SIMEC Mining:

Tahmoor North Western Domain Longwalls West 1 and West 2

Management Plan for Potential Impacts to Built Structures

AUTHORISATION OF MANAGEMENT PLAN

Authorised on behalf of Tahmoor Coal:	
Name:	MALCOLM WATERFALL
Signature:	Malcolm Waterfall
Position:	MINING ENGINEERING MANAGER
Date:	13 · NOV · 19.

DOCUMENT REGISTER

Date	Report No.	Rev	Comments
Nov-19	MSEC1045-12	A	Draft for LW W1-W2
Nov-19	MSEC1045-12	B	Final for LW W1-W2 following review and provision of additional information

References:

AS/NZS 4360:2004	Risk Management
AS/NZS ISO 31000:2009	Risk Management – Principles and guidelines
MSO (2017)	Managing risks of subsidence – Guide | WHS (Mines and Petroleum Sites) Legislation, NSW Department of Planning & Environment, Resources Regulator, Mine Safety Operations, February 2017.
MSEC (2019)	Tahmoor Coal - Longwalls W1 and W2 - Subsidence Predictions and Impact Assessments for Natural and Built Features due to the Extraction of the Proposed Longwalls W1 and W2 in Support of the Extraction Plan Application. (Report No. MSEC1019, Revision B, July 2019), prepared by Mine Subsidence Engineering Consultants.
Tahmoor Coal (2019)	Risk Assessment Report – Infrastructure. Tahmoor North – Western Domain, Longwalls West 1 and West 2, April 2019.
Douglas Partners (2019a)	Report on Geotechnical Assessment Longwalls W1 and W2, Picton, Douglas Partners, Report No. 89541.00, July 2019.
Douglas Partners (2019b)	Preliminary Comment – Farm Dam Assessment Existing Dams FD5 & FD7, Picton, Memorandum No. 89541.03, 13 November 2019.

CONTENTS

Tables

Tables are prefaced by the number of the chapter in which they are presented.

Figures

Figures are prefaced by the number of the chapter or the letter of the appendix in which they are presented.

Drawings

Drawings referred to in this report are included in Appendix A at the end of this report.

Drawing No.	*Description*	*Revision*
MSEC1045-00-01	Monitoring over LW W1-W2	05
MSEC1045-12-01	Structures	01

1.1. Background

Tahmoor Coal is located approximately 80 km south-west of Sydney in the township of Tahmoor NSW. It is managed and operated by SIMEC Mining. Tahmoor Coal has previously mined 31 longwalls to the north and west of the mine's current location. Longwall 32 completed extraction in September 2019.

Longwalls West 1 and West 2 (LW W1-W2) are the first two longwalls to be mined in the Western Domain. The longwall panels are located to the north of the current longwall series, and to the south of Cedar and Stonequarry Creeks, as shown in Fig. 1.1. A small number of structures are located directly above LW W1-W2.

A summary of the dimensions of LW W1-W2 is provided in Table 1.1. The longwalls will be extracted from the north towards the south.

Table 1.1 Longwall dimensions

Longwall	Overall void length including the installation heading (m)	Overall void width including the first workings (m)	Overall tailgate chain pillar width (m)
LW W1	1875	283	-
LW W2	1685	283	39

The depths of cover directly above LW W1-W2 varies between a minimum of 455 m above the commencing end of LW W1 and a maximum of 535 m on the eastern edge of LW W2. The longwall will mine a constant height of 2.1 m.

This Management Plan provides detailed information about how the risks associated with the mining of LW W1-W2 beneath and adjacent to structures will be managed by Tahmoor Coal, taking into account the experiences gained during the mining of Longwalls 22 to 32. The Management Plan is a live document that can be amended at any stage of mining.

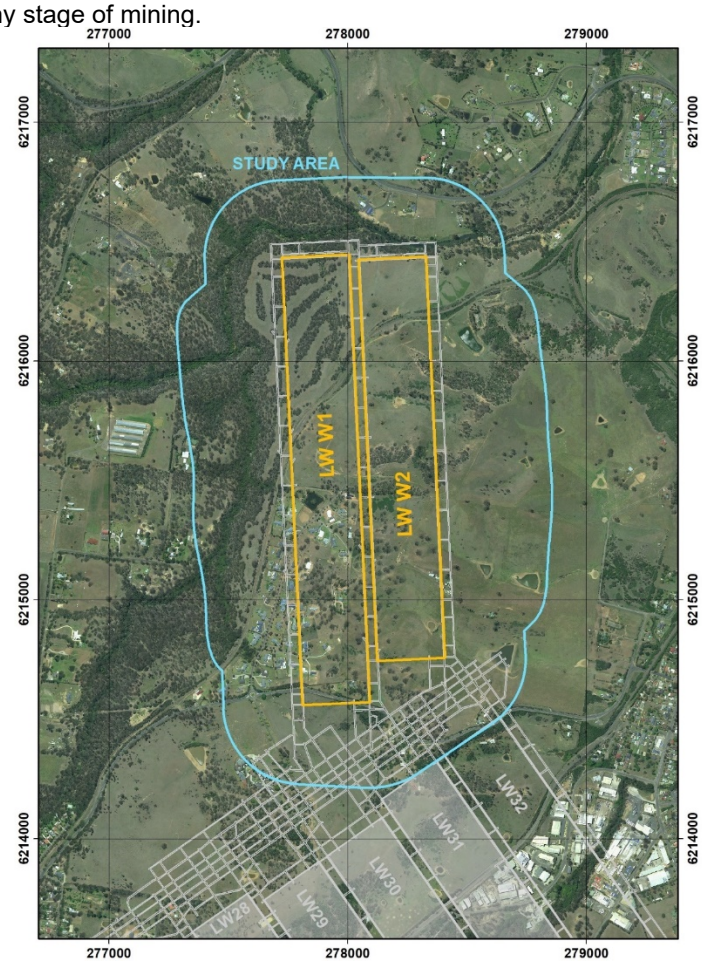


Fig. 1.1 Aerial photograph showing proposed longwalls and the Study Area

1.2. Objectives

The objectives of this Management Plan are to establish procedures to measure, control, mitigate and repair potential impacts that might occur to structures.

The objectives of the Management Plan have been developed to:

- ensure the safety and serviceability of all building structures and infrastructure. Public safety is paramount. Ensure that the health and safety of people who may be present in structures are not put at risk due to mine subsidence;
- avoid disruption and inconvenience, or, if unavoidable, keep to minimal levels;
- monitor ground movements and the conditions of building structures and associated infrastructure during mining;
- establish procedures to measure, monitor, control, mitigate and repair building structures and associated infrastructure;
- initiate and coordinate action to mitigate or remedy potential significant impacts that are expected to occur to the building structures;
- provide a plan of action in the event that the impacts of mine subsidence are greater than those that are predicted;
- establish a clearly defined decision-making process to ensure timely implementation of risk control measures for high consequence but low likelihood mine subsidence induced hazards that involve potential serious injury or illness to a person or persons at the properties that may require emergency evacuation, entry restriction or suspension of work activities;
- provide a forum to report, discuss and record impacts to the surface. This will involve Tahmoor Coal, the affected landowner and/or resident, relevant government agencies and consultants, as required; and
- establish lines of communication and emergency contacts.

1.3. Scope

The Management Plan is to be used to protect and monitor the condition of structures identified such that the health and safety of people who may be present at structures are not put at risk due to mine subsidence. The major items at risk are:

- residential establishments;
- non-residential structures; and
- public amenities.

There are no industrial, commercial and business establishments within the Study Area for LW W1-W2.

The locations of the structures near LW W1-W2 are shown in Drawing No. MSEC1045-12-01, in Appendix A.

This Management Plan describes measures that will be undertaken due to the mining LW W1-W2 only. The plan will be updated for future longwalls at Tahmoor Coal.

Separate management plans have been or will be developed for the following structures:

- structures owned by owners of services infrastructure, such as bridges, culverts and sewage pumping stations;
- structures associated with the Stonequarry Estate wastewater treatment plant;
- heritage structures at Mill Hill; and
- public amenity structures, including heritage structures at Queen Victoria Memorial Home.

1.4. Limitations

This Management Plan is based on the predictions of the effects of mining on surface infrastructure as provided in Report No. MSEC1019 by Mine Subsidence Engineering Consultants (MSEC, 2019). Predictions are based on the planned configuration of LW W1-W2 at Tahmoor Coal (as shown in Drawing No. MSEC1045-12-01), along with available geological information and data from numerous subsidence studies for longwalls previously mined in the area.

The structures and infrastructure considered in this Management Plan have been identified from aerial photographs, site visits and from discussions between Tahmoor Coal and property owners.

The impacts of mining on the building structures and associated infrastructure have been assessed in detail. It is recognised, however, that the prediction and assessment of subsidence can be relied upon only to a certain extent. The limitations of the prediction and assessment of mine subsidence are discussed in report MSEC1019 by Mine Subsidence Engineering Consultants.

As discussed in the report, there is a low probability that ground movements and their impacts could exceed the predictions and assessments. However, if these potentially higher impacts are considered prior to mining, they can be managed. This Management Plan will not necessarily prevent impacts from longwall mining but it will limit the impacts by establishing appropriate procedures that can be followed should evidence of increased impacts emerge.

1.5. Descriptions of the structures

The *Study Area* for the purpose of this management plan has been defined as the surface area that is located within the predicted limit of vertical subsidence, taken as the predicted 20 mm subsidence contour due to the extraction of LW W1-W2 or the 35 degree angle of draw, which is the greatest. The *Study Area* for LW W1-W2 is shown in Drawing No. MSEC1045-12-01, in Appendix A.

The building structures and associated infrastructure that are located within the Study Area include: houses, rural structures, public amenities and public utilities. A summary of the structures located within the Study Area for LW W1-W2 is provided in Table 1.2.

Table 1.2 Structures located within the Study Area for LW W1-W2

Type	Number of structures		
	Above LW W1-W2	Outside LW W1-W2	Total within Study Area
Houses	26	36	62
Rural structures	25	120	145
Swimming pools	3	14	17
Public amenities	0	4	4
Public utilities	0	13	13
All structures	**54**	**187**	**241**

A total of 241 structures are located within the Study Area, of which, 54 structures are located directly above LW W1-W2.

1.6. Proposed mining schedule

It is planned that LW W1-W2 will extract coal working south from the northern ends. This Management Plan covers longwall mining until completion of mining in LW W2 and for sufficient time thereafter to allow for completion of subsidence effects. The current schedule of mining for this longwall is shown in Table 1.3.

Table 1.3 Schedule of mining

Longwall	Start Date	Completion Date
LW W1	November 2019	August 2020
LW W2	September 2020	May 2021

Please note the above schedule is subject to change due to unforeseen impacts on mining progress.

1.7. Definition of active subsidence zone

As a longwall progresses, subsidence begins to develop at a point in front of the longwall face and continues to develop after the longwall passes. The majority of subsidence movement typically occurs within an area 150 m in front of the longwall face to an area 450 m behind the longwall face.

This is termed the “active subsidence zone” for the purposes of this Management Plan, where surface monitoring is generally conducted. The active subsidence zone for each longwall is defined by the area bounded by the predicted 20 mm subsidence contour for the active longwall and a distance of 150 m in front and 450 m behind the active longwall face, as shown by Fig. 1.2.

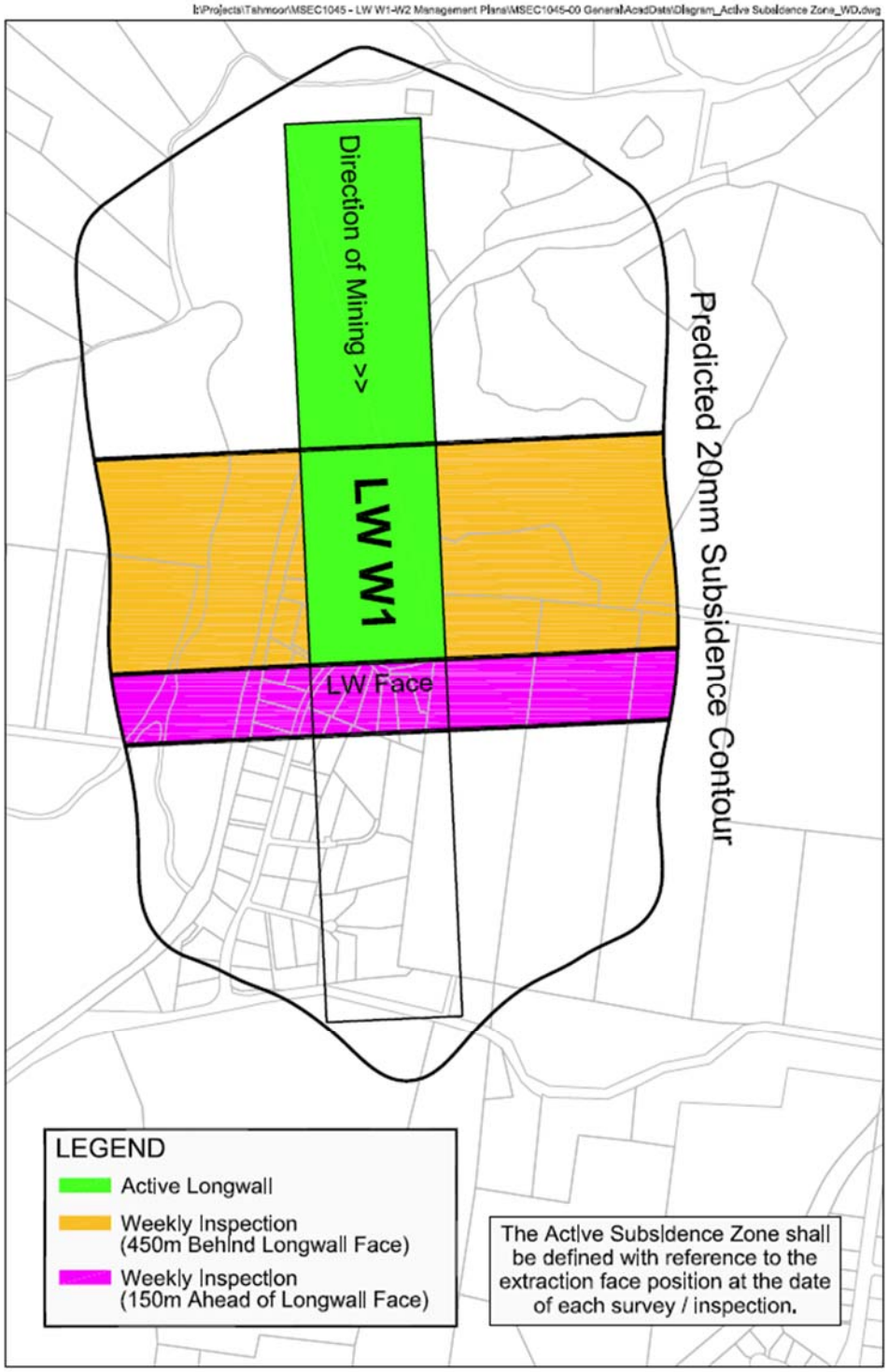


Fig. 1.2 Diagrammatic representation of the active subsidence zone

2.1. Maximum predicted conventional subsidence parameters

Predicted mining-induced conventional subsidence movements were provided in Report No. MSEC1019, which was prepared in support of Tahmoor Coal's Extraction Plan Application for LW W1-W2.

A summary of the maximum predicted incremental conventional subsidence parameters due to the extraction of LW W1-W2 is provided in Table 2.1. The incremental values represent the additional movements due to the extraction of each of the longwalls.

Table 2.1 Maximum predicted incremental conventional subsidence parameters for LW W1-W2

Longwall	Maximum predicted incremental vertical subsidence (mm)	Maximum predicted incremental tilt (mm/m)	Maximum predicted incremental hogging curvature (km^{-1})	Maximum predicted incremental sagging curvature (km^{-1})
LW W1	475	3.0	0.03	0.06
LW W2	650	5.0	0.06	0.11

A summary of the maximum predicted total conventional subsidence parameters due to the extraction of LW W1-W2 is provided in Table 2.2. The total values represent the accumulated movements due to the extraction of LW W1-W2.

Table 2.2 Maximum predicted total conventional subsidence parameters for LW W1-W2

Longwall	Maximum predicted total vertical subsidence (mm)	Maximum predicted total tilt (mm/m)	Maximum predicted total hogging curvature (km^{-1})	Maximum predicted total sagging curvature (km^{-1})
LW W1	475	3.0	0.03	0.06
LW W2	750	5.5	0.06	0.11

2.2. Observed subsidence during the mining of Longwalls 22 to 32

The extraction of longwalls at Tahmoor Mine has generally resulted in mine subsidence movements that were typical of those observed above other collieries in the Southern Coalfield of NSW at comparable depths of cover.

However, observed subsidence was greater than the predicted values over Longwalls 24A and the southern parts of Longwalls 25 to 27. Monitoring during the mining of Longwalls 28 to 32 has found that subsidence behaviour has returned to normal levels.

Ground surveys will continue to be undertaken above LW W1-W2. Survey results will be checked against predictions to confirm whether subsidence develops in a normal manner during the mining of LW W1-W2.

2.3. Potential non-conventional ground movements on structures located above hidden creeks

Hidden creeks are defined as natural watercourses that appear to have been covered during development of a property or road. Hidden creeks have been identified from surface contours and historical aerial photographs.

One house has been identified above a 'hidden' creek, being Ref. PSC_027_h01, which is located at the corner of Thirlmere Way and Stonequarry Creek Road above Rumker Gully. This house is located outside the extents of the proposed longwalls, at a distance of approximately 140 metres west of LW W1. This house could experience slightly higher compressive strains due to valley closure movements. Predictions of subsidence, upsidence and valley closure along Rumker Gully are shown in Fig. 2.1.

Houses above hidden creeks are considered to have a greater chance of experiencing non-conventional upsidence and closure movements during mining. When tested against observations during the mining of Longwalls 22 to 32, however, no clear increase in frequency of impact is observed.

A total of 52 houses above hidden creeks have experienced subsidence during the mining of Longwalls 22 to 27, and 22 houses have experienced impacts, including five houses directly above Longwall 27. The impacted houses include some on Oxley Grove, where a creek had been infilled, and houses on York Street

and Remembrance Drive where a small tributary to Myrtle Creek had been infilled. The claim rate is higher than the overall claim rate of 42 % and may represent a trend, though the impacts to these houses have been generally very minor (less than Category 1) and the sample size is small. Furthermore, the majority of impacts occurred at houses that were located directly above the extracted longwalls, rather than beyond the panel edges.

The observations of very minor impacts may be explained by the fact that the valleys in which the houses are located are very small and may not be sufficiently incised to generate significant upsidence and closure movements. If any movements do occur, it is also possible that they may not be completely transferred from the bedrock to the house through the constructed fill, depending on the design of the building foundations.

Notwithstanding the above, it is possible that unconventional subsidence could occur due to the geological complexities indicated by the presence of the buried creek. With the implementation of a robust subsidence management plan, unconventional subsidence movements and associated impacts can be detected at an early stage in their gradual development, allowing sufficient time to respond before they might develop into a severe impact.

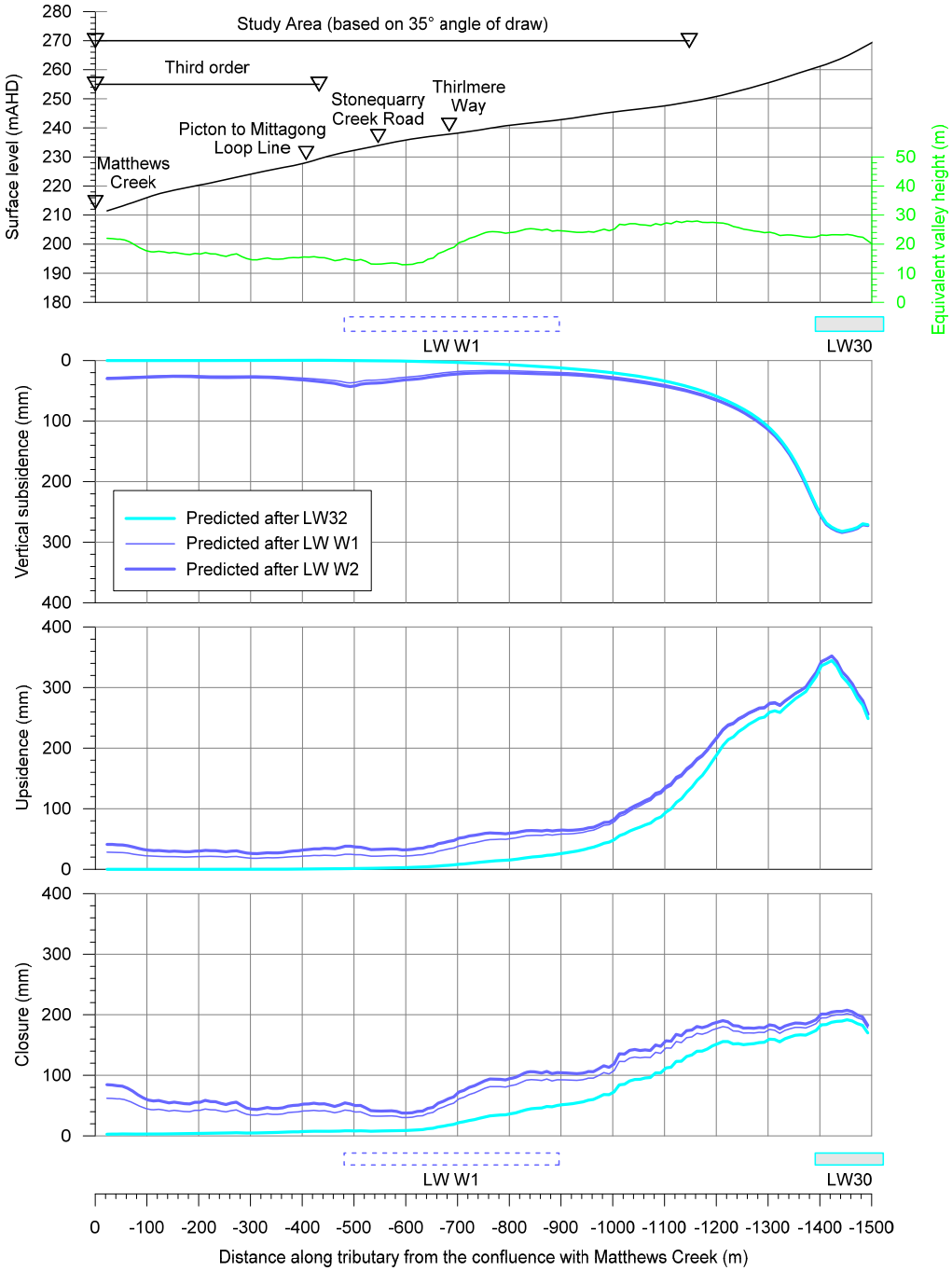


Fig. 2.1 Predicted profiles of vertical subsidence, upsidence and closure along Rumker Gully due to the extraction of LW W1-W2

2.4. Predicted strain

The prediction of strain is more difficult than the predictions of subsidence, tilt and curvature. The reason for this is that strain is affected by many factors, including curvature and horizontal movement, as well as local variations in the near surface geology, the locations of pre-existing natural joints at bedrock, and the depth of bedrock. Survey tolerance can also represent a substantial portion of the measured strain, where the strains are of a low order of magnitude. The profiles of observed strain, therefore, can be irregular even when the profiles of observed subsidence, tilt and curvature are relatively smooth.

In previous MSEC subsidence reports, predictions of conventional strain were provided based on the best estimate of the average relationship between curvature and strain. Similar relationships have been proposed by other authors. The reliability of the strain predictions was highlighted in these reports, where it was stated that measured strains can vary considerably from the predicted conventional values.

Adopting a linear relationship between curvature and strain provides a reasonable prediction for the conventional tensile and compressive strains. The locations that are predicted to experience hogging or convex curvature are expected to be net tensile strain zones and locations that are predicted to experience sagging or concave curvature are expected to be net compressive strain zones. In the Southern Coalfield, it has been found that a factor of 15 provides a reasonable relationship between the maximum predicted curvatures and the maximum predicted conventional strains.

At a point, however, there can be considerable variation from the linear relationship, resulting from non-conventional movements or from the normal scatters which are observed in strain profiles. When expressed as a percentage, observed strains can be many times greater than the predicted conventional strain for low magnitudes of curvature. In this report, therefore, we have provided a statistical approach to account for the variability, instead of just providing a single predicted conventional strain.

The data used in an analysis of observed strains included those resulting from both conventional and non-conventional anomalous movements, but did not include those resulting from valley related movements, which are addressed separately in this report. The strains resulting from damaged or disturbed survey marks have also been excluded.

For features that are in discrete locations, such as building structures, farm dams and archaeological sites, it is appropriate to assess the frequency of the observed maximum strains for individual survey bays.

2.4.1. Predictions of strain above goaf

The survey database has been analysed to extract the maximum tensile and compressive strains that have been measured at any time during the extraction of Longwalls 22 to 32 at Tahmoor Mine, for survey bays that were located directly above goaf or the chain pillars that are located between the extracted longwalls, which has been referred to as "*above goaf*".

A histogram of the maximum observed total tensile and compressive strains measured in survey bays above goaf at Tahmoor Mine is provided in Fig. 2.2. A number of probability distribution functions were fitted to the empirical data. It was found that a *Generalised Pareto Distribution (GPD)* provided a good fit to the raw strain data, and this is also shown in this figure.

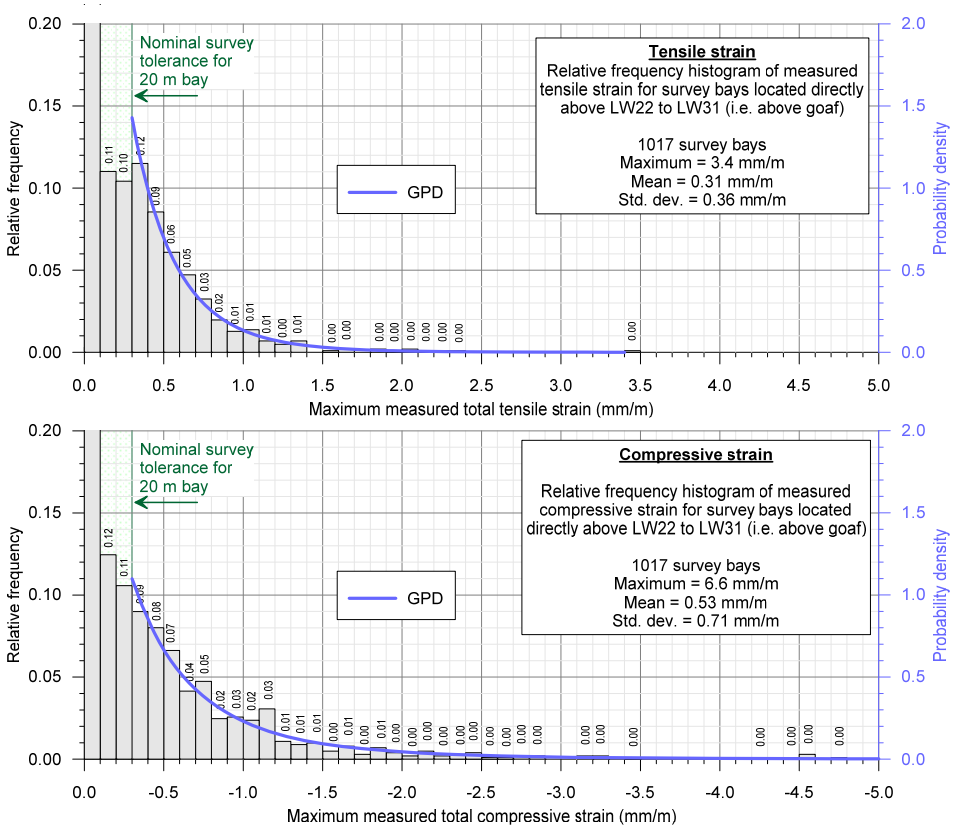


Fig. 2.2 Distributions of the maximum measured tensile and compressive strains during the extraction of previous longwalls for survey bays located above goaf

The 95 % confidence levels for the maximum total strains that the individual survey bays *above goaf* experienced at any time during mining were 1.0 mm/m tensile and 1.8 mm/m compressive. The 99 % confidence levels for the maximum total strains that the individual survey bays *above goaf* experienced at any time during mining are 1.6 mm/m tensile and 3.4 mm/m compressive.

2.4.2. Predictions of strain above solid coal

The survey database has also been analysed to extract the maximum tensile and compressive strains that have been measured at any time during the extraction of Longwalls 22 to 32 at Tahmoor Mine, for survey bays that were located outside and within 200 metres of the nearest longwall goaf edge, which has been referred to as "*above solid coal*".

A histogram of the maximum observed tensile and compressive strains measured in survey bays above solid coal at Tahmoor Mine is provided in Fig. 2.3. The probability distribution functions, based on the fitted GPDs, have also been shown in this figure.

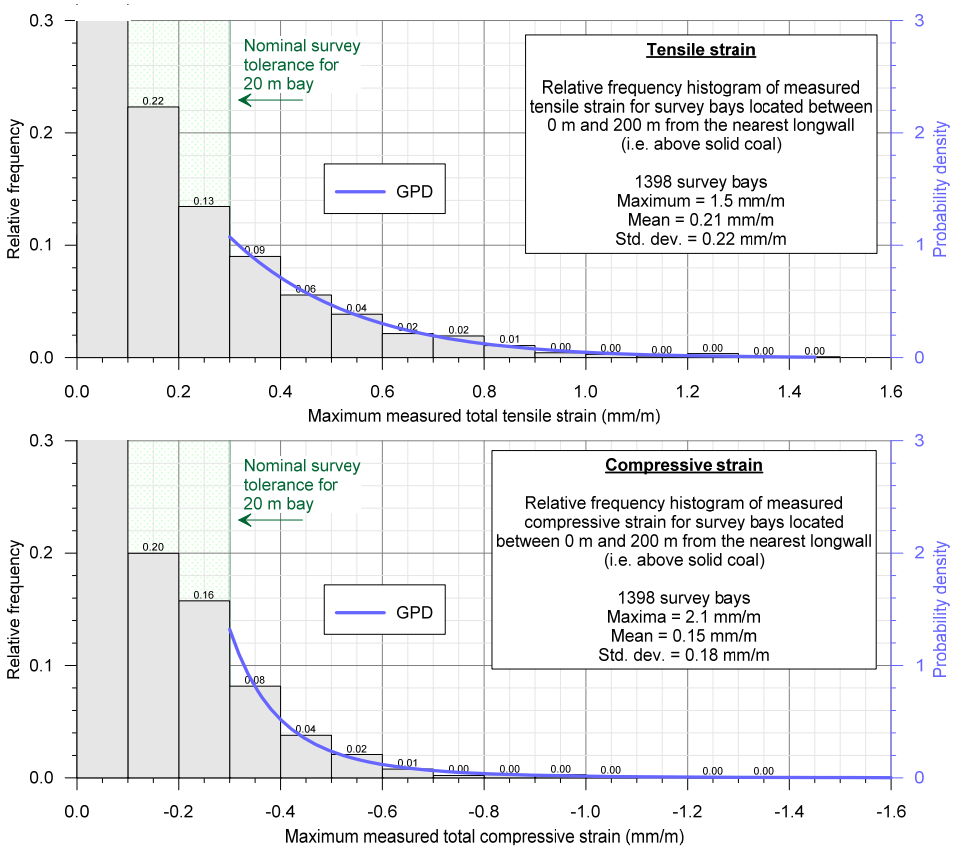


Fig. 2.3 Distributions of the maximum measured tensile and compressive strains during the extraction of previous longwalls for survey bays located above solid coal

The 95 % confidence levels for the maximum total strains that the individual survey bays *above solid coal* experienced at any time during mining were 0.7 mm/m tensile and 0.5 mm/m compressive. The 99 % confidence levels for the maximum total strains that the individual survey bays *above solid coal* experienced at any time during mining are 1.0 mm/m tensile and 0.8 mm/m compressive.

3.1. NSW Work Health and Safety Legislation

All persons conducting a business or undertaking (PCBUs), including mine operators and contractors, have a primary duty of care to ensure the health and safety of workers they engage, or whose work activities they influence or direct. The responsibilities are legislated in *Work Health and Safety Act 2011* and the *Work Health and Safety (Mines and Petroleum Sites) Act 2013* and associated Regulations (collectively referred to as the 'WHS laws').

The *Work Health and Safety (Mines and Petroleum Sites) Regulation 2014* commenced on 1 February 2015 and contains specific regulations in relation to mine subsidence.

As outlined in the Guide by the NSW Department of Trade & Investment Mine Safety:

"a PCBU must manage risks to health and safety associated with mining operations at the mine by:

- *complying with any specific requirements under the WHS laws*
- *identifying reasonably foreseeable hazards that could give rise to health and safety risks*
- *ensuring that a competent person assesses the risk*
- *eliminating risks to health and safety so far as is reasonably practicable*
- *minimising risks so far as is reasonably practicable by applying the hierarchy of control measures, any risks that it is are not reasonably practical to eliminate*
- *maintaining control measures*
- *reviewing control measures*

The mine operator's responsibilities include developing and implementing a safety management system that is used as the primary means of ensuring, so far as is reasonably practicable:

- *the health and safety of workers at the mine, and*
- *that the health and safety of other people is not put at risk from the mine or work carried out as part of mining operations."*

Detailed guidelines have also been released by the NSW Department of Planning & Environment, Resources Regulator, Mine Safety Operations (MSO, 2017).

The risk management process has been carried out in accordance with guidelines published by the NSW Department of Planning & Environment, Resources Regulator, Mine Safety Operations (MSO, 2017). The following main steps of subsidence risk management have been and will be undertaken, in accordance with the guidelines.

1. identification and understanding of subsidence hazards;
2. assessment of risks of subsidence;
3. development and selection of risk control measures;
4. implementation and maintenance of risk control measures; and
5. continual improvement and change management.

Each of the above steps have been or will be conducted together with the following processes.

1. consultation, co-operation and co-ordination; and
2. monitoring and review.

This Management Plan documents the risk control measures that are planned to manage risks to health and safety associated with the mining of LW W1-W2 directly beneath and adjacent to structures in accordance with the WHS laws.

3.2. General

The method of assessing potential mine subsidence impacts in the Management Plan is consistent with the Australian/New Zealand Standard for Risk Management. The Standard defines the terms used in the risk management process, which includes the identification, analysis, assessment, treatment and monitoring of potential mine subsidence impacts. In this context:

3.2.1. Consequence

'The outcome of an event expressed qualitatively or quantitatively, being a loss, injury, disadvantage or gain. There may be a range of possible outcomes associated with an event.'[1] The consequences of a hazard are rated from very slight to very severe.

3.2.2. Likelihood

'Used as a qualitative description of probability or frequency.'[2] The likelihood can range from very rare to almost certain.

3.2.3. Hazard

'A source of potential harm or a situation with a potential to cause loss.'[3]

3.2.4. Method of assessment of potential mine subsidence impacts

The method of assessing potential mine subsidence impacts combines the likelihood of an impact occurring with the consequence of the impact occurring. In this Management Plan, the likelihood and consequence are combined via the Simec Risk Matrix to determine an estimated level of risk for particular events or situations. A copy of the Risk Matrix is included in the Appendix of this Management Plan.

[1] AS/NZS 4360:2004 – Risk Management pp2
[2] AS/NZS 4360:2004 – Risk Management pp2
[3] AS/NZS 4360:2004 – Risk Management pp2

4.1. Predicted subsidence effects for structures

Predicted mining-induced conventional subsidence movements were provided in Report No. MSEC1019, which was prepared in support of Tahmoor Coal's Extraction Plan for LW W1-W2.

A summary of the maximum predicted incremental subsidence parameters due to the extraction of LW W1-W2 and the maximum predicted total conventional subsidence parameters due to the extraction of Longwalls 22 to 32 for the houses, are provided in Table 4.1.

Table 4.1 Maximum predicted conventional subsidence parameters due to the extraction of LW W1-W2 for the houses

Longwall	Maximum Predicted Subsidence (mm)	Maximum Predicted Tilt (mm/m)	Maximum Predicted Hogging Curvature (1/km)	Maximum Predicted Sagging Curvature (1/km)
After LW W1	425	2.5	0.02	0.05
After LW W2	700	4.0	0.03	0.05

The maximum predicted total tilt is 4.0 mm/m (i.e. 0.4 %, or 1 in 250). The maximum predicted curvatures for these structures are 0.03 km^{-1} hogging and 0.05 km^{-1} sagging, which represent minimum radii of curvature of 33 km and 20 km, respectively.

Distributions of the predicted vertical subsidence, tilt and curvatures for the houses within the Study Area are illustrated in Fig. 4.1, Fig. 4.2 and Fig. 4.3.

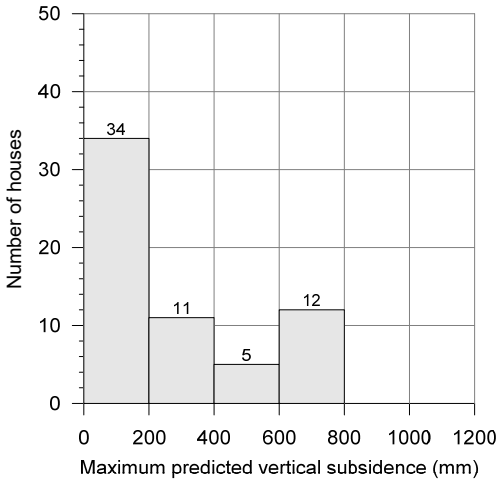


Fig. 4.1 Maximum predicted vertical subsidence for the houses

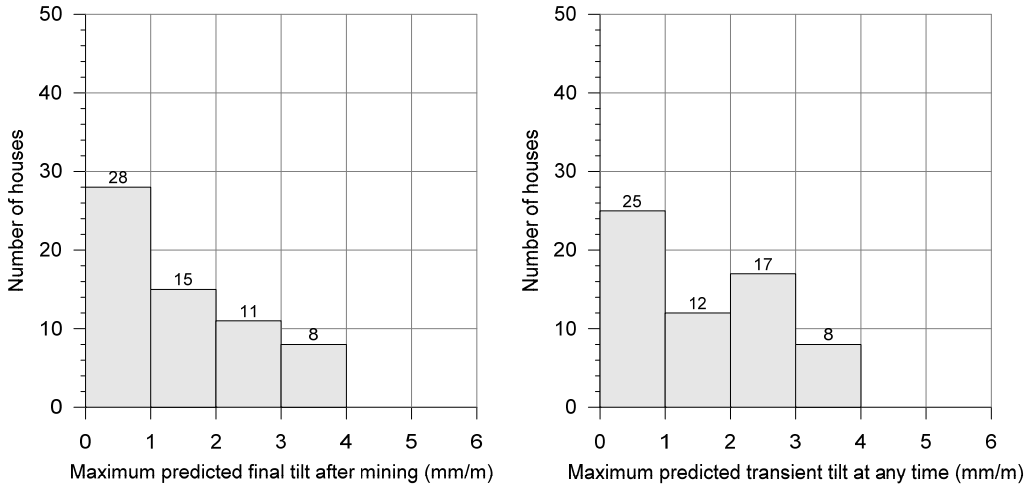


Fig. 4.2 Maximum predicted final tilt (left-side) and transient tilt (right-side) for the houses

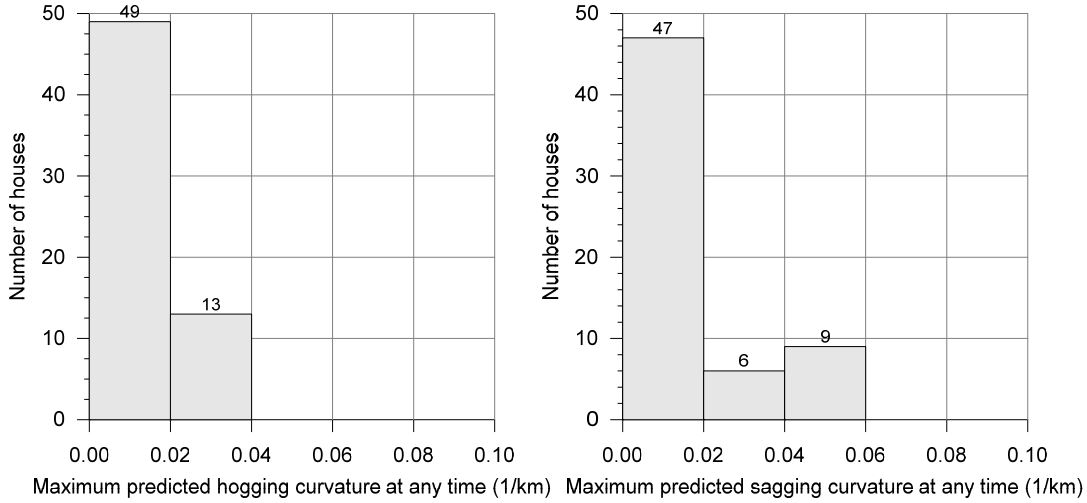


Fig. 4.3 Maximum predicted hogging curvature (left-side) and sagging curvature (right-side) at any time for the houses

The maximum predicted conventional strains for the houses, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 0.5 mm/m tensile and 1 mm/m compressive. Higher strains could develop at the houses due to irregular ground movements or topographic effects.

The predicted distributions of strain due to the extraction of LW W1-W2 are described in Report No. MSEC1019. The houses are at discrete locations and, therefore, the most relevant distribution of strain is the maximum strains measured in individual survey bays above previous longwall mining. The maximum predicted total strains directly above the proposed longwalls are 1.0 mm/m tensile and 1.8 mm/m compressive based on the 95 % confidence level.

The strains have been predicted for each of the houses using the method described by Barbato (2017). This method considers the position of each house relative to the longwalls, the surface slope, surface lithology and the potential for irregular anomalous movements.

The predicted total strains for each of the houses within the Study Area are provided in Report No. MSEC1019. The distributions of the predicted total strains based on the mean and on the 95 % confidence levels are provided in Fig. 4.4 and Fig. 4.5, respectively.

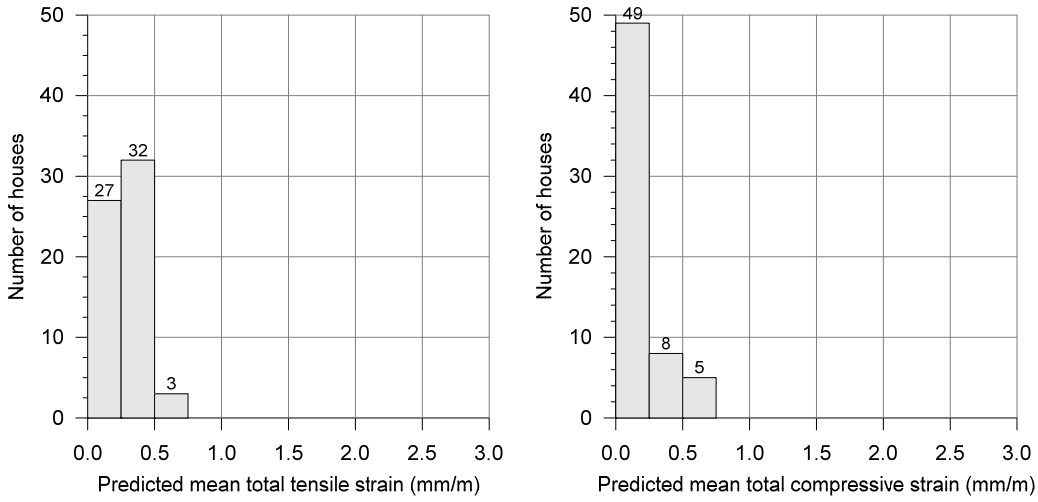


Fig. 4.4 Predicted total tensile strain (left-side) and total compressive strain (right-side) for the houses based on the mean

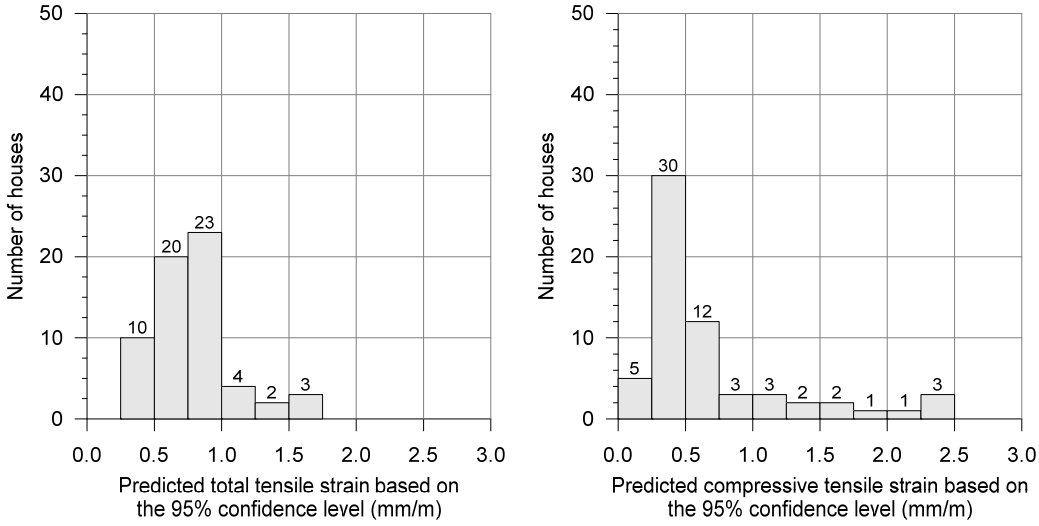


Fig. 4.5 Predicted total tensile strain (left-side) and total compressive strain (right-side) for the houses based on the 95 % confidence level

The houses within the Study Area are predicted to experience total tensile strains between 0.3 mm/m and 1.7 mm/m and total compressive strains between 0.2 mm/m and 2.4 mm/m based on the 95 % confidence levels. The predicted mean values range between 0.2 mm/m and 0.7 mm/m tensile and compressive.

5.1. Experience of mining beneath structures

There is extensive experience of mining beneath building structures at Tahmoor, as well as other mines elsewhere in the Southern Coalfield.

More than 2000 houses, public amenities and commercial and business establishments have experienced subsidence movements at Tahmoor, during the mining of Longwalls 22 to 32. The following observations have been made based on the experiences of mining beneath building structures in the Southern Coalfield:

- Mine subsidence has not directly exposed residents to any immediate or sudden safety hazards;
- Subsidence Advisory NSW (SA NSW) had received 547 claims from individual properties (not including refused claims), at the completion of Longwall 30, of which, 489 claims included impacts to main structures. The remaining 58 claims related solely to damage to small improvements such as swimming pools, sheds and pavements;
- The overall claim rate at the completion of Longwall 30 is 489 out of 1955 main structures, or 25 %. In other words, no impacts have been reported for 75 % of the main structures;
- The rate of impact for structures located directly above the longwalls is greater than that based on all structures located within the predicted limit of vertical subsidence. There are 1190 houses, commercial and business establishments and public amenities located directly above Longwalls 22 to 27 (or the pillars between them). A total of 385 claims have been made from this subset, which represents a claim rate of 32 % for structures that are located above goaf;
- The rate of impact for structures located outside the mining area is less. There are 352 houses, commercial and business establishments and public amenities located outside of Longwalls 22 to 27 but within the predicted limit of vertical subsidence. A total of 48 claims have been made from this subset, which represents a claim rate of 14 % for structures that are located above solid coal; and
- The majority of impacts are considered very slight to slight (i.e. Categories R0 to R2) and consist of sticky doors and minor impacts to internal walls, ceilings or floor finishes. However, 2.5 % of impacts are considered to be moderate or greater (i.e. Categories R3 or greater). In 12 of these cases (i.e. 0.5 % of all building structures), the impacts were substantial and the costs to repair these structures were deemed to be greater than the costs to rebuild (i.e. Category R5).

5.2. Managing public safety

The primary risk associated with mining beneath structures is public safety. Tahmoor Coal has previously directly mined beneath or adjacent to more than 2000 houses and civil structures, commercial and retail properties, the Main Southern Railway and local roads and bridges. Tahmoor Coal has implemented extensive measures prior to, during and after mining to ensure that the health and safety of people have not been put at risk due to mine subsidence. People have not been exposed to immediate and sudden safety hazards as a result of impacts that have occurred due to mine subsidence movements.

Emphasis is placed on the words “immediate and sudden” as in rare cases, some structures have experienced severe impacts, but the impacts did not present an immediate risk to public safety as they developed gradually with ample time to repair the structure.

The potential for impacts on public safety has been assessed on a case by case basis. The assessments include inspections by a structural engineer. The findings of the assessments are described in this Management Plan in the sections below.

5.2.1. Subsidence impact management process

Tahmoor Coal has developed a *risk management process* to manage potential impacts on structures due to the extraction of LW W1-W2. This plan has been developed based on the experience of mining beneath and adjacent to structures during the extraction of Longwalls 22 to 32. This management process will be reviewed and updated based on continuing experiences gained from the mining of longwalls at Tahmoor Mine.

The risk management process for LW W1-W2 includes the following processes, which are illustrated in the flowchart in Fig. 5.1:

1. Regular consultation, cooperation and coordination with the community before, during and after mining as described in Section 6.3. This includes letters and door knocking to all residents of structures that will soon be affected by subsidence. The letters offer a free pre-mining inspection and hazard identification inspection by a structural engineer;
2. Site-specific investigations, where they are necessary and appropriate, into the conditions of buildings and associated structures and their surrounding environment (where access is allowed). Site-specific investigations have been, and will continue to be undertaken early so that there is adequate time, if required, to arrange additional inspections and/or surveys and implement any mitigation measures before mining-induced impacts are experienced.

   As a general rule, site-specific investigations are undertaken before the longwall face approaches to within 300 m of travel prior to directly mining beneath each property. For properties located directly above the first 300 m of the commencing end of a longwall, the investigations are targeted to be undertaken prior to extraction, or at the latest, they will be undertaken prior to the first 200 m of extraction of the longwall.

   Site-specific investigations include the following:

   a) At the time of preparing Report No. MSEC1019 (2019) in support of Tahmoor Coal's Extraction Plan Application, structures were identified from aerial photographs, with structure types identified from kerbside inspections;
   b) Front of house risk and visual screening inspections by Tahmoor Coal in company with a structural engineer for all properties that are predicted to experience more than 20 mm of incremental vertical subsidence due to the extraction of LW W1-W2. The purpose of the inspections is to identify hazards where access has not been granted by the landowner.

      In some cases, particularly in semi-rural and rural areas, it is difficult to inspect a structure that is remote from the street front. Where these cases involve properties that are located directly above LW W1-W2, Tahmoor Coking Coal Operations will request access to conduct a pre-mining inspection and hazard identification inspection by a structural engineer;
   c) Tahmoor Coal will request access to conduct pre-mining geotechnical inspections of structures located on or immediately adjacent to steep slopes that are predicted to experience more than 20 mm of incremental vertical subsidence due to the extraction of LW W1-W2 (refer Section 5.3.1);
   d) Tahmoor Coal will request access to conduct pre-mining hazard identification inspections by a structural engineer (where access is allowed by the landowner) to properties with structures that have been specifically targeted on the basis that may be more sensitive to mine subsidence movements due to the extraction of LW W1-W2. These include:
      i) Commercial and business establishments, public amenities and public utilities that are predicted to experience more than 20 mm of incremental vertical subsidence due to the extraction of LW W1-W2 (refer to Sections 5.11 and 5.12);
      ii) Structures of heritage significance that are predicted to experience more than 20 mm of incremental vertical subsidence due to the extraction of LW W1-W2 (refer Section 5.3.2);
      iii) Structures that are located above hidden creeks that are predicted to experience more than 20 mm of incremental vertical subsidence due to the extraction of LW W1-W2 (refer Section 5.3.3);
      iv) Structures that are located above mapped geological structures that are predicted to experience more than 20 mm of incremental vertical subsidence due to the extraction of LW W1-W2;
      v) Structures that are located on or adjacent to steep slopes or that have been recommended for inspection by a geotechnical engineer;
      vi) Structures that have been identified as being potentially unstable or unsafe by landowners (Item 1), or from the front of house inspections (Item 2b);
      vii) Houses and units located outside the declared Mine Subsidence Districts that are predicted to experience more than 150 mm of subsidence (refer Section 5.3.5); and
      viii) Houses and units estimated to have been constructed prior to the declaration of the Picton Mine Subsidence District as originally declared in 1997 or if outside the original declared boundary, prior to the declaration of the current boundary in 2017. (refer Section 5.3.5).

3. Implementation of mitigation measures following inspections by the geotechnical engineer and the structural engineer, in consultation and agreement with the landowner. These will be implemented before the longwall face approaches to within 100 m of travel prior to directly mining beneath each property;
4. Surveys and inspections during mining within the active subsidence area (refer Table 6.1 for timing and frequencies):
    i) detailed visual inspections and vehicle-based inspections along the streets;
    ii) ground surveys along the streets;
    iii) baseline ground surveys of pegs installed around semi-rural and rural houses that are remote from local streets and located directly above LW W1-W2, or where requested by a landowner;
    iv) specific ground surveys for selected properties, where recommended by the geotechnical engineer or structural engineer due to their proximity to steep slopes or pre-existing condition;
    v) visual inspections of residential structures that are either: located on or adjacent to steep slopes, are in poor existing condition (based on the hazard identification inspections), have previously reported impacts, or where recommended by the Structures Response Group;
    vi) visual inspections of pool fences and gates; and
    vii) visual inspections of commercial, industrial and business establishments, public amenities and public utilities.

The *subsidence impact management process* has been developed in consideration of the following facts and observations:

1. Australian standards have been available for use in the design of structures since 1948. The majority of structures at Tahmoor and Thirlmere (approximately 80 %) have been constructed after the declaration of the Bargo Mine Subsidence District in November 1975;
2. There is sufficient redundancy in structural design such that ductile deformation will develop and be noticeable to residents before structural failure occurs;
3. Subsidence movements develop gradually over time at Tahmoor as they have above other previously extracted longwalls at similar depths of cover;
4. Experiences during the mining of Longwalls 22 to 32 have found that the most effective method of managing potential impacts on the safety and serviceability of structures are by way of community consultation. Residents living within the active subsidence zone have often provided early feedback to Tahmoor Coal and/or SA NSW about impacts developing at their houses or along their local roads. Contact is made well before impacts develop to a level of severity sufficient to become a safety hazard;
5. On the basis of the above, there is sufficient time for residents to notify Tahmoor Coal or SA NSW of significant displacement or deflection well before structural failure will occur; and
6. The conclusions are supported by the observation that residents have not been exposed to immediate and sudden safety hazards as a result of impacts that occur due to mine subsidence movements at Tahmoor and above other previously extracted longwalls at similar depths of cover. This includes the recent experience at Tahmoor during the mining of Longwalls 22 to 32, which have subsided more than 1900 houses and civil structures.

    While severe impacts have developed during the mining of Longwalls 22 to 32, there is sufficient redundancy in structural design such that when structures have experienced severe impacts, they have developed gradually with ample time for residents to notify Tahmoor Coal or SA NSW to repair the structure and/or relocate residents before structural failure occurs. This conclusion is supported by structural engineer John Matheson & Associates (JMA, 2014).

While the three most important factors in managing risks to public safety are redundancy in structural design, gradual development of subsidence movements and an effective community consultation program, a number of additional management measures have been or will be undertaken including: site-specific investigations, regular surveys and inspections during mining and triggered response measures as detailed in this Management Plan.

A flowchart illustrating the subsidence impact management process prior to, during and after each structure potentially experiencing mine subsidence movements is shown in Fig. 5.1.

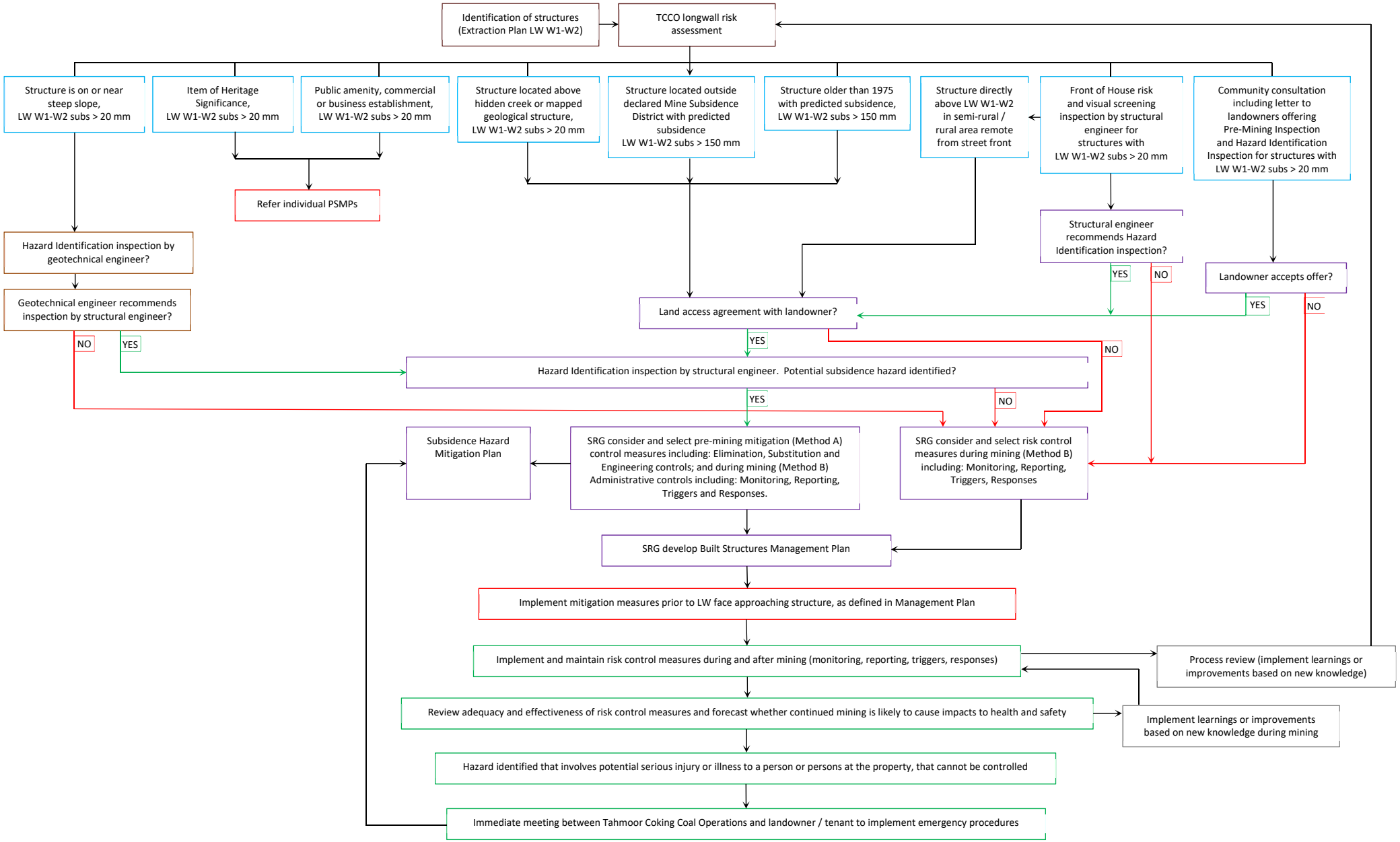


Fig. 5.1 Flowchart for subsidence impact management process for built structures

5.3. Residential structures

A total of 62 houses are located within the Study Area for LW W1-W2, of which 26 are located directly above LW W1-W2.

Tahmoor Coal has and will continue to request access to conduct pre-mining hazard identification inspections by a structural engineer (where access is allowed by the landowner) to properties with structures that have been specifically targeted on the basis that they may be more sensitive to mine subsidence movements due to the extraction of LW W1-W2, including those outlined in the following sections.

5.3.1. Structures on steep slopes

A steep slope has been defined in this management plan as an area of land having a natural gradient greater than 1 in 3 (i.e. a grade of 33 %, or an angle to the horizontal of 18°). The areas with steep slopes were determined from 1 m surface level contours generated from an airborne laser scan of the area and are shown in Reports No. MSEC1019 (MSEC, 2019).

Areas with natural steep slopes have been identified above LW W1-W2. The steep slopes are associated with small ridgelines and along the creaks and drainage lines. There are also artificial steep slopes along the alignments of the roads and railway.

An analysis of the LiDAR survey has also identified steep slopes that have been constructed, such as dam walls, embankments and cutting faces. In some cases, retaining walls have been cut into the side of a natural slope with a gradient that is less than 1 in 3 but the analysis has identified a “steep slope” due to the presence of the retaining walls. There are no structures located near cliffs.

A total of 46 structures within the Study Area have been built on or near steep slopes. A summary of these structures is provided in Table 5.1 and their locations are shown in Fig. 5.2.

Table 5.1 Structures and dams within the Study Area that are located on or near steep slopes

Structure Type	Description	No.
H	Houses	11
P	Pool	1
R	Rural structures	21
PU	Public Utilities	13
	Total	**46**

Hazard identification inspections have been or will be conducted by geotechnical engineer Douglas Partners at the identified properties, where access has been provided by the landowner.

It is possible, though unlikely, that tension cracks may form at the top of the slope and these may coincide with some houses and cause additional impacts to them. It is considered extremely unlikely that the houses would be severely damaged due to large-scale slope failure. No impacts have been observed to steep slopes during the mining of Longwalls 22 to 32, including steep slopes on the banks of Myrtle Creek and along the Redbank Range.

Fig. 5.2 Locations of structures on or near steep slopes

5.3.2. Structures of heritage significance

Building structures within the Study Area of heritage significance are associated with Mill Hill and the Queen Victoria Memorial Home. Separate management plans have previously been developed for these properties for LW 32. The plans will be revised prior to the influence of mining of LW W1-W2.

5.3.3. Structures above 'hidden' creeks

One house has been identified above a 'hidden' creek, being Ref. PSC_027_h01, which is located at the corner of Thirlmere Way and Stonequarry Creek Road above Rumker Gully. This house is located outside the extents of the proposed longwalls, at a distance of approximately 140 metres west of LW W1.

A structural hazard identification inspection has been conducted at this property.

5.3.4. Houses prone to flooding or inundation

Flood modelling has been undertaken by WRM based on the existing topography as surveyed by LiDAR and predicted subsidence movements due to the extraction of the proposed longwalls WRM (2019).

The study found that flows are generally contained within the channels of Matthews Creek, Cedar Creek and Stonequarry Creek within the Study Area. The crest of Barkers Lodge Road may be overtopped during a Probable Maximum Flood (PMF) event. The subsidence resulting from the mining of the proposed LW W1-W2 results in a negligible change in flood levels, flow velocities and flood extent within the catchment area (WRM, 2019).

There are no houses located below the flood level for a 1% AEP event (1 in a 100 year).

5.3.5. Older Houses and Houses outside declared Mine Subsidence Districts

The Study Area is located entirely within the Picton MSD. The Picton MSD district was proclaimed in 1997 and originally encompassed properties on Stonequarry Creek Road, Carramar Close, Attunga Close and Booyong Close and parts of Thirlmere Way. The Picton MSD was expanded in 2017 and now covers all properties within the Study Area.

A total of 52 of the 62 houses (84%) within the Study Area are located within the original boundary of the Picton MSD and were constructed after the declaration of the Picton MSD in 1997. There are eight houses within the Study Area that were constructed prior to 1994 (i.e. prior to the declaration of the Picton MSD). An additional two houses within the Study Area have been identified as having been constructed on or after the original declaration of the Picton MSD in 1997 but located outside the original boundary of the Picton MSD as declared in 1997.

Nine of the houses constructed prior to the declaration of the Picton MSD are Type H1, i.e. single storey houses with lengths of less than 30 m and one house is Type H2, i.e. single storey house with length greater than 30 m. The wall construction of these houses comprise five brick or brick-veneer, and five weatherboard. The footing types of these houses comprise three slab on ground, three piered footings, and three strip footings.

The hazard associated with these houses is that they may be less tolerant to mine subsidence movements as their designs have not been checked and approved by Subsidence Advisory NSW. Some old houses may also be in poor condition. Many of the houses are constructed with timber frames and weatherboard panels or fibro sheets.

Analysis of impacts to structures during the mining of Longwalls 22 to 25 in December 2008 did not find any significant trend between the rate of impacts and structure age.

Tahmoor Coal has or will conduct a hazard identification inspection for houses located outside a Mine Subsidence District or were constructed prior to declaration of the Mine Subsidence District and are predicted to experience more than 150 mm of subsidence during the mining of LW W1-W2.

5.3.6. Future house construction

New houses have been identified from aerial photographs captured in 2019. The houses have been mapped and included in Drawing No. MSEC1045-12-01.

LW W1-W2 will extract within a semi-rural area. It is possible that additional houses may be constructed that may be affected by the extraction of LW W1-W2. No large-scale developments are currently under construction in this area.

The hazard associated with new houses is considered to be generally low for the following reasons:

- The design for new houses will be approved by SA NSW; and
- The condition of the houses will generally be good as they are newly constructed.

As described in Section 6.3, Tahmoor Coal attempts to notify landowners at multiple stages during the mining process. New landowners may be contacted in this manner.

For newly constructed houses, Tahmoor Coal will offer a pre-mining hazard identification inspection by a structural engineer and provide an impact assessment and risk analysis to the landowner upon request.

Standard risk control procedures will be applied to new houses, which are provided in this Management Plan.

5.4. Flats or units

There are no flats or units affected by the extraction of LW W1-W2.

5.5. Pools

5.5.1. Pools

A total of 16 pools and one spa are predicted to experience more than 20 mm of incremental vertical subsidence due to the extraction of LW W1-W2. All the pools are inground. The majority of the pools are located to the side of LW W1, with only 3 pools located directly above the longwall panel.

As of June 2017, a total of 157 pools have experienced mine subsidence movements during the mining of Longwalls 22 to 30. Impacts have been reported for a total of 36 pools, which represents an impact rate of approximately 23 %. A higher proportion of impacts have been observed for in-ground pools, particularly fibreglass pools.

The majority of the impacts related to tilt or cracking, though in a small number of cases the impacts are limited to damage to skimmer boxes or the edge coping.

Mining-induced tilts are more noticeable in pools than other structures due to the presence of the water line and small gap to the edge coping, particularly when the pool lining has been tiled. Skimmer boxes are also susceptible to being lifted above the water line due to mining tilt. The Australian Standard AS2783-1992 (Use of reinforced concrete for small swimming pools) requires that pools be constructed level within ± 15 mm. This represents a tilt of approximately 3.3 mm/m for pools that are 10 metres in length. Australian Standard AS/NZS 1839:1994 (Swimming pools – Pre-moulded fibre-reinforced plastics – Installation) also requires that pools be constructed with a tilt of 3 mm/m or less.

5.5.2. Pool gates

The hazard to pool gates is that they may not close due to mine subsidence impacts, even if they are spring-loaded. A number of pool gates have been impacted by mine subsidence due to mining in the Southern Coalfield. While the gates can be easily repaired, the consequence of breaching the pool fence integrity is considered to be severe.

Consultation with pool owners is considered to be the most effective method of managing potential impacts on pool gates. Tahmoor Coal will inspect pool fences on a weekly basis, during the active subsidence period, where access is permitted. Pool owners will monitor the pool gates where Tahmoor Coal has not been provided with access to the property. Any damage to pool fences and gates caused by mine subsidence will be repaired immediately.

5.6. Septic tanks

The risk to septic tanks is that they could be damaged and/or rendered unserviceable from mine subsidence impacts. There are two types of potential damage to septic tanks:

- compressive ground strains could cause cracking and leaking of the tanks; and
- shearing could also occur at joints connecting sewerage pipes to septic tanks, as sewerage pipes are generally able to slide as the ground moves horizontally beneath them, while the septic tanks are fixed and unable to slide relative to the sewerage pipes.

Given that tanks are quite small (usually less than 3 m in diameter), constructed of reinforced concrete and are usually bedded in sand and backfilled, the likelihood of cracking to septic tanks is assessed as low. It is noted that no impacts to septic tanks have been reported during the mining of Longwalls 22 to 32.

Pipe joints are usually flexible and consist of relatively short lengths, due to the proximity of septic tanks to houses. However, given that both the house and septic tank are effective ground anchors, it is possible that pipe joints can pull out or shear as a result of subsidence. SA NSW reports that this has been observed in a small number of cases during the mining of Longwalls 22 to 32. This impact is relatively easy to repair.

SA NSW also report that on two occasions during the mining of Longwalls 22 to 26, the grade of the sewer pipe to the septic tank has reversed. The impacts are considered to have been partially due to very low pre-mining grades. In both cases, the repairs were straightforward, where the pipes were re-laid at an improved fall, entering the septic tank at a slightly lower level.

5.7. Sheds and other associated structures

A total of 145 sheds and associated structures are predicted to experience more than 20 mm of incremental vertical subsidence due to the extraction of LW W1-W2. The risk to sheds and other associated structures is that they could be damaged and/or rendered unserviceable from mine subsidence impacts. The structures include garages, sheds, carports, shade structures and tanks.

These structures are able to withstand greater subsidence movements than houses as they are generally lighter, more flexible in construction, and smaller in size. The risk of damage to sheds and other domestic structures is therefore considerably less when compared to houses.

Impacts have been reported to a small number of sheds and other domestic structures during the mining of Longwalls 22 to 32, all of which are considered to be relatively minor and easy to repair.

5.8. General services

There are many services on the properties within the Study Area for LW W1-W2. These services include potable water pipes, wastewater pipes, stormwater pipes, electrical services and communications services.

Pipes and ducts are generally flexible and will be able to withstand the mine subsidence movements that are predicted to occur. Water, wastewater, stormwater and gas pipes have been directly mined beneath in many locations in Tahmoor and other locations within the Southern Coalfield and very few impacts have been observed, all of which have been minor.

Cables are extremely flexible and will be able to withstand the mine subsidence movements that are predicted to occur. Very few impacts have been observed to cables as a result of previous mining.

5.9. Private roads and walking trails close to steep slopes

There are a small number of private driveways that are located on steep slopes.

It is possible that tension cracks may form at the tops or sides of the slopes and compression ridges may form at the bottoms of the slopes. These impacts may coincide with the private driveways. If the tension cracks are left untreated, these may cause erosion to occur, which may further damage driveways. It is unlikely that large-scale slope failure will occur.

Small ripples were observed at locations along the private driveway of a house on Tickle Drive during the mining of Longwall 26.

5.10. Access and mobility

It is possible that cracks or steps might form in the natural ground or external pavements that might affect access to properties. Any impacts that adversely affect access and mobility will be repaired immediately.

5.11. Commercial, industrial and business establishments.

There are no commercial, industrial and business establishments affected by the extraction of LW W1-W2

5.12. Public amenities and utilities

A total of 17 public amenities and utilities structures are predicted to experience more than 20 mm of incremental vertical subsidence due to the extraction of LW W1-W2. The public amenities and utilities are described in Report Nos. MSEC1019 (MSEC, 2019).

The public amenities that are located within the Study Area for LW W1-W2 include:

- Queen Victoria Memorial Home (Ref. V04) is located on Thirlmere Way to the south-east of LW W1. The complex comprises a total of 46 buildings and 12 dams, of which, 4 buildings are located wholly or partially within the Study Area.

The public utilities that are located within the Study Area for LW W1-W2:

- Stonequarry Estate water treatment plant (Ref. PSC_090_pu01 to PSC_090_pu13) is located approximately 90 metres to the east of LW W2.

Separate management plans have been or will be developed for these public amenities and public utilities establishments prior to the influence of mining of LW W1-W2.

5.13. Risks associated with existing structural condition

The existing condition of structures varies within the general mining area. This is a function of age, structural design, construction workmanship and maintenance. Tahmoor Coal has undertaken of pre-mining hazard identification inspections of structures during the mining of Longwalls 22 to 32. Pre-mining hazard identification inspections have identified elements of structures that did not appear to comply fully with Australian Standards, in regard to design and construction. In a small number of cases, the existing structural condition has been considered unsafe and Tahmoor Coal has undertaken measures to repair the defect or has informed the landowner of the hazard.

There is a remote possibility that the comparatively small additional contribution of mine subsidence movements could be sufficient to result in the structures that do not meet Australian Standards to become potentially unsafe. While the warnings appear dire, it should be noted that the likelihood of structural failure is still considered to be remote as no structures have collapsed as a result of mine subsidence movements in the Southern Coalfield.

The experience from the mining of Longwalls 22 to 32, affecting more than 2000 structures shows that residents have not been exposed to immediate and sudden safety hazards as a result of impacts that occur due to mine subsidence movements. In rare cases, some structures have experienced severe impacts, but the impacts did not present an immediate risk to public safety as they developed gradually with ample time to relocate residents.

The management strategy described in Section 5.2 includes measures to identify potentially 'unstable structures. The residential properties that are located within the predicted 20 mm subsidence contour due to LW W1-W2 have been offered a hazard identification inspection by a structural engineer. These inspections have specifically targeted the structures that could have increased risks due to their existing structural conditions, including the older structures and structures that are located outside of declared Mine Subsidence Districts.

The structural engineer has recommended additional management measures to be undertaken at 1 property prior to the influence of LW W1-W2 as result of either pre-mining hazard identification inspections, or pre-mining Front of House risk and visual screening inspections. Details are provided in Table A.1, which is included in the Appendix.

5.14. Farm dams

A total of 19 dams are located within the Study Area for LW W1-W2, of which 4 dams are located directly above the longwall panels.

There is extensive experience of mining directly beneath farm dams in the Southern Coalfield, which indicates that the incidence of impacts on these features is very low. Farm dams are commonly constructed with cohesive materials in the bases and walls which can absorb the conventional subsidence movements typically experienced in the Southern Coalfield without the development of substantial cracking. Non-conventional movements can result in localised cracking and deformations at the surface and, where coincident with farm dams, could result in adverse impacts.

TCCO has mined LW22 to LW31 beneath a total of 103 dams. While a small number of landowners have advised of impacts, there has been one claim to Subsidence Advisory NSW for impacts on farm dams at the time of the report. The farm dam is located directly above previously extracted Longwall 27. This represents an impact rate of less than 1%. The dataset includes some large water treatment dams above Longwall 24A. A similar experience is found at dams located above other extracted longwalls at Appin and West Cliff Collieries, where the depth of cover is similar. While no impacts have been reported to dam walls, seepage was observed at the base of one dam wall that is located above Longwall 702 at Appin Colliery.

The dams are typically constructed from cohesive soils with reasonably high clay contents. The walls of the farm dams should be capable of withstanding tensile strains of up to 3 mm/m without significant impacts, because of their inherent plasticity.

As undertaken during the mining Longwalls 22 to 32, Tahmoor Coal will visually inspect the dams immediately prior to and immediately after active subsidence. Nine (9) dams have been inspected prior to the commencement of LW W1. The dams do not show any signs of distress. The likelihood of leakage of a dam wall or floor due to subsidence is considered to be rare. If impacts occur, however, Tahmoor Coal will supply water to the landowner on a temporary basis until the dam is repaired.

From a public safety point of view, there are no structures located immediately downstream of the dams directly above LW W1-W2. The Picton-Mittagong Loop Line is located downstream of two dams and potential impacts on the railway culverts and embankments will be managed by Tahmoor Coal, Transport Heritage NSW and the landowners. The two dams (Ref. PSC_090_d01 and PSC_019_d01) have been inspected by geotechnical engineer Douglas Partners (2019b), who advise that both dams are in good condition with relatively flat batter slopes and are performing in accordance with industry accepted expectations. No signs of instability were observed. These dams will be inspected regularly during the period of active subsidence.

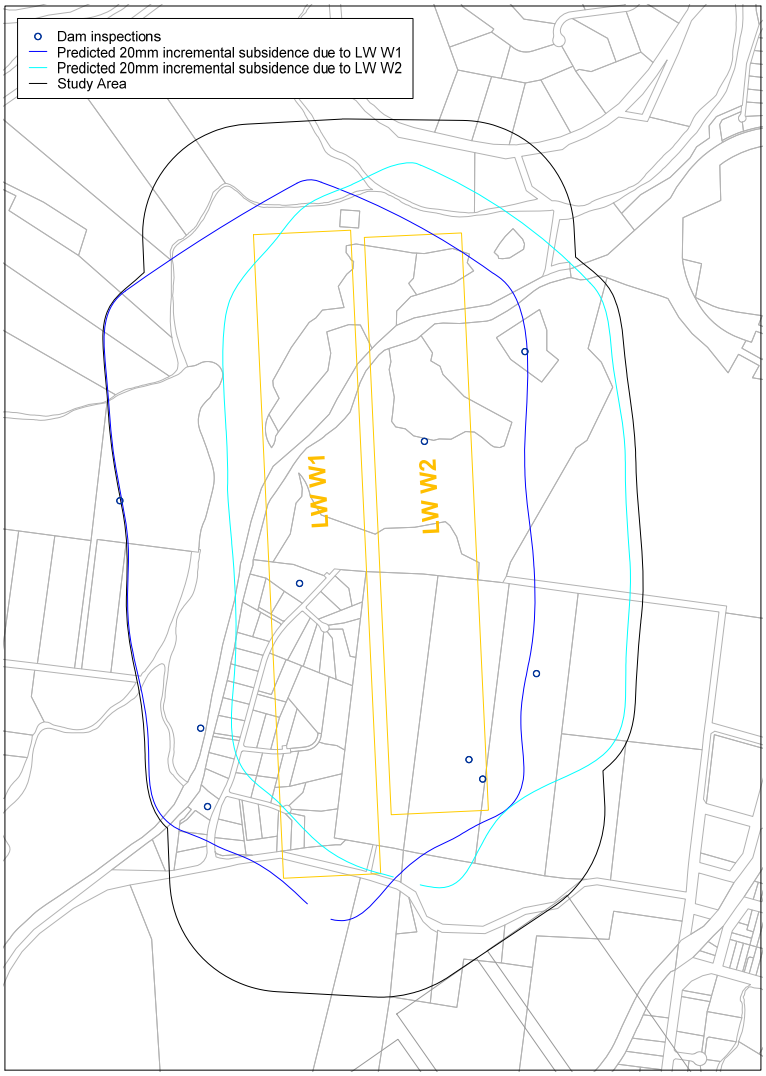


Fig. 5.3 Locations of dams

5.15. Summary of potential impacts

A summary of the assessed levels of potential impacts on building structures is provided in Table 5.2. The summary is consistent with the risk assessment undertaken by Tahmoor Coal (2019), which is included in Appendix A. The assessment has been based on the credible worst case, with the implementation of the proposed management strategies and preventive measures outlined in this plan.

Table 5.2 Summary of potential mine subsidence impacts on building structures

Risk	Likelihood	Consequence	Level of potential impact
Structures			
Impacts on health and safety	RARE	MODERATE	LOW
Damage to structures	POSSIBLE	MINOR	MEDIUM
Pools			
Impacts on health and safety due to damage to pool gate	RARE	MAJOR	MEDIUM
Damage to pools	LIKELY	MINOR	MEDIUM
Septic Tanks			
Damage to tanks	UNLIKELY	MINOR	LOW
Farm dams			
Leak of dam water	RARE	MINOR	LOW

5.16. Identification of subsidence hazards that could give rise to risks to health and safety

Clause 34 of the Work Health and Safety Regulation (2017) requires that the duty holder (in this case Tahmoor Coal), in managing risks to health and safety, must identify reasonably foreseeable hazards that could give rise to risks to health and safety.

This section of the Management Plan summarises hazards that have been identified for structures which could give rise to risks to health and safety of people.

Using the processes described in Section 5.2 of this Management Plan, mine subsidence hazards have been identified, investigated and analysed in a systematic manner by examining each aspect of the property, as described in Sections 5.3 to 5.14 of this Management Plan. Each of the built features below could potentially experience mine subsidence movements that could give rise to risks to the health and safety of people:

- building structure(s);
- services to properties, including pipes, cables, fire protection, security, access and mobility;
- items noted during inspections by structural or geotechnical engineer;
- finishes; and
- external pavements, fences and gates.

The following mine subsidence hazards were identified that could give rise to risks to health and safety in respect to structures due to the extraction of LW W1-W2:

- potential mine subsidence damage to building structures (refer Sections 5.3 and 5.7);
- steep slopes (refer to Sections 5.3.1 and 5.9);
- potential damage to pools and pool gates (refer Section 5.5);
- potential damage or loss of services to properties (refer Section 5.8); and
- potential development of trip hazards on internal floors and external pavements (refer Section 5.10).

As shown in Table 5.2 the Structures Response Group assessed the likelihood of the above hazards affecting health and safety, and the severity of potential health and safety consequences during the risk assessment as a group, based on the assessed worst-case consequence. The results of the risk assessment are included in Appendix A.

The identification and risk assessment process took into account the location of the structures relative to LW W1-W2 and the associated timing and duration of the subsidence events, as described in Section 1.7 of this Management Plan.

Whilst mine subsidence predictions and extensive past experiences from previous mining at Tahmoor Mine were taken into account, the identification and risk assessment process recognised that there are uncertainties in relation to predicting subsidence movements, and uncertainties in how mine subsidence movements may adversely impact properties, as discussed in Section 1.4 and Chapter 2 of this Management Plan.

Tahmoor Coal has considered the outcomes of the hazard identification and risk assessment process when developing measures to manage potential impacts on the health and safety of people, and potential impacts on properties in general. These are described in Chapter 6 of this Management Plan.

6.1. Structures Response Group (SRG)

The Structures Response Group (SRG) is responsible for taking the necessary actions required to manage the risks that are identified for structures. The SRG's key members are:

- Tahmoor Coal;
- JMA Solutions; and
- MSEC.

SA NSW may also participate in SRG meetings as observers when available. The SRG may invite other specialist consultants from time to time, including Douglas Partners where issues relate to slope stability.

6.2. Mitigation measures

Mitigation measures have been or will be undertaken where recommended by the structural engineer based on hazard identification inspections.

Mitigation measures have been recommended at one property prior to the influence of LW W1-W2, where the base connections for verandah posts are recommended to be upgraded so that they bear on the centre of the foundations supporting them. Details are provided in Table A.1, which is included in Appendix A of this Management Plan.

6.3. Community consultation, co-operation and co-ordination

Experiences during the mining of Longwalls 22 to 32 have found that the most effective method of managing potential impacts on the safety and serviceability of structures are by way of community consultation. Residents living within the active subsidence zone have often provided early feedback about impacts developing at their houses or along their local roads. Contact is made well before impacts develop to a level of severity sufficient to become a safety hazard.

Community consultation commenced when the Tahmoor Coal applied for development consent to mine. A Commission of Inquiry was undertaken as part of this process. Tahmoor Coal continued to develop their mine plans after development approval was received. These plans were discussed with the Tahmoor Colliery Community Consultative Committee (TCCCC), which was set up in accordance with the conditions of development consent. Prior to mining the first longwall beneath Tahmoor, the Mine increased the level of communication with the community.

The approaches adopted by Tahmoor Coal are listed below.

- *Undertake conservative predictions and impact assessments*

  Tahmoor Coal and MSEC have adopted a conservative approach to predicting subsidence and assessing impacts. This reduces the likelihood of under-stating the predicted impacts. For example, predictions for each structure have been made by predicting the maximum subsidence, tilt and strain within a 20 m radius around each structure;

- *Undertake detailed predictions and impact assessments*

  By undertaking detailed subsidence predictions, Tahmoor Coal is able to provide residents with predictions for their own structures. Individual assessments provide some comfort to concerned residents. This is particularly helpful for residents that live beyond the extent of mining and are expected to experience only small movements;

- *Community information days*

  A number of advertised information days are held by Tahmoor Coal throughout the year. The information days allow members of the community to directly meet Tahmoor Coal representatives and its consultants. SA NSW is also present on information days to answer questions;

  The information exchanged at information days also assists Tahmoor Coal, as members of the community sometimes provide information about particular surface features or impacts that Tahmoor Coal might not have been aware of;

- *Tahmoor Colliery Community Consultative Committee*

  The committee meets at regular (quarterly) intervals. Meetings allow Tahmoor Coal to present information to the committee and receive feedback. The committee is committed to ensuring that the concerns of the community are well understood by Tahmoor Coal. Many of the members have been part of the committee for several years, and this facilitates informed discussion;

- *Letters to residents and door knocking*

  Tahmoor Coal sends letters to the community advising of imminent longwall mining in their area. By continuing to engage with residents at each stage of mining, Tahmoor Coal is able to find new residents who might not have been aware that mining was taking place. The letters include:

  - Notification of preparation of Extraction Plan application for LW W1-W2 and notification of lodgement of Extraction Plan application. The notification letter attached a Subsidence Information Pack, which included information on longwall mining and mine subsidence, the claims process with SA NSW, recommendations to undertake pre-mining hazard identification inspections, and a list of emergency contact numbers and point of contact at Tahmoor Coal;
  - Notification to all landowners within the application area of Extraction Plan approval for LW W1-W2;
  - Notification of imminent commencement of each longwall. The letter is sent to all landowners whose properties are located directly above the active longwall panel plus landowners whose properties are located directly above the next longwall panel. The letter encourages landowners to undertake pre-mining hazard identification inspections;
  - For properties where pre-mining hazard identification inspections have been or will be undertaken in accordance with this Management Plan, Tahmoor Coal have or will make direct contact to arrange access with the landowner by mail, letterbox drop, phone and/or door knocking;
  - Door knocking of houses located directly above the active longwall:
    - This exercise is an attempt to directly engage with residents and is undertaken in conjunction with front of house inspections;
    - This exercise will be undertaken before the longwall face approaches within 300 m of each property, so that there is adequate time, if required, to arrange additional inspections and/or surveys and implement any mitigation measures if required before mining-induced impacts are experienced.

- *Individual meetings with residents*

  Many members of the community prefer to meet with Tahmoor Coal representatives face to face. Tahmoor Coal has held many individual meetings with concerned residents to explain how mine subsidence develops and what the impacts might be. This is a time consuming but rewarding process for residents and Tahmoor Coal;

- *Newspaper advertisements*

  Tahmoor Coal places advertisements in the newspaper from time to time to advise the community at large about consultation opportunities, including community information days;

- *Regular reporting*

  Tahmoor Coal provides regular updates on the progress of mining in the area. This is conducted mainly by community newsletter by mail, email, website and notice boards for any member of the community who wishes to be regularly informed. The updates advise the current position of the longwall and any impacts that have been observed;

- *Prompt response to reported impacts*

  Tahmoor Coal responds quickly to impacts that are reported by the community. If a severe impact is reported, Tahmoor Coal checks neighbouring properties to see whether the incident is localised or part of a larger potential issue;

- *Ongoing monitoring if impacts occur*

  Where impacts have been reported, Tahmoor Coal offers to continue monitoring the property for further impacts.

6.4. Development and selection of risk control measures

Tahmoor Coal has developed and selected risk control measures in consultation, co-ordination and co-operation with landowners in accordance with WHS legislation. In accordance with Clauses 35 and 36 in Part 3.1 of the Work Health and Safety regulation (2017) and the guidelines (MSO, 2017), a hierarchy of control measures has been considered and selected where reasonably practicable, using the following process:

1. Eliminate risks to health and safety so far as is reasonably practicable, and
2. If it is not reasonably practicable to eliminate risks to health and safety – minimise those risks so far as is reasonably practicable, by doing one or more of the following:
   (a) substituting (wholly or partly) the hazard giving rise to the risk with something that gives rise to a lesser risk
   (b) isolating the hazard from any person exposed to it
   (c) implementing engineering controls
3. If a risk then remains, minimise the remaining risk, so far as is reasonably practicable, by implementing administrative controls.
4. If a risk then remains, the duty holder must minimise the remaining risk, so far as is reasonably practicable, by ensuring the provision and use of suitable personal protective equipment.

A combination of the controls set out in this clause may be used to minimise risks, so far as is reasonably practicable, if a single control is not sufficient for the purpose.

There are primarily two different methods to control the risks of subsidence, namely:

Method A – Selection of risk control measures to be implemented prior to the development of subsidence, (Items 1 and 2 above), and

Method B – Selection of risk control measures to be implemented during the development of subsidence (Items 3 and 4 above).

Method A and B risk control measures are described in Sections 6.5 to 6.11. Prior to selecting Method B risk control measures, Tahmoor Coal has investigated and confirmed that the measures are feasible and effective for the site-specific conditions due to the extraction of LW W1-W2.

6.5. Avoidance and mitigation measures

Based on its own assessments, and the assessments by the structural engineer and geotechnical engineer, Tahmoor Coal considered Method A and B risk control measures, in accordance with the process described in Section 6.4.

Elimination

In this instance, no reasonably practicable controls could be identified that would eliminate the identified risks.

Substitution

In this instance, no reasonably practicable controls could be identified that will change the environment so the hazards could be substituted for hazards with a lesser risk.

Isolation

In this instance, no reasonably practicable controls could be identified to isolate a hazard from any person exposed to it.

Engineering controls

Hazard identification inspections by structural engineer JMA Solutions have identified elements that are in poor existing condition or elements that could be susceptible to mine subsidence movements. The structural engineer has recommended engineering controls and monitoring to minimise risk.

A summary of the inspections, engineering controls and monitoring that have been recommended by the structural engineer, to date, are provided in Table A.1, in Appendix A. The engineering controls will be implemented prior to the structure experiencing active subsidence from LW W1-W2, i.e. before the longwall face approaches to within 100 m of travel of mining beneath the structure.

Additional engineering controls may be developed as further hazard identification inspections are completed by the structural engineer. There are currently three remaining hazard identification inspections planned to be completed. The hazard identification inspections will be undertaken before the longwall face approaches to within 300 m of travel of mining beneath each property.

Administrative controls

The following administrative Controls were identified and selected that will put in place procedures to minimise the potential of impacts on health and safety:

- Implementation of a Monitoring Plan and Trigger Action Response Plan (TARP). As described in Table 6.1, the SRG has developed and implemented a management strategy of detecting early the development of potential adverse subsidence movements, so that contingency response measures can be implemented before impacts on safety and serviceability develop. The TARP includes the following:
  - ground monitoring and visual inspections along streets in the active subsidence zone;
  - baseline ground surveys of pegs installed around semi-rural and rural houses that are remote from local streets and located directly above LW W1-W2, or where requested by landowners;
  - specific ground surveys for selected properties, where recommended by the geotechnical engineer or structural engineer due to their proximity to steep slopes or pre-existing condition;
  - visual inspections of residential structures that are either: located on or adjacent to steep slopes, are in poor existing condition (based on the hazard identification inspections), have previously reported impacts, or where recommended by the Structures Response Group;
  - visual inspections of pool fences and gates;
  - visual inspections of public amenities and public utilities;
  - additional surveys and inspections, if required, such as regular recording of widths of any new cracks that might appear;
  - repair of impacts that create a serious public safety hazard;
  - repair of impacts that impair any essential services;
  - repair of impacts that impair access and mobility to properties, even if further impacts are anticipated; and
  - in the worst case, as a last resort, advise landowners to restrict entry to part of the property or emergency evacuate the premises.

With the implementation of the above management strategies, Tahmoor Coal will ensure that the health and safety of people on properties will not be put at risk due to differential mine subsidence movements due to the extraction LW W1-W2.

6.6. Site-specific structure inspection plan

6.6.1. Identification of building structures

At the time of preparing Reports Nos. MSEC647 (MSEC, 2014) and MSEC1019 (MSEC, 2019), in support of the SMP and Extraction Plan Applications, structures were identified from orthophotographs, with structure types identified from kerbside inspections. Additional structures have been identified from Nearmap images in July 2019 and from kerbside inspections as part of the preparation of this Management Plan.

Front of house risk and visual screening inspections have been carried out by a structural engineer for the properties that are predicted to experience more than 20 mm of incremental vertical subsidence due to the extraction of LW W1-W2, where they were visible from the street. The purpose of these inspections is to identify structures that are in poor existing condition or elements that could be sensitive to mine subsidence movements, where access was not granted by the owner for the hazard identification inspections.

In some cases, particularly in semi-rural and rural areas, it is difficult to inspect a structure that is remote from the street front. Where these cases involve properties that are located directly above LW W1-W2 Tahmoor Coal have requested access to conduct a pre-mining inspection and hazard identification inspection by a structural engineer.

The locations of residential structures where Front of House risk and visual screening inspections have been completed by a structural engineer prior to commencement of LW W1-W2 are shown in Fig. 6.1.

Fig. 6.1 Residential structures where front of house risk and visual screening inspections have been completed prior to commencement of LW W1-W2

6.6.2. Pre-mining hazard identification inspections by geotechnical engineer

A qualified geotechnical engineer (Douglas Partners) has inspected the steep slopes at 20 locations on which structures are located to determine whether there is any potential for slope instability prior to, during or after mining. The inspections confirmed the assumptions and assessments provided in the preliminary report (Douglas Partners,2019a), and have not identified additional geotechnical issues.

A map showing locations where geotechnical hazard identification inspections have been completed, and where geotechnical hazard identification inspections are required is shown in Fig. 6.2.

A hazard identification inspection will be conducted at nine properties will be inspected by Douglas Partners prior to the longwall face approaching within 300 metres of the structures. This includes five properties that were recommended for geotechnical inspections by structural engineer JMA Solutions.

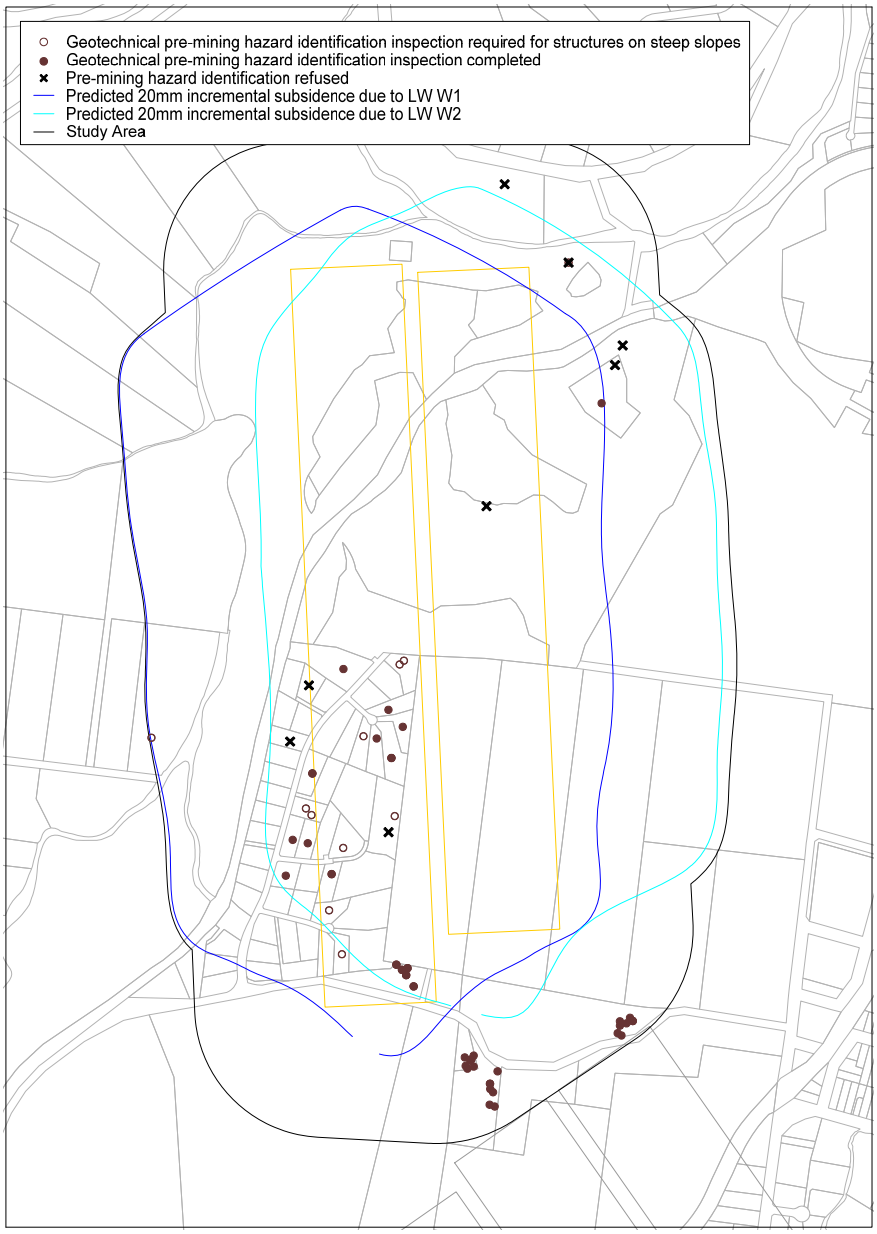


Fig. 6.2 Locations of structures near steep slopes that require pre-mining hazard inspection by geotechnical engineer for LW W1-W2

6.6.3. Pre-mining hazard identification inspections by structural engineer

Tahmoor Coal has contacted residents of properties that are located within the predicted 20 mm subsidence contour due to LW W1-W2, offering a pre-mining hazard identification inspection by a structural engineer.

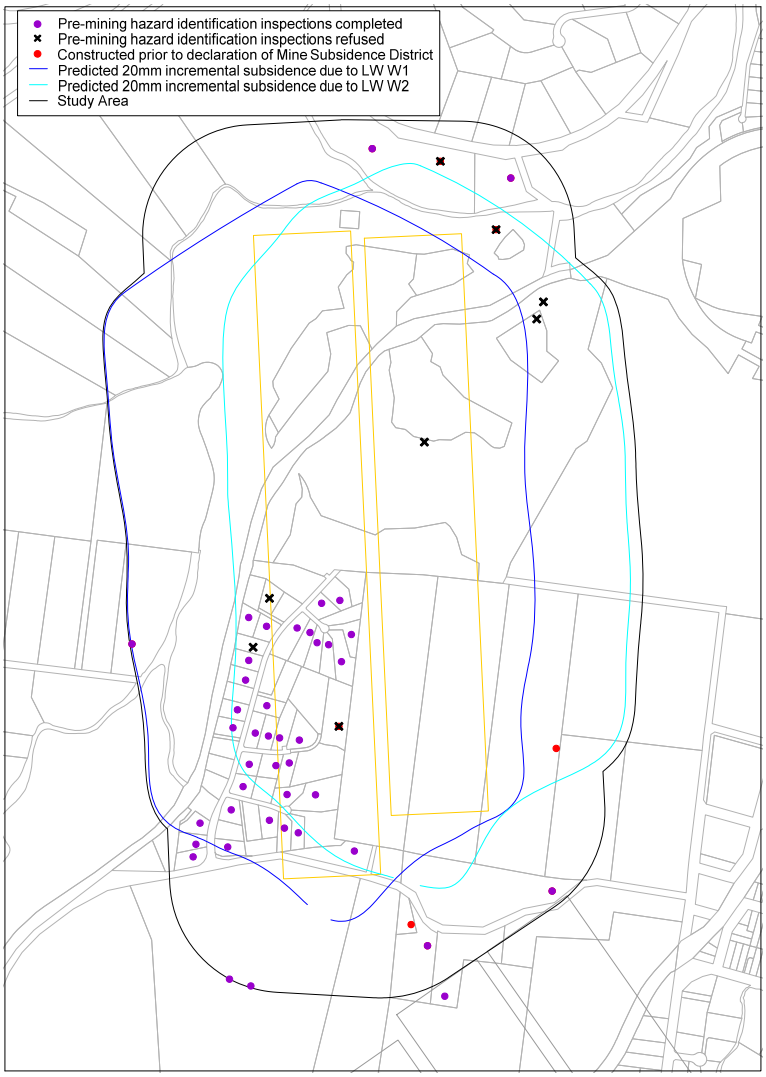
In addition, Tahmoor Coal has requested access to conduct pre-mining hazard identification inspections at properties with structures that have been specifically targeted on the basis that they may be more sensitive to mine subsidence movements due to the extraction of LW W1-W2, as outlined in Section 5.2.

The hazard identification inspections required to be completed will be undertaken before the longwall face approaches to within 300 m of travel prior to directly mining beneath each property. Where access is not granted by the landowner, inspections are limited to Front of House inspections where the structures are visible from the street.

Hazard identification inspections have been completed at 41 properties prior to the commencement of LW W1. The majority of the 41 properties requested an inspection in response to the offer by Tahmoor Coal. Almost all structures that were specifically targeted on the basis that they may be more sensitive to mine subsidence movements due to the extraction of LW W1-W2, as outlined in Section 5.2 (two have currently refused an inspection).

There are currently three remaining hazard identification inspections planned to be completed.

The locations of structures where pre-mining hazard identification inspections have been completed by structural engineer JMA Solution are shown in Fig. 6.3. It can be seen from Fig. 6.3 that hazard identifications inspection for structures located above the commencing end of LW W1 have been completed. Outstanding inspections will be undertaken prior to LW W1 approaching within 300 metres of each structure.



Note: all properties that are predicted to experience more than 20 mm of incremental subsidence have been offered a pre-mining hazard identification inspection.

Fig. 6.3 Locations of structures where pre-mining hazard inspections have been completed by structural engineer prior to commencement of LW W1-W2

6.6.4. Pre-mining inspections by SA NSW

SA NSW has undertaken a small number of pre-mining inspections above LW W1-W2. Further inspections may be conducted by SA NSW in the future, if requested by a landowner.

In order to reduce inconvenience to landowners, Tahmoor Coal will offer to conduct a pre-mining inspection for SA NSW to be conducted by the structural engineer at the same time as the hazard identification inspection. The landowner is not obliged to take up the offer when agreeing to the hazard identification inspection.

6.6.5. Visual kerbside inspections during mining

Detailed visual inspections will be undertaken along streets on a weekly basis within the active subsidence area from the commencement of LW W1. Vehicle-based inspections will also be undertaken once a week within the active subsidence area during the mining of LW W1-W2, commencing after 200 m of extraction.

The frequency of inspections can be increased, if required, based on actual observations.

6.6.6. Visual inspections of structures during mining

Weekly visual inspections will be conducted for the following structures, when they are located within the active subsidence zone, where access is provided by the landowner:

- residential structures located on or adjacent to steep slopes, where recommended by the geotechnical or structural engineer;
- residential structures in poor existing condition, based on the hazard identification inspections by the structural engineer;
- residential structures that have experienced impacts as a result of mining previous longwalls, or where recommended by the SRG;
- pool fences and gates;
- commercial, industrial and business establishments; and
- public amenities and utilities.

Weekly visual inspections planned to be conducted during active subsidence are illustrated in Fig. 6.4. The active subsidence zone is described in Section 1.7, with the weekly inspections of the houses carried out from when they are 150 m in front of the longwall face to 450 m behind the longwall face.

Weekly inspections for the structures located near the longwall commencing end will start after the first 200 m of longwall extraction. Weekly inspections for the structures located beyond the longwall finishing end will be carried out for the last 300 m of extraction.

In addition to the above, farm dams will be inspected by a geotechnical engineer monthly during the period of active subsidence for each dam.

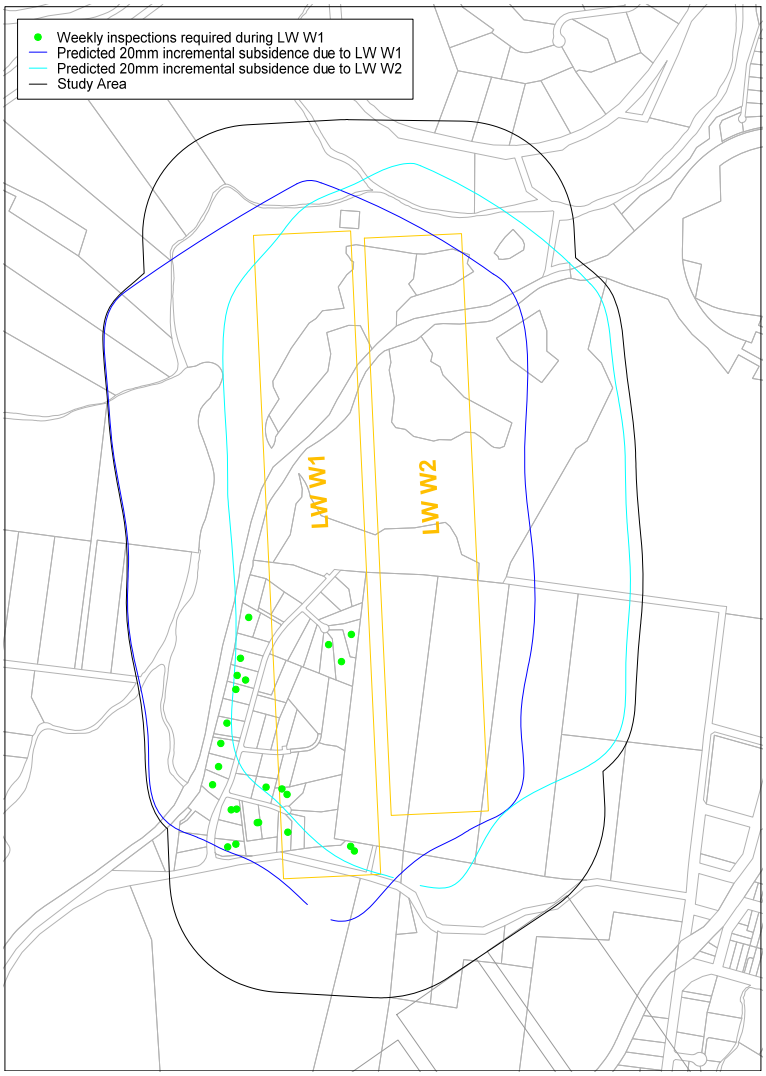


Fig. 6.4 Inspections during active subsidence

6.7. Ground and structure monitoring plan

6.7.1. Ground surveys along the streets

Survey marks will be installed along streets above and adjacent to LW W1-W2, as shown in Drawing No. MSEC1045-00-01. The survey pegs will be surveyed during the period of active subsidence of these features during the extraction of LW W1-W2.

6.7.2. Specific structure surveys

Tahmoor Coal will undertake building surveys where recommended by the geotechnical or structural engineer, or where requested by the landowner. Tahmoor Coal will also install and baseline survey pegs around semi-rural and rural houses that are remote from local streets and located directly above LW W1-W2, where access is permitted.

Ground surveys around structures are used as a baseline monitoring tool. Surveys are undertaken following completion of each longwall unless impacts or high tilts are observed. Tahmoor Coal will place permanent ground survey marks around each subject building. Tahmoor Coal will endeavour to place marks at each external and internal corner of the building, and one mark at the centre of each external side of reasonable length (this will depend on the overall size of the building, but is approximately 10 m).

Tahmoor Coal will record the reduced levels of each mark, as well as the relative horizontal position between each mark around the perimeter of the building (local 3D survey). The survey information will provide subsidence, tilt, curvature and strain information on the ground around the building. This general surveying scheme is illustrated in Fig. 6.5. It is recognised that in some cases, it will not be possible to gain access and suitable lines of sight to the entire perimeter of the building, and in some cases, the number of survey pegs may be reduced. However, as a minimum, survey marks will be placed at every corner of the building.

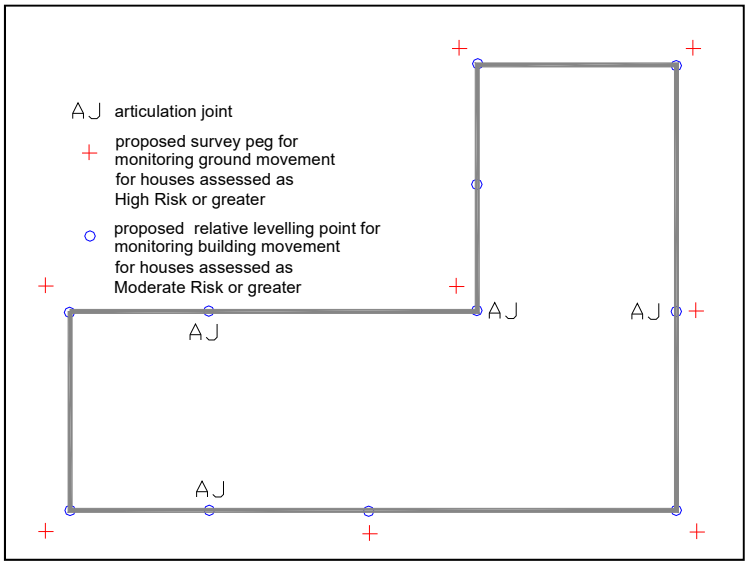


Fig. 6.5 Schematic layout for ground movement and building level surveys around a typical building

The properties where landowners have requested or agreed with Tahmoor Coal to install survey pegs are shown in Fig. 6.6. Survey pegs have been installed at two properties, including the property located on Barkers Lodge Road.

Survey marks will be installed and baseline surveyed at the remaining properties prior to the longwall face approaching within 400 metres of each property.

Fig. 6.6 Properties for which survey marks are required or have been requested

6.8. Schedule of inspections and surveys

A schedule of inspections and surveys is maintained by Tahmoor Coal.

6.9. Inspection and survey register

A register will be kept by Tahmoor Coal, recording when inspections and surveys are conducted. Tahmoor Coal can, at any time, provide a copy of the register to MSO.

6.10. Triggers and responses

Trigger levels have been developed by Tahmoor Coal based on observed ground movements or impacts. Trigger levels for each monitoring parameter are described in the risk control procedures in Table 6.1. Structural inspections will be undertaken for any structure where ground tilt is observed to exceed 7 mm/m or curvature is observed to exceed 0.2 km^{-1}.

Tahmoor Coal will coordinate and ensure that building contractors are on standby for immediate call out and service in the event of impacts occurring. Temporary alternative accommodation will also be arranged by Tahmoor Coal in the unlikely event that a residence becomes unsafe as a result of mine subsidence impacts.

Immediate responses will be undertaken by Tahmoor Coal for the following impacts:

- impacts that create a serious public safety hazard;
- impacts to all entry and exit doors, and all other doors that must remain operational for security and fire egress reasons, even if further impacts are anticipated;
- impacts that impair any essential services;
- impacts to sensitive equipment, even if further impacts are anticipated; and
- in the worst case, restriction on entry to part of the property and the provision of alternative accommodation for the resident.

The risk control measures described in this Management Plan have been developed to ensure that the health and safety of people who may be present at the properties are not put at risk due to mine subsidence. It is also an objective to avoid disruption and inconvenience to owner, or if unavoidable, keep disruption and inconvenience to minimal levels.

With respect to the extraction of LW W1-W2, no potential hazards have been identified that could reasonably give rise to the need for an emergency response for structures that will be affected by LW W1-W2. It is noted that pool gates can malfunction during the period of active subsidence and any impacts will be repaired immediately. It is possible that irregular ground movements could cause a severe impact on a building structure; however, this will develop gradually allowing the risk to be managed.

Mine subsidence movements develop gradually and there will be ample time to identify the development of potentially adverse differential subsidence movements early, consider whether any additional management measures are required, and repair or adjust affected surface features, in close consultation with landowners.

Tahmoor Coal and the SRG will review and assess monitoring reports and consider whether any additional management measures are required on a weekly basis. If irregular movements or adverse impacts are detected, it is anticipated that a focussed inspection will be undertaken for the affected property, and a decision will likely be made to increase the frequency of surveys and/or inspections. Additional management measures may also be implemented. It is therefore expected that, as a potential adverse situation escalates, Tahmoor Coal will be present on site on a more frequent basis to survey or inspect the property, and that the landowner will be consulted on a more frequent basis.

Given the gradual development of subsidence movements, it is extremely unlikely that a situation will arise where observations change from a benign scenario to an emergency scenario within one week. Tahmoor Coal will also brief landowners on what signs to look for to detect the development of potential impacts.

Notwithstanding the above, if a hazard has been identified that involves potential serious injury or illness to a person or persons at a property, and it cannot be controlled, the immediate response is to remove people from the hazard. If such a situation is observed or is forecast to occur by either Tahmoor Coal or by people at the property, Tahmoor Coal and the landowner will immediately meet and implement emergency procedures.

The implementation of emergency procedures may include any or a combination of the following:

- restriction of access to the hazardous area; and/or
- in the worst case, the relocation of residents to alternative accommodation until the hazard is rectified.

6.11. Risk control procedures for LW W1-W2

Risk control procedures for the management of potential impacts to residential, commercial and business establishments, public amenities and public utilities are provided in Table 6.1.

Table 6.1 Risk control procedures for built structures for LW W1-W2

Infrastructure	Hazard / impact	Risk	Trigger	Control procedure/s	Timing and frequency	By whom?
Items of heritage significance, public amenities, commercial, business and industrial establishments predicted to experience more than 20 mm of subsidence due to the extraction of LW W1-W2				Refer separate Property Subsidence Management Plans		
Residential structures that will experience mine subsidence effects due to the mining of LW W1-W2	Impacts occur	Low to Moderate	Prior to mining	Community consultation, including letters to landowners offering a Pre-Mining Inspection and Hazard Identification inspection for structures predicted to experience more than 20 mm of subsidence due to the extraction of LW W1-W2.	Complete	Tahmoor Coal
				Front of house screening inspection to identify any potentially unstable structures, for structures predicted to experience more than 20 mm of subsidence due to the extraction of LW W1-W2.	Complete	Tahmoor Coal (JMA)
				Conduct pre-mining hazard identification inspection and assessment by geotechnical engineer of structures on or near steep slopes to check whether there is any potential for slope instability prior to, during or after mining, for structures predicted to experience more than 20 mm of subsidence due to the extraction of LW W1-W2.	Majority complete Complete remainder prior to longwall face approaching within 300 m of each property	Tahmoor Coal (Douglas Partners)
				Conduct pre-mining hazard identification inspection and assessment by structural engineer, including: • structures requested for inspection by landowner during community consultation • structures directly above LW W1-W2 in semi-rural / rural areas remote from street front, where front of house screening is not practicable • structures that have been recommended for structural inspection by the geotechnical engineer • structures that have been recommended for structural inspection during front of house screening inspections • structures built outside Mine Subsidence District that are predicted to experience more than 150 mm of subsidence due to the extraction of LW W1-W2 • structures built prior to declaration of the Mine Subsidence District (1997) and predicted to experience more than 150 mm of subsidence due to the extraction of LW W1-W2 • structures above potential hidden creeks that are predicted to experience more than 20 mm of subsidence due to the extraction of LW W1-W2 • structures above mapped geological structures that are predicted to experience more than 20 mm of subsidence due to the extraction of LW W1-W2	Majority complete Complete remainder prior to longwall face approaching within 300 m of each property	Tahmoor Coal (JMA)
				Installation of additional monitoring measures or mitigation/strengthening measures as recommended by structural engineer.	Prior to longwall face approaching within 100 m of each property	Tahmoor Coal
				Install ground monitoring lines on streets above LW W1-W2 and survey initial levels and strain distances (as shown in Drawing No. MSEC1045-00-01).	For new survey pegs, install prior to longwall face approaching to within 400 m of each property.	Tahmoor Coal (SMEC)
				Install ground pegs for structures as requested by or agreed with landowners	Complete prior to longwall face approaching within 400 m of each property	Tahmoor Coal (SMEC)
				Confirm arrangements for building contractors to remain on standby for immediate call out and service in the event of impacts affecting safety or serviceability.	Complete	Tahmoor Coal
			Discovery of potential structural issue prior to mining	Conduct structural hazard identification inspection and assessment and consider: - any mitigation / strengthening measures to improve the existing structural condition - any management measures that should be undertaken prior to or during mining - any monitoring and inspection measures, triggers and responses during mining	Within 1 week of discovery	Tahmoor Coal
				Advise property owner, SA NSW and MSO of findings of structural engineer.	Within 1 week of inspection	Tahmoor Coal
				Undertake mitigation / strengthening measures if decided by SRG.	Prior to longwall face approaching to within 100 m of structure	Tahmoor Coal

Infrastructure	Hazard / impact	Risk	Trigger	Control procedure/s	Timing and frequency	By whom?
Residential structures that will experience mine subsidence effects due to the mining of LW W1-W2	Impacts occur	Low to Moderate	During the mining of LW W1-W2	Surveys of street survey lines within active subsidence area, including Barkers Lodge Road, Thirlmere Way, Stonequarry Creek Road, Attunga Close, Booyong Close and Carramar Close	Weekly for pegs located within active subsidence zone	Tahmoor Coal (SMEC)
				Conduct kerbside visual inspection of streets and structures	Detailed inspection once a week Vehicle based inspection once a week within active subsidence area	Tahmoor Coal
				Conduct inspections during mining for following structures: a) Structures that have previously experienced mine subsidence impacts, where recommended by the SRG b) Pool gates c) Any other structures recommended for regular inspections and/or structure surveys by geotechnical or structural engineer following pre-mining hazard identification inspection and assessment	Weekly within active subsidence zone, or as required by geotechnical or structural engineer	Tahmoor Coal
				Analyse and report results of monitoring and inspections to SRG	Monthly from start of LW W1 and LW W2 Weekly after 800 m of extraction of LW W1 and LW W2 until one month after completion of each LW, unless ongoing adverse movements are observed.	Tahmoor Coal (MSEC)
				SRG discuss results and consider whether any additional management measures are required	Monthly from start of LW W1 and LW W2 Weekly after 800 m of extraction of LW W1 and LW W2 until one month after completion of each LW, unless ongoing adverse movements are observed.	SRG
			Observed tilts are greater than 7 mm/m or observed curvatures are greater than 0.2 km^{-1} near structure	Conduct inspection of building and provide photographic survey and impact report	Within one week	Tahmoor Coal
				Consider structural inspection/additional monitoring and/or mitigation/strengthening measures	Immediately after building inspection	Tahmoor Coal (JMA)
			Significant non-conventional movement occurs or Impacts observed to any surface infrastructure (not just structures) or Slope slippage observed	Consider whether any additional management measures are required in light of observations, including additional geotechnical or structural inspections, increase frequency of surveys and inspections, additional community consultation	As required by SRG	SRG
				Notify landowner, Tahmoor Coal, SA NSW and MSO	Within one week	Tahmoor Coal

Infrastructure	Hazard / Impact	Risk	Trigger	Control procedure/s	Timing and frequency	By whom?
Residential establishments that will experience mine subsidence movements due to the mining of LW W1-W2	Impacts occur	Low to Moderate	Any impact occurs to structure	As information can come from many possible sources: If not already done, notify landowner, Tahmoor Coal, SA NSW	Within 24 hours	Tahmoor Coal
				Inspect impact of subsidence on building	As soon as possible	Tahmoor Coal
				Inspect condition of building by structural engineer, where recommended by the SRG based on feedback from SA NSW	As recommended by SRG with active subsidence area or as agreed with owner	Tahmoor Coal
				Rectify any adverse impacts that impair upon: - the safety, access and mobility, security or fire egress - any essential services - sensitive equipment	As soon as possible at any stage during mining	Tahmoor Coal
				Repair damage to structure	When subsidence impacts cease	Tahmoor Coal
			Observed impacts are greater than predicted impacts	Investigate cause(s) for greater impacts, including possibility of non-conventional or anomalous movements, type of structure. Investigate spatial trends in data to identify any pattern.	Within one week of observation	Tahmoor Coal
			Structure has become or is likely to be become hazardous as a result of subsidence	Notify landowner, Tahmoor Coal, SA NSW and MSO	Within 24 hours	Tahmoor Coal
				Inspect structural condition of building.	Within two days and then as recommended by structural engineer	Tahmoor Coal (JMA)
				Reassess final level of damage based upon likelihood of further damage and structural condition.	Immediately after structural re-inspection.	SRG
				Consider additional monitoring and/or mitigation/strengthening measures	Immediately after structural re-inspection.	SRG
			A hazard has been identified that involves potential serious injury or illness to a person or persons at the property, and cannot be controlled	Provide temporary accommodation for residents in coordinate with SA NSW	Immediately	Tahmoor Coal
				Notify MSO	Within 24 hours	Tahmoor Coal
				Utilise acquisition and compensation procedure from DA67/98-1999 Development Consent Conditions 18-26 and SA NSW procedures	Immediately	Tahmoor Coal
			Property owner does not accept acquisition	Temporarily relocate residents until building is repaired	Immediately	Tahmoor Coal

Infrastructure	Hazard / impact	Risk	Trigger	Control procedure/s	Timing and frequency	By whom?
Houses	House subsides below 100 year ARI flood level	Moderate	Prior to Mining	Assess potential for houses to subside below 100 year ARI flood level	Complete	Tahmoor Coal
			Completion of Mining	Conduct survey of surface topography	End of LW W2 (may be extended to LW W4 if extraction is approved in future)	Tahmoor Coal (SMEC)
				Assess whether any houses has subsided below 100 year ARI flood level	End of LW W2 (may be extended to LW W4 if extraction is approved in future)	Tahmoor Coal
			House(s) subside below 100 year ARI flood level	Raise house so that floor level is above 100 year ARI flood level	As required	Tahmoor Coal
Houses	Impacts to future houses	Low to Moderate	Prior to mining	Contact residents to inform them of commencement of mine subsidence. Request owners for information on whether any new houses have been constructed in the last year.	Prior to subsidence occurring	Tahmoor Coal
			Owner notifies of new house	Conduct pre-mining hazard identification inspection, if access provided by landowner	Prior to subsidence occurring	Tahmoor Coal (JMA)
				Follow risk control procedures, as for other houses	Immediately	Tahmoor Coal (MSEC)
			New house has maximum plan dimension greater than 30 m	Conduct subsidence predictions, impact assessment and risk assessment	Prior to subsidence occurring	Tahmoor Coal (MSEC)
				Follow risk control procedures, as for other houses	Immediately	Tahmoor Coal
Swimming pools and pool gates	Damage to pool	Low	None	Notify owner of potential impacts to pool	Before mine subsidence impacts occur	Tahmoor Coal
	Pool gate – won't shut	High	None	Notify owner of potential impact to pool gate and fence	Before mine subsidence impacts occur	Tahmoor Coal
				Visually inspect pool gate to check that it is operating properly	Weekly when each pool is within active subsidence zone, and at completion of each longwall	Tahmoor Coal
			Pool gate won't close	Notify resident and/or landowner, contact Subsidence Advisory NSW to repair gate	Immediately	Tahmoor Coal
				Repair gate	As soon as possible	Tahmoor Coal
Farm dams	Loss of water storage due to leakage of dam wall or floor	Low	During mining	Visual inspection of dam by geotechnical engineer, including recording of water levels	Monthly during period of active subsidence at each dam	Tahmoor Coal
			Cracks observed in dam	Repair cracks	As required	Tahmoor Coal
			Loss of water supply due to leakage of dam wall or floor	Supply water to landowner	As required	Tahmoor Coal

7.0 SRG REVIEW MEETINGS

The SRG undertakes reviews and, as necessary, revises and improves the risk control measures to manage risks to health and safety and potential impacts to building structures. The reviews are undertaken regularly during the period of active subsidence based on the results of surveys and visual inspections and summarised in regular monitoring reports, as described in Section 6.3.

The purpose of the reviews is to:

- detect changes, including the early detection of potential impacts on health and safety and impacts to building structures;
- verify the risk assessments previously conducted;
- ensure the effectiveness and reliability of risk control measures; and
- support continual improvement and change management.

SRG meetings will be held for discussion and resolution of issues raised in the operation of the Management Plan. The frequency of meetings shall be as agreed by the parties.

SRG meetings will discuss any incidents reported in relation to structures, the progress of mining, the extent of mine subsidence that has occurred, and comparisons between observed and predicted ground movements.

It will be the responsibility of the meeting representatives to determine whether the incidents reported are due to the impacts of mine subsidence, and what action will be taken in response.

In the event that a significant risk is identified for a particular surface feature, any member of the SRG may call an emergency SRG Meeting, with one day's notice, to discuss proposed actions and to keep other parties informed of developments in the monitoring of the surface feature.

8.0 AUDIT AND REVIEW

This Management plan can be reviewed and updated to continually to improve the risk management systems based on audit, review and learnings from the development of subsidence during mining and manage changes in the nature, likelihood and consequence of subsidence hazards.

The review process will be conducted to achieve the following outcomes:

- gain an improved understanding of subsidence hazards based on ongoing subsidence monitoring and reviews, additional investigations and assessments as necessary, ongoing verification of risk assessments previously conducted, ongoing verification of assumptions used during the subsidence hazard identification and risk assessment process, ongoing understanding of subsidence movements and identified geological structures at the mine;
- revise risk control measures in response to an improved understanding of subsidence hazards;
- gain feedback from stakeholders in relation to managing risks, including regular input from property and business owners;
- ensure on-going detection of early warnings of changes from the results of risk assessments to facilitate corrective or proactive management actions or the commencement of emergency procedures in a timely manner; and
- ensure timely implementation of a contingency plan in the event that the implemented risk control measures are not effective.

Some examples where review may be applied include:

- observation of greater impacts on surface features due to mine subsidence than was previously expected;
- observation of fewer impacts or no impacts on structures or surface features due to mine subsidence than was previously expected; and
- observation of significant variation between observed and predicted subsidence.

Should an audit of the Management Plan be required during that period, an auditor shall be appointed by Tahmoor Coal to review the operation of the Management Plan and report at the next scheduled plan review meeting.

9.0 RECORD KEEPING

Tahmoor Coal will keep and distribute minutes of SRG meetings.

10.0 CONTACT LIST

Organisation	Contact	Phone	Email
NSW Department of Planning and Environment – Resources Regulator (RR)	Phil Steuart	(02) 4063 6484	phil.steuart@planning.nsw.gov.au
	Gang Li	(02) 4063 6429 0409 227 986	gang.li@planning.nsw.gov.au
	Ray Ramage	(02) 4063 6485 0442 551 293	ray.ramage@planning.nsw.gov.au
JMA Solutions (JMA)	John Matheson*	(02) 9979 6618	john@jmasolutions.com.au
Subsidence Advisory NSW	Matthew Montgomery	(02) 4677 1967 0425 275 564	Matthew.Montgomery@customerservice.nsw.gov.au
Mine Subsidence Engineering Consultants (MSEC)	Daryl Kay*	(02) 9413 3777 0416 191 304	daryl@minesubsidence.com
SIMEC Mining Tahmoor Coal Acting Environment and Community Manager	David Talbert*	(02) 4640 0028 0414 905 565	David.Talbert@ simecgfg.com
SIMEC Mining Tahmoor Coal Approvals Coordinator	April Hudson*	(02) 4640 0022 0466 380 992	April.Hudson@simecgfg.com
Tahmoor Coal	Tahmoor Coal Control 24 hour contact	1800 154 415	-

* denotes member of Structures Response Group

APPENDIX A. Drawings and Supporting Documentation

The following supporting documentation is provided in Appendix A.

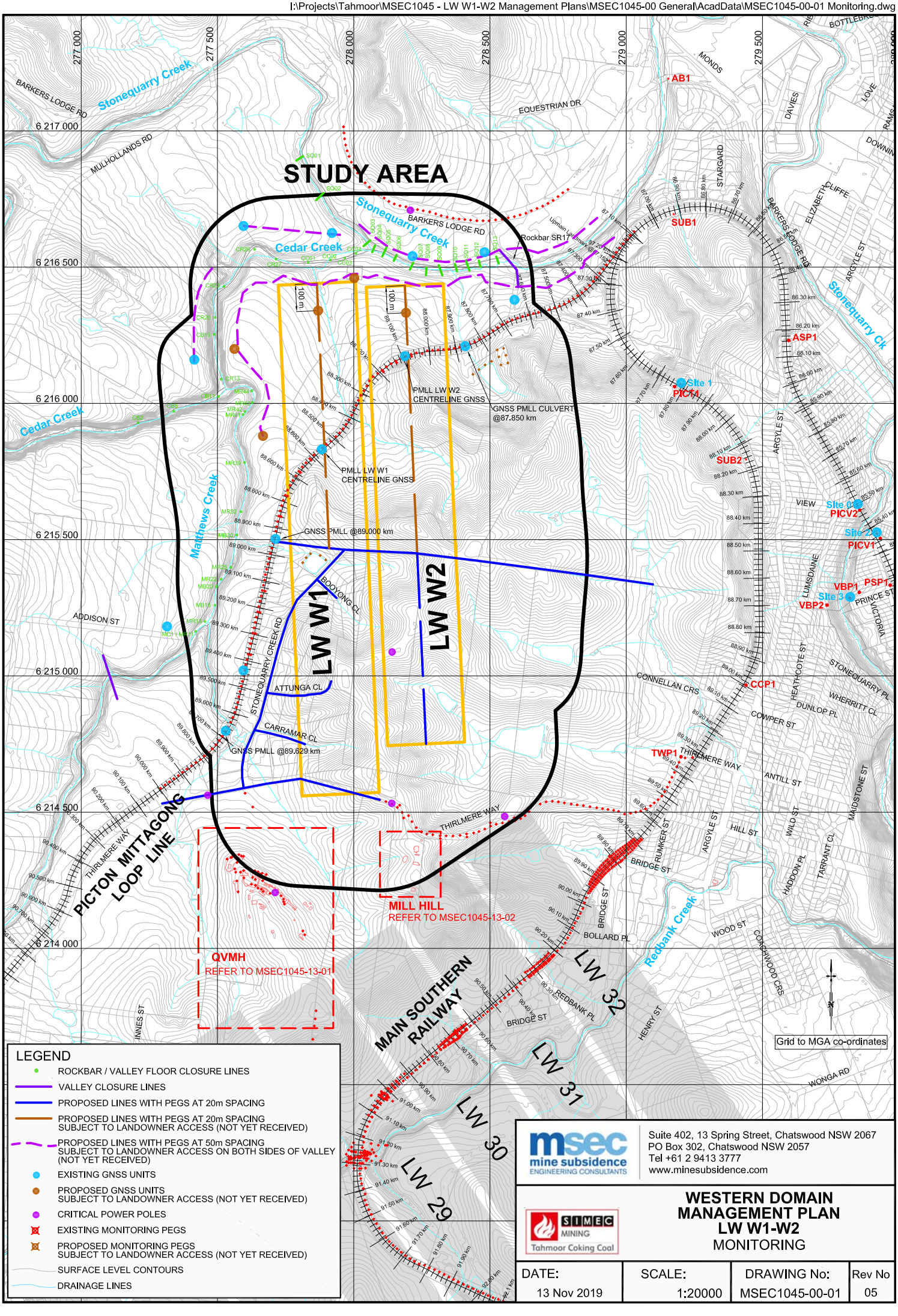
Drawings

Drawing No.	*Description*	*Revision*
MSEC1045-00-01	Monitoring over Longwall W1-W2	05
MSEC1045-12-01	Structures	01

Supporting Documentation

Tahmoor Coal (2019)	Risk Assessment Report – Infrastructure. Tahmoor North – Western Domain, Longwalls West 1 and West 2, April 2019.

I:\Projects\Tahmoor\MSEC1045 - LW W1-W2 Management Plans\MSEC1045-00 General\AcadData\MSEC1045-00-01 Monitoring.dwg



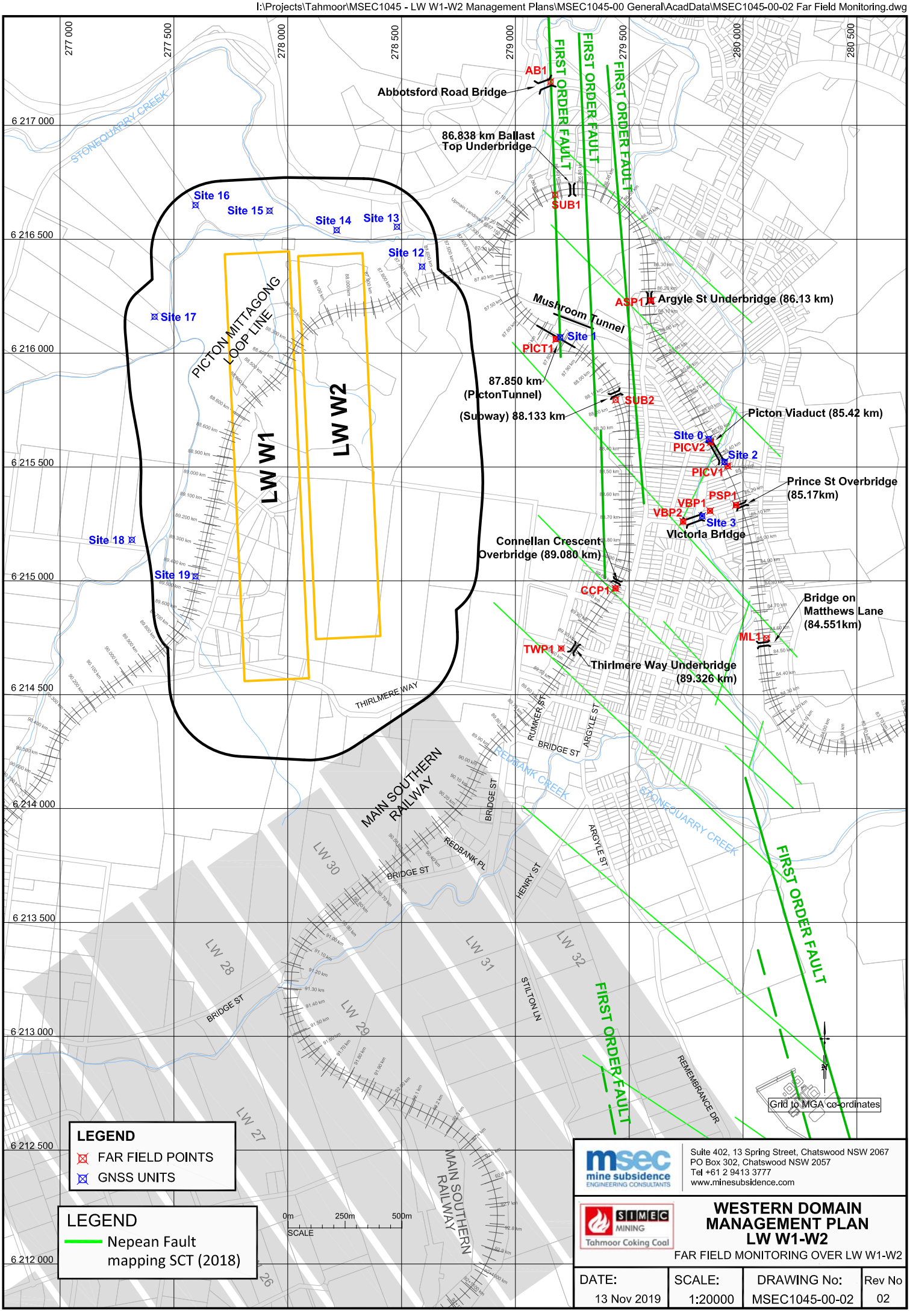
msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

SIMEC MINING Tahmoor Coking Coal

WESTERN DOMAIN MANAGEMENT PLAN LW W1-W2 MONITORING

DATE:	SCALE:	DRAWING No:	Rev No
13 Nov 2019	1:20000	MSEC1045-00-01	05

I:\Projects\Tahmoor\MSEC1045 - LW W1-W2 Management Plans\MSEC1045-00 General\AcadData\MSEC1045-00-02 Far Field Monitoring.dwg



msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

SIMEC MINING Tahmoor Coking Coal

WESTERN DOMAIN MANAGEMENT PLAN LW W1-W2

FAR FIELD MONITORING OVER LW W1-W2

DATE:	SCALE:	DRAWING No:	Rev No
13 Nov 2019	1:20000	MSEC1045-00-02	02

SIMEC

MEMBER OF GFG ALLIANCE

Tahmoor Coal Pty Ltd

RISK ASSESSMENT REPORT - INFRASTRUCTURE

Tahmoor North – Western Domain
Longwalls West 1 and West 2

Date Held: 26 March 2019

April 2019

simecgfg.com

This page has been left blank intentionally.

Document Control

DOCUMENT TITLE:	Tahmoor North – Western Domain LW W1-W2 – Infrastructure Risk Assessment
PUBLICATION DATE:	April 2019
DOCUMENT STATUS:	Final (Version 1)
PREPARED BY:	April Hudson Approvals Coordinator Tahmoor Coking Coal Operations – SIMEC Mining
APPROVED BY:	Ron Bush Environment and Community Manager Tahmoor Coking Coal Operations – SIMEC Mining

simecgfg.com

This page has been left blank intentionally.

Table of Contents

List of Figures

List of Tables

1 Introduction

1.1 Background

Tahmoor Coal is located approximately 80 kilometres south-west of Sydney in the township of Tahmoor NSW. It is managed and operated by SIMEC Mining. Tahmoor Coal has previously mined 31 longwalls to the north and west of the mine's current pit top location. It is currently mining Longwall 32, in accordance with current Development Consent (DA 67/98) and Subsidence Management Plan Approval for the extraction of Longwall 32.

Tahmoor Coal proposes to extend underground coal mining to the north-west of the Main Southern Railway, which will include Longwalls West 1 to West 4 (**LW W1-W4**) at Picton (refer to **Figure 1-1**). Mining of Longwalls West 1 and West 2 (**LW W1-W2**) is expected to commence in November 2019, and first workings of development headings for LW W1 have commenced.

Under Condition 13H of the Development Consent (DA 67/980, as modified, an Extraction Plan is required for all second workings from LW W1 and subsequent longwalls. The first Extraction Plan to be prepared will cover LW W1-W1, which are located in the Tahmoor North Lease area. The Extraction Plans will be required to be approved by the NSW Department of Planning and Environment (**DPE**), and relevant Infrastructure Management Plans are required to be approved by the relevant infrastructure owners.

The Extraction Plan shall address the Study Area for LW W1-W2, which is comprised of both the predicted 20 mm Total Subsidence Contour and the 35^{o} Angle of Draw Line (refer to **Figure 1-1**).

The Extraction Plan will provide detailed information on how the risks associated with mining under the Study Area will be managed by Tahmoor Coal during and following the extraction of LW W1-W2.

A Risk Assessment Workshop was held at the Administration Building at the Tahmoor Coking Coal Operations (**TCCO**) site on 26 March 2019 to determine the major infrastructure risks associated with LW W1-W2 that may impact on achieving timely approval for the commencement of LW W1-W2 extraction, as well as the completion of extraction of LW W1-W2.

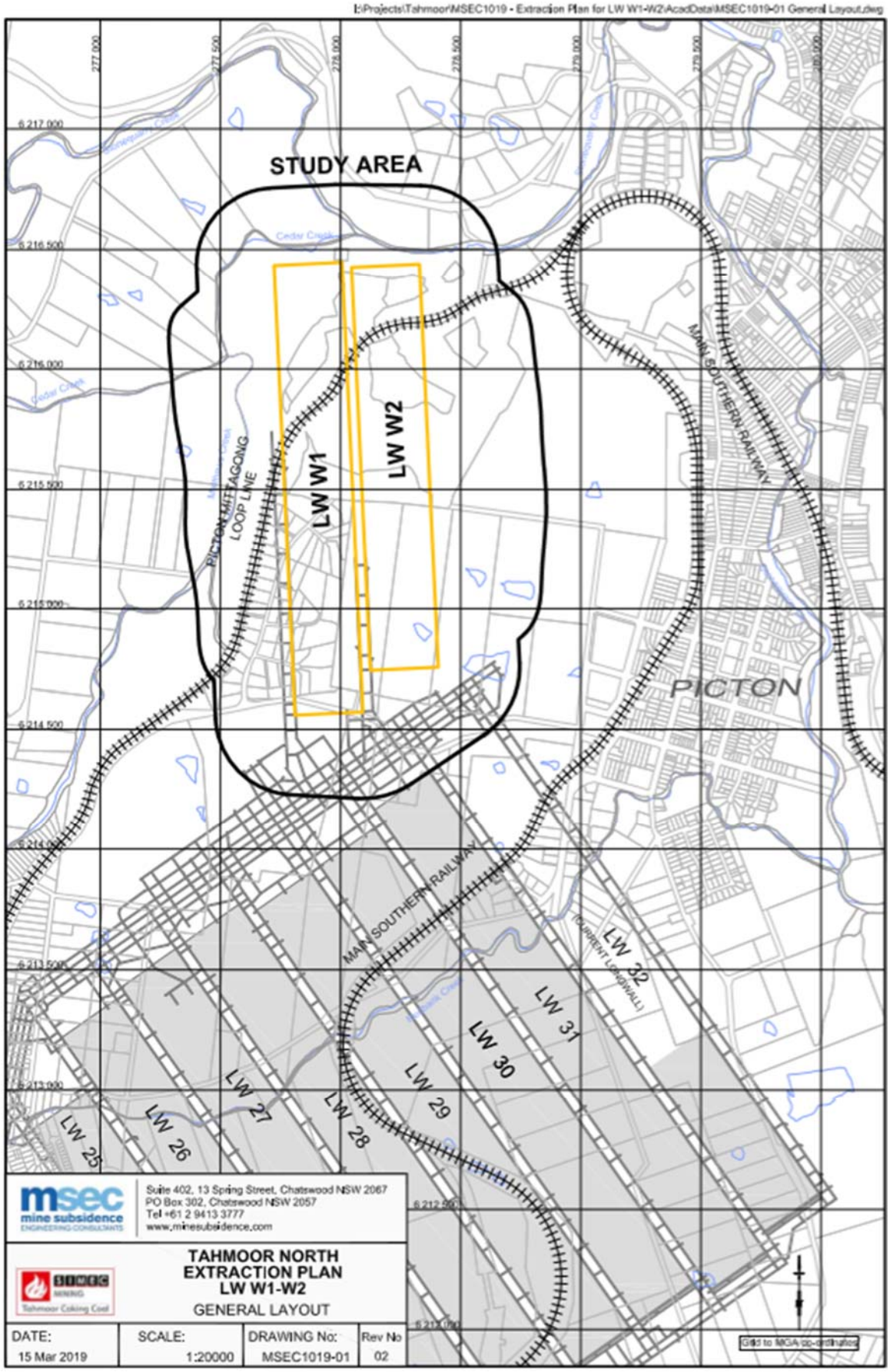


Figure 1-1 Study Area for LW W1-W2

1.2 Methodology

This risk assessment was completed using the Workplace Risk Assessment and Control methodology (**WRAC**).

It was compiled by a team of specialist personnel including:

- Compliance Officer and Risk Assessment Facilitator, Tahmoor Coal: Diana Harris;
- Environment and Community Manager, Tahmoor Coal: Ron Bush;
- Approvals Coordinator, Tahmoor Coal: April Hudson;
- Subsidence Engineer, MSEC: Daryl Kay;
- Structural Engineer, JMA Solutions: John Matheson; and
- Building Inspector, Building Inspection Services: Adam Walker.

The 12 step Risk Management process which forms part of the Tahmoor Coking Coal Operations Risk Management Standard has been adhered to in this risk assessment.

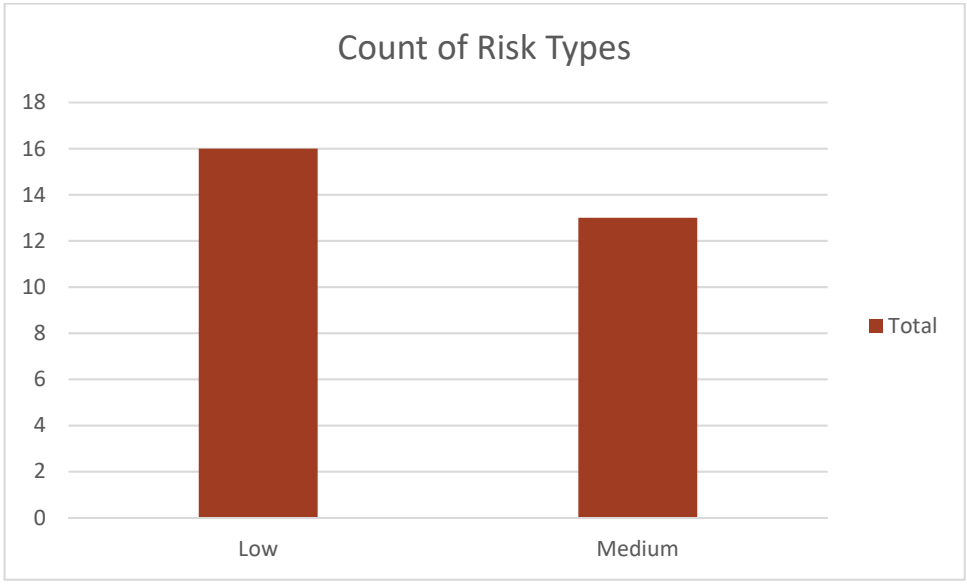
The risk matrix has been used to prioritise risk treatments.

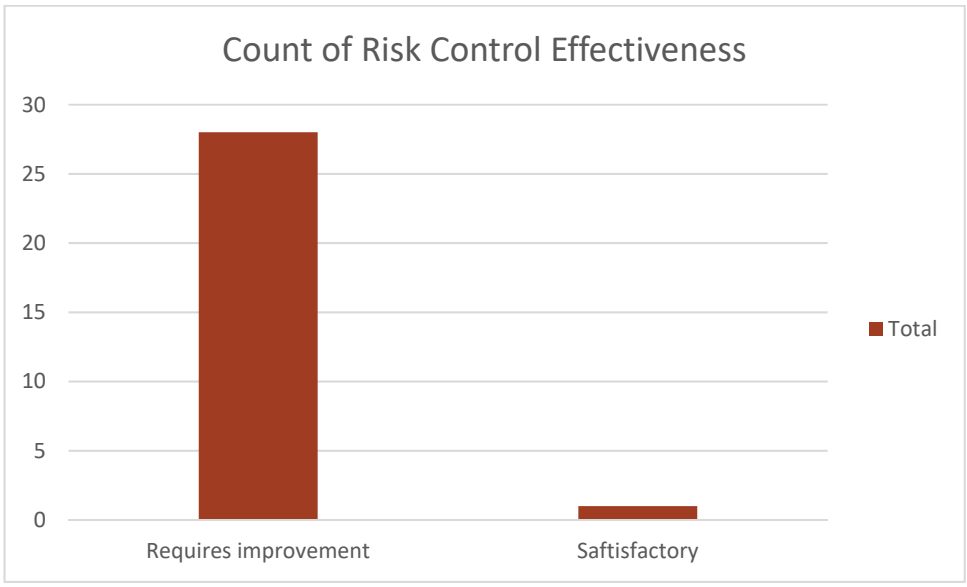
Prior to this risk assessment any previous risk assessments, safety alerts and High Potential Risk incidents have been sourced and put forward for consideration within the risk assessment workshop.

1.3 Outcome

This risk assessment identified a total of 29 risks / hazards (refer to **Figure 1-2**), which included:

- 13 medium risks and 16 low risks;
- One risk that was satisfactory and did not require any further risk control, and 28 risks that required further improvement;
- Risk consequences included:
    - Two risks with environmental impact consequences;
    - Seven risks with health and safety consequences; and
    - 20 risks with property damage consequences.





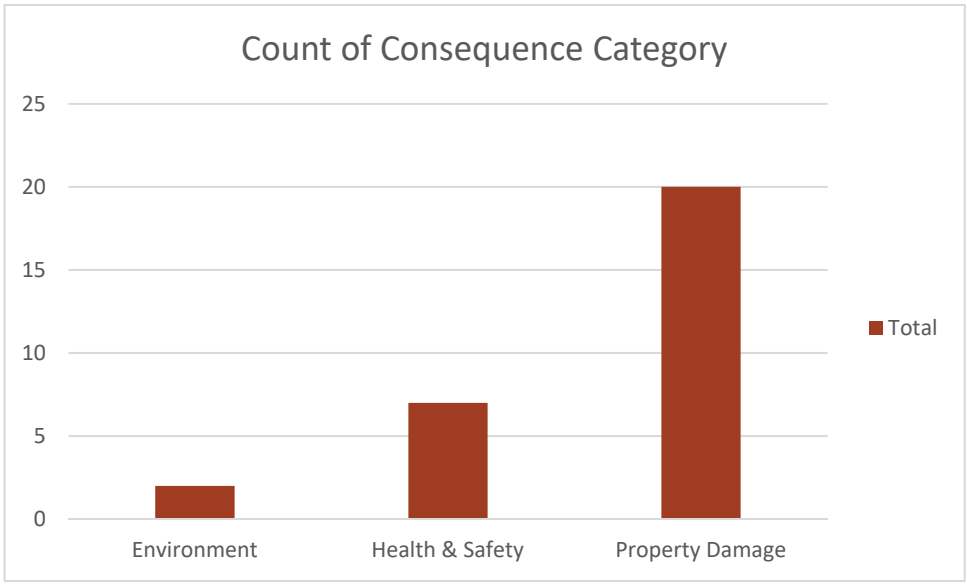


Figure 1-2 Graphs of Risk Type, Risk Control Effectiveness and Consequence Category

1.4 Further Actions

Further actions as identified in the Risk Assessment are identified in **Table 1-1**.

Table 1-1 Table of Further Actions

Treatment plans/tasks	Task Owner	Due Date
Develop Endeavour Energy Management Plan including TARP	April Hudson	14-Nov-2019
Endeavour Energy to complete Critical Poles Audit	April Hudson	14-Nov-2019
SMEC to complete survey of critical poles	April Hudson	14-Nov-2019
Building Inspection Services to complete baseline tilt measurement of poles	April Hudson	14-Nov-2019
Develop Sydney Water Potable Water Management Plan including TARP	April Hudson	14-Nov-2019
Develop Stonequarry Creek Estate Water Management Plan including TARP	April Hudson	14-Nov-2019
Develop Jemena Management Plan including TARP and contact details for Jemena	April Hudson	14-Nov-2019
Complete baseline gas detection survey (Macarthur Gas)	April Hudson	14-Nov-2019
Develop Telecommunications Management Plan including TARP	April Hudson	14-Nov-2019
Develop Wollondilly Shire Council Management Plan including TARP	April Hudson	14-Nov-2019
Develop traffic control plan for emergency repairs	April Hudson	14-Nov-2019
Develop Spatial Services Management Plan including TARP	April Hudson	14-Nov-2019
Notify Spatial Services via POSI application of predicted subsidence movements of the permanent survey control marks	April Hudson	14-Nov-2019
Ongoing monitoring and review of far field monitoring network, including GNSS network	April Hudson	14-Nov-2019
Develop Built Structures Management Plan including TARP for emergency evacuation procedures	April Hudson	14-Nov-2019
Prepare QVMH Management Plan including TARP	April Hudson	14-Nov-2019
Consultation plan to be developed	Samantha Beresford	14-Nov-2019
Prepare Mill Hill Management Plan including TARP	April Hudson	14-Nov-2019

2 Objective

The purpose of the Risk Assessment was to:

- Ensure the required infrastructure management plans for the proposed longwalls are approved and in place in a timely manner to manage infrastructure impacts during mining;
- Ensure the safe and serviceable operation of all surface infrastructure and structures in the Study Area;
- Ensure that the health and safety of people who may be present in the Study Area are not put at risk due to mine subsidence; and
- Assist in the establishment of procedures to measure, monitor, control, mitigate and repair infrastructure in the Study Area.

The Risk Assessment will also be used to:

- Develop, review and improve the treatment plans / tasks identified as a result of the identified risks;
- Provide a basis to determine whether the identified risk management measures are sufficient to address the identified risks;
- Meet the statutory requirements of legislation and regulation that relate to impacts to infrastructure; and
- Identify those processes requiring a more detailed level of risk assessment due to the Potential Maximum Consequence (**PMC**) level of risk.

3 Context

3.1 Scope

The risk assessment considered the areas below:

- Management of infrastructure owned by Endeavour Energy (electrical), Sydney Water (potable water only), Stonequarry Creek Estate Sewerage Plant (sewer), Jemena (gas), Telstra (telecommunications), NBN (telecommunications), Wollondilly Shire Council (roads, culverts and bridges), Spatial Services (survey control marks);
- Impacts to rural properties and structures such as built structures, pools, septic tanks, and farm dams; and
- Historical heritage buildings including Queen Victoria Memorial Home and Mill Hill.

3.2 Internal Context

This risk assessment was conducted for the Environment and Community Department of Tahmoor Coal to help identify the risks to infrastructure associated with LW W1-W2.

The risk assessment was conducted in accordance with the Risk Management Standard, utilising a cross-section of site personnel, relevant civil works experts, and an internal facilitator.

3.3 External Context

The risk assessment process is completed to satisfy Tahmoor Coking Coals requirements in relation to WHS and in compliance to Mining regulations and conditions and is completed in consultation with key stakeholders.

Key Stakeholders include:

- Tahmoor Coking Coal management;
- NSW Department of Planning and Environment (Planning, Resources and Geoscience);
- Resources Regulator (Subsidence, Environment);
- NSW Office of Environment and Heritage;
- Subsidence Advisory NSW;
- NSW Environment Protection Authority;
- NSW Department of Primary Industries (Agriculture);
- Dam Safety Committee;
- Crown Lands Division;
- NSW Roads and Maritime Services;
- WaterNSW;
- NSW State Emergency Services;
- Wollondilly Shire Council;
- Other utility providers including Endeavour Energy (electrical), Sydney Water (potable water only), Stonequarry Creek Estate Sewerage Plant (sewer), Jemena (gas), Telstra (telecommunications), NBN (telecommunications), Wollondilly Shire Council (roads, culverts and bridges), Spatial Service (survey control marks);
- Heritage stakeholders; and
- Landowners.

The external context for this Risk Management Process included consideration of:

- NSW Department of Planning and Environment as the approver of the Extraction Plan;
- NSW *Work Health and Safety (Mines and Petroleum Sites) Regulations 2014*;
- AS/NZS ISO 31000:2009 Risk Management - Principles and Guidelines; and
- Risk Management Handbook for the Mining Industry (MDG1010).

3.4 Exclusions / Assumptions

The participants in the risk assessment agreed to the following exclusions:

- Community effects will be managed as per Tahmoor Coal procedures and EMS (dust, lighting and noise);
- A detailed risk assessment for rail operational risks associated with LW W1-W2 will be conducted separately; and
- A broad risk assessment focusing on approvals, environmental and general infrastructure risks has been completed for LW W1-W2 on 12 February 2019 (CMO ID 201902202). Consideration of infrastructure risks addressed in this previously completed risk assessment were excluded. These considerations included:
    - Infrastructure Owner do not approve Infrastructure Management Plan;
    - Failure to implement Infrastructure Management Plan actions;
    - Greater than predicted subsidence in Study Area;
    - Stress to landowner/business owner;
    - Formation of Community Action Group; and
    - Land owners do not sign Land Access Agreements.

The participants in the risk assessment agreed to the following assumptions:

- All plant and equipment is fit for purpose;
- Personnel are competent and authorised;
- Inspection systems are in place and effective;
- People (employees, contractors) do present themselves fit for work;
- The appropriate PPE is utilised where required; and
- Observations and learnings from Longwall 32.

4 Issue / Reason for Review

The risk assessment was completed to identify significant implications relating to approval, environmental and infrastructure risks, and to identify the controls necessary to effectively manage these risks.

5 Risk Analysis Method

5.1 Risk Management Standard

All risk assessments are conducted in accordance with Tahmoor Coking Coal Operations Risk Management Standard.

The Tahmoor Coking Coal Operations Risk Management Standard is based on the ***ISO31000:2009 Risk Management – Principles and Guidelines International Standard.***

5.2 Risk Management Process

The risk management process is set out in the 12 Steps Risk Management Process (refer to **Figure 5-1**).

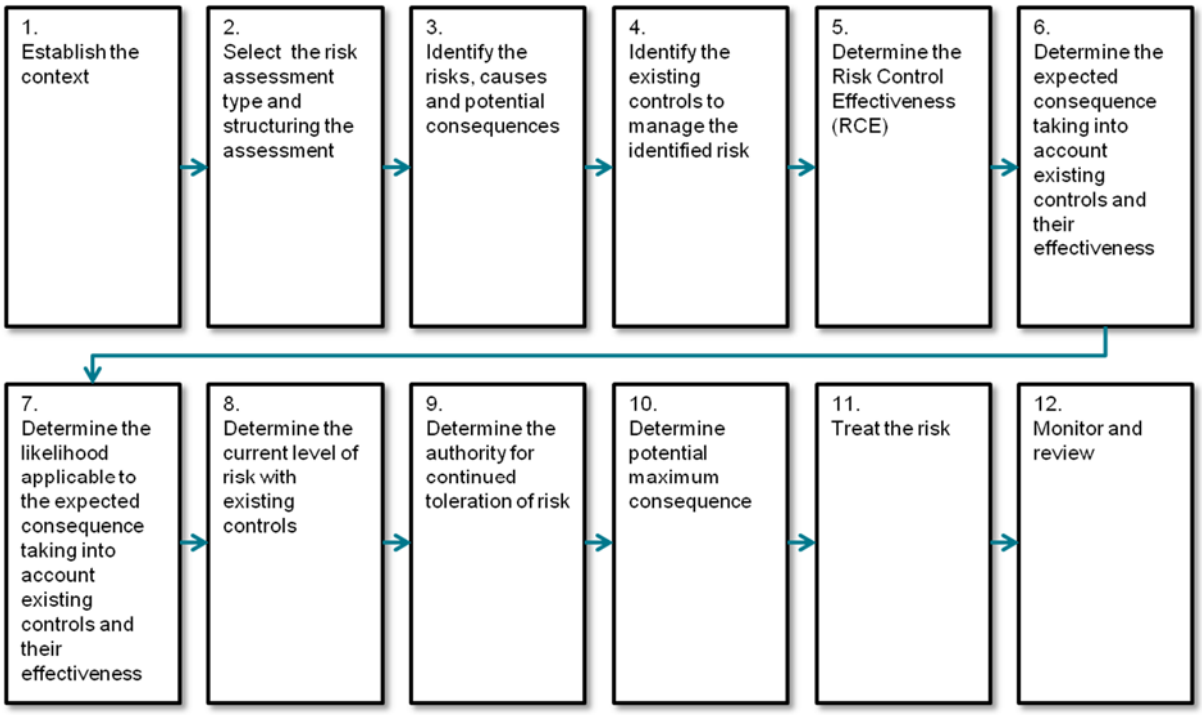


Figure 5-1 The 12 Steps Risk Management Process

5.3 Risk Matrix

The analyses of the risks identified in the workshop have undergone categorisation by the use of the risk matrix outlined within the Tahmoor Coking Coal Operations Risk Management Standard.

A copy of the risk matrix from Tahmoor Coking Coal Operations Risk Management Standard is provided in **Appendix A.**

5.4 Hierarchy of Controls

During the risk management process additional treatments and controls have been categorised using the hierarchy of controls table (refer to **Figure 5-2**).

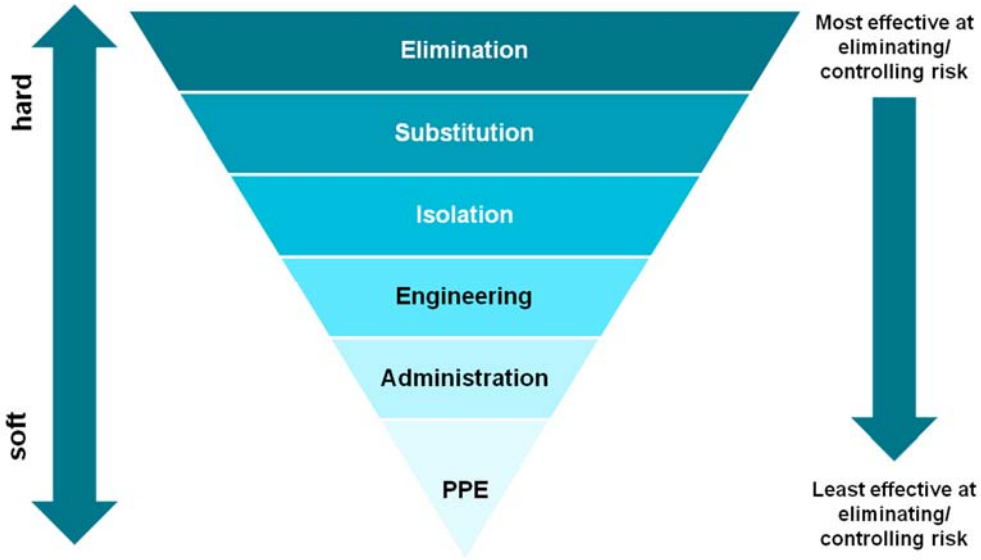


Figure 5-2 Hierarchy of Controls

5.5 Risk Assessment Team Members

Participating risk assessment team members are listed in **Table 5-1.**

Table 5-1 Participating Risk Assessment Team Members

Name	Position	Organisation	Qualifications	Related Experience
Ron Bush	Environment & Community Manager	SIMEC	BSc (Geol), GCEng, GD GW, MPlan, MProDev, MEng	30yrs
Diana Harris	Facilitator – Compliance Officer	SIMEC	Cert IV OH&S, G3 Risk Management	4yrs
April Hudson	Approvals Coordinator	SIMEC	B Env Sci (Hons)	9yrs
John Matheson	Structural Engineer	JMA Solutions	BE Struct (Hons)	20yrs
Daryl Kay	Subsidence Engineer	MSEC	BE, LLB	16yrs
Adam Walker	Building Inspector	Building Inspection Services	Cert IV Building	30yrs

A copy of the signed attendance sheet is attached in **Appendix B**.

6 Risk Assessment Register

The Risk Assessment Register is attached within **Appendix C**.

7 Treatment Plan

A treatment plan is provided in **Section 1.4.1**.

8 Risk Assessment Review Period

A review period for the risk assessment has not been identified.

Appendix A – Risk Matrix

RISK MATRIX

CONSEQUENCE [potential foreseeable outcome of the event]

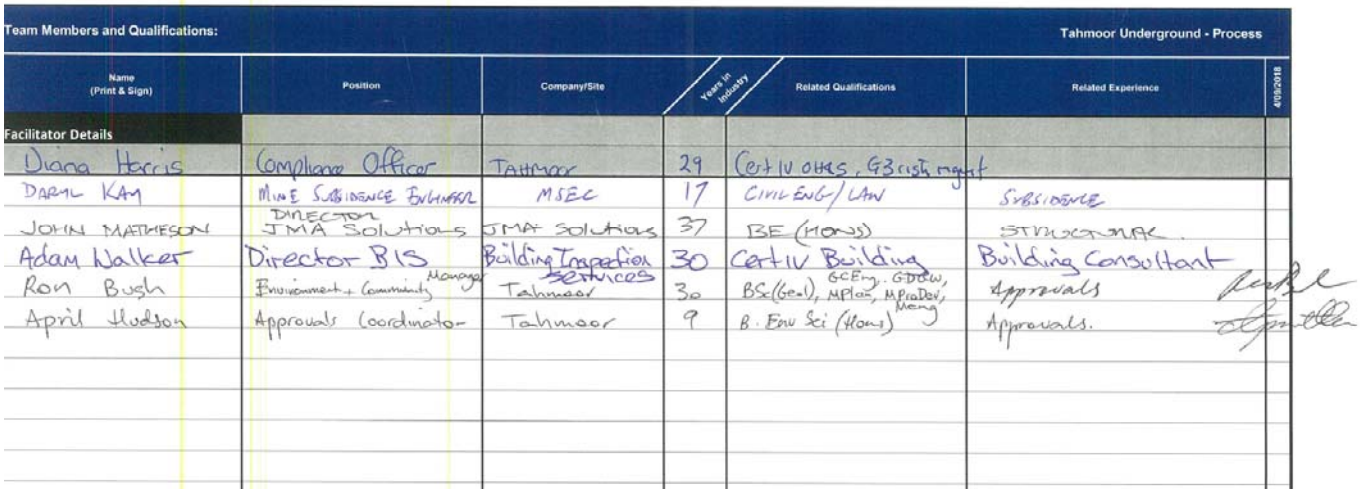
	Health & Safety	Environment	Financial Impact	Image & Reputation / Community	Legal & Compliance
5 Catastrophic	• Multiple fatalities (5 or more fatalities in a single incident) • Multiple cases (5 or more) of Permanent Damage Injuries or Diseases that result in permanent disabilities in a single incident	• Unconfined and widespread • Environmental damage or effect (permanent; >10 years) • Requires major remediation	• >$600M investment return • >$100M operating profit • >$20M property damage	• Loss of multiple major customers or large proportion of sales contracts • Sustained campaign by one or more international NGOs resulting in physical impact on the assets or loss of ability to operate • Security incident resulting in multiple fatalities or major equipment damage • Formal expression of significant dissatisfaction by government • Grievance from internal or external stakeholder alleging human rights violation resulting in multiple fatalities	• Major litigation / prosecution at SIMEC corporate level • Nationalisation / loss of licence to operate
4 Major	• Single incident resulting in: Less than 5 Fatalities • Permanent Damage Injury or Disease that results in a permanent disability- less than 5 cases in a single incident	• Long-term (2 to 10 years) impact • Requires significant remediation	• $60-600M investment return • $20-100M operating profit • $2-20M property damage	• Security/ stakeholder incident resulting in single loss of life or equipment damage • Grievance from internal or external stakeholder alleging human rights violation resulting in single fatality or serious injuries • Topic of broad societal concern and criticism • Negative media coverage at international level resulting in a Corporate statement within 24 hours • Investigation from government and/ or international (or high-profile) NGOs • Complaints from multiple "final" customers • Loss of major customer • Negative impact on share price	• Major litigation / prosecution at Department level
3 Moderate	• Lost Time Injury (LTI) • Lost Time Disease (LTD) • Permanent Disabling Injury (PDI) • Permanent Disabling Disease (PDD) • Single incident that results in multiple medical treatments	• Medium-term (<2 years) impact (typically within a year) • Requires moderate remediation	• $6-60M investment return • $2-20M operating profit • $200K-2M property damage	• Negative media coverage at national level over more than one day • Complaint from a "final" customer • Off-spec product • Local Stakeholder action resulting in national societal scrutiny	• Major litigation / prosecution at Operation level
2 Minor	• Medical Treatment Injury (MTI) • Medical Treatment Disease (MTD) • Restricted Work Injury (RWI) • Restricted Work Disease (RWD)	• Near source • Short-term impact (typically <week) • Requires minor remediation	• $600K-6M investment return • $200K-2M operating profit • $10-200K property damage	• Negative local/ regional media coverage • Complaint received from an internal or external stakeholder	• Regulation breaches resulting in fine or litigation
1 Negligible	• First Aid Injury (FAI) or illness (not considered disease or disorder)	• Near source and confined • No lasting environmental damage or effect (typically <day) • Requires minor or no remediation	• <$600K investment return • <$200K operating profit • <$10K property damage	• Negligible media interest	• Regulation breaches without fine or litigation

LIKELIHOOD [of the event occurring <u>with that consequence</u>]

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

Consequence Category	Consequence Type	Ownership	Action
Cat. 5	**Catastrophic Hazard**	Department / Functional / Operational / Asset Leadership	• Quantitative or semi-quantitative risk assessment required. • Capital expenditure will be justified to achieve ALARP ('As Low As Reasonably Practicable'). • Catastrophic Hazard Management Plans (CHMP) must be implemented where practical, Crisis Management Plans (CMP) tested and Catastrophic Event Recovery Plans (CERP) developed.
Cat. 4 (Health & Safety consequence)	**Fatal Hazard**	Department / Functional / Operational / Asset Leadership	• Fatal Hazard Protocols or appropriate management plans must be applied. • Capital expenditure will be justified to achieve ALARP.
Risk Rank	**Risk Rating**	**Ownership**	**Action**
17 to 25	**High Risk**	Department / Functional / Operational / Asset Leadership	• Install additional HARD and SOFT controls to achieve ALARP. • Capital expenditure will be justified to achieve ALARP.
7 to 16	**Medium Risk**	Operational / Asset Leadership	• install additional HARD and SOFT controls if necessary to achieve ALARP. • Capital expenditure may be justified.
1 to 6	**Low Risk**	Operational / Asset Leadership	• Install additional controls if necessary to achieve ALARP. • Capital expenditure is not usually justified.

Appendix B – Risk Assessment Attendance Sheet



Team Members and Qualifications: Tahmoor Underground - Process

Name (Print & Sign)	Position	Company/Site	Years in Industry	Related Qualifications	Related Experience	4/05/2018
Facilitator Details						
Diana Harris	Compliance Officer	Tahmoor	29	Cert IV OHES, G3 risk mgmt		
DARYL KAM	MINE SUBSIDENCE ENGINEER	MSEC	17	CIVIL ENG/LAW	SUBSIDENCE	
JOHN MATHESON	DIRECTOR JMA Solutions	JMA Solutions	37	BE (Mons)	STRUCTURAL	
Adam Walker	Director BIS	Building Inspection Services	30	Cert IV Building	Building Consultant	
Ron Bush	Environment + Community Manager	Tahmoor	30	BSc(Geol), GCEng. GDCW, MPlan, MPraDev, Mang	Approvals	
April Hudson	Approvals Coordinator	Tahmoor	9	B. Env Sci (Hons)	Approvals.	

Appendix C – Risk Assessment Register