ACARP, 2003** and **SDPS®**) have been used to generate subsidence profiles and contours above the proposed longwall panels after mining is complete. **Surfer 8®** software has then been used to generate subsidence, tilt, horizontal displacement, and strain contours above the panels from the **SDPS®** output files.

The subsidence predictions models used in this study are summarised below:

- **ACARP, 2003** - An empirical model that was originally developed for predicting maximum single and multiple longwall panel subsidence, tilt, curvature and strain in the Newcastle Coalfield. The model database included measured subsidence parameters and overburden geology data, which have been back analysed to predict the subsidence reduction potential (SRP) of massive lithology in terms of 'Low', 'Moderate' and 'High' SRP categories.

The model database also includes chain pillar subsidence, inflexion point distance, goaf edge subsidence and angle of draw prediction models, which allow subsidence profiles to be generated for any number of panels and a range of appropriate confidence limits. The Upper 95% Confidence Limit (U95%CL) has been adopted in this study for predictions of the Credible Worst-Case values.

The model has been updated by Ditton Geotechnical Services (DgS) since 2007 to allow the original **ACARP, 2003** model to be applied to other Australian Coalfields and improve its robustness over a greater range of mining geometries and geologies.

- **SDPS®, 2007** - A US developed (Virginia Polytechnical Institute) influence function model for subsidence predictions above longwalls or pillar extraction panels. The model requires calibration to measured subsidence profiles to reliably predict the subsidence and differential subsidence profiles required to assess impacts on surface features.

  The model also includes a database of percentage of hard rock (i.e. massive sandstone / conglomerate) that effectively reduces subsidence above super-critical and sub-critical panels due to either bridging or bulking of collapsed material. This is consistent with the **ACARP, 2003** models prediction methodology.

Pre-feasibility studies of appropriate panel widths and set-back distances required to minimise or limit surface impacts to manageable levels have been undertaken by Centennial Mandalong and DgS prior to the preparation of the predictions. The outcomes of the preliminary analysis have resulted in the mining geometry and layout adopted.

Based on regression analysis techniques, curves of 'best fit' have been used to estimate Mean and Credible Worst-Case (Upper 95% Confidence Limits) for the subsidence effects due to the proposed longwalls. The curves are based on measured subsidence data in the NSW Coalfields and key mining geometry parameters (refer **ACARP, 2003**). The Mandalong mining experience to-date has also been reviewed against the database (LW1-27).

The prediction method allows specialist consultants to assess the potential range of impacts to a given feature in a probabilistic manner. Impact Management Plans and strategies can then be developed that allows appropriate Trigger Action Responses and mine planning adjustments or mitigation measures necessary to deliver satisfactory outcomes to stakeholders.

6.3 Performance Measures

As outlined in **Section 6.1**, the primary objective of the mine design is to prevent any significant mine induced risk to public safety by providing low levels of subsidence, that allow built features including public infrastructure and private dwellings to remain safe, serviceable and repairable with negligible additional risk to public safety. The mine design also minimises the impact to natural and heritage features, consistent with subsidence impact performance measures.

The expected performance measures are outlined in the Development Consent SSD-5144.

Performance measures for Natural and Heritage Features are stipulated in Schedule 4 Condition 1 Table 6 of SSD-5144 as shown in **Table 5.**

Performance measures for Built Features are stipulated in Schedule 4 Condition 4 Table 7 of SSD-5144 as shown in **Table 6**.

Table 5 - Subsidence Impact Performance Measures – Natural and Heritage Features

Watercourses	
3rd Order and above streams Groundwater-dependent Ecosystems	No connective cracking between the surface, or the base of the alluvium, and the underground workings. No subsidence impact or environmental consequence greater than minor.
1st and 2nd Order streams	No subsidence impact or environmental consequences greater than predicted in the documents listed in condition 2(b) of Schedule 2. No connective cracking between the surface and the underground workings.
Aquatic and riparian ecosystems, including affected sections of Morans Creek, Wyee Creek, Tobins Creek and Mannering Creek	Maintain or improve baseline channel stability. Develop site-specific in-stream water quality objectives in accordance with ANZECC 2000 and *Using the ANZECC Guidelines and Water Quality Objectives in NSW* procedures (DECC 2006), or their latest versions.
Land	
Steep slopes and rock outcrops	No subsidence impact or environmental consequence greater than predicted in the documents listed in condition 2(b) of Schedule 2.
Agriculture	No loss of agricultural productivity greater than minor.
Biodiversity	
Threatened species, threatened populations and endangered ecological communities	Negligible environmental consequences.
Heritage sites	
Stone Arrangement RPS TBM 32	Negligible subsidence impacts or environmental consequences
All other Aboriginal Cultural Heritage sites/items at the site	No subsidence impact or environmental consequence greater than predicted in the documents listed in condition 2(b) of Schedule 2.
Mine workings	
First workings under an approved Extraction Plan beneath any feature where performance measures in this table require negligible subsidence impacts or negligible environmental consequences	To remain long-term stable and non-subsiding.
Second workings	To be carried out only within the approved mine plan, in accordance only with an approved Extraction Plan.

Notes:

- *Classification of streams in accordance with Strahler stream order system.*
- *Detailed performance indicators (including impact assessment criteria) for each of these performance measures will be detailed in the various management plans that are required under this consent.*
- *Measurement and/or monitoring of compliance with performance measures and performance indicators is to be undertaken using generally accepted methods that are appropriate to the environment and circumstances in which the feature or characteristic is located. These methods are to be fully described in the relevant management plans. In the event of a dispute over the appropriateness of proposed methods, the Secretary will be the final arbiter.*

Table 6 – Subsidence Impact Performance Measures – Built Features

Key Public Infrastructure	
M1 Motorway	Always safe and serviceable.
Main Northern Railway	
330 kV power supply infrastructure	Damage that does not affect safety or serviceability must be fully repairable, and must be fully repaired.
Other Built Infrastructure	
Power lines and power poles	Always safe.
Telecommunications infrastructure	
Privately-owned residences	Serviceability should be maintained wherever practicable.
Local Roads	
Other built features and improvements, (including access roads, farm dams, swimming pools, tracks and fences)	Loss of serviceability must be fully compensated. Damage must be fully repairable, and must be fully repaired or else replaced or fully compensated.
Public Safety	
Public Safety	Negligible additional risk.

Notes:

- *Key public infrastructure is shown in Figure 2 of Appendix 2 and in Figure 1 of Appendix 5*
- *Other built infrastructure is shown in Figure 1 of Appendix 5.*
- *The Applicant will be required to define more detailed performance indicators for each of these performance measures in the Built Features Management Plan, Property Subsidence Management Plans and Public Safety Management Plan (see condition 6 below).*
- *Measurement and/or monitoring of compliance with performance measures and performance indicators is to be undertaken using generally accepted methods that are appropriate to the environment and circumstances in which the feature or characteristic is located. These methods are to be fully described in the relevant management plans. In the event of a dispute over the appropriateness of proposed methods, the Secretary will be the final arbiter.*
- *Requirements regarding safety or serviceability do not preclude preventative or mitigatory actions being taken prior to or during mining in order to achieve or maintain these outcomes.*
- *Requirements under this condition may be met by measures undertaken in accordance with the Mine Subsidence Compensation Act 1961.*

6.4 Performance Indicators

To establish compliance with the performance measured outlined in **Section 6.3**, Centennial Mandalong has established a subsidence and environmental monitoring program developed in consultation with the affected stakeholders. Trigger Action Response Plans (TARPs) have also been established.

These documents establish the appropriate subsidence monitoring, parameters and associated trigger levels to demonstrate that subsidence performance satisfies the Subsidence Performance Measures set in **Table 5** for Natural and Heritage Features and in **Table 6** for Built Features.

The Performance Indicators have been established for each feature. The TARPS provide the trigger values as outlined in **Table 7**.

Table 7 – Performance Indicators

Performance Indicator	Tigger	Action / Response
Level 1 Low	Operations within prediction and approved impact.	Continued operations and monitoring as normal.
Level 2 Medium	Operations within approved impacts but exceed or potentially exceed predictions.	Review and investigation processes are engaged, with adaptive management as required.
Level 3 High	Operations exceed approved impact. *The approved Performance Measures of Development Consent SSD-5144 and other relevant approvals.*	Adaptive Management fully engaged

7 Monitoring Strategy and Approach

The primary management strategy implemented for subsidence and environmental impact adopted by Centennial Mandalong is avoidance or minimisation though the sub-critical longwall mine design. The mine design utilises the spanning capacity of the massive conglomerate and sandstone strata within the overburden to provide reduced levels of subsidence. Mining is expected to result in low levels of subsidence at the surface within the Extraction Plan Area.

Accordingly, monitoring will be undertaken to confirm that the mine design measures to minimise impact are implemented and are adequate. An integrated approach to monitoring and inspections has been specifically developed for this Subsidence Monitoring Program in order to:

- Demonstrate mine development and extraction is undertaken as per the approved design;
- Provide information to demonstrate statutory performance criteria and obligations are satisfied (refer **Section 6.3**);
- Target monitoring of surface features within the Extraction Plan Area;
- Meet stakeholder requirements to minimise environmental impact of monitoring on private property;
- Meet infrastructure owners monitoring requirements;
- Provide appropriate information required to assess against triggers within the relevant TARPs, including data for trend analysis to inform adaptive management; and
- To provide a suitable basis for future monitoring systems and Extraction Plans for ongoing mining within the lease, including establishing correlation areas of conventional survey and trials of non-conventional survey methods.

Mandalong Mine has a substantial subsidence monitoring network, comprising of more than 80 km of conventional subsidence monitoring lines, together with monitoring on infrastructure, private dwellings, buildings and dams. A substantial environmental monitoring has also been established, with a network with currently 57 groundwater monitoring bores, creek monitoring and monitoring established on nine wetland sites over the mining area.

The Subsidence Monitoring Program is scheduled in the Centennial Compliance Database. The compliance database allows for surveys, inspections and notifications to be scheduled on either time or productions schedule (longwall face chainage). The required actions are assigned to the relevant role to ensure the subsidence monitoring program is achieved.

8 Monitoring Program

The purpose of the Monitoring Program for the secondary extraction of LW30 and LW31 is to:

- Outline the Subsidence Movement and Effects Monitoring for the development of both conventional and non-conventional subsidence;
- Outline the Summary of Built Features Monitoring including private dwellings; and
- Outline the Consolidated Summary of Environmental Monitoring for management of environment, water, groundwater land, biodiversity and heritage.

All forms of subsidence monitoring will be undertaken by appropriately qualified and experienced personnel. The results from the subsidence monitoring program will be evaluated by appropriately qualified and experienced personnel against the performance measures and subsidence predictions. A summary of the performance measures and performance indicators are provided in **Section 6**.

Centennial Mandalong has prepared specific management plans as components of the Extraction Plan, including management plans for Water, Land, Biodiversity, Heritage, Public Safety, PSMPs and Built Features (including sub-plans for Public Roads, Communications and Powerline) as detailed in **Table 1**.

8.1 Subsidence Monitoring Zones

Mandalong Mine has developed three subsidence monitoring zones to accommodate the development of subsidence from the narrow longwall panels and the bridging effect of the overlying massive strata that provides the reduced levels of subsidence. Unique to Mandalong Mine and as a result of the bridging massive strata, subsidence develops later than in typical longwall operations, with the majority of subsidence realised after the longwall face has retreated approximately 500m.

Additional subsidence also develops over the longwall panel following the extraction of the next adjacent longwall panel. This is due to the compression of the intervening chain pillar and strata. The additional subsidence contributed is typically in the order of 0.30m and is dependent on the geotechnical conditions and the depth of cover. Tilts and strains typically remain relatively unchanged and may be reduced as a result of the decreased vertical subsidence differential between the maingate chain pillar and the centre of the longwall panel. In areas with higher depth of cover over 300m some additional minor settlement may occur following the extraction of the adjacent two to three longwall panels.

Accordingly, with 29 longwall panels now completed, Mandalong has developed three subsidence monitoring zones which define required monitoring activities in actively subsiding and stable areas of the mine as follows below. Full details of proposed monitoring activities within each zone are described within the Subsidence Monitoring Program for each Extraction Plan progressively approved by the mine.

8.1.1 Active Subsidence Zone for Visual Monitoring

The “Active Subsidence Zone” for visual monitoring inspections is defined as:

- 100m in advance of the current longwall face position; and
- the following 500m of longwall extraction (i.e. 500m behind the face position).

8.1.2 Active Longwall Zone for Crossline Monitoring

The "Active Longwall Subsidence Zone" includes the nominated crosslines for the current longwall panel and the three previous longwall panels.

8.1.3 Stable Longwall Subsidence Zone for Crossline Monitoring

The "Stable Longwall Subsidence Zone" represents the stable non-subsiding areas beyond the three previous longwall panels, defined as being from the start of the nominated crosslines up to the Active Longwall Subsidence Zone.

8.2 Monitoring of Subsidence Movement and Effects

The full Subsidence Movement and Effects Monitoring Program for LW1 to LW31 is included in **Appendix 1**. The program includes information on the subsidence line location, purpose, survey mark type, spacing, monitoring frequency, survey standard and responsibility.

Mandalong Mine has established a considerable network for monitoring Subsidence Movement and Effects since commencement of longwall mining in 2005. The network currently includes:

- 25 established crosslines;
- 14 Centrelines;
- 2 lines traversing Stockton Creek and Morans Creek;
- Transmission Towers – TL24 and TL25/26;
- Ausgrid power poles; and
- Monitoring on private properties, dwellings, buildings and dams.

Note that a number of the monitoring lines have been removed or partially removed over LW1-19 as approved by the RR Principal Subsidence Engineer.

Within the LW30-31 Extraction Plan Area, three crosslines will be established:

- Crossline 23 Centennial property from LW28-30;
- Crossline 24 Located along Toepfers Road and Kiar Ridge Fire Trail over LW30-31; and
- Crossline 25 Located along a private access road over LW31.

An extract of the Subsidence Movement and Effects Monitoring Program of the monitoring lines relevant to LW30-31 is shown in **Table 8** and their location shown in **Figure 3**.

8.2.1 Non-Conventional Subsidence

The normal ground movements resulting from the extraction of longwalls is referred to as conventional or systematic subsidence movements. Conventional subsidence profiles are typically smooth in shape and can be explained by the expected caving mechanisms associated with the overlying strata spanning the extracted void. At greater depths of cover, subsidence profiles along survey lines are generally smooth, which is the case for Mandalong Mine. At other mines, where the depth of cover is less than 100 metres, observed subsidence profiles are generally irregular as the collapsed zone above the longwalls extends up to or near the surface.

Irregular subsidence movement (non-conventional or non-systematic) can be observed at deeper depths of cover along an otherwise smooth subsidence profile. The cause of these irregular subsidence movements can be associated with:

- Sudden changes in geological conditions such as faulting.
- Steep topography, where elevated tensile strains at the tops of the steep slopes and elevated compressive strains develop near the base of the steep slopes due to slope instability movements; and
- Valley related mechanisms, including upsidence and valley closure.

It is not possible to predict the locations and magnitudes of non-conventional movements. In some cases, approximate predictions can be made where underlying geological or topographic conditions are known in advance, such as faulting and steep slopes. The subsidence monitoring program for LW30-31 provides for adequate coverage to detect non-conventional subsidence. The monitoring point spacing, survey methods and scheduled visual inspections allow for the detection of non-conventional subsidence movements due to any potential changes in geological conditions and mining within steep slope areas. There are no valleys or cliffs within the extraction plan area.

8.2.2 Baseline Monitoring

8.2.2.1 Conventional Survey

Conventional subsidence monitoring lines typically consist of buried star pickets with cast iron covers, nominally spaced at 10m intervals that are measured for vertical subsidence, tilt and strain. Within the Extraction Plan area, three crosslines are established:

- Crossline 23 Centennial property over LW28-30;
- Crossline 24 Located along Toepfers Road and Kiar Ridge Fire Trail over LW30-33; and
- Crossline 25 Located along a private access road over LW31.

8.2.2.2 Detailed Aerial Mapping

An aerial LIDAR survey was undertaken in April 2020, providing the pre-mining landform for the Extraction Plan Area and post mining landform for Longwalls 1 to 25. The LIDAR surveys provide surface mapping with a vertical accuracy of 0.15m. Aerial LIDAR surveys of the whole mining area are conducted approximately every three years and allow the post mining landform included in the flood model and to be used to analyse against subsidence predictions.

8.2.2.3 Aerial and Satellite Imagery

NearMap satellite Imagery is used by Mandalong Mine to assist in baseline comparison and detection of remnant ponding. The satellite imagery is updated several times each year. To manage and monitor remnant ponding, plan MG12274 documents the existing ponding, predicted and actual ponding, remediation works and rehabilitation status.

8.2.3 Subsidence Monitoring Locations

The location of subsidence monitoring lines is shown in **Figure 3** and in detail on plan MG10435 in **Appendix 1,** Section G.

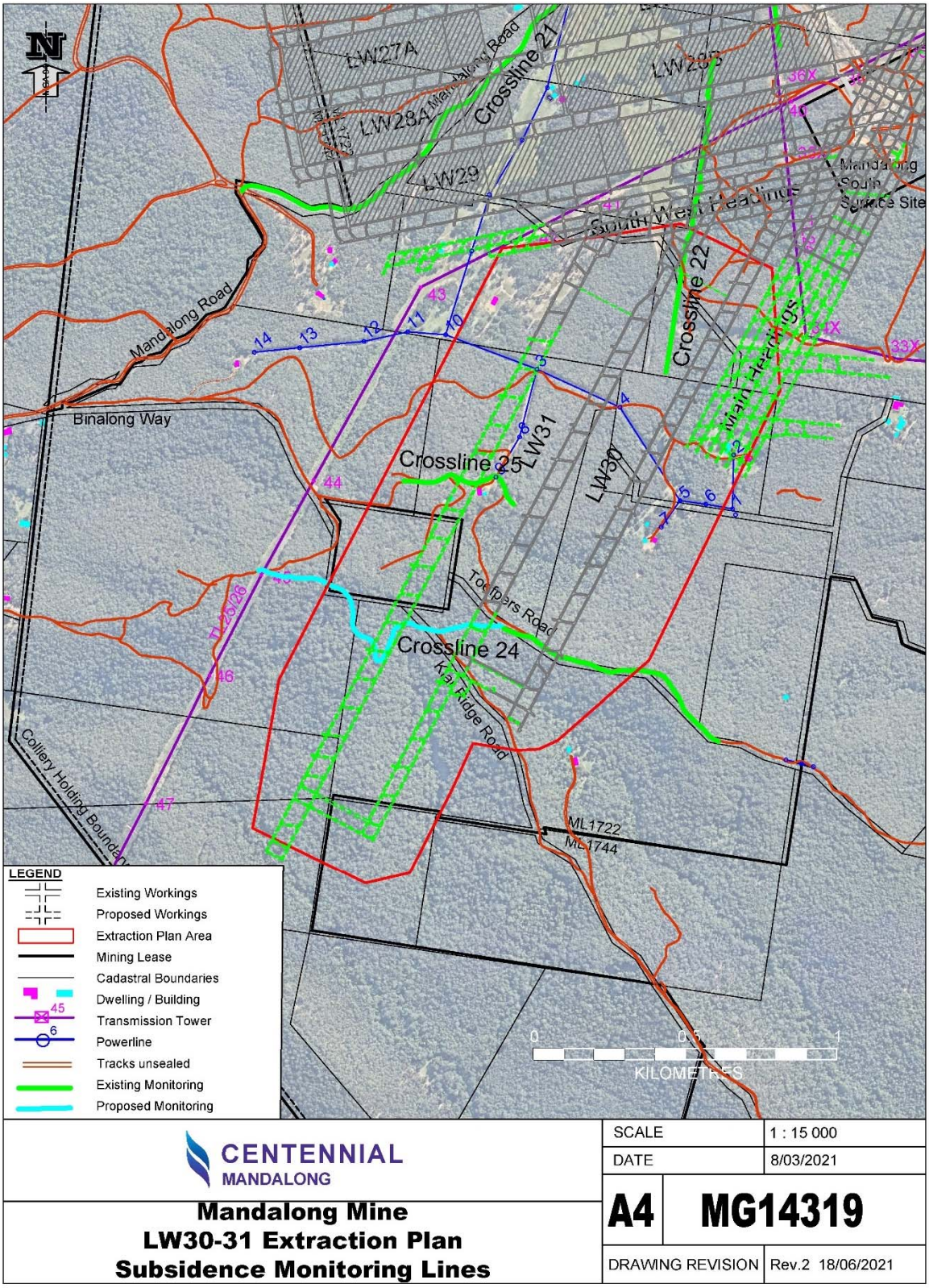


Figure 3 – Subsidence Monitoring Lines within Extraction Plan Area

Table 8 - Summary of Subsidence Movement and Effects Monitoring for LW30-31

Subsidence Line	Location	Purpose	Survey Marks	Mark Spacing	Monitoring Frequency and Duration	Survey Standards	Responsibility
Crossline 23 (CS23)	LW28-30 Centennial property	Subsidence, pillar compression and residual strains and tilts. To assist with refinement of subsidence model	1650mm star pickets driven into ground. Some of these marks will have cast iron covers.	10m	Prior to mining Longwall 27. Post mining each longwall 28 – 31.	Standard 1 Standard 2	Mining Approvals Coordinator Subsidence and Projects Surveyor
Crossline 24 (CS24)	LW30-33 Crown Rd. easement on Toefpers Rd and Kiar Ridge Fire Trail	Subsidence, pillar compression and residual strains and tilts. To assist with refinement of subsidence model	1650mm star pickets driven into ground. Some of these marks will have cast iron covers.	10m	Prior to mining Longwall 30 Post mining each longwall 30-33	Standard 1 Standard 2	Mining Approvals Coordinator Subsidence and Projects Surveyor
Crossline 25 (CS25)	LW31-32 Private access road	Subsidence, pillar compression and residual strains and tilts. To assist with refinement of subsidence model	1650mm star pickets driven into ground. Some of these marks have cast iron covers.	10m	Prior to mining Longwall 30 Post mining each longwall 30-33	Standard 1 Standard 2	Mining Approvals Coordinator Subsidence and Projects Surveyor

Refer to Appendix 1 for the full Subsidence Movement and Effects Monitoring Program.

8.3 Summary of Built Features Monitoring

Built Features with the Extraction Plan Area LW30-31 include Crown Roads, Telstra communications network, Ausgrid 11kV powerlines and State Survey Marks.

The overarching Built Features Management Plan is supported by Individual Infrastructure Management Plans that have been developed in consultation with each infrastructure owner/ operator (**Table 9**).

Table 9 - Built Features Management and Sub- Infrastructure Management Plans

Key Component Management Plan (Document No.)	Feature Managed and Monitored
Built Features Management Plan MEMS-EP-9000-BFMP-9050	Public Infrastructure, State Survey Marks, unsealed tracks.
Public Roads Management Plan - MEMS-EP-9000-BFMP-9051	Public Roads (Crown Lands)
Communications Management Plan – MEMS-EP-9000-CMP-9052	Telstra Communications Network
Powerline Management Plan - MEMS-EP-9000-PLMP-9054	Ausgrid Powerlines

A consolidated summary of the Built Features monitoring for LW30-31 is shown in **Table 10**. The full monitoring program for each infrastructure item is included in the Built Features Management Plan and relevant infrastructure management plan.

8.3.1 Baseline Monitoring

Baseline monitoring for the built features will be provided by pre-mining surveys on Crossline 23, 24 and 25, Aboriginal cultural heritage sites and private dwellings.

8.3.2 Built Feature Monitoring Locations

The location of subsidence monitoring lines is shown in **Figure 3** and in detail on plan MG10435 in **Appendix 1,** Section G. For further detail refer to the specific management plan.

Table 10 – Summary of Built Features Monitoring Program

Feature	Location	Monitoring Method	Parameter	Monitoring Frequency and Duration
Crown Roads Public Roads Management Plan **Private Access Roads** PSMP **Telstra Communications Network** Communications Management Plan **Ausgrid Powerlines** Powerline Management Plan	**Crown Roads** Toefpers Rd Kiar Ridge Rd **Private Access Roads** Private properties **Powerline easements** 11kV powerline	**Crossline 23** Star posts on Centennial property at 10m spacing **Crossline 24 and Crossline 25** Star posts adjacent to road at 10m spacing	Vertical subsidence, tilt and strain.	Baseline Prior to mining LW30 and LW31. Post Mining 2 months after mining LW30 and LW31. Stable Zone 2 yearly.
		Visual Inspection	Presence of mine-induced damage: • surface tensile cracking in pavement • surface compressive shearing in pavement • surface cracking in fill embankments • erosion of local slope stability for fill embankment if cracking occurs • cracking to culverts and under-road pipes • road drainage Risk to public safety Powerline –tilting pole, damage cross arms, insulators; change in conductor sag/tension; ground clearance. Communications - aerial cable, tilting pole; change in conductor sag/tension; ground clearance; damage to connections.	Active Zone Weekly visual inspection while road and adjacent powerlines and communications are within the active subsidence zone. Post Mining Monthly visual inspection for the following six months or until the commencement of weekly inspections for the next longwall panel.
		Telstra Visual inspection of infrastructure conducted by Comms Network Solutions.	Inspection of aerial cables, poles, pits, cables, joints and conduits.	Baseline Prior to mining LW30-31 Post Mining 2 months after mining LW30-31
		Powerlines Ausgrid	Overhead powerline modelling using LIDAR data.	Baseline Prior to mining LW30 and 31 2015 LIDAR information. Post mining After the completion of mining LW30-31.

Feature	Location	Monitoring Method	Parameter	Monitoring Frequency and Duration
		Powerlines - 3D Scanning Trimble SX10 Scanning Total Station of each pole affected by subsidence.	3D scan of power pole, High resolution photograph of pole, Vertical subsidence at pole Tilt of pole, Change in distance between poles.	Baseline Prior to mining impacting poles from the extraction of LW30 and 31. Post Mining 2 months after mining LW30 and LW31.
Steep Slopes Land Management Plan	Private properties Centennial Olney State Forest	Visual Inspection	Presence of mine-induced damage – surface cracking and rock falls, damage to tracks and drainage	Active Zone Weekly visual inspection of steep slopes from public and private access roads. Post Mining Visual inspection following completion of each LW panel.
Private Dwellings PSMP LW30-31	Centennial Ref. MS0025 MS0107 MS0137 MS0139	Monitoring points installed as agreed in consultation with each landowner: • Four points in ground surrounding dwelling • Pins installed at dwelling corners • Points on dams and other structures • As agreed in PSMP	Vertical subsidence, tilt and strain	Baseline Prior to being affected by mining LW30-31 Post Mining 2 months after mining LW30-31
		Visual Inspection	Pre-mining Structural Assessment by civil/structural engineer Pre-mining Inspection SA NSW Centennial Mandalong Inspection	Baseline Prior to being affected by mining LW30-31
			Post-mining SA NSW Inspection (where claim is lodged for subsidence damage) Centennial Mandalong	Post Mining Following completion of subsidence or request by landowner

8.4 Consolidated Summary of Environmental Monitoring

A summary of the consolidated environmental monitoring programs implemented to evaluate the impacts from subsidence within the Extraction Plan Area is provided in **Table 12**.

The full monitoring program, evaluation of performance measures and potential mining related impacts on groundwater, surface water, biodiversity, heritage and surface features is described in detail within the management plans detailed in **Table 11**.

Table 11 - Summary of Environmental Management Plans and Features Monitored

Key Component Management Plan (Document No.)	Feature Managed and Monitored
Water Management Plan MEMS-EP-9000-WMP-9010	Surface Water Groundwater
Land Management Plan MEMS-EP-9000-LMP-9020	Steep Slopes and Outcrops Agricultural Land Soil Erosion
Biodiversity Management Plan MEMS-EP-9000-BMP-9030	Habitat Threatened flora and fauna Endangered Ecological Communities (EEC) Groundwater Dependent Ecosystems (GDE) Aquatic ecosystems Wetlands
Heritage Management Plan MEMS-EP-9000-HMP-9040	Aboriginal Heritage Non-Aboriginal Heritage
Public Safety Management Plan MEMS-EP-9000-PMP-9060	Steep slopes and rock outcrops Public infrastructure Private dwellings
Property Subsidence Management Plans MEMS-EP-9000-PSMP-9070	Private Property Dwellings and built features (sheds, dams, fences, access roads) Flooding Soil Erosion Slope stability Land use and agriculture

8.4.1 Baseline Monitoring

Detailed baseline monitoring is included in each of the management plans shown in **Table 11** and summarised in **Table 12.**

8.4.2 Environmental Monitoring Locations

The environmental monitoring site locations are summarised in **Table 12** and shown in figures outline below:

Figure 4 – Surface Water Monitoring Locations

Figure 5 – Watercourse Stability Monitoring LW25-31

Figure 6 – Flood Monitoring Locations

Figure 7 – Groundwater Monitoring Bore Locations for LW30-31

Figure 8 – Potential Remnant Ponding Locations LW30 to 33

Table 12 – Summary of Environmental Monitoring Program LW30-31

Feature	Management Plan	Monitoring Component / Location	Monitoring Method	Parameter	Frequency and Duration
Steep slopes	Land Management Plan Public Safety Management Plan PSMP	Private and Centennial property	Visual Inspection	Presence of mine-induced damage, surface cracking and rock falls, damage to tracks and drainage	Baseline Prior to mining LW30-31 Active Zone Weekly visual inspection of steep slopes along public and private access roads. Post Mining Visual inspection following completion of each LW panel.
Agricultural Land	Land Management Plan PSMP	Private property Farm dams and drainage paths	Conventional monitoring PSMP Visual inspection	Vertical subsidence, tilt and strain.	Baseline Prior to mining LW30-31 Post Mining 2 months after mining LW30-31
Potential Remnant Ponding	Land Management Plan PSMP Flood Assessment	Property ref. and Flood Assessment Location: MS0019 Location 'A'(LW25) MS0050 Location 'B' (LW25) MS0012 Location 'C" (LW26) MS0012 Location 'D' (LW27) MS0025 Location 'H' (LW25) MS0065 Location 'G' (LW31)	Visual inspection PSMP Flood Path Inspections NearMap satellite imagery Plan MG12274	Increase in existing ponding New ponding locations	Baseline Prior to mining LW25-31 Post Mining 2 months after mining LW25-31
Dispersible Soils	Land Management Plan PSMP	Private Property	Visual and photographic monitoring	Increase in erosion	Baseline Prior to mining LW30-31 Post Mining 2 months after mining LW30-31

Feature	Management Plan	Monitoring Component / Location	Monitoring Method	Parameter	Frequency and Duration
		Earthworks for subsidence repair	Sodic subsoils where exchangeable sodium is <5	Remnant ponding or drainage repairs.	Post rehabilitation, 6 and 12 months
Groundwater	Water Management Plan	Mandalong Groundwater Bore Monitoring Network	Water Level (bgl), Water quality	Water Level (bgl), Water quality parameters	Quarterly Annual for metals
Water Courses	Water Management Plan	Morans Creek tributaries	Visual inspection and subsidence monitoring on private property as per PSMP and landowner access agreement	Erosion, flow conveyance, ponding.	<u>Baseline</u> Prior to mining LW30-31 <u>Post Mining</u> 2 months after mining LW30-31
			Flood Path Monitoring - Visual inspection	Erosion, flow conveyance, ponding	Six monthly Flood Path Inspection After flood event
			Flood Monitoring – flood level at Point Locations 1, 2, 3 and 4. Mandalong Rd.	Water level at flood depth indicators, photographs, road closure, anecdotal evidence.	Following rainfall event exceeding 100mm in 24 hours – equivalent 1 year ARI Storm Event
Aboriginal Heritage	Heritage Management Plan and Centennial Coal Northern Region ACHMP	25 heritage sites located over LW30-31 EP Area	Survey control points, digital photography and condition report.	Vertical subsidence, tilt photography, condition report	Three phase monitoring <u>Baseline</u> Prior to mining LW30-31 <u>Post Mining</u> 2 months after mining LW30-31 8 months after completion of subsidence.

Feature	Management Plan	Monitoring Component / Location	Monitoring Method	Parameter	Frequency and Duration
Flora & Fauna	Biodiversity Management Plan	Terrestrial Biodiversity *Rhodamnia rubescens, Corybas dowlingii* and any other threatened flora species identified during ongoing surveys with potential to occur in riparian areas.	Representative sample of known locations of *R. rubescens*, monitored against reference populations	Condition assessments	<u>Baseline</u> Prior to mining <u>During and Post Mining</u> Annually and for two years post mining.
		Terrestrial Biodiversity Vegetation communities and threatened species habitat assessments (EECs and GDEs) to assess potential impacts from predicted ponding	PCT 1523 PCT 1568 PCT 1573 PCT 1723	Biometric plots to assess vegetation condition.	
		Terrestrial Biodiversity Cave-associated threatened bats	Representative sampling of bat activity adjacent to suitable cave habitat, ideally monitored against reference populations.	Bat activity levels (i.e. bat echolocation call frequency) Cave entrance watch at dusk; Harp trapping (if maternity roost of threatened cave-associated bat suspected)	
		Terrestrial Biodiversity Brush-tailed Rock Wallaby	Representative sampling of Brush tailed Rock Wallaby adjacent to suitable habitat, ideally monitored against reference populations	Brush-tailed Rock Wallaby activity using infrared camera traps (if found to be present during baseline monitoring)	
		Aquatic Biodiversity Water Quality and Macroinvertebrate Surveys	Larger Creeks with permanent flows within the Extraction Plan Area (or immediately downstream if permanent water is not sufficiently available in this area).	Invertebrate species diversity and water quality – pH, EC (In accordance with NSW AUSRIVAS)	Annually (during spring)

Feature	Management Plan	Monitoring Component / Location	Monitoring Method	Parameter	Frequency and Duration
		Aquatic Biodiversity Amphibian Surveys	Creeks and dams within the Extraction Plan Area	Diurnal and nocturnal amphibian searches during spring and summer over 4 nights	Following 100mm or more rain in 24 hour period (Oct.-Mar.)
Surface Water	Water Management Plan	Morans Creek SW003, SW004, SW006 and SW011	Grab sample	**Physicochemical parameters:** electrical conductivity (EC), pH, total suspended solids (TSS), turbidity. **Nutrients:** ammonia, total nitrogen, total phosphorus. **Metals (dissolved and total):** aluminium, arsenic, boron, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver, zinc. **Others:** oil and grease.	Quarterly
		SWMP06, SWMP07 and SWMP08	Grab sample	**Physicochemical parameters:** EC, hardness, pH, total dissolved solids, TSS, turbidity. **Nutrients:** ammonia, biochemical oxygen demand, total Kjeldahl nitrogen (TKN), total nitrogen, total phosphorus. **Major ions:** alkalinity, calcium, chloride, magnesium, potassium, sodium, sulfate. **Metals (dissolved and total):** aluminium, arsenic, barium, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, silver, zinc. **Others:** cyanide, fluoride, oil and grease**.**	Quarterly

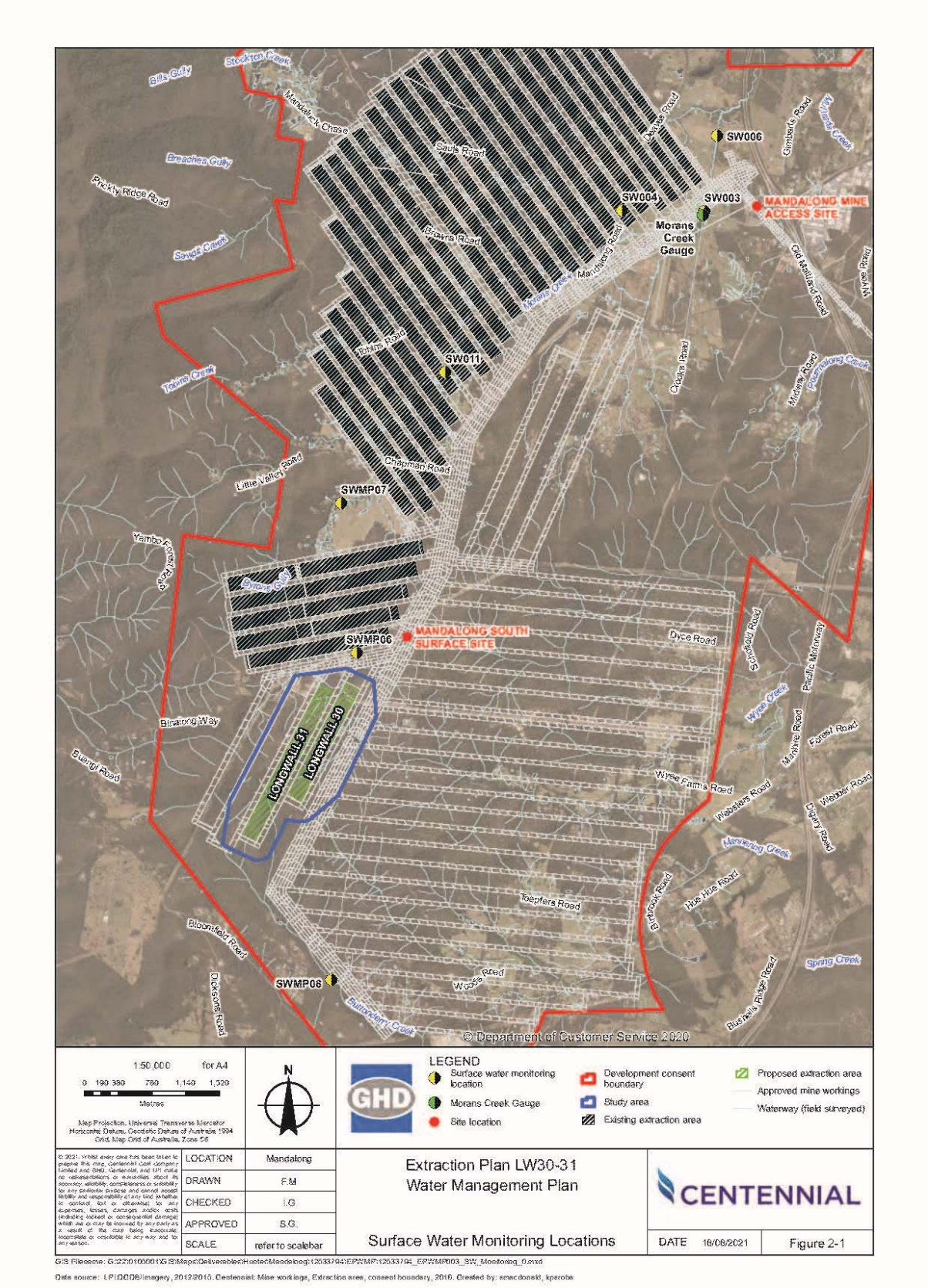


Figure 4 – Surface Water Monitoring Locations

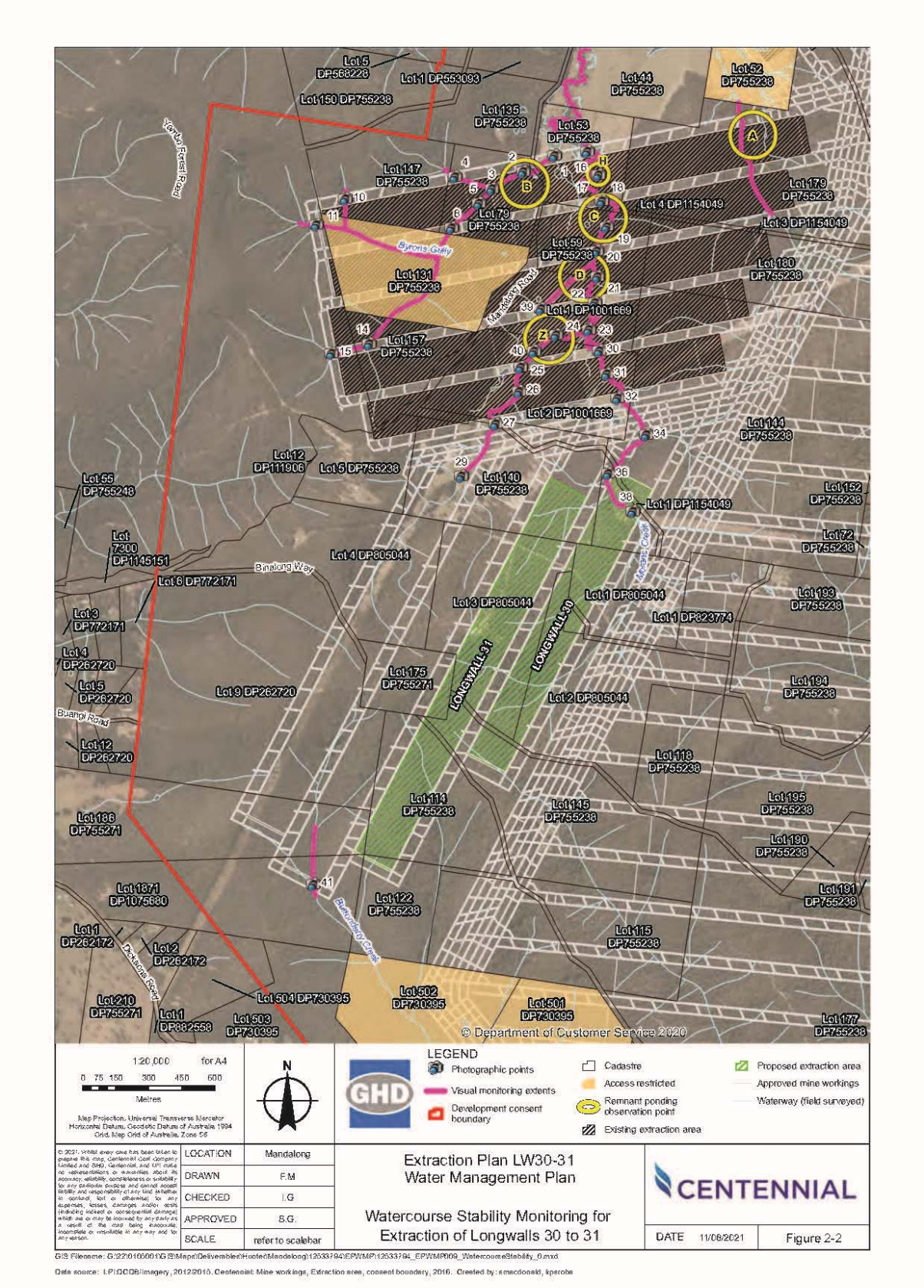


Figure 5 – Watercourse Stability Monitoring LW25-31

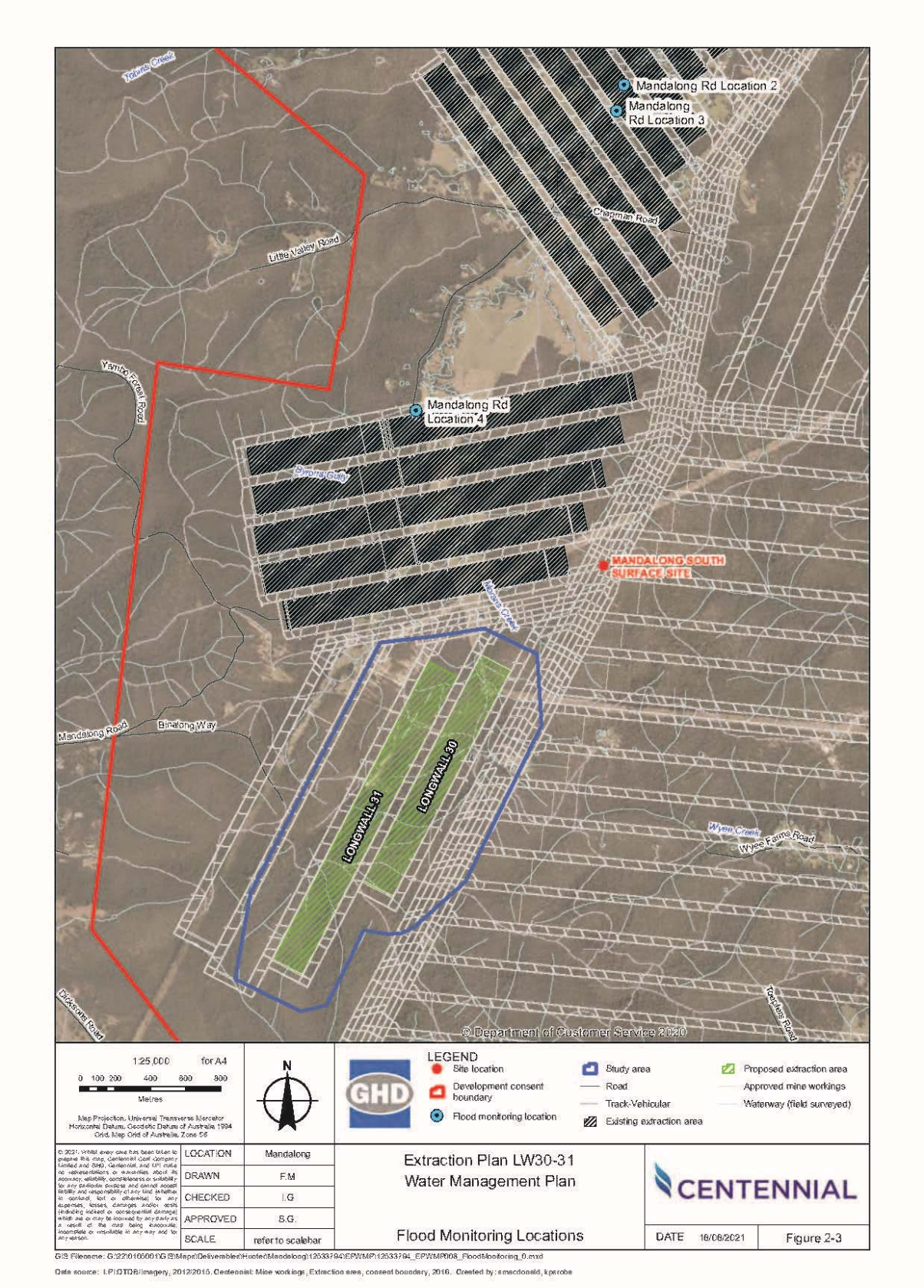


Figure 6 – Flood Monitoring Locations

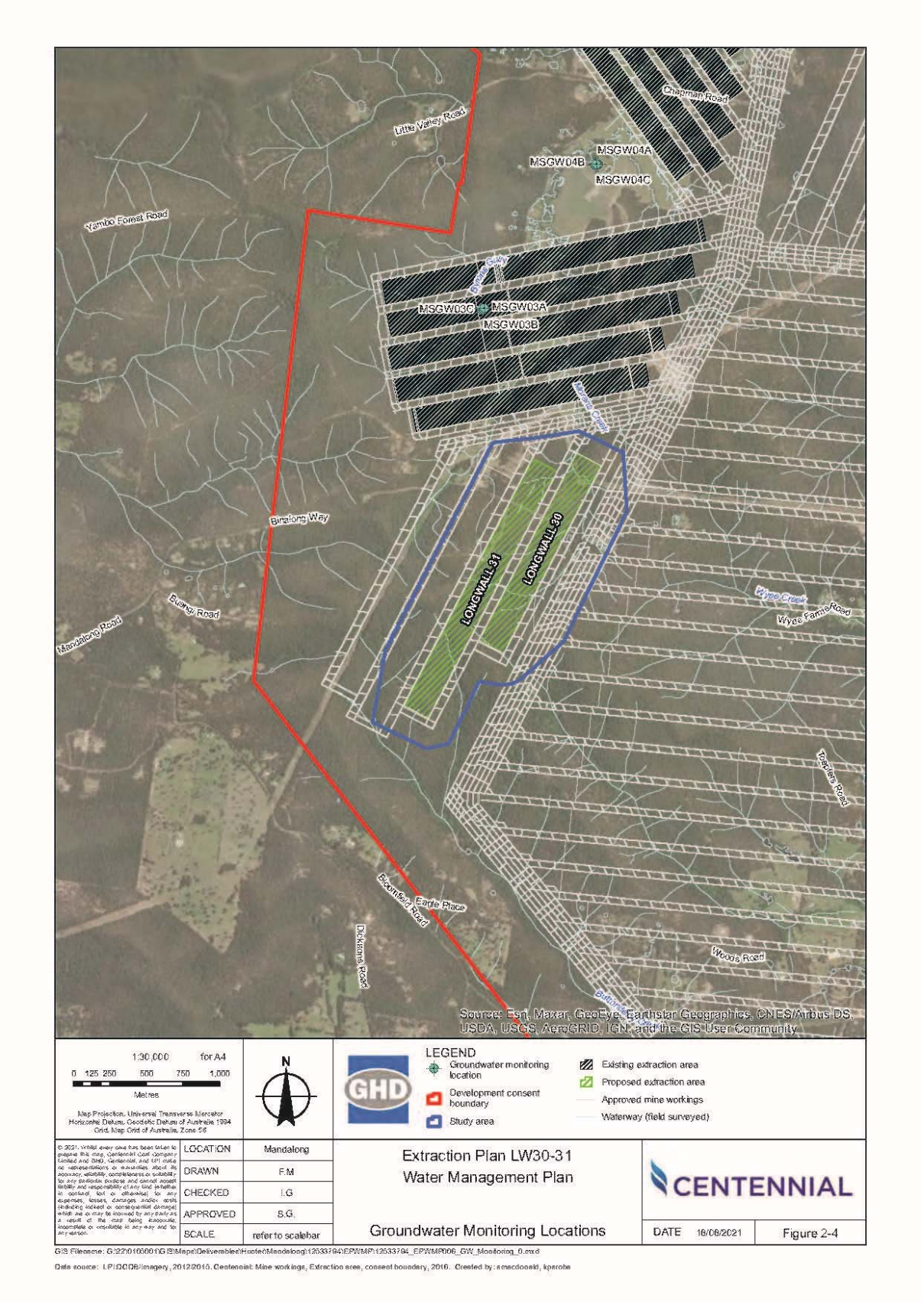


Figure 7 – Groundwater Monitoring Bore Locations for LW30-31

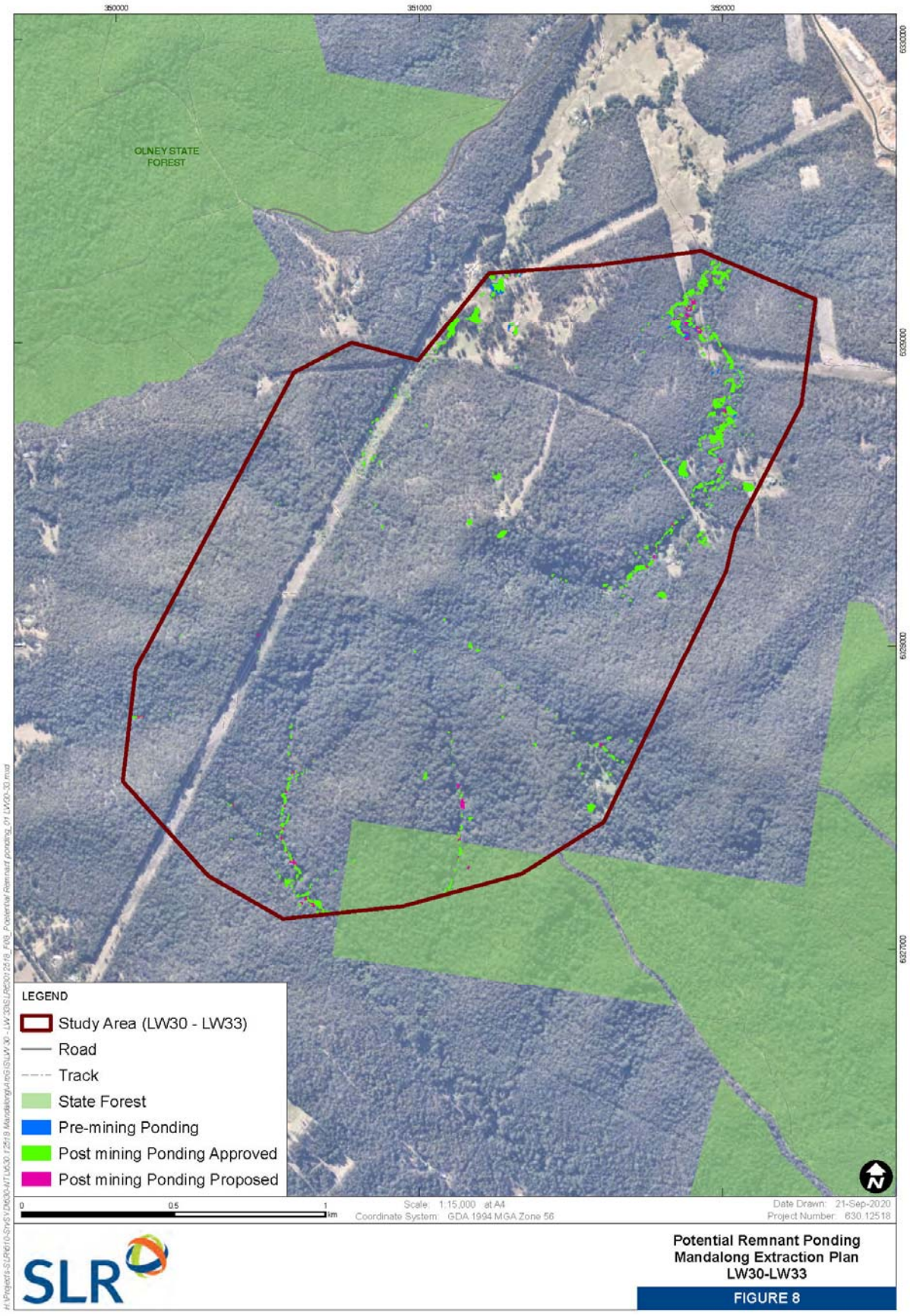


Figure 8 – Potential Remnant Ponding Locations LW30 to 33

9 Adaptive Management

In addition to the conservative narrow longwall panel design specifically designed to provide reduced levels of subsidence and impact, Centennial Mandalong developed an adaptive management approach designed to avoid repetition of any unpredicted subsidence and or environmental consequences. This system involves the monitoring and evaluation of impacts to built and natural features against the performance indicators defined in **Section 6.4** and contingency plans (TARPs) in the event that a performance indicator is exceeded. Refer to the relevant management plan and TARP.

10 Contingency Plans

Trigger Action Response Plans (TARP) have been developed using performance indicators for built features. In the event that subsidence monitoring and or visual inspections identify that a performance indicator has been exceeded, Centennial Mandalong will implement the contingency measures as detailed in the TARP for the specific management plan.

11 Roles and Responsibilities

The responsibility for implementation, monitoring and review of the Subsidence Monitoring Program lies with the Mining Approvals Coordinator. The roles and responsibilities for the Subsidence Monitoring Program are outline in **Table 13**.

Table 13 – Roles and Responsibilities

Position	Responsibility
Mine Manager	• Authorisation of the Subsidence Monitoring Program • Ensuring that sufficient resources are available to implement this plan.
Mining Approvals Coordinator	Implementation, monitoring and review of this plan, including: • Ensure that the Subsidence Monitoring Program, required inspections, mining notifications are scheduled into the Centennial Compliance Database prior to the commencement of each longwall panel. • Ensuring subsidence monitoring and inspections are conducted at the required schedule and persons conducting monitoring/inspections are trained in the requirements of this plan. • Consulting with the private landowners and relevant government departments including DPIE, RR and SA NSW. • Review and assess the subsidence monitoring results against the performance measures and predictions. • Notification of any exceedance of performance indicators in accordance with the TARPs, management plans and WHS legislation. • Coordinating any remedial work as required. • Preparation and submission of formal reporting requirements outlined in this plan. • Review and audit the Subsidence Monitoring Program.
Subsidence Surveyor	• Establishment of subsidence monitoring in accordance with the Subsidence Monitoring Program. • Ensure all subsidence surveys are conducted in accordance with the approved Subsidence Monitoring Program. • Review and assess subsidence monitoring results. • Notify the Mining Approvals Coordinator of any identified public safety issues. • Provide the monitoring results to the Mining Approvals Coordinator, DRE, SA NSW, Ditton Geotechnical Services and stakeholders.
Survey Department	• When required, conduct inspections within the applicable subsidence zone to the standard required, using the subsidence inspection checklist. • Promptly notify the Mining Approvals Coordinator of any issue identified during a subsidence inspection.
Environment and community Coordinator	• Consulting with the private landowners and relevant government departments including DPIE, RR and DRE. • Notification of any exceedance of performance indicators in accordance with the TARPs and management plans. • Coordinating any remedial work as required. • Preparation and submission of formal reporting requirements outlined in this plan.

12 Reporting

Reporting will be completed in accordance with the *Guidelines for the Preparation of Extraction Plans* (NSW Department of Planning & Environment, 2015), as summarised in **Table 14**.

Table 14 - Reporting Requirements

Report	Trigger	Requirements	Stakeholders
Incident Reporting	Any occasion or incident in accordance with consent condition or TARP.	In accordance with requirements of consent condition or TARP.	RR DPIE Local Councils Ausgrid Ditton Geotechnical Services SA NSW CCC
Bi-Monthly Subsidence Impact Reporting	If a new impact is identified, compile after monthly subsidence.	Distinguish impact: • within predictions; • those which exceed predictions but remain within performance measures and/or performance indicators; and • those which exceed performance measures and/or performance indicators. Report to include: • full description; • location identification using aerial photos with longwall layout superimposed; • photos of the impact; and • preliminary characterisation of the impact in accordance with the relevant TARP(s).	
Annual Review	Annual Report required under development consent SSD-5144.	Report to include: • six-monthly reports of impacts and environmental monitoring results; • monitoring results; and • summary of subsidence impacts.	RR DPIE CCC Local Councils Ausgrid
Community Consultative Committee (CCC)	CCC meetings are typically held three times per year.	Subsidence and environmental performance is included as an agenda item at each meeting.	CCC
Mining Notifications	One month prior to mining beneath infrastructure or property.	Scheduled date that mining beneath the infrastructure or property and the duration within the active subsidence zone.	Local Councils, Forestry Corp., Telstra, Ausgrid, Crown Lands, Private landowners.

13 Audit and Review

Audit and review procedures are outlined in Centennial Mandalong's Safety Management System that comply with the NSW Work Health and Safety (Mines and Petroleum Sites) Regulations. These procedures are utilised to manage audit and review functions of the Subsidence Monitoring Program. Refer Document **HSMS-SE-1028- System Evaluation**.

13.1 Audit

The requirements of the Subsidence Monitoring Program are to be audited annually for compliance and effectiveness during the extraction of LW30-31.

Any non-conformances or deficiencies found during the audit are to be brought to the attention of the System Coordinator so that corrective actions can be outlined. These corrective actions are to be allocated and carried out accordance with **HSMS-SE-1029 - Corrective Action Procedure**.

13.2 Review

The Subsidence Monitoring Program will be reviewed every three years or in the event that one of the following occurs:

- Stakeholders raise issues that necessitates a review;
- Where unpredicted impacts or consequences have required implementation of contingency actions under this plan;
- Monitoring, incident or audit processes demonstrate a review is required;
- With each Extraction Plan;
- Where triggered by a TARP;
- Where triggered by circumstances in either Clause 10 or Clause 128 of WHS (Mines and Petroleum Sites) Regulation or Clause 38 WHS Regulation; or
- Change in mine design or layout.

14 Document Control

An integrated Document Control Procedure is incorporated into Centennial Mandalong's Safety Management System.

Documents, data and records pertaining to this plan will be managed according to **HSMS-SE-1025-Information Control**.

15 BIBLIOGRAPHY

Comms Network Solutions. (2020). *Telstra Communications Assessment Report for Extraction Plan LW30-33.*

Ditton Geotechnical Services. (2020). *Subsidence Predictions and Impact Assessment for SSD-5144 Mod 9 Submissions Report MAN-005/1.*

Ditton Geotechnical Services. (2021). *Subsidence Predictions and Impact Assessment for Proposed LW30 and 31 - MAN-005/2.*

Ditton Geotechnical Services. (2021). *Subsidence Assessment for the Proposed Shortening of LW30 as a Variation to the LW30 & 31 Extraction Plan - MAN-005/8.*

NSW Department of Industry - Resources Regulator. (2017). *Managing Risk of Subsidence, Guide: WHS(Mines and Petroleum Sites) Legislation.*

NSW Department of Planning & Environment. (2015). Draft Guidelines for the Preparation of Extraction Plans V5.

SLR. (2020). *Centennial Mandalong Land and Agricultural Resource Assessment LW30-LW33.*

Umwelt. (2020). *Flood Impact Assessment, Mandalong Southern Extension Project Modification 9.*

Appendix 1 – Subsidence Movement and Effects Monitoring Program LW1-31

Appendix 1 – Subsidence Movement and Effects Monitoring Program LW1-31

Mandalong Mine Subsidence Monitoring Program

Longwalls 1 to 31

Section A - Monitoring program

Section B - Monitoring program for dwellings

Section C - Monitoring program for surface infrastructure

Section D - Survey standards

Section E - Definitions

Section F - Revision Details

Section G - Subsidence Monitoring Plan MG10435

All subsidence monitoring proposed in this program is subject to the necessary access agreements being available for privately held properties and dwellings.

Mandalong Mine will endeavour to obtain the necessary agreements, however there may be instances where the landholder may not allow access to a property or dwelling.

Revision No. 26

25/03/2021

Section A – Subsidence Monitoring Program

Subsidence Line	Location	Purpose	Survey Marks	Mark Spacing	Monitoring Frequency and Duration	Survey Standards	Responsibility
LW1 Centreline 1 **(LW1 – CL1)** **REMOVED 2012**	Longwall 1 Ch 1530-2021 + 150m past start Approx. centre line of panel	Centreline subsidence, travelling abutment subsidence rate and residual strains and tilts at abutment	Feno marks with 600mm spike if no rock.	10 metres	Completed	Standard 1 Standard 2	Mining Approvals Coordinator Subsidence and Projects Surveyor
LW1 Centreline 2 **(LW1 – CL2)** **PARTIALLY REMOVED 2012**	Longwall 1 Ch 580 - + 150m past end of LW. Marks installed on Ferris property are to be buried Approx. centre line of panel	Centreline subsidence, travelling abutment subsidence rate and residual strains and tilts at abutment. Monitoring of Ferris turf production area	1800mm star pickets driven into ground with concrete collar or Buried stainless steel pin set in mass concrete	10 metres	Completed Part removed to Ferris boundary line	Standard 1 Standard 2	Mining Approvals Coordinator Subsidence and Projects Surveyor
LW2 Centreline 3 **(LW2 – CL3)** **REMOVED 2012**	Longwall 2 Ch 760 - + 150m past end of LW. Marks installed on Ferris property are to be buried Approx. centre line of panel	Centreline subsidence, travelling abutment subsidence rate and residual strains and tilts at abutment. Impact of reverse faulting Monitoring of Ferris turf production area	1800mm star pickets driven into ground with concrete collar or Buried stainless steel pin set in mass concrete	8 metres or 10 metres	Completed Removal of access covers. Pegs remain buried	Standard 2	Mining Approvals Coordinator Subsidence and Projects Surveyor
LW3 Centreline 4 **(LW3 – CL4)** **REMOVED 2012**	Longwall 3 Ch 680-0 + 150m past end of LW. Approx. centre line of panel	Centreline subsidence, residual strains and tilts at abutment. Impact of reverse faulting	1800mm star pickets driven into ground with concrete collar	10 metres	Completed	Standard 2	Mining Approvals Coordinator Subsidence and Projects Surveyor

Subsidence Line	Location	Purpose	Survey Marks	Mark Spacing	Monitoring and Duration	Survey Standards	Responsibility
LW4 Centreline 5 **(LW4 – CL5)** **REMOVED 2012**	Longwall 4 Ch 486-0 + 262m past end of LW. Approx. centre line of panel	Centreline subsidence, residual strains and tilts at abutment. Impact of reverse faulting	1800mm star pickets driven into ground with concrete collar	10 metres	Completed	Standard 2	Mining Approvals Coordinator Subsidence and Projects Surveyor
LW5 Centreline 6 **(LW5 – CL6)** **PARTIALLY REMOVED 2018**	Longwall 5 Ch 2350-1470m Approx. centre line of panel	Centreline subsidence at maximum cover.	1800mm star pickets driven into ground to refusal or 1500mm deep.	10 metres	Agreed Monitoring Completed Additional monitoring by Mandalong	Standard 1 Standard 2	Mining Approvals Coordinator Subsidence and Projects Surveyor
LW5 Centreline 7 **(LW5 – CL7)** **PARTIALLY REMOVED 2017**	Longwall 5 Ch 1470-0 + 367m Approx. centre line of panel	Centreline subsidence, residual strains and tilts at abutment. Impact of reverse faulting	1800mm star pickets driven into ground to refusal or 1500mm deep.	10 metres	Agreed Monitoring Completed Additional monitoring by Mandalong	Standard 1 Standard 2	Mining Approvals Coordinator Subsidence and Projects Surveyor
LW6 Centreline 8 **(LW6 – CL8)** **PARTIALLY REMOVED 2014 and 2017**	Longwall 6 Ch 3230-0 + 335m Approx. centre line of panel	Centreline subsidence, residual strains and tilts at abutment. Impact of reverse faulting	Ch 1140-0 + 335 1800mm star pickets driven into ground to refusal or 1500mm deep. Ch 1140-3230 Wooden Dumpy Peg With “Kone” Nail	10 metres	Agreed Monitoring Completed Additional monitoring by Mandalong	Standard 1	Mining Approvals Coordinator Subsidence and Projects Surveyor
LW7 Centreline 9 **(LW7 – CL9).** **REMOVED 2014**	Longwall 7 Ch 2465-3025 + 240m Approx. centre line of panel	Centreline subsidence, residual strains and tilts at abutment.	1650mm star pickets driven into ground to refusal or 1500mm deep.	10 metres	Completed	Standard 1 Standard 2	Mining Approvals Coordinator Subsidence and Projects Surveyor

Subsidence Line	Location	Purpose	Survey Marks	Mark Spacing	Monitoring and Duration	Survey Standards	Responsibility
LW7 Centreline 10 **(LW7 – CL10)** **PARTIALLY REMOVED 2017**	Longwall 7 Ch 2170-0 + 335m Approx. centre line of panel	Centreline subsidence, residual strains and tilts at abutment.	1650mm star pickets driven into ground to refusal or 1500mm deep. Some of these marks will have cast iron covers over them due to live stock.	10 metres	Agreed Monitoring Completed Additional monitoring by Mandalong	Standard 1 Standard 2	Mining Approvals Coordinator Subsidence and Projects Surveyor
LW8 Centreline 11 **(LW8 – CL11)** **PARTIALLY REMOVED 2018**	Longwall 8 Ch 1400-0 + 300m Approx. centre line of panel	Centreline subsidence, residual strains and tilts at abutment.	1650mm star pickets driven into ground to refusal or 1500mm deep. Some of these marks have cast iron covers over them due to live stock.	10 metres	Agreed Monitoring Completed Additional monitoring by Mandalong	Standard 1	Mining Approvals Coordinator Subsidence and Projects Surveyor
LW9 Centreline 12 **(LW9 – CL12)** **PARTIALLY REMOVED 2017**	Longwall 9 Ch 1200-0 + 80m Approx. centre line of panel	Centreline subsidence, residual strains and tilts and effect of steep seam roll	1650mm star pickets driven into ground to refusal or 1500mm deep. Some of these marks will have cast iron covers over them due to live stock.	10 metres	Agreed Monitoring Completed Additional monitoring by Mandalong	Standard 1	Mining Approvals Coordinator Subsidence and Projects Surveyor
LW10 Centreline 13 **(LW10 – CL13)**	Longwall 10 Ch 1236-0 + 230m Approx. centre line of panel	Centreline subsidence, residual strains and tilts and effect of steep seam roll	1650mm star pickets driven into ground to refusal or 1500mm deep. Some of these marks will have cast iron covers over them due to live stock.	10 metres	Agreed Monitoring Completed Additional monitoring by Mandalong	Standard 1	Mining Approvals Coordinator Subsidence and Projects Surveyor

Subsidence Line	Location	Purpose	Survey Marks	Mark Spacing	Monitoring and Duration	Survey Standards	Responsibility
LW17 Centreline 14 **(LW17 – CL14)**	Longwall 17 Ch. 750m – 0m + AOD Approx. centre line of panel	Centreline subsidence, residual strains and tilts at abutment	1650mm star pickets driven into ground to refusal. Some of these marks will have cast iron covers over them due to live stock.	10 metres	Pre-mining Twice at time of mining End of longwall Pre and post mining adjacent longwall	Standard 1	Mining Approvals Coordinator Subsidence and Projects Surveyor
LW11 Maingate 1 **(LW11 – MG1)**	Longwall 11 Ch 2463 to 2812m Approx. centre line of Maingate 11	Maingate subsidence, Pillar and Floor Compression	1650mm star pickets driven into ground to refusal. Some of these marks will have cast iron covers over them due to live stock.	10 metres	Agreed Monitoring Completed Additional monitoring by Mandalong	Standard 1	Mining Approvals Coordinator Subsidence and Projects Surveyor
LW11 Maingate 2 **(LW11 – MG2)**	Longwall 11 Ch 67 to 1080m Approx. centre line of Maingate 11	Maingate subsidence, Pillar and Floor Compression	1650mm star pickets driven into ground to refusal. Some of these marks will have cast iron covers over them due to live stock.	10 metres	Agreed Monitoring Completed Additional monitoring by Mandalong	Standard 1	Mining Approvals Coordinator Subsidence and Projects Surveyor
LW25 Centreline	Longwall 25 Ch. 570m – 0m + AOD	Centreline subsidence, residual strains and tilts at abutment	1650mm star pickets driven into ground to refusal. Some of these marks will have cast iron covers over them due to live stock.	10 metres	Pre-mining Post-mining + 1 month Longwall 25 and Longwall 26.	Standard 1 Standard 2	Mining Approvals Coordinator Subsidence and Projects Surveyor

Subsidence Line	Location	Purpose	Survey Marks	Mark Spacing	Monitoring Frequency and Duration	Survey Standards	Responsibility
Crossline 1 (CS1) **REMOVED 2013**	LW 1 (and part 2) Along Gibson fence line at approx. 45° to LW1 Crossing LW 1 cl at approx. Ch 1800m	Subsidence and residual strains and tilts for Longwall 1	Feno marks with 600mm spike if no rock.	10 metres	Completed	Standard 1 Standard 2	Mining Approvals Coordinator Subsidence and Projects Surveyor
Crossline 2 (CS2) **PARTIALLY REMOVED 2020**	LW 1-20 At 90° to Longwall panels. Crossing LW 1 cl at approx. Ch 1630m and extends into Olney State Forest	Subsidence, pillar compression and residual strains and tilts. To assist with refinement of visualisation model	Feno marks with 600mm spike if no rock or 1650mm Star Post. Some of these marks will have cast iron covers over them due to live stock.	10 metres	**Active Zone** Prior to the mining each adjacent longwall 2 months after mining **Stable Zone** 2 yearly **Completion of LW20** 1 year after the completion of LW20. Then at 3 years and 5 years after completion of LW20	Standard 1 Standard 2 Standard 4 Standard 4	Mining Approvals Coordinator Subsidence and Projects Surveyor
Crossline 3 (CS3)	LW 1 Across Deaves property Crossing LW1 cl at approx. Ch 1150m	Subsidence and pillar compression for Longwall 1. Installed to comply with cutting height restriction.	Feno marks with 600mm spike if no rock.	10 metres	Completed Additional monitoring by Mandalong	Standard 2	Mining Approvals Coordinator Subsidence and Projects Surveyor

Subsidence Line	Location	Purpose	Survey Marks	Mark Spacing	Monitoring Frequency and Duration	Survey Standards	Responsibility
Crossline 3 Extension (CS3EX) **PARTIALLY REMOVED 2020 (LW16-17)**	LW 3-22 Across Red Lea and Centennial Property Crossing LW3-5 cl at approx. Ch 1000m and LW6-9CL @1250m.	Subsidence, pillar compression and residual strains and tilts. Installed to monitor old chicken sheds.	1800mm or 1650mm star pickets driven into ground. Some of these marks will have cast iron covers over them due to livestock.	10 metres	**Active Zone** Prior to the mining each adjacent longwall 2 months after mining **Stable Zone** 2 yearly **Completion of LW22** 1 year after the completion of LW22. Then at 3 years and 5 years after completion of LW22	Standard 1 Standard 2 Standard 4 Standard 4	Mining Approvals Coordinator Subsidence and Projects Surveyor

Subsidence Line	Location	Purpose	Survey Marks	Mark Spacing	Monitoring Frequency and Duration	Survey Standards	Responsibility
Crossline 4 (CS4) **Deaves Road** **PARTIALLY REMOVED 2013**	LW 1-5 Along Deaves Rd from Sauls Rd intersection to 150m past LW	Subsidence, pillar compression and residual strains and tilts. Monitoring of subsidence impacts on Deaves Road and infrastructure	1800mm or 1650mm star pickets driven into ground with concrete collar or Feno marks with 600mm spike if no rock.	10 metres	Completed Additional monitoring by Mandalong	Standard 1 Standard 2	Mining Approvals Coordinator Subsidence and Projects Surveyor
Crossline 5 (CS5) **PARTIALLY REMOVED TO LW5, 2013** **TO LW6, 2017** **TO LW8, 2018**	LW 1-13 At 90° to Longwall panels. Crossing LW 1 cl at approx. Ch 300m and extending to Browns Rd	Subsidence, pillar compression and residual strains and tilts. To assist with refinement of visualisation model	1800mm or 1650mm star pickets driven into ground. Some of these marks will have cast iron covers over them due to live stock.	10 metres	**Stable Zone** 2 yearly until 2018	Standard 4	Mining Approvals Coordinator Subsidence and Projects Surveyor
Crossline 6 (CS6) **PARTIALLY REMOVED 2013**	LW 1-2 Along Ferris fence line at approx. 60° to LW1 Crossing LW 1 cl at Approx. Ch 150m	Subsidence along Ferris property boundary	1800mm star pickets driven into ground with concrete collar	20 metres	Completed	Standard 2	Mining Approvals Coordinator Subsidence and Projects Surveyor
Crossline 7 (CS7)	LW 1 Crossing corner of LW 1 abutment at 45° and joining LW1 – CL2 Marks installed on Ferris property are buried	Subsidence and residual strains and tilts for Longwall 1 across abutment Monitoring of Ferris turf production area	Buried stainless steel pin set in mass concrete	8 metres	Completed Removal of access covers. Pegs to remain buried.	Standard 1 Standard 2	Mining Approvals Coordinator Subsidence and Projects Surveyor

Subsidence Line	Location	Purpose	Survey Marks	Mark Spacing	Monitoring Frequency and Duration	Survey Standards	Responsibility
Crossline 8 (CS8) **Mandalong Road** **PARTIALLY REMOVED TO LW5, 2013** **TO LW7, 2017**	LW 3-24A Adjacent to Mandalong Road commencing at Property Ref.6. Terminates 260m south of Chapmans Lane	Monitoring of subsidence impacts on Mandalong Road and infrastructure	1800mm or 1650mm star pickets driven into ground with concrete collar. Some of these marks will have cast iron covers over them due to slashing and public safety.	10 metres	**Active Zone** Prior to the mining each adjacent longwall 2 months after mining Daily visual inspections while the road is in the current LW active zone. **Stable Zone** 2 yearly	Standard 1 Standard 2 Standard 4	Mining Approvals Coordinator Subsidence and Projects Surveyor
Crossline 9 (CS9) **Sauls Road** **PARTIALLY REMOVED TO LW8, 2018**	LW 6-14 Adjacent to Sauls Road – west from Deaves Road intersection. Extends to LW14 + 342m from installation face.	Monitoring of subsidence impacts on Sauls Road and infrastructure	1800mm or 1650mm star pickets driven into ground.	10 metres	**Stable Zone** 2 yearly **Completion of LW17** 1 year after completion of LW17 Then 3 years and 5 years after completion of LW17	Standard 4 Standard 4	Mining Approvals Coordinator Subsidence and Projects Surveyor
Crossline 10 (CS10) **REMOVED 2014**	LW 4-8 At 90° to Longwall panels. Crossing LW 5 cl at Ch 2760m and extending to centreline of LW 8	Subsidence, pillar compression and residual strains and tilts. To assist with refinement of visualisation model	1800mm or 1650mm star pickets driven into ground with concrete collar (Subject to landholder approval)	10 metres	Completed	Standard 1 Standard 2	Mining Approvals Coordinator Subsidence and Projects Surveyor

Subsidence Line	Location	Purpose	Survey Marks	Mark Spacing	Monitoring Frequency and Duration	Survey Standards	Responsibility
Crossline 11 (CS11) **REMOVED 2014**	LW 6-7 At 90° to Longwall panels. Crossing LW 6 cl at Ch 2436m to cl of LW 7	Subsidence, pillar compression and residual strains and tilts. To assist with refinement of visualisation model	1650mm star pickets driven into ground. Also investigating the use of tilt meters on this line.	10 metres	Completed	Standard 1 Standard 2	Mining Approvals Coordinator Subsidence and Projects Surveyor
Crossline 12 (CS12)	LW 6-7 At 90° to Longwall panels. Crossing LW 6 cl at Ch 1706m and extending to MG8	Subsidence, pillar compression and residual strains and tilts. To assist with refinement of visualisation model	1650mm star pickets driven into ground. Also investigating the use of tilt meters on this line.	10 metres	Agreed monitoring completed	Standard 1 Standard 2	Mining Approvals Coordinator Subsidence and Projects Surveyor
Crossline 13 (CS13) **REMOVED 2017**	LW 6-7 At 90° to Longwall panels. Crossing LW 6 cl at Ch 806m and extending to MG7	Subsidence, pillar compression and residual strains and tilts. To assist with refinement of visualisation model	1650mm star pickets driven into ground.	10 metres	Agreed monitoring completed	Standard 1	Mining Approvals Coordinator Subsidence and Projects Surveyor
Crossline 14 (CS14) **REMOVED 2017**	LW 6-7 At 90° to Longwall panels. Crossing LW 6 cl at Ch 496m and extending to MG 8	Subsidence, pillar compression and residual strains and tilts. To assist with refinement of visualisation model	1650mm star pickets driven into ground. Some of these marks will have cast iron covers over them due to live stock.	10 metres	Agreed monitoring completed	Standard 1	Mining Approvals Coordinator Subsidence and Projects Surveyor
Crossline 15 (CS15)	LW 10-14 At 90° to Longwall panels. Crossing LW 11 cl at Ch 2812m and extending to MG 13	Subsidence, pillar compression and residual strains and tilts. To assist with refinement of visualisation model	1650mm star pickets driven into ground. Some of these marks will have cast iron covers over them due to live stock.	10 metres	Agreed monitoring completed	Standard 1	Mining Approvals Coordinator Subsidence and Projects Surveyor

Subsidence Line	Location	Purpose	Survey Marks	Mark Spacing	Monitoring Frequency and Duration	Survey Standards	Responsibility
Crossline 16 (CS16)	LW 6-7 At 90° to Longwall panels. Crossing LW 12 cl at Ch 2542m and extending to MG 12	Subsidence, pillar compression and residual strains and tilts. To assist with refinement of visualisation model	1650mm star pickets driven into ground. Some of these marks will have cast iron covers over them due to slashing.	10 metres	Agreed monitoring completed	Standard 1	Mining Approvals Coordinator Subsidence and Projects Surveyor
Crossline 17 (CS17) Browns Road	LW 13-14 Installed in road pavement	Monitoring of subsidence impacts on Browns Road and infrastructure	Pin in road pavement	10 metres	Agreed monitoring completed	Standard 1	Mining Approvals Coordinator Subsidence and Projects Surveyor
Crossline 18 (CS18)	LW16 -22 At 90° to Longwall panels Crossing LW16 at Ch. 420m and extending past proposed LW21	Subsidence, pillar compression and residual strains and tilts. To assist with refinement of visualisation model	1650mm star pickets driven into ground. Some of these marks will have cast iron covers over them due to live stock.	10 metres	**Active Zone** Prior to mining each adjacent longwall 2 months after mining **Stable Zone** 2 yearly	Standard 1 Standard 4	Mining Approvals Coordinator Subsidence and Projects Surveyor
Crossline 19 (CS19) **Tobins Rd**	LW17-24 Installed in road pavement	Monitoring of subsidence impacts on Tobins Road and infrastructure.	Pin in road pavement	10 metres	Post Longwall 17 to 21 Daily visual inspections while the road is in the current LW active zone.	Standard 1	Mining Approvals Coordinator Subsidence and Projects Surveyor
Crossline 20 (CS20)	LW18-20 Extends along ridgeline within the crown road easement for Prickly Ridge Rd.	Monitoring the impact of subsidence on steep slopes, down slope movement and on joint sets.	1650mm star pickets driven into ground with cast iron covers and pins in rock.	5 metres	Prior to mining each longwall and adjacent longwall. Two months after mining each longwall.	Standard 1	Mining Approvals Coordinator Subsidence and Projects Surveyor

Subsidence Line	Location	Purpose	Survey Marks	Mark Spacing	Monitoring Frequency and Duration	Survey Standards	Responsibility
Crossline 21 (CS21)	LW25-29 Mandalong Road Road easement and pavement	Monitoring of subsidence impacts on Mandalong Road and infrastructure.	1650mm star pickets driven into ground. Some of these marks will have cast iron covers. Pin in road pavement	10m Beyond AOD at 25m	Prior to mining Longwall 25. Post mining each longwall 25 – 30.	Standard 1 Standard 2	Mining Approvals Coordinator Subsidence and Projects Surveyor
Crossline 22 (CS22)	LW25-28 Transmission Line No. 24 easement	Subsidence, pillar compression and residual strains and tilts. To assist with refinement of subsidence model	1650mm star pickets driven into ground with cast iron covers.	10m	Prior to mining Longwall 25. Post mining each longwall 25 – 29.	Standard 1 Standard 2	Mining Approvals Coordinator Subsidence and Projects Surveyor
Crossline 23 (CS23)	LW28-30 Centennial property	Subsidence, pillar compression and residual strains and tilts. To assist with refinement of subsidence model	1650mm star pickets driven into ground. Some of these marks will have cast iron covers.	10m	Prior to mining Longwall 27. Post mining each longwall 28 – 31.	Standard 1 Standard 2	Mining Approvals Coordinator Subsidence and Projects Surveyor
Crossline 24 (CS24)	LW30-33 Crown Rd. easement on Toefpers Rd and Kiar Ridge Fire Trail	Subsidence, pillar compression and residual strains and tilts. To assist with refinement of subsidence model	1650mm star pickets driven into ground. Some of these marks will have cast iron covers.	10m	Prior to mining Longwall 30 Post mining each longwall 30-33	Standard 1 Standard 2	Mining Approvals Coordinator Subsidence and Projects Surveyor
Crossline 25 (CS25)	LW31-32 Private access road	Subsidence, pillar compression and residual strains and tilts. To assist with refinement of subsidence model	1650mm star pickets driven into ground. Some of these marks have cast iron covers.	10m	Prior to mining Longwall 30 Post mining each longwall 30-33	Standard 1 Standard 2	Mining Approvals Coordinator Subsidence and Projects Surveyor

Subsidence Line	Location	Purpose	Survey Marks	Mark Spacing	Monitoring Frequency and Duration	Survey Standards	Responsibility
Crossline H Creek	LW 3-14 Line follows Stockton Creek Crossing LW 3 cl at Ch 440m and extending to LW14	Subsidence and ponding effects on Stockton Creek.	1800 and 1650mm star pickets driven into ground. Some of these marks will have cast iron covers over them due to live stock.	Nominal 20 metres or bends in creek. Or **Heavily Vegetated Areas –** Minimum of two marks located over each Maingate and two marks over the centre of LW panels	**Active Zone** Completed **Stable Zone** Six monthly flood path visual inspections have ceased.	Standard 4	Mining Approvals Coordinator Subsidence and Projects Surveyor Environmental Coordinator
Crossline Morans Creek	LW15-24 Crossing LW15 at Ch 100m.	Subsidence and ponding effects on creek Potential for remnant ponding over LW15-16.	Wooden pegs 1650mm star pickets driven into ground. Some of these marks will have cast iron covers over them due to live stock	Minimum of two marks located over each Maingate and two marks over the centre of LW panels	Prior to the mining each adjacent longwall 2 months after mining Annually for 2 years Six monthly flood path visual inspections	Standard 4	Mining Approvals Coordinator Subsidence and Projects Surveyor Environmental Coordinator
Wetland Monitoring **Centennial Property Reference 42** **REMOVED 2018**	LW 8-9 Line follows wetlands Crossing LW 8 cl at Ch 860m	Subsidence effects on wetland Consent Condition 74	3000mm star pickets driven into ground.	10 metres	Agreed monitoring completed	Standard 1	Mining Approvals Coordinator Subsidence and Projects Surveyor Environmental Coordinator

Subsidence Line	Location	Purpose	Survey Marks	Mark Spacing	Monitoring Frequency and Duration	Survey Standards	Responsibility
Wetland Monitoring **Centennial Property Reference 68**	LW16-17 Wetland circumference	Subsidence effects on wetland Consent Condition 74	3000mm star pickets driven into ground.	10 metres	Prior to the mining each adjacent longwall After mining 6 monthly for 2 years (summer and winter variation)	Standard 1	Mining Approvals Coordinator Subsidence and Projects Surveyor Environmental Coordinator
Tower Simulation Monitoring	LW17 LW17 abutment pillar and LW 17 Ch. 150	Monitor subsidence at simulation sites over LW17 for transmission towers TL24/48 located over LW21 abutment pillar and TL24/47 located over LW22 goaf.	1650mm star pickets driven into ground	Corners of tower 4m x 8m	Monitoring completed	Standard 1	Mining Approvals Coordinator Subsidence and Projects Surveyor
TL24 Tower 48 **TransGrid**	LW21 LW21 abutment pillar	Monitor subsidence at TransGrid TL24 Tower 48. Monitoring for level, tilt and strain. Mandalong Mine TransGrid TL24/48 Management Plan	Steel survey pins in tower concrete footings, and 1650mm star pickets driven into ground.	Four marks located outside each corner of the tower. Standard tower monitoring	LW20 chainage 300m, 100m, 0m and one month after completion. LW21 – refer TransGrid Tower 48 monitoring schedule in Section C	Standard 1 Standard 2	Mining Approvals Coordinator Subsidence and Projects Surveyor
TL24 Tower 47 **TransGrid**	LW22	Monitor subsidence at TransGrid TL24 Tower 47. Monitoring for level, tilt and strain. Mandalong Mine TransGrid TL24/46-47 Management Plan	Steel survey pins in tower concrete footings, and 1650mm star pickets driven into ground.	Four marks located outside each corner of the tower. Standard tower monitoring	LW22 chainage 300m, 100m, 0m and one month after completion. LW23 chainage 200m, 0m. LW22-refer TransGrid Tower 48 monitoring schedule in Section C	Standard 1 Standard 2	Mining Approvals Coordinator Subsidence and Projects Surveyor

Subsidence Line	Location	Purpose	Survey Marks	Mark Spacing	Monitoring Frequency and Duration	Survey Standards	Responsibility
TL24 Tower 46 **TransGrid**	LW23, LW24	Monitor subsidence at TransGrid TL24 Tower 46. Monitoring for level, tilt and strain. Mandalong Mine TransGrid TL24/46-47 Management Plan Mandalong Mine TransGrid TL24/45-46 Management Plan	Steel survey pins in tower concrete footings, and 1650mm star pickets driven into ground.	Four marks located outside each corner of the tower. Standard tower monitoring	LW23 chainage 450m, 200m, 0m and one month after completion. LW23-refer TransGrid Tower 47 monitoring schedule in Section C LW24 chainage 570m, 300m, 200m, 0m and one month after completion. LW24A chainage 100m and 0m. LW24-refer TransGrid Tower 46 monitoring schedule in Section C	Standard 1 Standard 2	Mining Approvals Coordinator Subsidence and Projects Surveyor
TL24 Tower 45 **TransGrid**	LW24A	Monitor subsidence at TransGrid TL24 Tower 45. Monitoring for level, tilt and strain. Mandalong Mine TransGrid TL24/45-46 Management Plan	*Steel survey pins in tower concrete footings, and 1650mm star pickets driven into ground. * Pending landowner access agreement for access to property, drill hole in footing grout tubes to be used instead of steel survey pins.	Four marks located outside each corner of the tower. Standard tower monitoring	LW24A chainage 450m, 100m, 0m and one month after completion. LW24A-refer TransGrid Tower 45 monitoring schedule in Section C	Standard 1 Standard 2	Mining Approvals Coordinator Subsidence and Projects Surveyor

Subsidence Line	Location	Purpose	Survey Marks	Mark Spacing	Monitoring Frequency and Duration	Survey Standards	Responsibility
TL24 Towers 35X, 36X, 37X and 38X **Relocated section of TransGrid TL24** **Suspension towers installed with cruciform footings**	LW25-29	Monitor subsidence at TransGrid TL24 Tower 35X – 38X. Monitoring for level, tilt and strain. Mandalong Mine TransGrid TL24/35X-38X Management Plan	Steel survey pins in tower concrete footings, and 1650mm star pickets driven into ground.	Four marks located outside each corner of the tower. Standard tower monitoring	Refer Transmission Line Management Plan TransGrid Towers TL24 / 35X – 38X	Standard 1 Standard 2	Mining Approvals Coordinator Subsidence and Projects Surveyor
TL24 Tower 34X and 39X **Relocated section of TransGrid TL24** **Tension Towers**	Located outside LW25 angle of draw (26.5°)	Monitor subsidence at TransGrid TL24 Tower 34X (cruciform footing) and Tower 39X Monitoring for level, tilt and strain. Mandalong Mine TransGrid TL24/35X-38X Management Plan	Steel survey pins in tower concrete footings, and 1650mm star pickets driven into ground.	Four marks located outside each corner of the tower. Standard tower monitoring	Refer Transmission Line Management Plan TransGrid Towers TL24 / 35X – 38X Additional surveys for Tower 39X: LW25 Chainage 600m and 100m. Strain measurements between tower legs at LW25 chainage 500m, 300m and 200m.	Standard 1 Standard 2	Mining Approvals Coordinator Subsidence and Projects Surveyor
TL25/26 Towers 39, 40, 41 and 42. **Suspension towers installed with cruciform footings**	LW28-29	Monitor subsidence at TransGrid TL25/26 Tower 39 – 42. Monitoring for level, tilt and strain. Mandalong Mine TransGrid TL25/26 Towers 39-42 Management Plan	Steel survey pins in tower concrete footings, and 1650mm star pickets driven into ground.	Standard tower monitoring	Refer Transmission Line Management Plan TransGrid TL25/26 Towers 39-42	Standard 1 Standard 2	Mining Approvals Coordinator Subsidence and Projects Surveyor

Subsidence Line	Location	Purpose	Survey Marks	Mark Spacing	Monitoring Frequency and Duration	Survey Standards	Responsibility
TL25/26 Tower 43 **Tension Tower**	LW29	Monitor subsidence at TransGrid TL25/26 Tower 43 Monitoring for level, tilt and strain. Mandalong Mine TransGrid TL25/26 Towers 39-42 Management Plan	Steel survey pins in tower concrete footings, and 1650mm star pickets driven into ground.	Standard tower monitoring	Refer Transmission Line Management Plan TransGrid TL25/26 Towers 39-42	Standard 1 Standard 2	Mining Approvals Coordinator Subsidence and Projects Surveyor
Area 2 **First Workings** **(no subsidence)**	Area 2 Crooks Road easement	Confirm no movement from first workings development. Monitoring for level	1650mm star pickets driven into ground with cast iron covers and existing SSM.	150m to 200m Centre of panel and barrier pillars	Completion of each panel.	Standard 4	Mining Approvals Coordinator Subsidence and Projects Surveyor

Section B – Monitoring Program for Dwellings

Monitoring

A survey monitoring grid consisting of levelled marks at selected locations around dwellings is to be established *Standard 3*.

The Monitoring grid will be surveyed:

- Prior to mining – initial survey is to be conducted before mining is within 200 metres of the dwelling;
- At completion of mining, by agreement with landholder; and
- At other times following completion of mining as required by the landholder, Subsidence Advisory NSW or the Principal Subsidence Engineer (Resources Regulator).

Inspection

A pre-mining building inspection will be conducted by the Subsidence Advisory NSW.

The inspection will be completed:

- Prior to mining – initial inspection is to be conducted before mining is within 200 metres of the dwelling; and
- At completion of mining, by agreement with landholder.

Communication

The landowner or tenant will be notified at least one month prior to undermining. Regular communication will be undertaken to:

- Advise of mining progress;
- Determine the extent of any damage; and
- Arrange rectification or remediation works as necessary.

Dwellings to be monitored for Longwalls 6 – 31 by Mandalong Mine Subject to Landholder Approval.

Landowner	Centennial Property Reference No.	Longwall	Monitoring Conducted by	Monitoring Established
Marosszeky	102	Longwall 6 and 7	Mandalong Mine	28/06/07
Patience	30	Longwall 6 and 7	Mandalong Mine	21/12/07
Smith & Jones	117B	Longwall 6 and 7	Mandalong Mine	21/12/07
Auston (previously Banks)	28	Longwall 9	Mandalong Mine	05/08/09
McCready	41	Longwall 10	Mandalong Mine	24/03/10
See	115	Longwall 11	Mandalong Mine	10/05/11
Glynn	116	Longwall 13	Mandalong Mine	05/10/11
Aubin	46	Longwall 13	Mandalong Mine	14/12/12
Burzacott	13	Longwall 14	MSB	May 2012
Yula Punaal	22	Longwall 14	Mandalong Mine	18/7/12
Eltro Investments	39	Longwall 15	Mandalong Mine	30/10/13
Baillie	47	Longwall 15	Access denied	Access denied
Chapman	67	Longwall 15	Mandalong Mine	02/11/14
Brady & Brackem	33	Longwall 16	Mandalong Mine	12/11/13
Van Bezouwen (previously Brown)	34	Longwall 16	Mandalong Mine	31/10/13
Howe	38	Longwall 16	Mandalong Mine	13/11/13
Davies	20	Longwall 17	Mandalong Mine	08/07/14
Forestry Corporation	71	Longwall 17	Mandalong Mine	08/08/14
Armstrong	82	Longwall 18	Mandalong Mine	02/07/15
Barnicoat	77	Longwall 19	Mandalong Mine	15/07/15
Mandalong Fire Shed LMCC	78	Longwall 19	Mandalong Mine	30/07/15
Flaherty	79	Longwall 19	Mandalong Mine	30/07/15
Read	74	Longwall 21	Mandalong Mine	18/05/16
Allen	73	Longwall 22	Mandalong Mine	09/03/17
S Swann	88	Longwall 22	Mandalong Mine	25/05/17
Ferrier	89	Longwall 22	Mandalong Mine	21/07/17
Lawrence	90	Longwall 22	Mandalong Mine	08/02/17

Landowner	Centennial Property Reference No.	Longwall	Monitoring Conducted by	Monitoring Established
Boon	221	Longwall 22	Mandalong Mine	09/02/17
Corkery	220	Longwall 22	Mandalong Mine	13/02/17
S Swann	212	Longwall 23	Mandalong Mine	25/05/17
Hodge and Kelly	207	Longwall 23	Mandalong Mine	15/09/17
Ostergaard	219	Longwall 23	Mandalong Mine	22/06/17
Kearns	214	Longwall 24A	Mandalong Mine	08/11/18
T Swann	218	Longwall 24A	Mandalong Mine	05/09/18 (remote)
Markowski	MS0051	Longwall 25	Mandalong Mine	20/06/19
Veliss	MS0012	Longwall 25	Mandalong Mine	22/05/19
Daykin	MS0029	Longwall 26	Mandalong Mine	Owner declined
T. Swann	MS0127	Longwall 28	Mandalong Mine	08/05/20
Sharpe	MS0061	Longwall 29	Mandalong Mine	Owner declined
Campbell	MS0137	Longwall 30	Mandalong Mine	
Brereton	MS0139	Longwall 30	Mandalong Mine	
Laruffa	MS0107	Longwall 31	Mandalong Mine	20/11/2020
Saunders	MS0025	Longwall 32	Mandalong Mine	

Note: Monitoring on dwellings is to be installed in consultation with landowner and with agreement.

Section C– Monitoring Program for Infrastructure

Note: Monitoring for LW30 and LW31 has been replaced by the Extraction Plan for LW30-31.

Built Features Management Plan LW25-31 – Subsidence Monitoring Program Summary				
Feature	**Location**	**Monitoring Method**	**Parameter**	**Monitoring Frequency and Duration**
Public Roads Public Roads Management Plan **Ausgrid Powerlines** Powerline Management Plan **Telstra Communications Network** Communications Management Plan	**Mandalong Road** **and** **Powerline easements**	**Crossline 21** adjacent to road at 10m spacing; and Feno nails in pavement 0.15m from edge of road at 10m spacing.	Vertical subsidence, tilt and strain.	Baseline Prior to mining LW25, LW26, LW27, LW28 and LW29. Post Mining 2 months after mining LW25, LW26, LW27, LW28 and LW29. Stable Zone 2 yearly.
		Visual Inspection	Presence of mine-induced damage: • surface tensile cracking in pavement • surface compressive shearing in pavement • surface cracking in fill embankments • erosion of local slope stability for fill embankment if cracking occurs • cracking to culverts and under-road pipes • road drainage Risk to public safety Powerline –tilting pole, damage cross arms, insulators; change in conductor sag/tension; ground clearance.	Active Zone Daily visual inspection while road and adjacent powerlines are within the current LW25-31 active zone. Weekly inspection on powerlines remote from Mandalong Rd. Post Mining Weekly visual inspection for the following six months or next longwall panel.
		Telstra Visual inspection of infrastructure conducted by Comms Network Solutions.	Inspection of pits, cables, joints, conduits.	Baseline Prior to mining LW25 to LW28 Post Mining 2 months after mining LW25 to 29
		3D Scanning Trimble SX10 Scanning Total Station of each power pole affected by subsidence.	3D scan of power pole, High resolution photograph of pole, Vertical subsidence at pole Tilt of pole, Change in distance between poles.	Baseline Prior to mining impacting poles from the extraction of LW25 to 31. Post Mining 2 months after mining LW25 to LW31.

Built Features Management Plan LW25-31 – Subsidence Monitoring Program Summary				
Feature	**Location**	**Monitoring Method**	**Parameter**	**Monitoring Frequency and Duration**
		Ausgrid	Overhead powerline modelling using LIDAR data.	Baseline Prior to mining LW25 to 31 2015 LIDAR information. Post mining After the completion of mining LW25-31.
	Access Track off Binalong Way and powerline easement. Local CAN – Aerial cables Near limit of subsidence LW31	**Visual Inspection**	Presence of mine-induced damage – surface cracking, road surface, drainage, pipes and culverts. Risk to public safety Aerial cable –tilting pole; change in conductor sag/tension; ground clearance; damage to connections. Risk to public safety.	Active Zone Weekly visual inspection while road is within the current LW active zone. Post Mining Weekly visual inspection for the following six months or next longwall panel.
		Telstra Visual inspection of aerial cables and infrastructure conducted by Telstra – Comms Network Solutions	Inspection of poles, cables and joints.	Baseline Prior to mining LW25-31 Post Mining Completion of mining LW25-31
Steep Slopes Land Management Plan	Private properties MS0051, MS0061, MS0107, MS0128. Centennial MS0019, MS0020 Olney State Forest MS0050, MS0094, MS0096	Visual Inspection	Presence of mine-induced damage – surface cracking and rock falls, damage to tracks and drainage	Weekly visual inspections while steep slopes are within the current LW active zone. Post Mining Visual inspection following completion of each LW panel.
TransGrid Transmission Line No.24 TransGrid Management Plan	TL24 Suspension Towers 35X to 38X	Tower monitoring	Tower vertical subsidence, tilt and strain at cruciform footing and 4 surrounding ground pegs. Tilt of tower and at peak earthwire (transverse and longitudinal to line)	Refer TransGrid Management Plan TL24 Towers 35X to 38X Refer Transmission Line Management Plan

Built Features Management Plan LW25-31 – Subsidence Monitoring Program Summary				
Feature	**Location**	**Monitoring Method**	**Parameter**	**Monitoring Frequency and Duration**
TL24 Towers 35X to 38X		Visual Inspection	Transmission towers – tilting, buckling; damage to cross arms, insulators; change in conductor sag/tension; reduced conductor ground clearance.	
	TL24 Tension Towers 34X and 39X	Tower monitoring	Tower vertical subsidence, tilt and strain at footing / cruciform footing and 4 surrounding ground pegs. Tilt of tower and at peak earthwire (transverse and longitudinal to line)	<u>Additional surveys for Tower 39X:</u> LW25 Chainage 600m and 100m. Strain measurements between tower legs at LW25 chainage 500m, 300m and 200m.
		Visual Inspection	Transmission towers – tilting, buckling; damage to cross arms, insulators; change in conductor sag/tension; reduced conductor ground clearance.	
Private Dwellings PSMP LW25-31	Centennial Ref. MS0012 MS0025 MS0029 MS0051 MS0061 MS0127	Monitoring points installed as agreed in consultation with each landowner: • Four points in ground surrounding dwelling • Pins installed at dwelling corners • Points on dams and other structures • As agreed in PSMP	Vertical subsidence, tilt and strain	<u>Baseline</u> Prior to being affected by mining LW25-31 <u>Post Mining</u> 2 months after mining LW25-31
		Visual Inspection	Pre-mining Structural Assessment by civil/structural engineer Post-mining SA NSW Inspection Centennial Mandalong Inspection	<u>Baseline</u> Prior to being affected by mining LW25-31
			Post-mining SA NSW Inspection (where claim lodged) Centennial Mandalong	<u>Post Mining</u> Following completion of subsidence or request by landowner

Built Features Management Plan LW30-31 – Subsidence Monitoring Program Summary				
Feature	**Location**	**Monitoring Method**	**Parameter**	**Monitoring Frequency and Duration**
Crown Roads Public Roads Management Plan **Private Access Roads** PSMP **Telstra Communications Network** Communications Management Plan **Ausgrid Powerlines** Powerline Management Plan	**Crown Roads** Toefpers Rd Kiar Ridge Rd **Private Access Roads** Private properties **Powerline easements** 11kV powerline	**Crossline 23** Star posts on Centennial property at 10m spacing **Crossline 24 and Crossline 25** Star posts adjacent to road at 10m spacing	Vertical subsidence, tilt and strain.	<u>Baseline</u> Prior to mining LW30 and LW31. <u>Post Mining</u> 2 months after mining LW30 and LW31. <u>Stable Zone</u> 2 yearly.
		Visual Inspection	Presence of mine-induced damage: • surface tensile cracking in pavement • surface compressive shearing in pavement • surface cracking in fill embankments • erosion of local slope stability for fill embankment if cracking occurs • cracking to culverts and under-road pipes • road drainage Risk to public safety Powerline –tilting pole, damage cross arms, insulators; change in conductor sag/tension; ground clearance. Communications – aerial cable, tilting pole; change in conductor sag/tension; ground clearance; damage to connections.	<u>Active Zone</u> Weekly visual inspection while road and adjacent powerlines and communications are within the active subsidence zone. <u>Post Mining</u> Monthly visual inspection for the following six months or until the commencement of weekly inspections for the next longwall panel.
		Telstra Visual inspection of infrastructure conducted by Comms Network Solutions.	Inspection of aerial cables, poles, pits, cables, joints and conduits.	<u>Baseline</u> Prior to mining LW30-31 <u>Post Mining</u> 2 months after mining LW30-31
		3D Scanning Trimble SX10 Scanning Total Station of each power pole affected by subsidence.	3D scan of power pole, High resolution photograph of pole, Vertical subsidence at pole Tilt of pole, Change in distance between poles.	<u>Baseline</u> Prior to mining impacting poles from the extraction of LW30-31. <u>Post Mining</u> 2 months after mining LW30-LW31.

Built Features Management Plan LW30-31 – Subsidence Monitoring Program Summary				
Feature	**Location**	**Monitoring Method**	**Parameter**	**Monitoring Frequency and Duration**
		Ausgrid	Overhead powerline modelling using LIDAR data.	Baseline Prior to mining LW30 and 31 2015 LIDAR information. Post mining After the completion of mining LW30-31.
Steep Slopes Land Management Plan	Private properties Centennial Olney State Forest	Visual Inspection	Presence of mine-induced damage – surface cracking and rock falls, damage to tracks and drainage	Active Zone Weekly visual inspection of steep slopes along public and private access roads. Post Mining Visual inspection following completion of each LW panel.
Private Dwellings PSMP LW30-31	Centennial Ref. MS0025 MS0107 MS0137 MS0139	Monitoring points installed as agreed in consultation with each landowner: • Four points in ground surrounding dwelling • Pins installed at dwelling corners • Points on dams and other structures • As agreed in PSMP	Vertical subsidence, tilt and strain	Baseline Prior to being affected by mining LW30-31 Post Mining 2 months after mining LW30-31
		Visual Inspection	Pre-mining Structural Assessment by civil/structural engineer Pre-mining SA NSW Inspection Centennial Mandalong Inspection	Baseline Prior to being affected by mining LW30-31
			Post-mining SA NSW Inspection (where claim is lodged for subsidence damage) Centennial Mandalong	Post Mining Following completion of subsidence or request by landowner

Section D – Survey Standards

Standard 1 – EDM differential levelling and strain measurement

- EDM differential levelling will be conducted with reference to the quality as defined in SP1 of *6mm * √k (km)*
- EDM strain measurements will be conducted with reference to the quality as defined in SP1, relative uncertainty target accuracy ± 2mm per strain bay distance.
- Survey equipment specification – 1" total station theodolite, distance measurement ± 2mm + 2 ppm.

Standard 2 – Digital Level differential levelling and strain measurement

- Digital Level differential levelling will be conducted with reference to the quality as defined in SP1of *6mm * √k (km)*
- Strain measurements by standardised steel band. Target accuracy ± 2mm per strain bay distance.

Standard 3 – Dwelling Monitoring

Marks to be placed at selected locations around and or on the dwelling. Marks are to be placed at locations to effectively determine subsidence induced movement and should be installed in a manner to minimise impact on the structure and safety of the occupier.

Standard 4 – Digital Level differential levelling only

Levelling only over 'Stable Longwall Subsidence Zone for Crossline Monitoring'

Digital level differential levelling will be conducted with reference to the quality as defined in SP1 of *6mm * √k (km)*

Where vertical movement is greater than 0.14m from the last strained test, strains measurements will be completed by the appropriate method (Standard 1 or 2).

Note: *Document reference* – Special Publication 1 (SP1) Version 2.0 *(Release 24 October 2013)*

All initial and final surveys will be coordinated by Traversing (*Standard 1)* and levelled by differential levelling (*Standard 2*).

Section E – *Definitions*

Active Subsidence Zone for Visual Monitoring

The “active subsidence zone” is when mining is within 100m in front of the face and 500m following mining beneath the Structure or feature.

Active Longwall Subsidence Zone for Crossline Monitoring

The “active longwall subsidence zone” includes the current longwall panel and the three previous longwall panels.

Stable Longwall Subsidence Zone for Crossline Monitoring

The “stable longwall subsidence zone” is from the start of the crossline up to the “active longwall subsidence zone”.

SP1

Inter-Governmental Committee on Surveying and Mapping, Standards and Practices for Control Surveys (SP1).

Section F – *Revision Details*

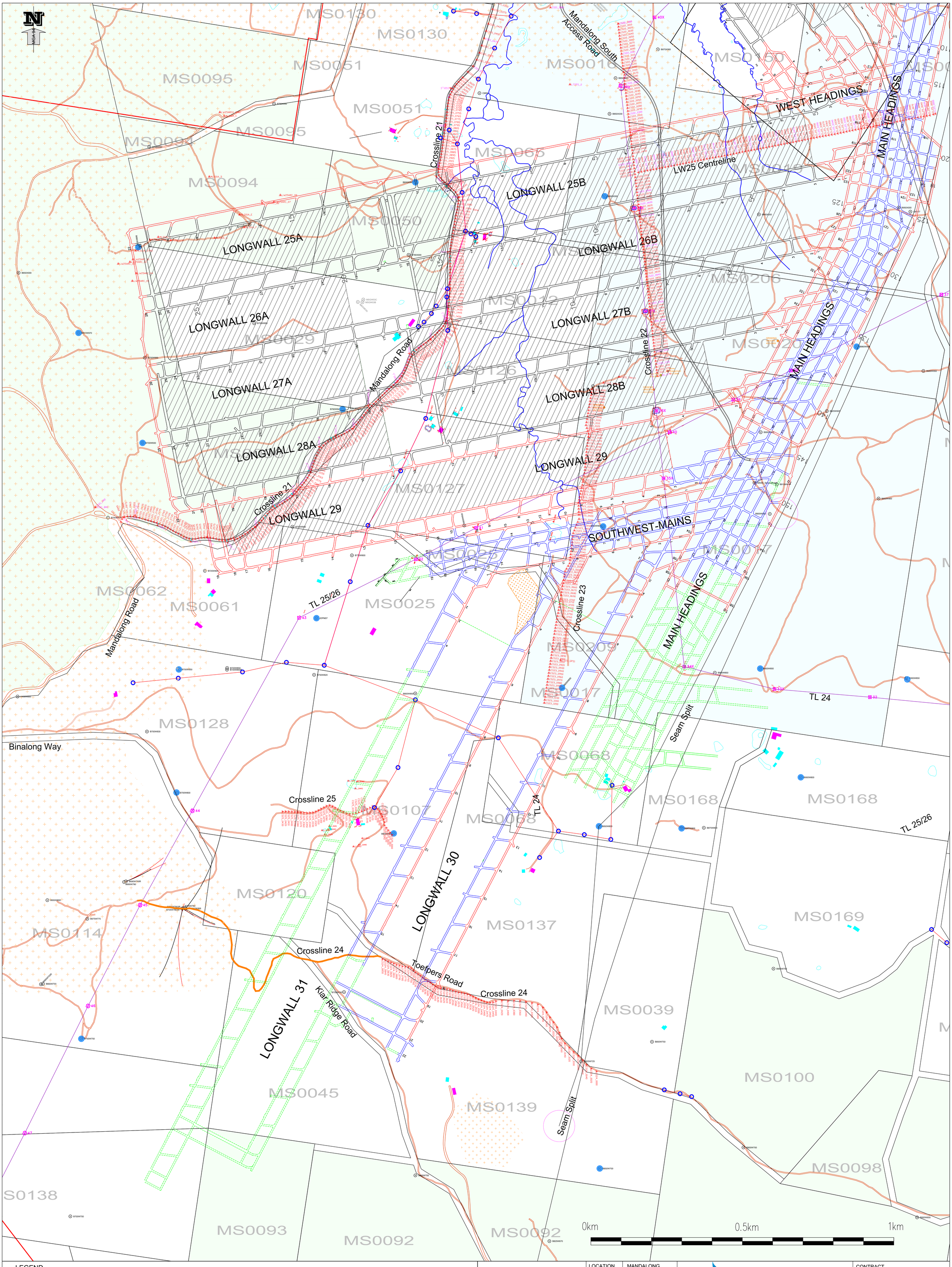
Revision No.	Revision Details	Date
Revision 1	Longwalls 1 to 3	
Revision 2	Longwalls 1 to 5	20/03/2007
Revision 3	Longwalls 1 to 7	28/05/2007
Revision 4	Longwalls 1 to 10	22/01/2008
Revision 5	Longwalls 1 to 10 ➢ Telstra Management Plan Monitoring for LW7	12/09/2008
Revision 6	Longwalls 1 to 10 ➢ Telstra Management Plan Monitoring for LW8, ➢ Revised monitoring program ➢ Revision of Section D –Survey Standards and Section E – Definitions	27/03/2009
Revision 7	Longwalls 1 to 10 ➢ Revised Telstra Management Plan Monitoring for LW8	15/09/2009
Revision 8	Longwalls 1 to 10 ➢ Telstra Management Plan Monitoring for LW9 ➢ Addition of Revision Details section.	31/03/2010
Revision 9	Longwalls 1 to 14 ➢ Extend Crosslines 2, 3Ex, 5, 8 and 9 ➢ Extend H Creek (Stockton Creek) ➢ Install Crosslines 15, 16 and 17 ➢ Install LW11 Maingate 1 and LW 11 Maingate 2 (detect pillar and floor compression)	23/07/2010
Revision 10	Longwalls 1 to 14 ➢ Telstra Management Plan Monitoring for LW10	11/10/2010
Revision 11	Longwalls 1 to 14 ➢ Telstra Management Plan Monitoring for LW11	10/06/2011

Revision No.	Revision Details	Date
Revision 12	Longwalls 1 to 14 ➢ Telstra Management Plan Monitoring for LW12 ➢ Revised subsidence peg spacing for Crossline H Creek (Stockton Creek) due to vegetation density.	1/12/2011
Revision 13	Longwalls 1 to 14 ➢ Telstra Management Plan Monitoring for LW13	11/07/2012
Revision 14	Longwalls 1 to 14 ➢ Telstra Management Plan Monitoring for LW14	20/12/2012
Revision 15	Longwalls 1 to 17 ➢ Revised monitoring program up to LW17 ➢ Update for removal or partial removal of subsidence lines over LW1 to LW4 ➢ Proposed extension of Crossline 2 and Crossline 3 Ex ➢ Proposed installation of 16 Crossline 18 and 17 Centreline 14 ➢ Telstra Management Plan Monitoring for LW15	19/9/2013
Revision 16	Longwalls 1 to 17 ➢ Telstra Management Plan Monitoring for LW16 ➢ Update of dwelling monitoring table ➢ Update for removal or partial removal of 6 Centreline 8, 7 Centreline 9, Crossline 10, Crossline 11. ➢ Installation of Morans Creek monitoring over LW15-16	6/08/2014
Revision 17	Longwalls 1 to 21 ➢ Addition of Standard 4 – levelling only monitoring for Stable Longwall Subsidence Zone ➢ Update monitoring frequency for completion of Crossline 2 and Crossline 3Ex after LW20 and LW21. ➢ Installation of Crossline 19 along Tobins Rd over LW17-21 ➢ Update of dwelling monitoring table ➢ Update Survey standards with reference to SP1 (Version 2.0) ➢ Telstra Management Plan Monitoring for LW17	24/11/2014

Revision No.	Revision Details	Date
Revision 18	Longwalls 1 to 21 ➢ Installation of Crossline 20 along Prickly Ridge Rd crown road easement. ➢ Extension of Morans Creek ➢ Tower simulation monitoring for TL24/48 and TL24/47. ➢ Update of dwelling monitoring table ➢ Update Survey standards with reference to SP1 (Version 2.0) ➢ Update of Section C – Monitoring program for infrastructure.	1/05/2015
Revision 19	Longwalls 1 to 21 ➢ Update of Section C – Monitoring program for Telstra infrastructure LW18-21 ➢ Update of dwelling monitoring table	14/08/2015
Revision 20	Longwalls 1 to 21 ➢ Update of Section C – Monitoring program for Telstra infrastructure LW18-21. Monitoring completed for LW18. ➢ Update Section G – Subsidence Monitoring Plan MG10435. Revised start position of LW20 and LW21.	6/05/2016
Revision 21	Longwalls 1 to 21 ➢ TransGrid TL24 Tower 48 subsidence monitoring LW20 and LW21 (Section A). ➢ Update Section C – Monitoring Program for TransGrid TL24 Tower 48 – LW21 and Inspection Summary. ➢ Update Section G – Subsidence Monitoring Plan MG10435	25/08/2016
Revision 22	Longwalls 1 to 23 ➢ Changed responsibility from Technical Services Coordinator to Mining Approvals Coordinator ➢ Update Section A – proposed extension for Morans Creek Crossline past LW23 ➢ Update Section B – included dwellings affected by LW22-23 ➢ Update Section C – delete Telstra monitoring for LW19, include built features monitoring for LW22-23 ➢ Update Section G – Subsidence Monitoring Plan MG10435 -	21/12/2016

Revision No.	Revision Details	Date
Revision 23	Longwalls 1 to 24A ➢ Update Section A – extension for Morans Creek Crossline to LW24, partial removal of 5CL7, 6CL8, 7CL10, 1CS5 and 2CS8 ➢ Update Section B – established monitoring and included dwellings affected by LW24-24A ➢ Update Section C –include built features monitoring summary for LW24-24A and update Inspection Summary – Infrastructure and Public Safety Management Plan. ➢ Update Section G – Subsidence Monitoring Plan MG10435	5/12/2017
Revision 24	Longwalls 1 to 31 ➢ Update Section A – establish monitoring Crosslines 21, 22 and 23, establish LW25 Centreline, ➢ Update Section A partial removal of 5CL6, 8C11, 9CL12, CS5, CS9, CS13, CS14 and Wetland (property ref. 42). ➢ Update Section B – established monitoring and included dwellings affected by LW25-31 ➢ Update Section C –include built features monitoring summary for LW25-31. ➢ Update Section G – Subsidence Monitoring Plan MG10435	9/10/2018
Revision 25	Longwalls 1 to 31 ➢ Update Section A – additional monitoring for TransGrid TL24 Tension Tower 39X. ➢ Update Section B – update established monitoring on dwellings. ➢ Update Section C –update built features monitoring summary for LW25-31 to include additional monitoring for TransGrid TL24 Tower 39X.	15/11/2018
Revision 26	Longwalls 1 to 31 ➢ Update Section A – Reorientation LW30-31, Crossline 24, Crossline 25, additional monitoring for TransGrid TL25/26 Towers and Area 2 first workings panels. Partial removal of Crossline 2 and Crossline 3Ex. ➢ Update Section B – update monitoring on dwellings. ➢ Update Section C –update built features monitoring summary for LW30-31, remove summary for completed LW24-24A. ➢ Updated Section G – Subsidence Monitoring Plan MG10435.	25/03/2021

Section G – Subsidence Monitoring Plan MG10435



LEGEND

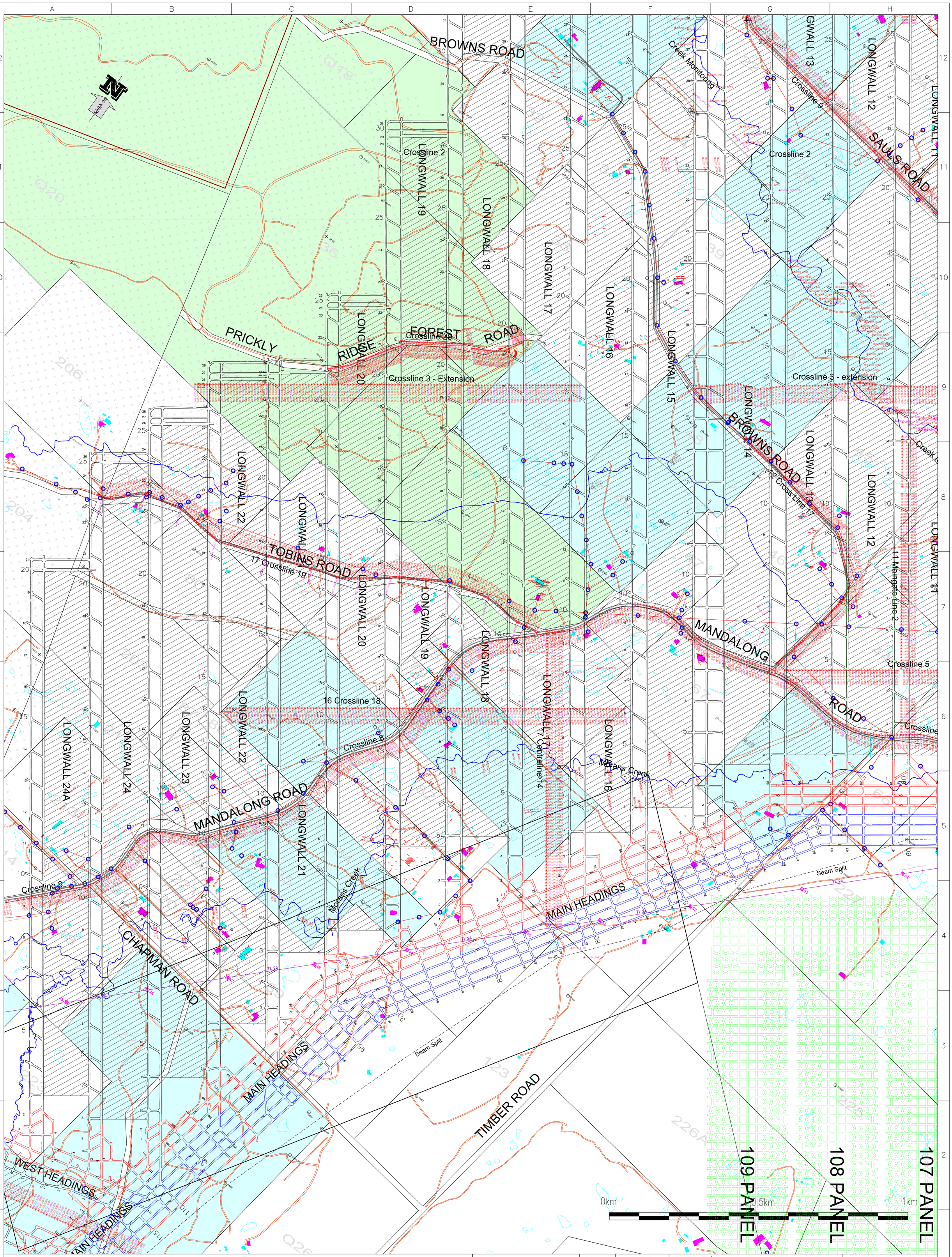
- Subsidence Line - Proposed
- Proposed Subsidence Monitoring Station
- Subsidence Monitoring Station
- Existing Workings
- Proposed Workings
- Creek
- Dyke
- Sealed Road
- Access Track
- Igneous Sill
- Dwelling
- Building
- 330kV TransGrid Tower
- 11kV Powerlines
- Olney State Forest
- Centennial Property
- Borehole
- Groundwater Monitoring Bore

LOCATION	MANDALONG
SEAM	WEST WALLARAH
DRAWN	PJS 19/07/06
CHECKED	
APPROVED	
SCALE	1:4000

CENTENNIAL MANDALONG

MANDALONG MINE
SUBSIDENCE SURVEY LINES
LW25-31

CONTRACT	
PLOTFILE:MG10435_210618.PDF	
A0	MG10435
DRAWING REVISION	18/06/2021



LEGEND

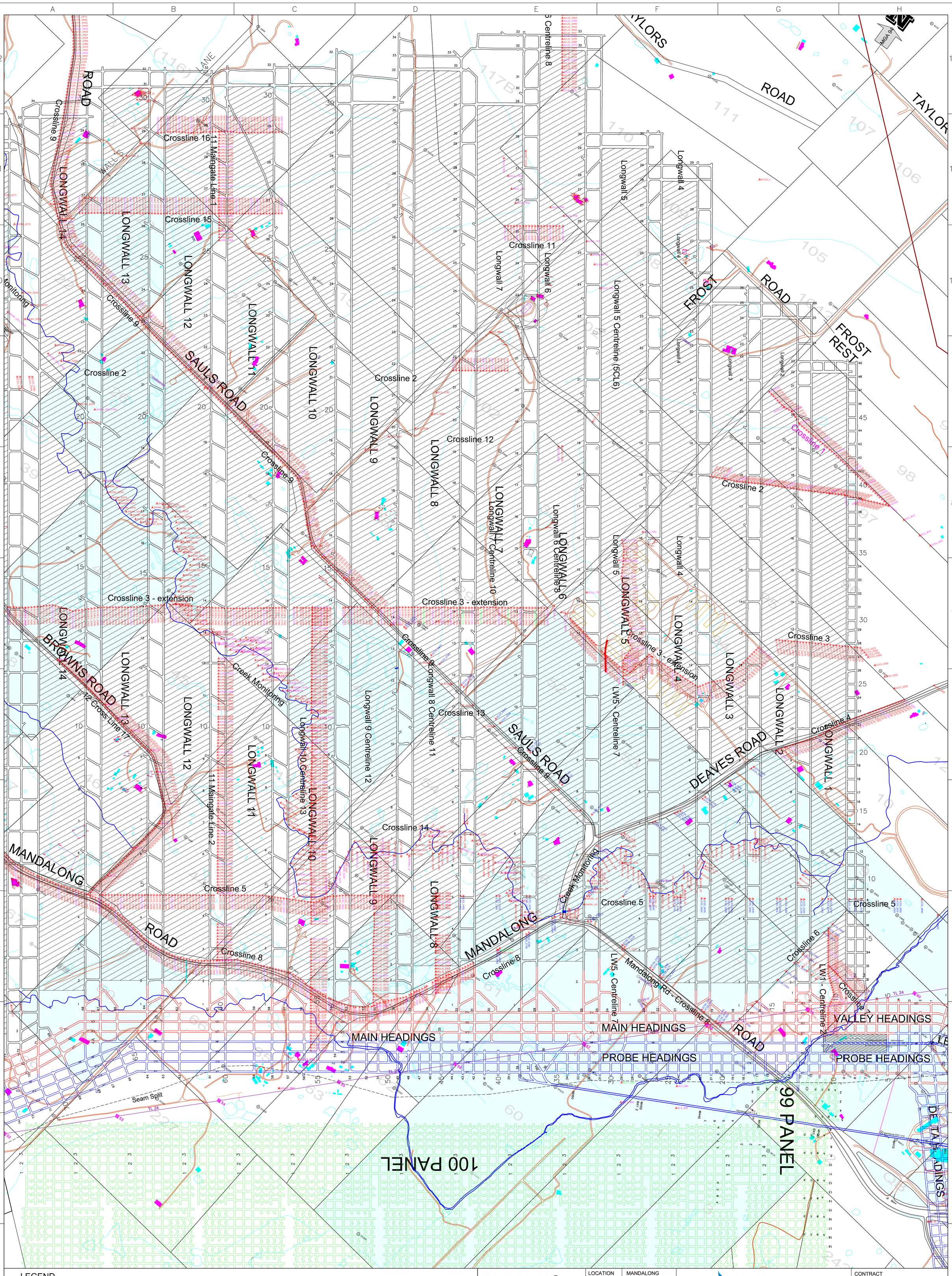
- Subsidence Line - Proposed
- Proposed Subsidence Monitoring Station
- Subsidence Monitoring Station
- Existing Workings
- Proposed Workings
- Creek
- Dyke
- Sealed Road
- Access Track
- Igneous Sill
- Dwelling
- Building
- 330kV TransGrid Tower
- 11kV Powerlines
- Seam Roll
- Olney State Forest
- Centennial Property
- Borehole
- Groundwater Monitoring Bore

LOCATION	MANDALONG
SEAM	WEST WALLARAH
DRAWN	PJS 19/07/06
CHECKED	
APPROVED	
SCALE	1:4000

CENTENNIAL MANDALONG

MANDALONG MINE
SUBSIDENCE SURVEY LINES
LW15-24A

CONTRACT	
PLOTFILE	
A0	MG10435
DRAWING REVISION	25.03.2021



LEGEND

- Subsidence Line - Proposed
- STN Subsidence Monitoring Station
- Dyke
- Existing Workings
- Proposed Workings
- Creek
- Sealed Road
- Access Track
- Igneous Sill
- Dwelling
- Building
- Seam Roll
- Olney State Forest
- Centennial Property

LOCATION	MANDALONG
SEAM	WEST WALLARAH
DRAWN	PJS 19/07/06
CHECKED	
APPROVED	
SCALE	1:4000

CENTENNIAL MANDALONG

MANDALONG MINE
SUBSIDENCE SURVEY LINES
LW1-14

CONTRACT	
PLOTFILE	
A0	MG10435
DRAWING REVISION	25.03.2021

Centennial Mandalong

12 Kerry Anderson Drive
Mandalong NSW 2264
PO Box 1000
Toronto NSW 2283
Telephone 1800 730 919
Facsimile 49 730 999

Centennial Mandalong

12 Kerry Anderson Drive
Mandalong NSW 2264
PO Box 1000
Toronto NSW 2283
Telephone 1800 730 919
Facsimile 49 730 999