msec mine subsidence ENGINEERING CONSULTANTS

SIMEC

SIMEC Mining:

Tahmoor South Longwalls S1A to S6A

Management Plan for potential impacts to Sydney Water Potable Water Infrastructure

Sydney WATER

 | REPORT NUMBER: MSEC1193-04 | REVISION B

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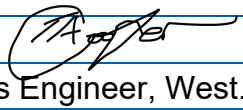
Signature:	
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Nov-22	MSEC1193-04	A	Draft for submission to Sydney Water
Dec-22	MSEC1193-04	B	Update following feedback from Sydney Water

References:-

AS/NZS ISO 31000:2009 Risk Management – Principles and guidelines

Kay, D.J., et al. (2017). *Experiences from Longwall Mining beneath Railway Cuttings.* Kay, D.J.; Pidgeon, A.; Bloor, C.; Christie, D.; Leventhal, A.; Matheson, J.; Robinson, G.; Rolles, J.; Pinkerton, R.; Barber, R.; Sheppard, I.; Talbert, D.; Brunero, C.; Patterson, D., Proceedings of the 10th Triennial Mine Subsidence Technological Society Conference, Pokolbin, Hunter Valley, NSW, 5-7 November 2017 (pp. 95-110).

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 (2022) *Tahmoor South- Longwalls S1A to S6A - Subsidence ground movement predictions and subsidence impact assessments for natural features and surface infrastructure in support of the Extraction Plan Application. (Report No. MSEC1192, Revision A, May 2022)*, prepared by Mine Subsidence Engineering Consultants.

Tahmoor Coal (2022) *Risk Assessment Report – Infrastructure. Tahmoor Underground – Sydney Water – Sewer and Potable Water*. Tahmoor Coal, October 2022.

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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***
MSEC1193-01-01	Monitoring plan	A
MSEC1193-04-01	Water Infrastructure	A
MSEC1193-03-02	MSR Rail Viaduct & Remembrance Drive Bridge over Bargo River	B
MSEC1193-03-03	Bargo River Road Bridges	B
MSEC1193-03-07	Remembrance Drive Embankment over Teatree Hollow over LW S3A (RE4)	B
MSEC1193-03-08	Remembrance Drive Cutting and Embankment north of Yarran Road over LWs S4A and S5A (RE3)	B
MSEC1193-03-09	Remembrance Drive Embankment south of Yarran Road over LW S5A (RE2)	B
MSEC1193-03-10	Remembrance Drive Embankment at Wellers Road intersection beyond LW S6A (RE1)	B
MSEC1193-03-11	Remembrance Drive Cutting north of Yarran Road over LW S4A and S5A (RC1)	B

1.1. Background

Tahmoor Coal Pty Ltd (Tahmoor Coal), owns and operates Tahmoor Mine, an existing underground coal mine located approximately 80 km southwest of Sydney in the Southern Coalfields of New South Wales (NSW). Tahmoor Coal is a wholly owned entity within the SIMEC Mining division of the GFG Alliance group. Tahmoor Coal has extracted 36 longwalls to the north and west of the mine's surface facilities.

Tahmoor Coal received development consent in April 2021 for the Tahmoor South Project, which is an extension of the current Tahmoor Mine underground coal mining within the Bulli seam towards the south of the existing Tahmoor Mine.

Tahmoor Coal has submitted an Extraction Plan for Longwalls S1A to S6A (LW S1A-S6A), which will be the first longwall panels to be extracted in the Tahmoor South domain. The proposed longwalls are located between Tahmoor's surface facilities to the north and the township of Bargo to the south. Infrastructure owned by Sydney Water is located within this area.

A summary of the dimensions of LW S1A-S6A are provided in Table 1.1.

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 S1A	1,711	283	-
LW S2A	1,768	285	38
LW S3A	1,808	285	36
LW S4A	1,860	285	36
LW S5A	1,949	285	36
LW S6A	1,999	285	36

This Management Plan provides detailed information about how the risks associated with mining beneath Sydney Water's potable water infrastructure will be managed by Tahmoor Coal and Sydney Water.

The Management Plan is a live document that can be amended at any stage of mining, to meet the changing needs of Tahmoor Coal and Sydney Water.

1.2. Sydney Water's Potable Water assets potentially affected by LW S1A-S6A

The locations of Sydney Water's potable water infrastructure in relation to LW S1A-S6A are shown in Drawing No. MSEC1193-04-01.

The potable water infrastructure includes a Cast Iron Cement Lined (CICL) 450 mm diameter watermain which follows the alignment of Remembrance Drive, before crossing beneath the Main Southern Railway and following Great Southern Road.

A 100 mm diameter CICL pipe runs along Caloola Road and a 200 mm diameter CICL and 100 mm diameter Ductile Iron Cement Lined (DICL) water pipelines are located along Yarran Road. A 100 mm DICL water pipeline runs along Remembrance Drive to the south of Yarran Road.

1.3. Consultation

1.3.1. Consultation with Sydney Water

Tahmoor Coal regularly consults with Sydney Water in relation to mine subsidence effects. This includes consultation during the development of Subsidence Management Plans for previous Longwalls 22 to 32, and LW W1-W4, and regular reporting of subsidence movements and impacts.

Details regarding consultation and engagement are outlined below:

- Risk assessment with Nad Balgunan and Trop Cooper (Sydney Water), Amanda Bateman, Amanda Fitzgerald, Diana Harris (Tahmoor Coal) and Daryl Kay (MSEC);
- Provision of the draft Subsidence Management Plan for LW S1A-S6A to Troy Cooper (Sydney Water) in November 2022.

Tahmoor Coal will continue to consult regularly with Sydney Water during the extraction of LW S1A-S6A in relation to mine subsidence effects.

1.3.2. Consultation with Government Agencies & Key Infrastructure Stakeholders

Government agencies including the NSW Department of Planning & Environment, Resources Regulator, Mine Safety Operations, Subsidence Advisory NSW and key infrastructure stakeholders including Wollondilly Shire Council, Endeavour Energy, Telstra and Jemena have also been consulted as part of the Extraction Plan approval process.

1.4. Limitations

This Management Plan is based on the predictions of the effects of mining on surface infrastructure as provided in Report No. MSEC1192 by Mine Subsidence Engineering Consultants (MSEC, 2022). Predictions are based on the planned configuration of LW S1A-S6A at Tahmoor South (as shown in Drawing No. MSEC1193-04-01), along with available geological information and data from numerous subsidence studies for longwalls previously mined in the area.

Infrastructure considered in this Plan has been identified from site visits and aerial photographs and from discussions between Tahmoor Coal and Sydney Water representatives.

The impacts of mining on surface and sub-surface features have been assessed in detail. However, it is recognised 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 MSEC1192 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 will limit the impacts by establishing appropriate procedures that can be followed should evidence of increased impacts emerge.

1.5. Objectives

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

The objectives of the Management Plan have been developed to:

- Ensure the safe and serviceable operation of all surface infrastructure. Public and workplace safety is paramount. Ensure that the health and safety of people who may be present on public property 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 condition of infrastructure during mining;
- Initiate action to mitigate or remedy potential significant impacts that are expected to occur on the surface;
- Provide a plan of action in the event that the impacts of mine subsidence are greater than those that are predicted;
- Establish a clearly defined decision-making process to ensure timely implementation of risk control measures for high consequence but low likelihood mine subsidence induced hazards that involve potential serious injury or illness to a person or persons that may require emergency evacuation, entry or access restriction or suspension of work activities;
- Provide a forum to report, discuss and record impacts to the surface. This will involve Tahmoor Coal, Sydney Water, relevant government agencies as required, and consultants as required; and
- Establish lines of communication and emergency contacts.

1.6. Scope

The Management Plan is to be used to protect and monitor the condition of the Sydney Water infrastructure identified to be at risk due to mine subsidence and to ensure that the health and safety of people who may be present on public property or Sydney Water property are not put at risk due to mine subsidence.

The major items at risk are:

- Water pipelines

The pipelines are shown in Drawing No. MSEC1193-04-01.

The Management Plan only covers the potable water infrastructure that is located within the limit of subsidence, which defines the extent of land that may be affected by mine subsidence as a result of mining LW S1A-S6A only. The management plan does not include other potable water infrastructure owned by Sydney Water which lies outside the extent of this area.

Tahmoor Coal is also managing potential impacts on features that may be sensitive to mining-induced differential far field movements, such as the Main Southern Railway Viaduct over the Bargo River and the Bargo River Road Bridge over a tributary to the Bargo River. Sydney Water potable water pipelines are buried in the creek bed near these bridges and this Management Plan includes measures to manage the pipeline crossings that are located near these bridges.

This Management Plan does not include Sydney Water sewer infrastructure, which is included in a separate management plan.

1.7. Proposed mining schedule

It is planned that LW S1A-S6A will extract coal working south from the northern end. This Management Plan covers longwall mining until completion of mining in LW S6A and for sufficient time thereafter to allow for completion of subsidence effects. The current schedule of mining is shown in Table 1.2.

Table 1.2 Schedule of mining

Longwall	Start Date	Completion Date
LW S1A	October 2022	April 2023
LW S2A	May 2023	January 2024
LW S3A	February 2024	September 2024
LW S4A	October 2024	June 2025
LW S5A	July 2025	February 2026
LW S6A	March 2026	November 2026

Please note the above schedule is subject to change due to unforeseen impacts on mining progress. Tahmoor Coal will keep Sydney Water informed of changes. LW S1A commenced extraction on 18 October 2022.

1.8. Definition of Active Subsidence Zone

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

This is termed the “active subsidence zone” for the purposes of this 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 metres in front and 450 metres behind the active longwall face, as shown by Fig. 1.1.

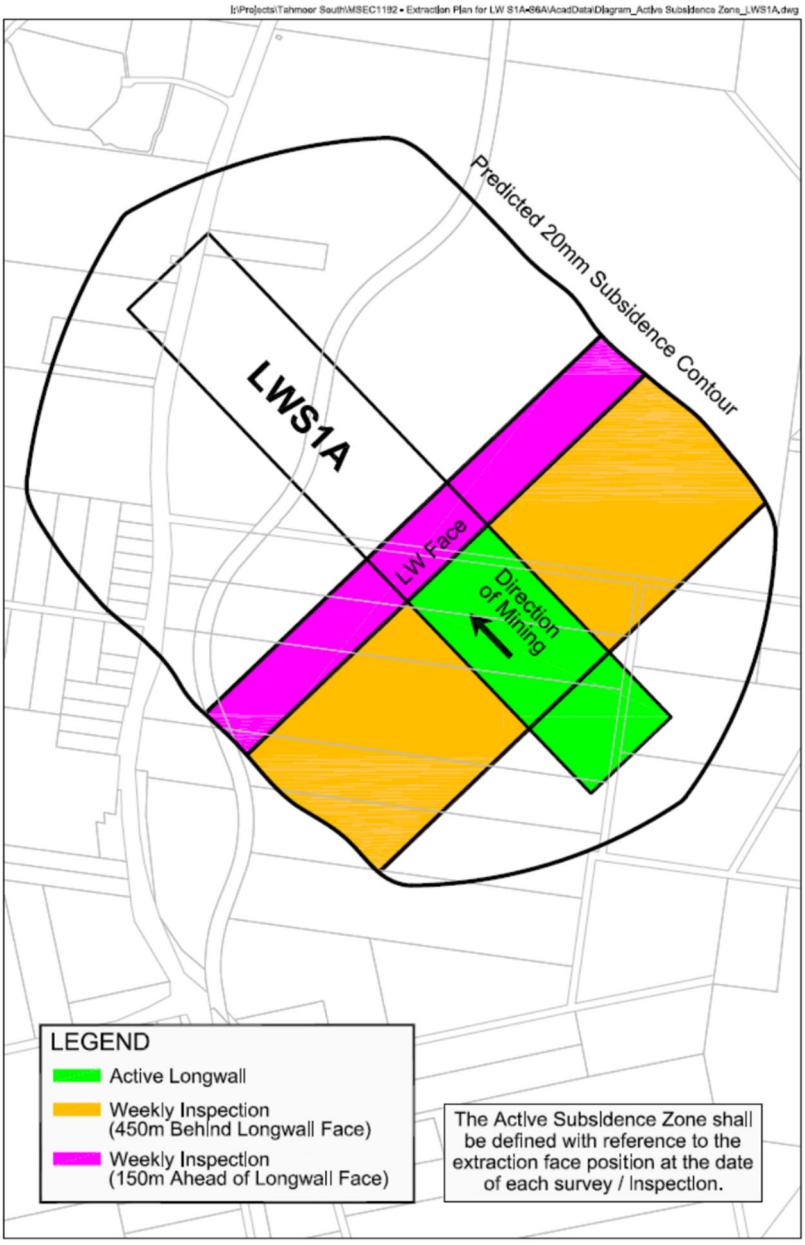

Fig. 1.1 Diagrammatic Representation of Active Subsidence Zone

1.9. Compensation

The *Coal Mine Subsidence Compensation Act 2017* (MSC Act) is administered by Subsidence Advisory NSW (Mine Subsidence Board).

Currently, under the *Coal Mine Subsidence Compensation Act 2017*, any claim for mine subsidence damage needs to be lodged with Subsidence Advisory NSW. Subsidence Advisory NSW staff will arrange for the damage to be assessed by an independent specialist assessor. If the damage is attributable to mine subsidence, a scope will be prepared and compensation will be determined. For further details please refer to *Guidelines – Process for Claiming Mine Subsidence Compensation* at www.subsidenceadvisory.nsw.gov.au.

2.1. NSW Work Health & 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 hazard;
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 S1A-S6A in accordance with the WHS laws.

2.2. General

The method of assessing potential mine subsidence impacts in the Management Plan is consistent with the Australian/New Zealand Standard for Risk Management (AS/NZS ISO 31000:2009). 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:-

2.2.1. 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.' The consequences of a hazard are rated from negligible to catastrophic.

2.2.2. Likelihood

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

2.2.3. Hazard

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

2.2.4. 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.

3.1. Maximum predicted conventional subsidence parameters

Predicted mining-induced conventional subsidence movements were provided in Report No. MSEC1192, which was prepared in support of Tahmoor Coal's Extraction Plan for LW S1A-S6A.

A summary of the maximum predicted values of incremental conventional subsidence, tilt and curvature, due to the extraction of each of the proposed longwalls, is provided in Table 3.1. The predicted ground strains are discussed in Section 3.4. The predicted tilts provided in this table are the maxima after the completion of each of the proposed longwalls. The predicted curvatures are the maxima at any time during or after the extraction of each of the proposed longwalls.

Table 3.1 Maximum predicted incremental conventional subsidence, tilt and curvature resulting from the extraction of each of the proposed longwalls

Longwall	Maximum predicted incremental conventional subsidence (mm)	Maximum predicted incremental conventional tilt (mm/m)	Maximum predicted incremental conventional hogging curvature (km^{-1})	Maximum predicted incremental conventional sagging curvature (km^{-1})
LW S1A	800	7.0	0.08	0.22
LW S2A	950	7.5	0.08	0.22
LW S3A	950	8.0	0.09	0.22
LW S4A	950	8.0	0.09	0.22
LW S5A	950	8.0	0.10	0.22
LW S6A	975	8.3	0.09	0.23

A summary of the maximum predicted values of total conventional subsidence, tilt and curvature, after the extraction of each of the proposed amended longwall series, is provided in Table 3.2.

Table 3.2 Maximum predicted total conventional subsidence, tilt and curvature resulting from the extraction of each of the proposed longwalls

Longwalls	Maximum predicted total conventional subsidence (mm)	Maximum predicted total conventional tilt (mm/m)	Maximum predicted total conventional hogging curvature (km^{-1})	Maximum predicted total conventional sagging curvature (km^{-1})
LW S1A	800	7.0	0.08	0.22
LW S2A	1,000	8.0	0.10	0.22
LW S3A	1,200	8.0	0.10	0.22
LW S4A	1,250	8.5	0.13	0.22
LW S5A	1,350	9.0	0.14	0.22
LW S6A	1,350	9.5	0.14	0.24

The maximum predicted total subsidence, after the completion of the proposed longwalls, is 1,350 mm which represents around 61 % of the extraction height. The maximum predicted total conventional tilt is 9.5 mm/m (i.e. 0.95 %), which represents a change in grade of 1 in 95. The maximum predicted total conventional curvatures are 0.14 km^{-1} hogging and 0.24 km^{-1} sagging, which represent minimum radii of curvature of 7.1 kilometres and 4.2 kilometres, respectively.

The values provided in the above table are the maximum predicted conventional subsidence parameters which occur within the Study Area.

3.2. Comparison of measured and predicted subsidence at Tahmoor Mine

Predictions using MSEC's Incremental Profile Method have been continually tested and refined during the mining of previous Longwalls 22 to 32 and Longwalls West 1 to West 3 (LW W1-W3), as described in Report No. MSEC1192.

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.

Longwalls 14B to 19 were mined between 1995 and 2002 and are located adjacent to LW S1A-S6A. A comparison between observed and predicted subsidence, tilt and curvature is shown along the 1000 Line in Fig. 3.1. While there is reasonable correlation, it is highlighted that, in some locations the observed subsidence, tilts and curvatures have exceeded prediction.

It is also difficult make meaningful comparisons between the profiles of raw observed curvature and predicted conventional curvature. The reason for this is that survey tolerance can be a large proportion of the measured curvatures and hence this can result in very irregular curvature profiles. When observed curvatures have been derived from smoothed subsidence profiles, a reasonable correlation between predicted and observed profiles can generally be found. Further details are provided in Report No. MSEC1192.

While reasonable correlations have generally been observed at Tahmoor Mine, substantially increased subsidence was observed over the predicted subsidence levels during the mining of LW 24A and then similar increased subsidence movements were also observed above the southern ends of LWs 25 to 27 and the commencing end of LW 32. This was a very unusual event for the Southern Coalfield and are linked to the presence of the Nepean Fault. Further details are provided in Report No. MSEC1192.

While the proposed LW S1A-S6A are not located near the Nepean Fault, the experiences are a reminder that increased subsidence movements can occur. Tahmoor Coal has extensive experience in successfully managing potential subsidence impacts on surface features, even when actual subsidence is substantially greater than the magnitudes that have been predicted above LW S1A-S6A.

This Management Plan, therefore, includes monitoring to measure the development of subsidence during the early stages of extraction to confirm that subsidence is developing within predictions. The Management Plan has been developed to manage potential impacts that could occur even if greater than predicted subsidence occurs. The plan includes regular reviews of observed subsidence movements to ensure that planned measures to manage potential subsidence impacts on Sydney Water infrastructure are adequate and effective.

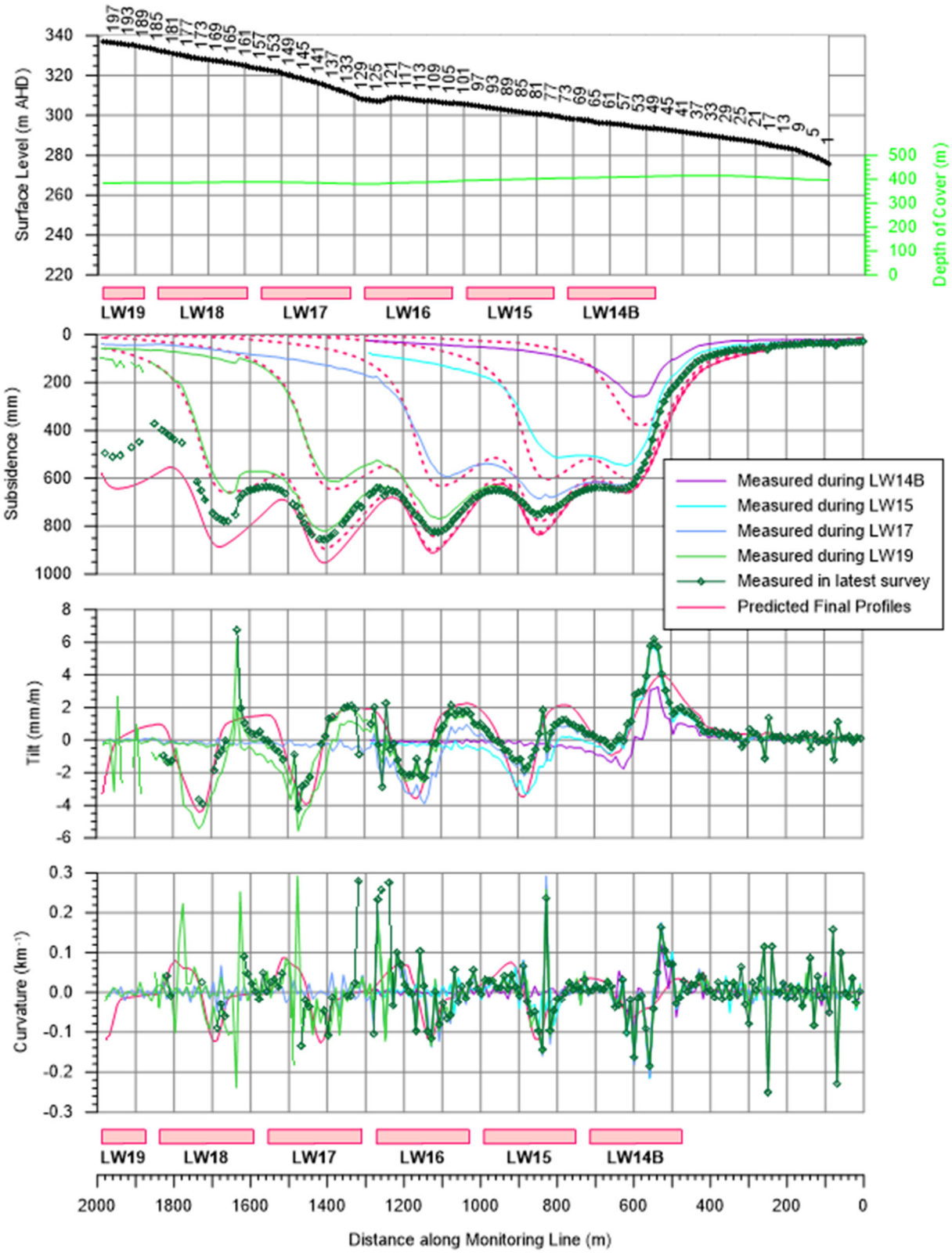

Fig. 3.1 Comparison between observed and predicted subsidence along 1000 Line across LWs 14B to 19 at Tahmoor Mine

3.3. Comparison of measured and predicted subsidence for single panels

Predictions using MSEC's Incremental Profile Method have been continually tested and refined during the mining of previous Longwalls 22 to 32 and LW W1-W3, as described in Report No. MSEC1192.

In this case, LW S1A will be the first longwall in a new series.

Observed subsidence above single panels is typically more variable than above subsequent longwall panels in a series. The variations are due to different strengths of the overburden strata above the panel, which is supported on all four sides of the longwall.

A review of observed subsidence for single panels at Tahmoor Mine has been conducted. A summary of observed maximum subsidence against predictions from the calibrated Incremental Profile Method is provided in Fig. 3.2.

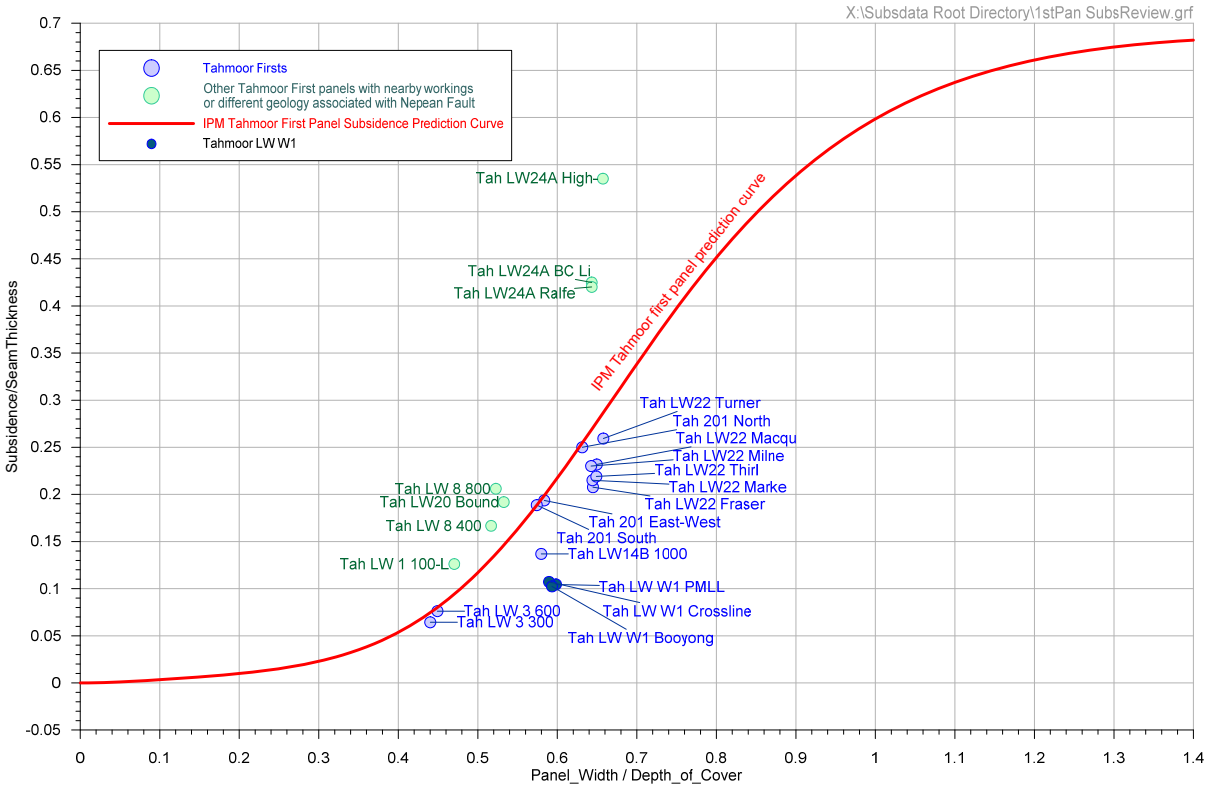

Fig. 3.2 Comparison between observed and predicted maximum subsidence for single panels at Tahmoor Mine

It can be seen from Fig. 3.2 that there has been a reasonable correlation between predicted and observed maximum subsidence for some single panels at Tahmoor Mine. This includes LW 14B, which is located adjacent to LW S1A. LW 1 was also adjacent to LW S1A but while it was the first longwall extracted at Tahmoor Mine, total extraction had occurred immediately adjacent to the longwall. LW 1 is, therefore, not an isolated, single panel and can be considered to be the second panel in a series.

Special circumstances also exist for other cases that are highlighted in green in Fig. 3.2 along with LW 1. LWs 8, 20 and 24A were also located adjacent to total extraction workings are not isolated, single panels. LWs 8 and 24A were also located near the Nepean Fault where increased subsidence movements have been observed.

This Management Plan, therefore, includes plans to measure the development of subsidence during the early stages of extraction of LW S1A to confirm that subsidence is developing within predictions. The Management Plan has been developed to manage potential impacts that could occur even if greater than predicted subsidence occurs. The plan includes regular reviews of observed subsidence movements to ensure that planned measures to manage potential subsidence impacts on Sydney Water infrastructure are adequate and effective.

3.4. 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 ground 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, in cases 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 predicted maximum curvatures and the predicted maximum 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, rather than providing a single predicted conventional strain.

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

3.4.1. Analysis of strains measured in survey bays

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.

Predictions of strain above goaf

A database of survey data has been analysed to extract the maximum tensile and compressive strains that have been measured at any time during the extraction of the previous longwalls at Tahmoor, Appin and West Cliff Collieries, 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, for monitoring lines at Tahmoor, Appin and West Cliff Collieries is provided in Fig. 3.3. Probability distribution functions, based on fitted *Generalised Pareto Distributions (*GPDs), have also been shown in this figure.

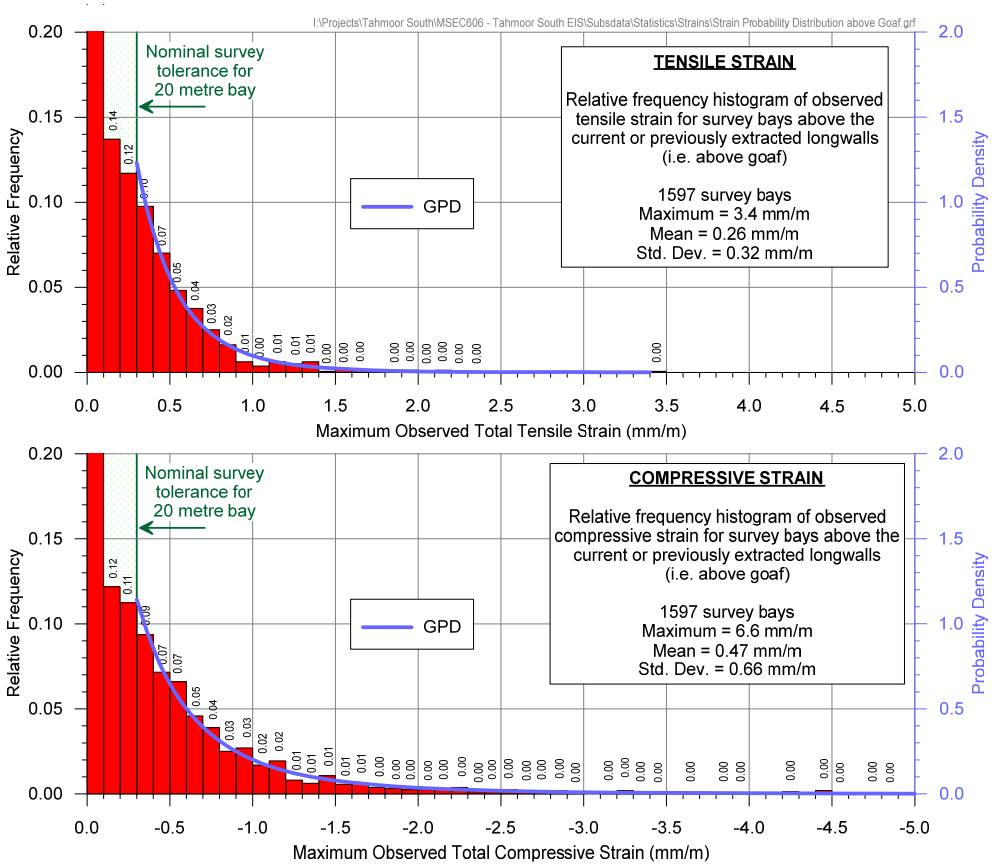

Fig. 3.3 Distributions of the maximum measured tensile and compressive strains for survey bays located above goaf at Tahmoor, Appin and West Cliff Collieries

The 95 % confidence levels for the maximum total strains that the individual survey bays *above goaf* experienced at any time during mining at Tahmoor, Appin and West Cliff Collieries were 0.9 mm/m tensile and 1.6 mm/m compressive. The strains for the proposed longwalls are predicted to be 20 % to 40 % greater than those previously observed at these collieries and, therefore, it is expected that 95 % of the strains measured *above goaf* would be less than 1.3 mm/m tensile and 2.2 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 at Tahmoor, Appin and West Cliff Collieries were 1.4 mm/m tensile and 3.1 mm/m compressive. Similarly, it is expected that 99 % of the strains measured *above goaf* for the proposed longwalls would be less than 2.0 mm/m tensile and 4.3 mm/m compressive.

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 the previous longwalls at Tahmoor, Appin and West Cliff Collieries, for survey bays that were located beyond the goaf edges of the mined panels and positioned on unmined areas of coal, i.e. outside panels but 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, for monitoring lines at Tahmoor, Appin and West Cliff Collieries is provided in Fig. 3.4. The probability distribution functions, based on the fitted GPDs, have also been shown in this figure.

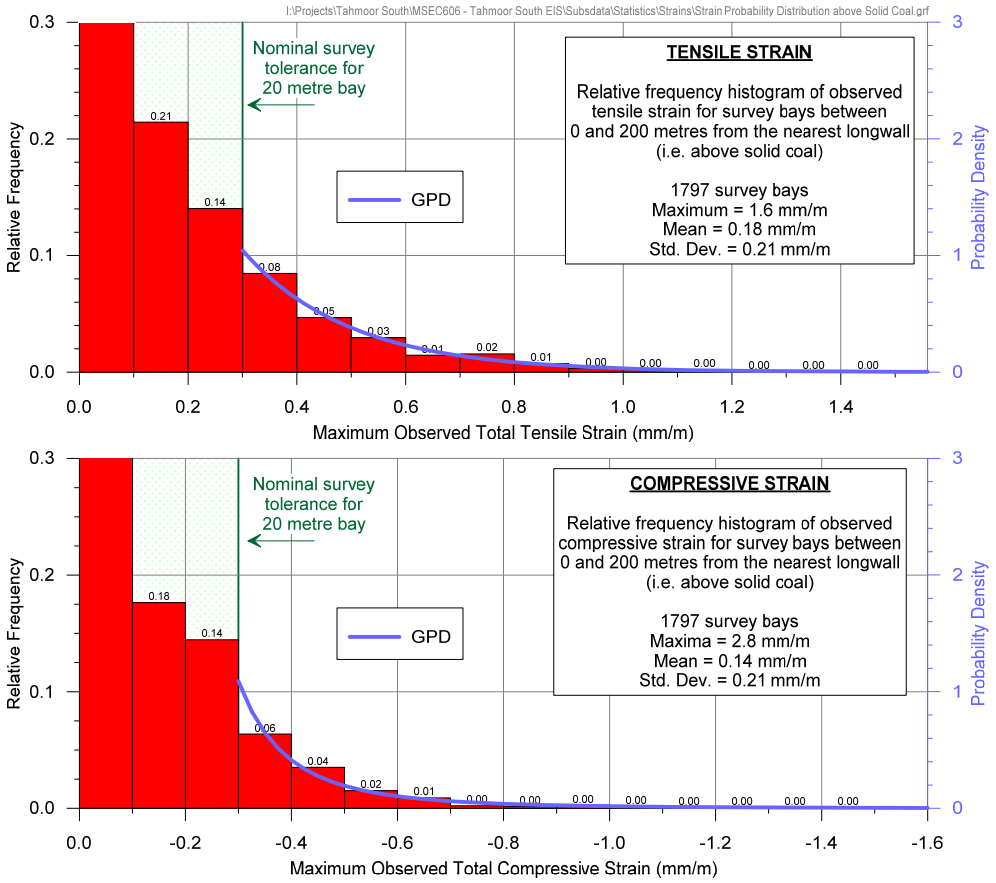

Fig. 3.4 Distributions of the maximum measured tensile and compressive strains for survey bays located above solid coal at Tahmoor, Appin and West Cliff Collieries

The 95 % confidence levels for the maximum total strains that the individual survey bays *above solid coal* experienced at any time during mining at Tahmoor, Appin and West Cliff Collieries were 0.6 mm/m tensile and 0.5 mm/m compressive. The strains for the proposed longwalls are predicted to be 20 % to 40 % greater than those previously observed at these collieries and, therefore, it is expected that 95 % of the strains measured *above solid coal* would be less than 1.0 mm/m tensile and compressive.

The 99 % confidence levels for the maximum total strains that the individual survey bays *above solid coal* experienced at any time during mining at Tahmoor, Appin and West Cliff Collieries were 0.9 mm/m tensile and compressive. Similarly, it is expected that 99 % of the strains measured *above solid coal* adjacent to the proposed longwalls would be less than 1.5 mm/m tensile and compressive.

3.4.2. Analysis of strains measured along whole monitoring lines

For linear features such as roads, cables and pipelines, it is more appropriate to assess the frequency of the maximum strains measured along whole monitoring lines, rather than for individual survey bays. That is, an analysis of the maximum strains measured anywhere along the monitoring lines, regardless of where the strain occurs.

A histogram of maximum observed total tensile and compressive strains measured anywhere along the monitoring lines, at any time during or after the extraction of the previous longwalls Tahmoor, Appin and West Cliff Collieries, is provided in Fig. 3.5.

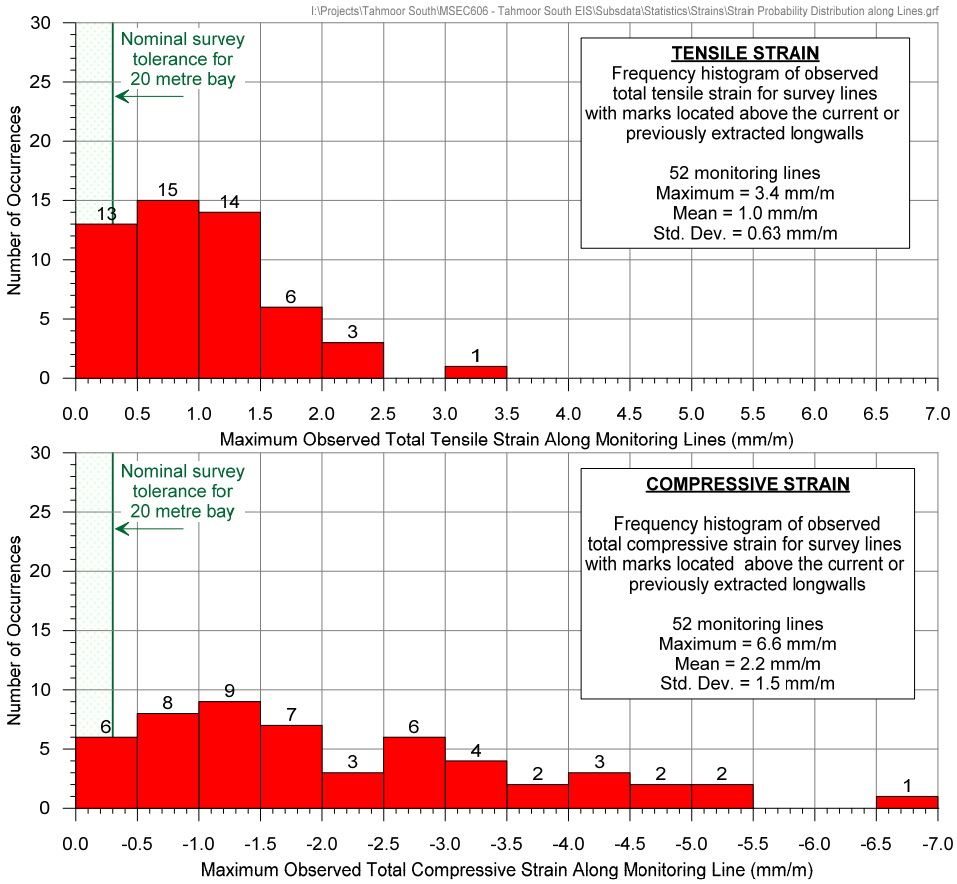

Fig. 3.5 Distributions of maximum measured tensile and compressive strains anywhere along monitoring lines at Tahmoor, Appin and West Cliff Collieries

It can be seen from the above figure, that 42 of the 52 monitoring lines (i.e. 92 % of the total) at Tahmoor, Appin and West Cliff Collieries had recorded maximum total tensile strains of 2.0 mm/m, or less. The strains for the proposed longwalls are predicted to be 20 % to 40 % greater than those previously observed at these collieries and, therefore, it is expected that 92 % of the monitoring lines above the proposed longwalls would experience maximum tensile strains of 3.0 mm/m, or less.

It can also be seen, that 45 of the 52 monitoring lines (i.e. 87 % of the total) at Tahmoor, Appin and West Cliff Collieries had recorded maximum total compressive strains of 4.0 mm/m, or less. The strains for the proposed longwalls are predicted to be 20 % to 40 % greater than those previously observed at these collieries and, therefore, it is expected that 87 % of the monitoring lines above the proposed longwalls would experience maximum compressive strains of 5.5 mm/m, or less.

3.5. Managing public safety

The primary risk associated with mining beneath potable water infrastructure 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. It 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.

In the case of this Subsidence Management Plan, the potential for impacts on public safety has been assessed on a case by case basis.

3.5.1. Subsidence Impact Management Process for Infrastructure

Tahmoor Coal has developed and acted in accordance with agreed subsidence management plans to manage potential impacts during the mining of Longwalls 22 to 32 and LW W1-W4 at Tahmoor North. The management strategy has been reviewed and updated based on experiences gained during the mining of these longwalls, and the strategy for LW S1A-S6A at Tahmoor South includes the following process:

1. Regular consultation with Sydney Water before, during and after mining;
2. Site-specific investigations; and
3. Surveys and inspections during mining within the active subsidence area:
   - Detailed visual inspections and vehicle-based inspections along the streets;
   - Ground surveys along streets; and
   - Specific ground surveys and visual inspections, where recommended by an engineer based on the inspections and assessments.

A flowchart illustrating the subsidence impact management process prior to, during and after Sydney Water infrastructure experiences mine subsidence movements is shown in Fig. 3.6.

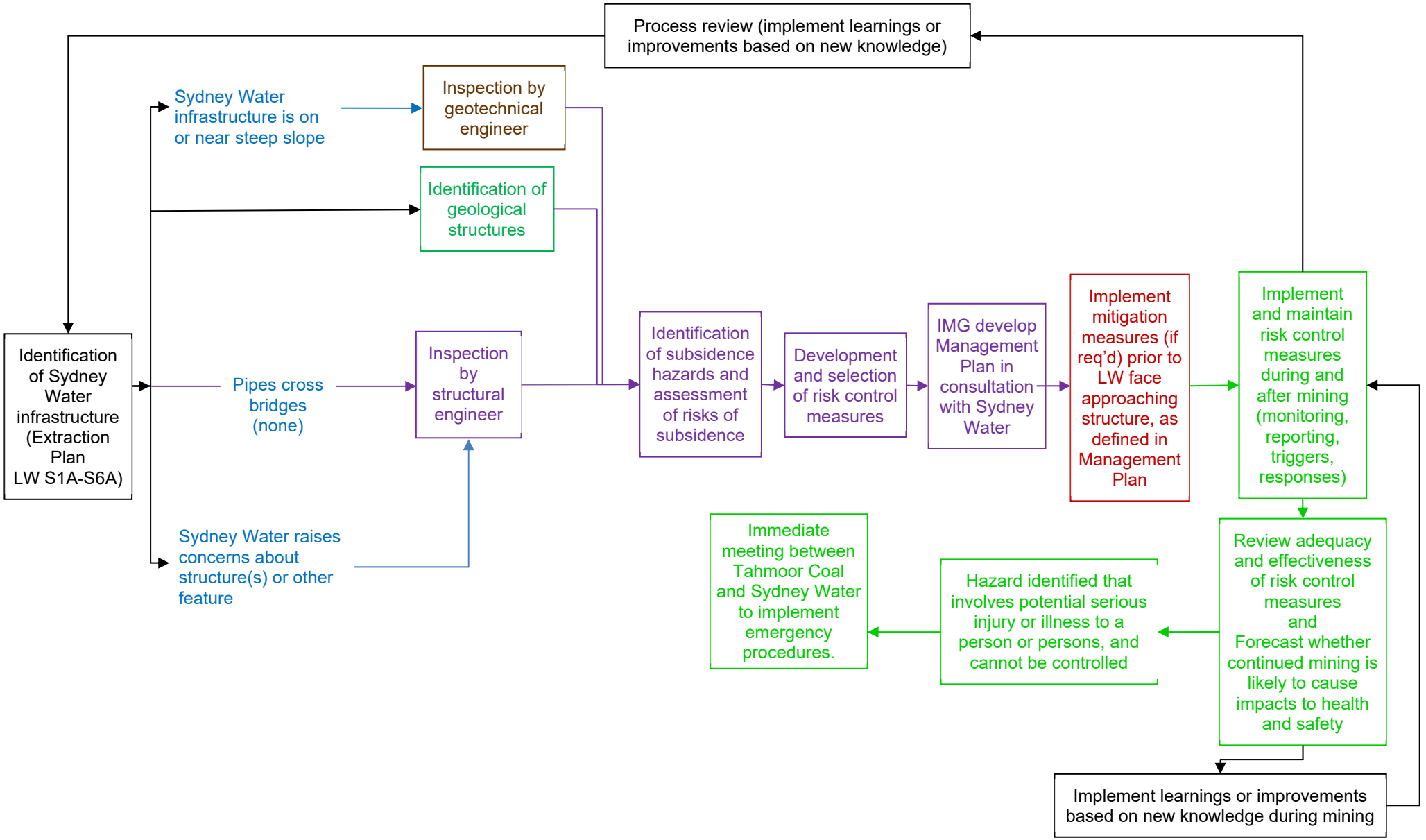

Fig. 3.6 Flowchart for Subsidence Impact Management Process

3.6. Summary of potential impacts

A summary of potential impacts on Sydney Water's Potable Water infrastructure is provided in Table 3.3. The summary is consistent with the risk assessment undertaken by Sydney Water and Tahmoor Coal (2022). The results of the risk assessment are included in the Appendix.

Table 3.3 Summary of Potential Mine Subsidence Impacts

Risk	Likelihood	Consequence	Level of Potential Impact
Leakage of local services within Study Area such as along Caloola Road and Yarran Road (i.e. not the 450mm dia water main)	UNLIKELY	MINOR	LOW
Leakage of 450 mm dia CICL water main within Study Area (in general)	UNLIKELY	MODERATE	MEDIUM
Leakage of 450 mm dia CICL water main at creek crossings within Study Area	LIKELY	MODERATE	HIGH*
Leakage of 450 mm dia CICL water main at crossings under Remembrance Drive and Main Southern Railway within Study Area	UNLIKELY	SEVERE	MEDIUM*
Leakage of buried 450 mm dia CICL water main beneath Bargo River bed near Railway Viaduct and buried water mains beneath tributary to Bargo River	RARE	SEVERE	MEDIUM

In the case of the two risks marked with an asterisk (*), it was agreed that the controls can be managed effectively within the implementation of additional, feasible measures. Additional investigations are required before the appropriate controls are assessed and selected.

Risk controls for the first creek crossing at the intersection of Remembrance Drive and Caloola Road will be selected prior to the influence of LW S2A. It is expected that the level of potential impact will be reduced from the currently assessed level of High.

Risk controls for the crossings under Remembrance Drive and the Main Southern Railway will be selected prior to the commencement of LW S4A. It is expected that the level of potential impact will be reduce from the currently assessed level of Medium.

In the case of the buried 450 mm water main beneath the Bargo River near the Railway Viaduct, the level of potential impact was assessed as Medium due to the length of time required to repair the leakage. It was agreed that the planned controls to manage the risk were effective and appropriate.

Additional information on each potential impact is provided below.

3.7. 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 in Chapter 3, which could give rise to risks to health and safety of people in the vicinity of potable water infrastructure.

Using the processes described in Section 3.5 of this Management Plan, mine subsidence hazards have been identified, investigated and analysed in a systematic manner by examining each aspect of the infrastructure, as described in Section 3.8 of this Management Plan. Each of the aspects below could potentially experience mine subsidence movements that give rise to risks to the health and safety of people:

- Water pipelines at creek crossings; and
- Water pipelines at crossings of Remembrance Drive and the Main Southern Railway.

The following mine subsidence hazards were identified that could give rise to risks to health and safety due to the extraction of LW S1A-S6A:

- Water main break.

The identification and risk assessment process took into account the location of infrastructure relative to LW S1A-S6A and the associated timing and duration of the subsidence event, as described in Section 1.8 of this Management Plan.

Whilst mine subsidence predictions and extensive past experiences from previous mining at Tahmoor 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 Sydney Water infrastructure, as discussed in Section 1.4 and Chapter 3 of this Management Plan. In this case, hidden creeks have been mapped that intersect water pipelines.

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 Sydney Water property in general. These are described in Chapter 4 of this Management Plan.

3.8. Potable water pipelines

There are a number of potable water pipelines that are located above and adjacent to LW S1A-S6A, as shown in Drawing No. MSEC1193-04-01:

- 450 mm diameter trunk mains

  Sydney Water's supply trunk main runs directly above and adjacent to LW S1A-S5A. The watermain follows the alignment of Remembrance Drive, before crossing beneath the Main Southern Railway and following Great Southern Road. The trunk feeds Sydney Water Reservoirs at Picton, Thirlmere, Buxton and Oakdale, all of which are located outside the Study Area. As shown in Drawing No. MSEC1193-04-01, the trunk main is generally constructed as CICL, with a short section of Steel Cement Lined (SCL) pipe beneath the creek crossing at Teatree Hollow, at the corner of Remembrance Drive and Caloola Road.

- 100 mm diameter CICL water mains

  As shown in Drawing No. MSEC1193-04-01, 100 mm diameter CICL water mains are located directly above and adjacent to LW S3A-S5A. The water mains follow the alignment of Caloola Road and the northern section of Great Southern Road.

- 100 mm diameter DICL water mains

  As shown in Drawing No. MSEC1193-04-01, 100 mm diameter DICL water mains are located directly above and adjacent to LW S5A-S6A. The water mains follow the alignment of Yarran Road and Remembrance Drive, south of the Yarran Road intersection.

- 200 mm diameter CICL water mains

  As shown in Drawing No. MSEC1193-04-01, a 200 mm diameter CICL water main is located west of LW S6A. The water main follows the alignment of Yarran Road. The water main is old and thought to have been constructed originally with plans to connect to the Bargo Weir.

- 150 mm diameter CICL water mains

  As shown in Drawing No. MSEC1193-04-01, 150 mm diameter CICL water mains are located to the southeast of LW S5A. The water mains connect to a property on Great Southern Road.

- 200 mm diameter DICL water mains

  As shown in Drawing No. MSEC1193-04-01, 200 mm diameter DICL water mains are located t the south of LW S6A. The water mains follow the alignment of Wellers Road.

A number of valves, hydrants and other fittings are located within the Study Area. The locations of stop valves are shown in Drawing No. MSEC1193-04-01, which can be used by Sydney Water to control water flows in the event that section of pipeline requires repair. Some of the valves have smaller bypass valves to allow the larger valves to be opened and closed more easily. One is is located approximately 320 metres south of Olive Lane near the finishing end of LW S1A.

Sydney Water advises that there have been no major watermain breaks along the section of 450 mm CICL above and adjacent to LW S1A-S6A in the last 25 years. There have been a few smaller leaks but these may have been related to service connections.

3.8.1. As-built survey of 450 mm diameter CICL water main

Tahmoor Coal has conducted an as-built survey of the 450 mm diameter CICL water main to confirm the actual position of the pipeline. The purpose of the survey was to provide information for contingency plans in the event that non-conventional movement develop within the road corridor.

The surveys were conducted on publicly accessible land and confirmed that Sydney Water's spatial mapping of the water main is reasonably accurate, including where the pipeline crosses under Remembrance Drive and the Main Southern Railway. A summary plan showing the surveyed locations of the watermain relative to Sydney Water's GIS shapefiles is shown in Fig. 3.7.

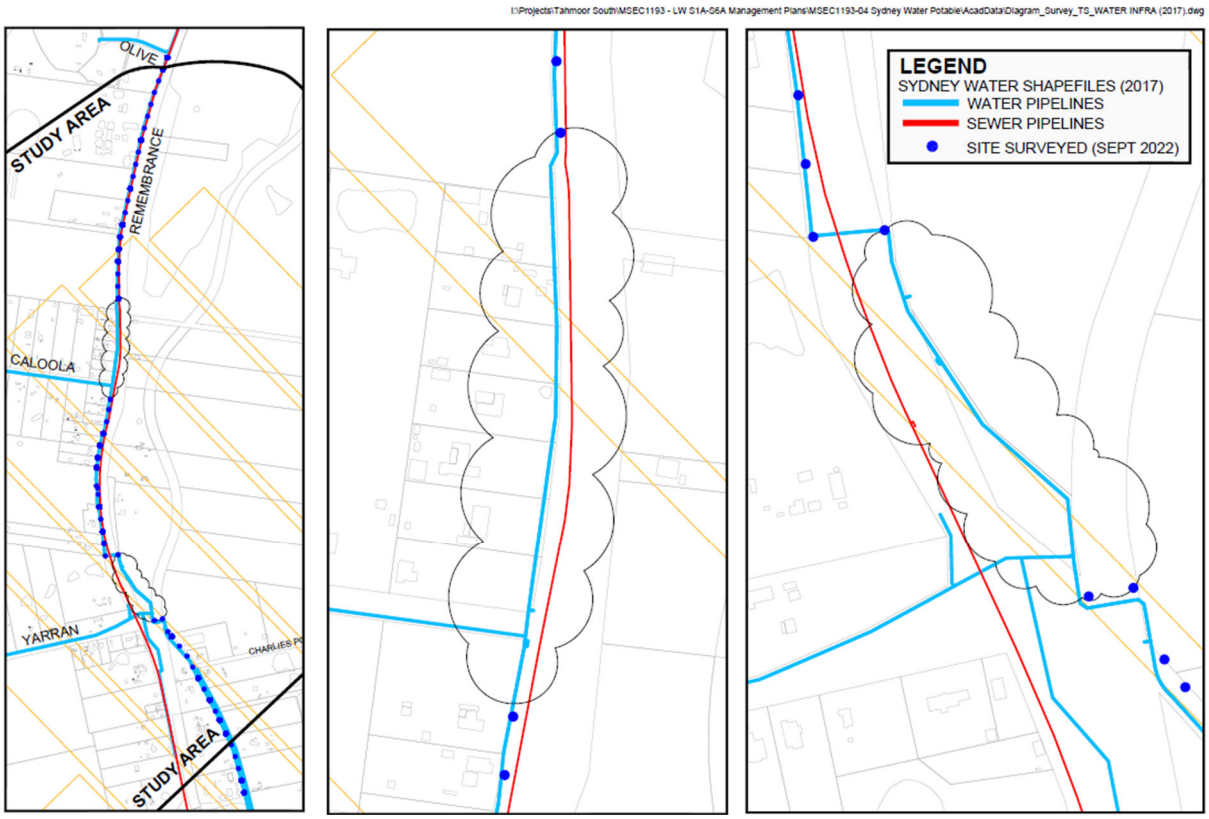

Fig. 3.7 Surveyed location of 450 mm diameter CICL water main relative to Sydney Water GIS shapefile

Based on the results of the as-built survey, drawings provided in this Management Plan are based on Sydney Water's GIS shapefiles.

3.8.2. Predicted subsidence movements

The potable water infrastructure includes a Cast Iron Cement Lined (CICL) 450 mm diameter watermain which follows the alignment of Remembrance Drive, before crossing beneath the Main Southern Railway and following Great Southern Road. 100 mm, 200 mm and 250 mm diameter CICL and DICL water pipelines are located along Caloola Road, Yarran Road and along a short section Remembrance Drive to the south of Yarran Road.

The predicted profiles of conventional subsidence and tilt along the alignment of Remembrance Drive, resulting from the extraction of the proposed longwalls, are shown in Fig. 3.8. A summary of the maximum predicted total conventional subsidence parameters for Remembrance Drive, after the extraction of each of the proposed longwalls, is provided in Table 3.4.

The predicted tilts are the maxima along the alignment of the road after the completion of each of the proposed longwalls. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each of the proposed longwalls.

Table 3.4 Maximum predicted total conventional subsidence parameters for Remembrance Drive due to the extraction of LWs S1A to S6A

Longwall	Maximum predicted subsidence (mm)	Maximum predicted tilt along alignment (mm/m)	Maximum predicted tilt across alignment (mm/m)	Maximum predicted hogging curvature in any direction (km^{-1})	Maximum predicted sagging curvature in any direction (km^{-1})
LW S1A	325	2.5	5.0	0.06	0.06
LW S2A	1000	5.0	5.5	0.08	0.20
LW S3A	1200	6.5	5.5	0.10	0.21
LW S4A	1250	6.0	6.0	0.12	0.21
LW S5A	1300	6.5	5.5	0.12	0.21
LW S6A	1350	7.5	5.5	0.12	0.21

The maximum predicted conventional strains for Remembrance Drive, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 1.8 mm/m tensile and 3.2 mm/m compressive. Non-conventional movements can also occur as a result of, among other things, anomalous movements. The analysis of strains provided in Chapter 4 includes those resulting from both conventional and non-conventional anomalous movements.

The pipeline is a linear feature and, therefore, the most relevant distribution of strain is the maximum strains measured along whole monitoring lines above previous longwall mining. The analysis of strains along whole monitoring lines during the mining of previous longwalls in the Southern Coalfield is discussed in Section 3.4.2 and the results are provided in Fig. 3.5.

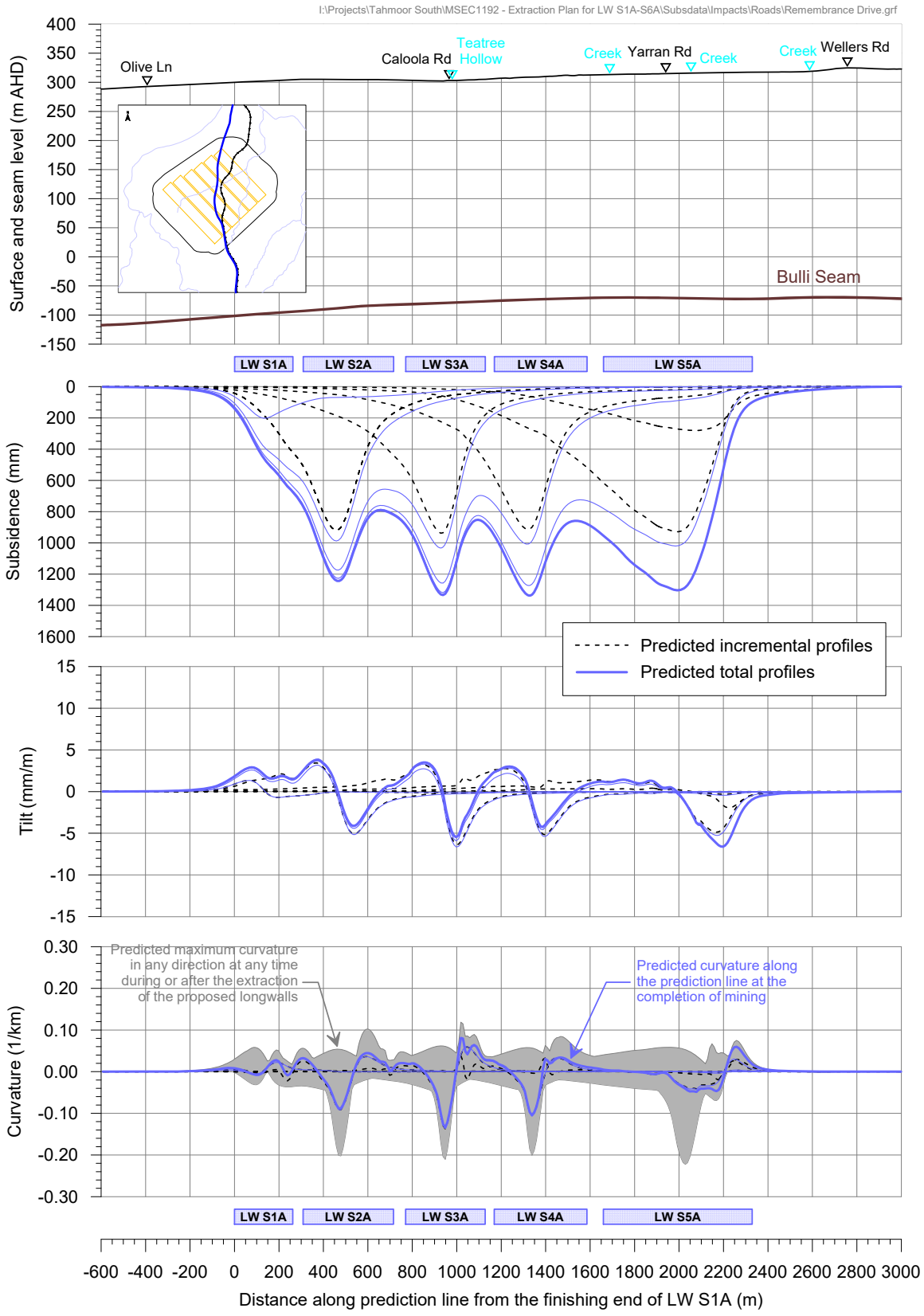

Fig. 3.8 Predicted profiles of total subsidence, tilt and curvature for the 450 mm dia water main along Remembrance Driveway after the mining of LW S1A-S6A

Caloola Road is located directly above LWs S3A to S5A and, therefore, could experience the full range of predicted subsidence movements. The predicted profiles of conventional subsidence and tilt along the alignment of Caloola Road, resulting from the extraction of the proposed longwalls, is shown in Fig. 3.9.

A summary of the maximum predicted total conventional subsidence parameters for Caloola Road, after the extraction of each of the proposed longwalls, is provided in Table 3.5.

The predicted tilts are the maxima along the alignment of the road after the completion of each of the proposed longwalls. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each of the proposed longwalls.

Table 3.5 Maximum predicted total conventional subsidence parameters for Caloola Road due to the extraction of LWs S1A to S6A

Longwall	Maximum predicted subsidence (mm)	Maximum predicted tilt along alignment (mm/m)	Maximum predicted tilt across alignment (mm/m)	Maximum predicted hogging curvature in any direction (km^{-1})	Maximum predicted sagging curvature in any direction (km^{-1})
LW S1A	325	2.5	5.0	0.06	0.06
LW S2A	1000	5.0	5.5	0.08	0.20
LW S3A	1200	6.5	5.5	0.10	0.21
LW S4A	1250	6.0	6.0	0.12	0.21
LW S5A	1300	6.5	5.5	0.12	0.21
LW S6A	1350	7.5	5.5	0.12	0.21

Yarran Road is located directly above LWs S5A and S6A and, therefore, could experience the full range of predicted subsidence movements. The predicted profiles of conventional subsidence and tilt along the alignment of Yarran Road, resulting from the extraction of the proposed longwalls, is shown in Fig. 3.10.

A summary of the maximum predicted total conventional subsidence parameters for Yarran Road, after the extraction of each of the proposed longwalls, is provided in Table 3.6.

The predicted tilts are the maxima along the alignment of the road after the completion of each of the proposed longwalls. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each of the proposed longwalls.

Table 3.6 Maximum predicted total conventional subsidence parameters for Yarran Road due to the extraction of LWs S1A to S6A

Longwall	Maximum predicted subsidence (mm)	Maximum predicted tilt along alignment (mm/m)	Maximum predicted tilt across alignment (mm/m)	Maximum predicted hogging curvature in any direction (km^{-1})	Maximum predicted sagging curvature in any direction (km^{-1})
LW S1A	325	2.5	5.0	0.06	0.06
LW S2A	1000	5.0	5.5	0.08	0.20
LW S3A	1200	6.5	5.5	0.10	0.21
LW S4A	1250	6.0	6.0	0.12	0.21
LW S5A	1300	6.5	5.5	0.12	0.21
LW S6A	1350	7.5	5.5	0.12	0.21

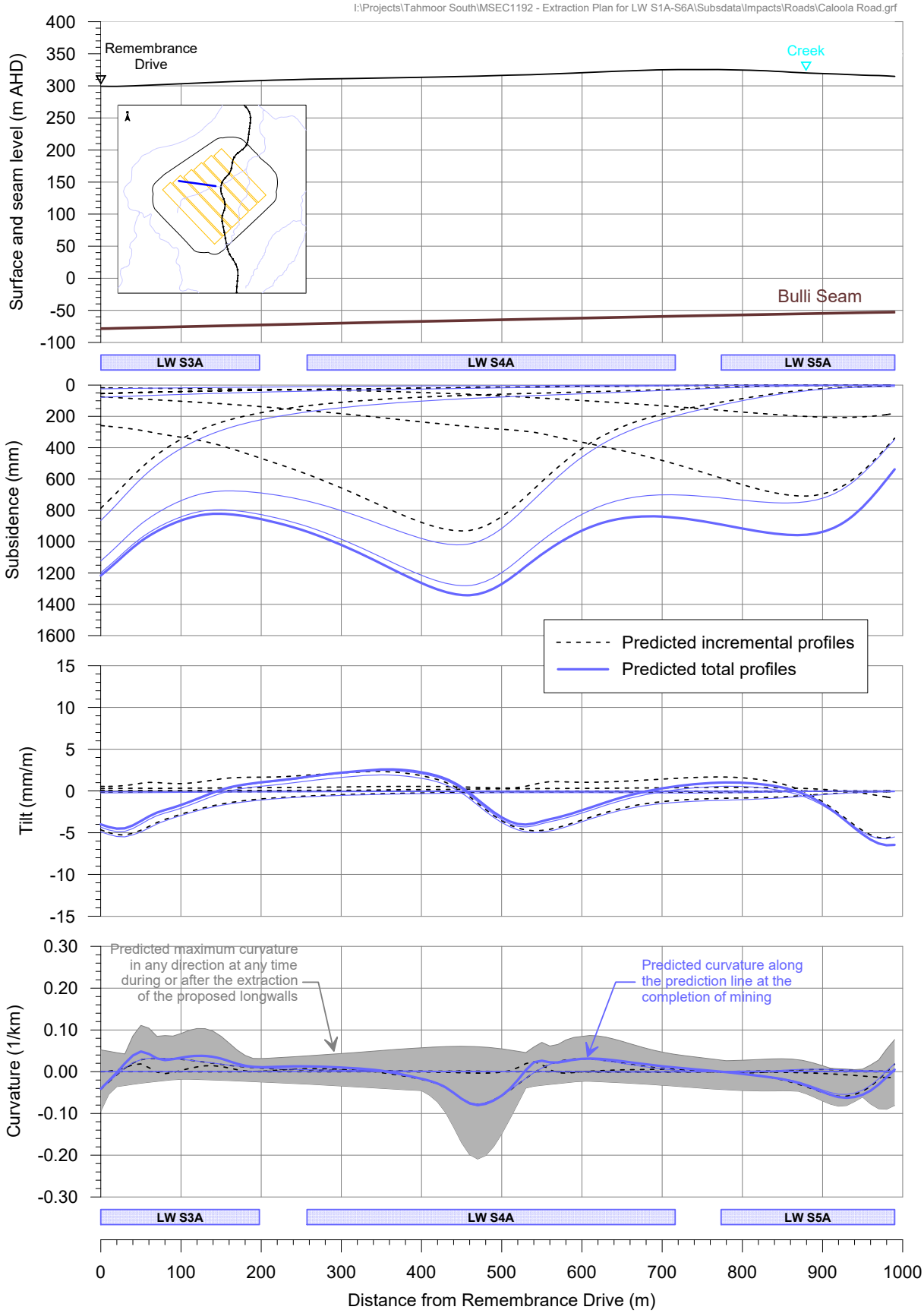

Fig. 3.9 Predicted profiles of total subsidence, tilt and curvature along Caloola Road after the mining of LW S1A-S6A

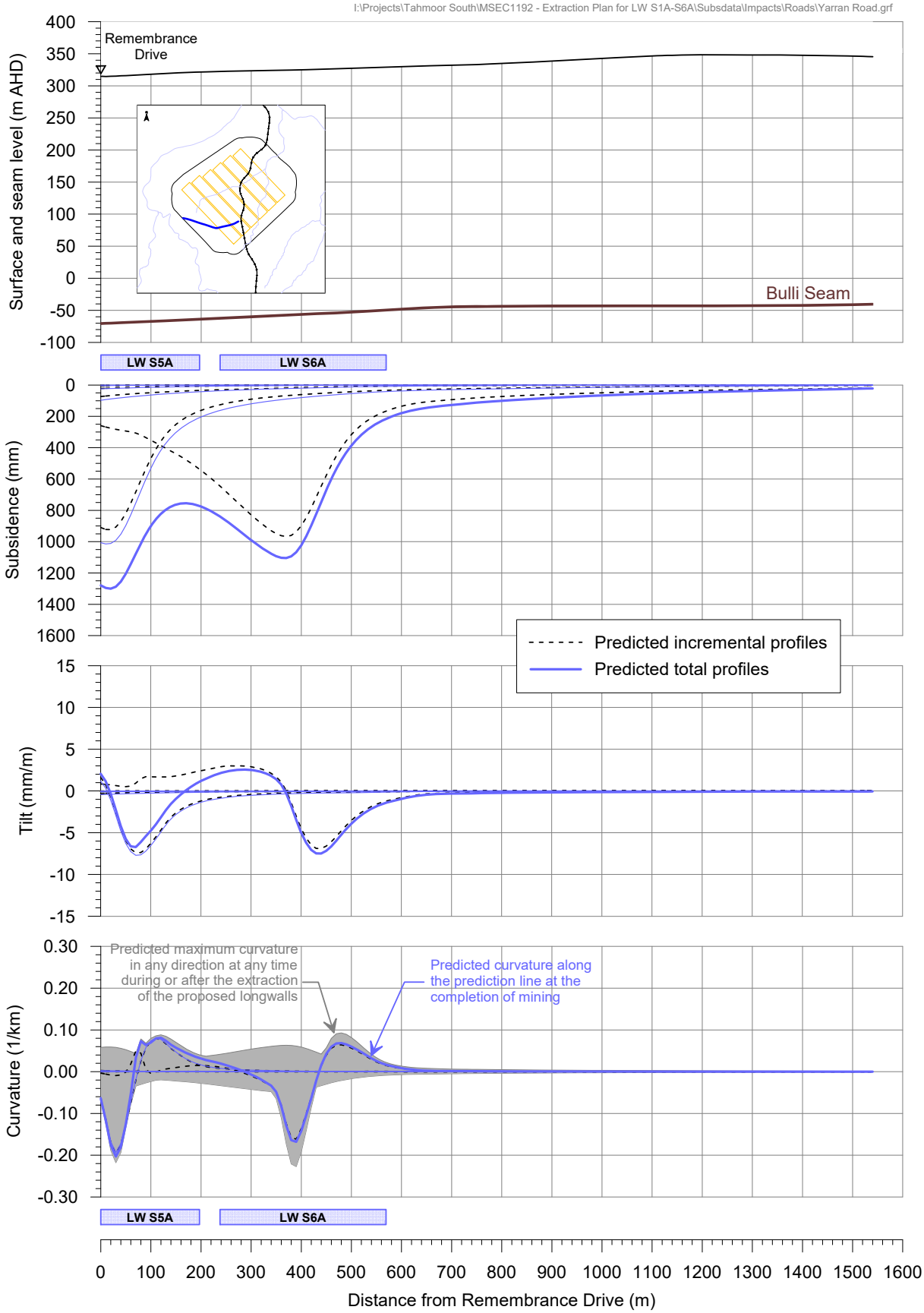

Fig. 3.10 Predicted profiles of total subsidence, tilt and curvature along Yarran Road after the mining of LW S1A-S6A

The 450mm diameter water main crosses Teatree Hollow and a number of its tributaries within the Study Area, as shown in Drawing No. MSEC1193-04-01. Valley-related movements could be experienced in these locations. A summary of the maximum predicted conventional subsidence and valley related movements for the crossing at Teatree Hollow is provided in Table 3.7.

Maps showing the location of the 450 mm water main relative to Remembrance Drive and the Main Southern Railway are shown in Drawings Nos. MSEC1193-03-07 to MSEC1193-03-09.

Table 3.7 Predicted Conventional Subsidence and Valley Related Movements for the creek crossings along Remembrance Drive and water main within the Study Area

Location	Maximum Predicted Total Subsidence (mm)	Maximum Predicted Total Hogging Curvature (1/km)	Maximum Predicted Total Sagging Curvature (1/km)	Maximum Predicted Total Upsidence (mm)	Maximum Predicted Total Closure (mm)
Opposite Tahmoor Mine above LW S2A	1250	0.05	-0.18	100	50
Teatree Hollow (Caloola Road) (upstream Remembrance Drive)	1300	0.06	-0.18	250	150
Tributary to Teatree Hollow (downstream Remembrance Drive)	1100	0.05	-0.04	125	100
Tributary to Teatree Hollow (downstream Main Southern Railway at 100.425 km)	1275	0.05	-0.12	150	75
Tributary to Teatree Hollow (Great Southern Road)	30	< 0.01	< 0.01	50	30

3.8.3. Potential subsidence impacts on water pipelines

Longwalls 22 to 32 at Tahmoor Mine have directly mined beneath approximately 5.5 kilometres of DICL pipe and 19.5 kilometres of CICL pipe, with only minor impacts recorded to the older CICL pipes. Water leaks were repaired by Sydney Water using normal response procedures.

The predicted systematic curvatures and strains for the water pipelines within the *Subsidence Study Area* are of a similar order of magnitude to those observed and predicted along the pipelines that have been mined directly beneath by previously extracted longwalls in the Southern Coalfield. The overall levels of impacts on the water pipelines in the *Subsidence Study Area*, therefore, are expected to be similar to those observed during the previously extracted longwalls in the Southern Coalfield. Longwalls in the Southern Coalfield have been mined directly beneath water pipelines in the past, and some of these cases are provided in Table 3.8.

Table 3.8 Examples of previous experience of mining beneath water pipelines in the Southern Coalfield

Colliery and Longwalls	Pipelines	Observed movements	Observed impacts
Appin LW301 and LW302	0.6 km of 150 dia. DICL 0.6 km of 300 dia. CICL 0.6 km of 1200 dia. SCL	650 mm Subsidence 4.5 mm/m Tilt 1 mm/m Tensile Strain 3 mm/m Comp. Strain (Measured M & N-Lines)	Leakage of the 150 mm and 300 mm CICL pipelines at a creek crossing, elsewhere no other reported impacts
Tahmoor Mine LW22 to LW32	5.5 km DICL pipes 19.5 km CICL pipes	1200 mm Subsidence 6 to 10 mm/m Tilt 1.5 mm Tensile Strain 2 mm (typ.) and up to 5 mm/m Comp. Strain (Extensive street monitoring)	Impacts occurred to the distribution network at 8 locations and a very small number of minor leaks in the consumer connection pipes
West Cliff LW5A3, LW5A4 & LW29 to LW34	2.8 km of 100 dia. CICL pipe directly mined beneath	1100 mm Subsidence 10 mm/m Tilt 1 mm/m Tensile Strain 5.5 mm/m Comp. Strain (Measured B-Line)	No reported impacts

Based on this experience, it is expected that some minor leakages of the water pipelines could occur at isolated locations, as a result of the extraction of the longwalls, however, the incidence of impacts is expected to be low. Impacts are more likely to occur in the locations of non-systematic movements, and at creek crossings, due to valley related movements.

Tahmoor Coal has previously developed and selected risk control measures in consultation, co-ordination and co-operation with Sydney Water in accordance with WHS legislation. The controls have been implemented during the mining of Longwalls 22 to 32 and LW W1-W4 at Tahmoor North.

Potential impact sites are identified by weekly ground surveys and visual inspections. The frequency of inspections are typically increased if non-conventional subsidence movements are identified. Any impacts to the pipelines along the local streets (e.g. Caloola Road and Yarran Road) are expected to be of a minor nature which could be easily repaired.

Sydney Water and Tahmoor Coal also have extensive experience in successfully managing potential impacts on the trunk water main along Remembrance Drive at Tahmoor and Argyle Street at Picton during the mining of previous Longwalls 22 to 32 and LW W4 at Tahmoor North. A water leak was immediately repaired by Sydney Water, for example, when mining-induced impacts were observed when LW 32 mined directly beneath the water main adjacent to the vehicle entrance to Sydney Water's Picton Water Recycling Plant.

Sydney Water advises that the 450 mm diameter CICL water main within the Study Area currently has a reasonable history of performance. Sydney Water currently reduces the potential consequences of water main break by remotely monitoring water pressure at pressure reducing valves stationed along the pipeline. Sydney Water are notified when water pressures build up, and a maintenance crew is sent to site to reduce pressure. This standard procedure will continue to be followed during the mining of LWs S1A-S6A.

Sydney Water has emergency plans in place to respond and repair leaks to the 450 mm diameter water main along Remembrance Drive within 24 hours to maintain supply to the downstream reservoirs, particularly during times of peak demand during the summer period.

In the event that the 450 mm diameter water main requires repair within the Study Area, the majority of the network will remain on mains supply as stop valves can be used to shut down and isolated the affected section of the pipeline. Prior to the influence of each longwall, Sydney Water will mark out the stop valves within the predicted extent of incremental subsidence to minimise the response time.

Customers will continue to receive potable water via the reservoirs at Picton, Thirlmere, Buxton and Oakdale. The storage capacities in the reservoirs are sufficient to supply water for at least 24 hours. Sydney Water will, therefore, ensure that reservoir levels are kept above 90 % whilst the water main is experiencing active subsidence movements to maximise the period of time available to repair a water main.

In the event of a leak, customers within the affected section of pipework will temporarily lose mains supply. Sydney Water has procedures and appropriate resources to notify the community and provide an alternative supply of potable water to consumers whilst the water main is shut down to complete the repairs. Tahmoor Coal can also contact affected customers and offer assistance. Water supply can be provided to all residential and commercial consumers, including the Wollondilly Anglican College during an outage, with the only exception being Tahmoor Mine itself.

Creek crossings

The most likely locations for severe ground deformations and impacts on the pipelines would be where they cross streams within the Study Area. The potable water pipelines are buried in the ground at the creek crossings.

Hidden creeks

As shown in Drawing No. MSEC1193-04-01, the 450 mm diameter CICL water main along Remembrance Drive does not cross creek crossings directly above LWs S1A and S2A. Two hidden creeks are located above LWs S1A and S2A but historical aerial photographs indicate that they did not extend to Remembrance Drive. It is possible, but not certain that non-conventional valley closure and upsidence movements could develop where the hidden creeks are projected to intersect the pipeline and a conservative prediction has been provided in Table 3.7 where the hidden creek is projected to cross beneath above LW S2A. It is planned to manage potential impacts at these locations by regular ground surveys and visual inspections, with responses triggered by actual observations.

Teatree Hollow at Caloola Road

LW S3A will extract directly beneath the water main where it crosses Teatree Hollow at the intersection of Remembrance Drive and Caloola Road. A Steel Cement Lined (SCL) pipe is buried directly under the creek bed, which is connected to the CICL pipework on both sides.

The pipeline runs within private properties, except where it crosses the creek and Caloola Road, as shown in Drawing No. MSEC1193-03-07. A Google Streetview image of the intersection is shown in Fig. 3.11 and a photograph of the Sydney Water pit is shown in Fig. 3.12.

It can be seen that the water main is located upstream of the road embankment but approximately 10 metres away from the toe of the embankment. In the event of a water leak, water will drain through the twin culverts under the embankment and is extremely unlikely to erode the embankment.

Fig. 3.11 Google Streetview image at intersection of Remembrance Drive and Caloola Road

Fig. 3.12 Sydney Water pit for potable water main at intersection of Remembrance Drive and Caloola Road

Whilst the predictions of valley closure and upsidence are based on a conservative, upper-bound model, it is considered likely that the pipeline will experience an increase in compressive strains and increased changes in vertical and/or lateral alignment at or near the creek crossing. It is likely, therefore, that the capacity of some existing SCL-CICL or CICL-CICL joints will fully close in response to valley closure and rotations caused by vertical and/or lateral alignment could result in rotation of the joints and possible leaks to the pipe.

If actual valley closure and upsidence approach the upper-bound predictions, leaks could develop on multiple occasions at the creek crossing site.

In light of the assessment, Tahmoor Coal and Sydney Water have agreed to conduct further investigations for the purposes of considering and selecting options and implementing additional risk controls at the creek crossing site, prior to the influence of LW S2A. Potential options include:

- Implementation of enhanced monitoring of pipework joints at the creek crossings with triggers to respond early and avoid leakage events; and/or
- Exposure of pipework on either side of the creek crossings during periods of active subsidence to decouple the CICL pipework on either side of the SCL pipe from the ground and monitor changes at the joints;
- Storage of parts and fittings prior to active subsidence to install additional expansion joints and/or pipe sleeves at locations identified by ground surveys where valley closure and upsidence is focussing during active subsidence;
- Installation of additional stop valve(s) to isolate a shorter section of pipeline across the creek crossing during times of repair and, therefore, reduce the number of customers that would be inconvenienced; and/or
- Introduction of additional expansion joints or replacement of CICL pipework with new DICL pipework with deep socket and spigot joints to accommodate valley closure and changes in vertical and/or lateral alignment prior to mining.

Whilst investigations are ongoing, it is currently planned to install an expansion joint at the creek crossing prior to the influence of LW S2A.

Tributaries to Teatree Hollow north of Yarran Road and at Main Southern Railway at 100.425 km

The water main crosses tributaries to Teatree Hollow on the downstream side of embankments along Remembrance Drive and the Main Southern Railway, as shown in Drawings Nos. MSEC1193-03-08 and MSEC1193-03-09. In the event of a water leak, water will drain away from the embankments.

Whilst the predicted valley closure and upsidence is less than those provided at the Teatree Hollow crossing, Tahmoor Coal and Sydney Water have agreed to consider and select options and implement additional risk

controls at the creek crossing site, prior to the commencement of LW S4A. Potential options at these sites are similar to those listed above.

Whilst investigations are ongoing, it is currently planned to install an expansion joint at the creek crossing prior to the influence of LW S4A.

Tributary to Teatree Hollow at Great Southern Road

The water main crosses the Tributary to Teatree Hollow at Great Southern Road beyond the commencing end of LW S5A, as shown in Drawing No. MSEC1193-04-01. The valley is not particularly incised at this location.

It is possible, but not certain that non-conventional valley closure and upsidence movements could develop where at the creek crossing and a conservative prediction has been provided in Table 3.7. It is planned to manage potential impacts at this location by regular ground surveys and visual inspections, with responses triggered by actual observations.

Road and Rail Crossings

Remembrance Drive crossing

The 450 mm diameter CICL water main crosses beneath Remembrance Drive between Caloola and Yarran Roads, directly above the chain pillar between LWs S4A and S5A, as shown in Drawing No. MSEC1193-03-08. The crossing consists of direct buried CICL pipe sections with two right angle bends at a cut-fill interface along Remembrance Drive.

Sydney Water's GIS shapefiles indicate the pipes are direct buried CICL pipe sections that are not concrete encased. There is good access at both ends of each crossing, as shown in Fig. 3.13.

Fig. 3.13 Google Streetview image of crossing beneath Remembrance Drive

Main Southern Railway crossing

The 450 mm diameter CICL water main crosses beneath Main Southern Railway, directly above LW S5A, as shown in Drawing No. MSEC1193-03-09. The crossing consists of direct buried CICL pipe sections with two right angle bends at a cut-fill interface along the Railway near Kilometrage 100.380 km.

Sydney Water's GIS shapefiles indicate the pipes are direct buried CICL pipe sections that are not concrete encased. There is good access at both ends of each crossing, as shown in Fig. 3.14.

The likelihood of mining-induced impacts at the crossings are similar to those along the majority of the water main. There is, however, a chance of impacts to pipe joints that are located at the right angle bends because the bends could act as anchor points in the ground as the pipe sections slide relative to them.

A concern for Sydney Water is that a leak could occur directly beneath Remembrance Drive or the Main Southern Railway, where it could take longer than 24 hours to be repaired, potentially resulting in a loss of water supply to customers in the region. Traffic management would be required in both instances to safely access the damaged pipeline.

Photograph courtesy Precision Surveys

Fig. 3.14 Photograph of crossing beneath Main Southern Railway at 100.380 km

In light of the assessment, Tahmoor Coal and Sydney Water have agreed to conduct further investigations for the purposes of considering and selecting options and implementing additional risk controls at the road and rail crossing sites, prior to the commencement of LW S4A. Potential options include:

- Implementation of enhanced monitoring of pipework joints at the crossings with triggers to respond early and avoid leakage events; and/or
- Exposure of pipework on either side of the road and rail crossings during periods of active subsidence to decouple the CICL pipework bends from the ground and monitor changes at the joints;
- Installation of a temporary bypass line that runs through nearby road and railway culverts to re-establish water supply to the network whilst the damaged pipework is repaired;
- Installation of additional stop valve(s) to isolate a shorter section of pipeline across the Remembrance Drive crossing during the time of repair and, therefore, reduce the number of customers that would be inconvenienced if a leak occurs (stop valves are already installed at both ends of the rail crossing); and/or
- Development of a contingency plan that plans for a prompt repair of the damaged pipework, in accordance with appropriate road and rail traffic management plans;
- Introduction of additional expansion joints or replacement of CICL pipework with new DICL pipework with deep socket and spigot joints to accommodate differential mine subsidence movements at the road and rail crossings prior to mining.

Whilst investigations are ongoing, it is currently planned to install valve tees and connection points on both sides of the rail crossing prior to the influence of LW S4A. The valve tees and connection points will allow a temporary bypass line to be connected, if required, through the railway culvert whilst the pipe crossing is repaired or replaced. In the event of impacts to the rail crossing, the permanent repair is most likely to require a new horizontal bore to be constructed beneath the railway line.

Fig. 3.15 Conceptual plan showing valve tees and connections to allow for emergency installation of a temporary bypass line

Management of potential impacts to potable water infrastructure

Tahmoor Coal has previously developed and selected risk control measures in consultation, co-ordination and co-operation with Sydney Water in accordance with WHS legislation. The controls were implemented during the mining of LWs 22 to 32 and LW W1-W4 at Tahmoor North.

In this instance, reasonably practicable controls have been identified that could eliminate, substitute or isolate the identified risks and engineering controls have been identified that could put in place a structure or item that prevents or minimises risks.

- Mark out locations of stop valves prior to the influence of each longwalls;
- Arrange for reservoirs within the network to be more than 90% capacity during periods of active subsidence;
- Consider and select options and implement additional risk controls at the creek crossing sites (most likely to be installation of expansion joints at Teatree Hollow at Caloola Road and Tributary to Teatree Hollow north of Yarran Road);
- Consider and select options and implement additional risk controls at the road and rail crossing sites (most likely to be installation of valve tees and connections points at the road and rail crossings);

Tahmoor Coal has identified controls that will manage potential issues associated with damage to pipelines resulting in damage to potable water pipelines during the extraction of LW S1A-S6A by implementing the following measures:

- Regular ground surveys along streets located within the active subsidence zone;
- Absolute 3D survey of subsidence along Remembrance Drive;
- Regular visual inspections along streets located within the active subsidence zone;
- Regular consultation with the community to report potential impacts;
- Additional surveys and/or inspections, if triggered by monitoring results;
- If triggered by monitoring results, excavate and expose the pipeline to relieve it from ground deformations; and
- In the worst case, repair of damaged pipeline.

3.9. Sydney Water potable water mains near bridges

There are no bridges along local roads within the vicinity of LW S1A-S6A., though some bridges may experience far field movements during the mining of LW S1A-S6A. Sydney Water's potable water mains are located alongside two bridges.

Tahmoor Coal is managing potential impacts on features that may be sensitive to mining-induced differential far field movements, such as the Main Southern Railway Viaduct over the Bargo River and the Bargo River Road Bridge over a tributary to the Bargo River.

Sydney Water potable water pipelines are buried in the creek bed near these bridges and this Management Plan includes measures to manage the pipeline crossings that are located near these bridges. A photograph of the buried crossing beneath the Bargo River adjacent to the Main Southern Railway Viaduct is shown in Fig. 3.16.

A summary of the closest distances of LW S1A to S6A to the bridges are provided in Table 3.9.

Table 3.9 Bridges near Sydney Water potable water mains that may be potentially affected by far field movements

Bridge	Closest distance (m)	Closest LW	Closest LW end
Main Southern Railway over the Bargo River	1,755 m	LW S1A	Finishing end (North-western end)
Bargo River Road Bridge over a tributary to Bargo River	1,790 m	LW S1A	Finishing end (North-western end)

Tahmoor Coal is managing potential impacts on the bridges in consultation with Wollondilly Shire Council and the Australian Rail Track Corporation. The management plans include monitoring of absolute and differential movements at the bridges and visual inspections.

Fig. 3.16 Photograph of buried crossing of 450 mm CICL water main beneath the Bargo River adjacent to the Main Southern Railway Viaduct

The potential for impacts on the pipeline crossings do not result from absolute far-field horizontal movements, but rather from differential horizontal movements. It can be seen from Fig. 3.17 that infrastructure located well away from active longwalls are likely to experience relatively small differential horizontal movements, particularly given that a large proportion of the measured variations are within survey tolerance. Statistical analyses were not conducted for offset distances greater than 1800 metres as there are insufficient measurements beyond the nominal survey tolerance of 3 mm.

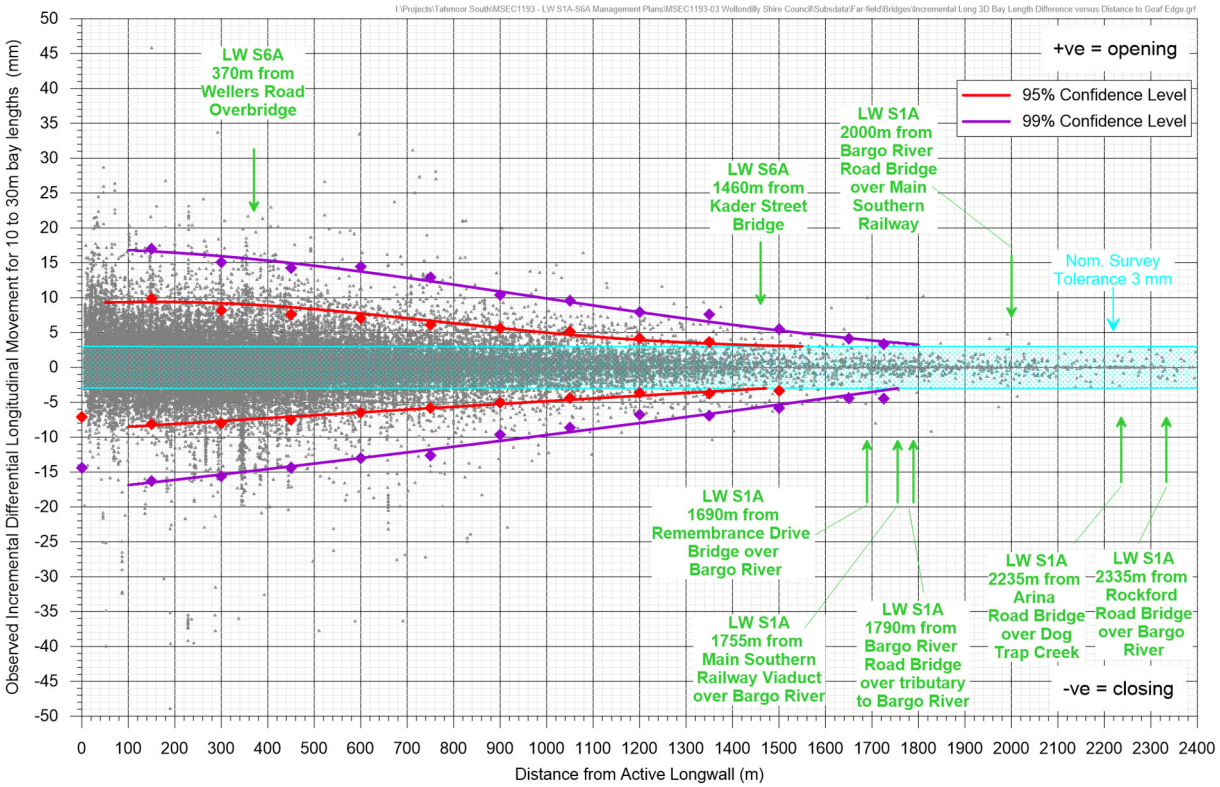

Fig. 3.17 Observed incremental differential longitudinal horizontal movements versus distance from active longwall for marks spaced between 10 and 30 metres

The buried water mains are located approximately 1,700 metres from LWs S1A to S6A. It can be seen from Fig. 3.17 that only 1% of previously observed differential horizontal movements have exceeded 5 mm over a bay length of 20 metres. Differential movements of this magnitude are likely to be accommodated at the pipe joints, even if they concentrate at one joint.

A concern for Sydney Water is that if actual differential mining-induced were greater than expected, a leak could occur directly beneath the river bed, where depending on water flows, it could take longer than 24 hours to be repaired, potentially resulting in a loss of water supply to customers in the region.

Tahmoor Coal has developed and selected risk control measures in consultation, co-ordination and co-operation with Sydney Water in accordance with WHS legislation.

In this instance, there are no reasonably practicable controls which could eliminate, substitute or isolate the identified risks, nor engineering controls that could put in place a structure or item that prevents or minimises risks. Tahmoor Coal has identified controls that will ensure that Sydney Water's water mains will remain safe and serviceable during and after the extraction of LW S1A-S6A by implementing the following measures:

- Continuously monitor differential movements between the ends of the Bargo River Railway Viaduct by GNSS units;
- Regular absolute and local 3D surveys of the bridges during mining;
- Regular visual inspections of the bridges during mining;
- Regular consultation with the community to report potential impacts;
- Additional surveys and/or inspections, if triggered by monitoring results;
- If triggered by monitoring results, install a temporary bypass line across the Bargo River either along the Viaduct or the adjacent Remembrance Drive Bridge over the Bargo River; and
- In the worst case, repair of damaged pipeline.

4.1. Infrastructure Management Group (IMG)

The Infrastructure Management Group (IMG) is responsible for taking the necessary actions required to manage the risks that are identified from monitoring the infrastructure and to ensure that the health and safety of people who may be present on public property or Sydney Water property are not put at risk due to mine subsidence. The IMG develops and reviews this management plan, collects and analyses monitoring results, determines potential impacts and provides advice regarding appropriate actions. The members of the IMG are highlighted in Chapter 8.

4.2. Development and selection of risk control measures

Tahmoor Coal has developed and selected risk control measures in consultation, co-ordination and co-operation with the infrastructure owner 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 Section 4.3 to Section 4.6. 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 during the extraction of LW S1A-S6A.

4.3. Selection of risk controls for potable water infrastructure

Based on the above assessments, Tahmoor Coal considered Method A and Method B risk control measures, in accordance with the process described in Section 4.2.

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.

Tahmoor Coal and Sydney may identify additional risk controls to manage potential impacts at the creek crossing sites, prior to the influence of LW S2A and at the road and rail crossing sites prior to the commencement of LW S4A.

Isolation

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

Tahmoor Coal and Sydney may identify additional risk controls to manage potential impacts at the creek crossing sites, prior to the influence of LW S2A and at the road and rail crossing sites prior to the commencement of LW S4A.

Engineering Controls

In this instance, no reasonably practicable engineering controls could be identified to put in place a structure or item that prevents or minimises risks.

Tahmoor Coal and Sydney may identify additional risk controls to manage potential impacts at the creek crossing sites, prior to the influence of LW S2A and at the road and rail crossing sites prior to the commencement of LW S4A.

Administrative Controls

The following Administrative Controls were identified and selected that will put in place procedures on site to minimise the potential of impacts on the health and safety of people in relation to mining-induced damage to potable water infrastructure:

- Implementation of a Monitoring Plan and Trigger Action Response Plan (TARP)
  As described in the Management Plan, Tahmoor Coal and Sydney Water has developed and implemented a management strategy of detecting early the development of potential adverse subsidence movements in the ground, so that contingency response measures can be implemented before impacts on the safety and serviceability develop. The TARP includes the following:
    - Continuous GNSS monitoring along the centrelines of LWs S1A to S3A, and at each end of the Main Southern Railway Viaduct over the Bargo River;
    - Mark out locations of stop valves prior to the influence of each longwalls;
    - Arrange for reservoirs within the network to be more than 90% capacity during periods of active subsidence of the 450 mm diameter CICL water main;
    - Follow Sydney Water procedures to monitor and respond to high water pressure levels at water reducing valves;
    - Local 2D surveys along local roads as shown in Drawing No. MSEC1193-01-01. These include streets along which potable water pipelines are located, including Remembrance Drive, Caloola Road, Yarran Road and Great Southern Road;
    - Absolute 3D survey of subsidence along Remembrance Drive and the Main Southern Railway;
    - Monitoring along the Main Southern Railway in accordance with the Railway Subsidence Management Plan, including ground surveys, rail stress monitoring, track geometry surveys, and visual inspections;
    - Local 3D / Absolute 3D of structure and ground marks on the Remembrance Drive Bridge over the Bargo River, as shown in Drawing No. MSEC1193-03-02;
    - Local 3D / Absolute 3D of structure and ground marks on the Bargo River Road Bridges, as shown in Drawing No. MSEC1193-03-03;
    - Visual inspections along the streets within the active subsidence zone;
    - Additional surveys and/or inspections, if triggered by monitoring results;
    - Regular consultation with the community to report potential impacts;
    - If triggered by monitoring results, excavate and expose the pipeline to relieve it from ground deformations;
    - In the event of damage to the water mains, implement Sydney Water's emergency procedures; and
    - In the worst case, repair of damaged pipeline and supply water to affected customers by alternative methods.

4.4. Monitoring measures

A number of monitoring measures will be undertaken during mining.

4.4.1. Continuous GNSS monitoring

Global Navigation Satellite System (GNSS) units are fixed survey stations that continuously measure their absolute horizontal and vertical positions in real time.

The locations of GNSS units are shown in Drawings No. MSEC1193-01-01 and the GNSS units that are relevant to managing Sydney Water infrastructure are summarised below:

- Centrelines of LWs S1A to S3A - The GNSS units are located in bushland within the Australian Wildlife Sanctuary. The units are proposed to track the development of subsidence and horizontal movements above the commencing ends of the longwalls. The monitoring data will provide the first subsidence results for each panel to compare against subsidence predictions. Conventional survey lines are not possible in this area due to thick vegetation, preventing lines of sight; and
- Railway Viaduct across Bargo River - Two GNSS units have been installed within the Main Southern Railway corridor to measure far field movements, if any, between the abutments of the Viaduct. The two GNSS units will also allow valley closure, if any, to be detected. The results will be cross-checked by manual surveys across the Remembrance Drive over the Bargo River

4.4.2. Early warning survey lines

LW S1A Tahmoor Mine Boundary

A survey line has been installed along the southern boundary of Tahmoor Mine's property, as shown in Drawing No. MSEC1192-01-01. The survey line has been installed with pegs spaced nominally 20 metres apart. The survey line commences at the south-eastern end at the end of an unsealed road that is accessed from Charlies Point Road. The line terminates at the top of Teatree Hollow due to thick vegetation.

The purpose of the survey line is to measure the subsidence profile across the width of LW S1A prior to experiencing significant subsidence along the Main Southern Railway and Remembrance Drive. It is planned to survey the line once a month during the period of active subsidence of LW S1A. Additional surveys can be conducted, if required.

Main Southern Railway

LWs S1A to S4A will extract directly beneath the Main Southern Railway prior to mining directly beneath Sydney Water infrastructure along Remembrance Drive and Caloola Road.

A survey has been installed along the Main Southern Railway, as shown in Drawing No. MSEC1192-01-01. The survey line has been installed with pegs spaced nominally 20 metres apart.

Surveys along the Railway will provide an early warning of the magnitude of subsidence that is likely to develop. The surveys will also detect the development of non-conventional subsidence movements along the Railway and provide an opportunity to project locations where potential non-conventional subsidence movements may occur along Remembrance Drive. The IMG can assess the monitoring results and assess whether any additional monitoring and management measures may be required to manage potential impacts along Remembrance Drive and Caloola Road.

It is planned to survey the line weekly during periods of active subsidence. Additional surveys can be conducted, if required.

4.4.3. Ground Surveys along streets

Survey lines have been or will be installed along Remembrance Drive, Caloola Road, Yarran Road, Charlies Point Road and Great Southern Road, as shown in Drawing No. MSEC1193-01-01.

The survey lines consist of pegs spaced nominally every 20 metres. 2D surveys will measure levels and horizontal distances between adjacent pegs. Survey pegs along Remembrance Drive will be surveyed in 2D and 3D (level, eastings and northings).

4.4.4. Visual inspections

Visual inspections will be undertaken during the period of active subsidence by an experienced inspector appointed by Tahmoor Coal who is familiar with mine subsidence impacts. The inspector will undertake the following:

- Visual inspections along streets within the active subsidence zone;
- Visual inspections at pipeline crossings under creeks; and
- Visual inspections of culverts, embankments, cuttings and bridges.

4.4.5. Changes to monitoring frequencies

Monitoring frequencies will continue while Sydney Water infrastructure is experiencing active subsidence due to the extraction of LW S1A-S6A. As a general guide, monitoring is likely to continue until the longwall has moved away from the property by a distance of approximately 450 metres. Monitoring, however, may continue if ongoing adverse impacts are observed.

4.5. Triggers and responses

Trigger levels have been developed by Tahmoor Coal based on engineering assessments and consultation with Sydney Water.

Trigger levels for each monitoring parameter are described in the risk control procedures in Table 4.1.

Immediate responses, if triggered by monitoring results, may include:

- Increase in survey and inspection frequencies if required by the IMG;
- Additional surveys and inspections;
- Exposing pipeline to relieve it of stress;
- Repair of impacts that create a serious public safety hazard; and
- In the worst case, restriction on entry, or access to, Sydney Water infrastructure.

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

With respect to the extraction of LW S1A-S6A, no potential hazards have been identified that could reasonably give rise to the need for an emergency response. Of the potential hazards identified in Section 3.7, only a water main break beneath the crossings under Remembrance Drive and Main Southern Railway could possibly give rise to the need for an emergency response. In light of the assessment, Tahmoor Coal and Sydney Water have agreed to conduct further investigations for the purposes of assessing and selecting options and implementing additional risk controls at the road and rail crossing sites, prior to the commencement of LW S4A. With additional controls implemented, the likelihood is considered extremely remote and would require substantial differential subsidence movements to develop before such an event occurs.

As discussed in Section 3.1, mine subsidence movements will 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 Sydney Water.

As documented in Section 4.6, Tahmoor Coal and the IMG will review and assess monitoring reports and consider whether any additional management measures are required on a weekly basis. If potentially adverse differential subsidence movements are detected, it is anticipated that a focussed inspection will be undertaken in the affected area, 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 affected site, and that Sydney Water will be consulted on a more frequent basis.

Notwithstanding the above, if a hazard has been identified that involves potential serious injury or illness to a person or persons on public property or in the vicinity of potable water infrastructure, and 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 on public property, Tahmoor Coal and Sydney Water will immediately meet and implement emergency procedures.

4.6. Subsidence Impact Management Procedures

The procedures for the management of potential impacts to Sydney Water infrastructure are provided in Table 4.1.

Table 4.1 Risk Control Procedures during the extraction of Tahmoor LW S1A-S6A

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
Potable water infrastructure	Impacts to Sydney Water potable water infrastructure	Low to High	None	Follow Sydney Water procedures to monitor and respond to high water pressure levels at water reducing valves	Ongoing	Sydney Water
				Mark out locations of stop valves on site prior to the influence of each longwalls	Prior to active LW face approaching within 150 metres of each water main within predicted limit of incremental subsidence of each active LW.	Sydney Water
				Arrange for reservoirs within the network to be more than 90% capacity during periods of active subsidence of the 450 mm diameter CICL water main	LW S1A: start after 1300m extraction LW S2A: start after 900m extraction LW S3A: start after 800m extraction LW S4A: start after 200m extraction LW S5A: start after 200m extraction LW S6A: start after 200m extraction	Sydney Water
				Consider and select options and implement additional risk controls at the creek crossing site for the 450 mm diameter CICL water main (most likely to be installation of expansion joints, subject to ongoing investigations)	Teatree Hollow crossing at intersection of Remembrance Drive and Caloola Road prior to 900m of extraction of LW S2A Tributary to Teatree Hollow crossings north of intersections of Remembrance Drive and Yarran Road and at Main Southern Railway at 100.425 km prior to start of LW S4A	Tahmoor Coal and Sydney Water
				Consider and select options and implement additional risk controls at the crossing beneath Remembrance Drive and beneath the Main Southern Railway at 100.380 km (most likely to be installation of valve tees and connection points across the rail crossing, subject to ongoing investigations)	Prior to start of LW S4A	Tahmoor Coal and Sydney Water
				Continuous GNSS monitoring as shown in Drawing No. MSEC1193-01-01	GNSS units installed Continuous readings, with data averaged over 24 hours and recorded once per day until end of LW S6A.	Tahmoor Coal (Unit Zero)
				2D survey line along Tahmoor Mine property boundary	Pegs installed. Baseline survey prior to commencement of LW S1A. Monthly survey during LW S1A between 200m and 1300m extraction, and continue if ongoing adverse movements are observed. End of LW S1A.	Tahmoor Coal (SMEC)
				Conduct 2D / Absolute 3D surveys along Main Southern Railway in accordance with Railway Management Plan	Monthly 3D / Weekly 2D surveys for pegs within active subsidence zone during LWs S1A to S6A	Tahmoor Coal (SRS)
				Conduct 2D / Absolute 3D surveys along Remembrance Drive	Pegs installed from northern boundary of Tahmoor Mine site to Caloola Road. Baseline survey prior to 900m extraction of LW S1A. Extend line and baseline survey pegs within predicted limit of incremental subsidence of each active LW, prior to active LW face approaching within 600 metres of survey line. Monthly 3D / Weekly 2D surveys for pegs within active subsidence zone commencing as per below: LW S1A: start after 1300m extraction LW S2A: start after 900m extraction LW S3A: start after 800m extraction LW S4A: start after 300m extraction LW S5A: start after 200m extraction LW S6A: start after 200m extraction Continue surveys until outside active subsidence zone or one month after end of LW and continue further if ongoing adverse movements are observed. End of LW S1A-S6A.	Tahmoor Coal (SMEC)
				Conduct 2D surveys along Caloola Road	Pegs installed. Baseline survey prior to 900m extraction of LW S1A.. Survey at end of LW S1A. Weekly 2D surveys for pegs within active subsidence zone commencing as per below: LW S2A: start after 900m extraction LW S3A: start after 900m extraction LW S4A: start after 900m extraction LW S5A: start after 900m extraction LW S6A: start after 900m extraction Continue surveys until outside active subsidence zone or one month after end of LW and continue further if ongoing adverse movements are observed. End of LW S2A-S6A.	Tahmoor Coal (SMEC)

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
Potable water infrastructure	Impacts to Sydney Water potable water infrastructure	Low to High	None	Conduct 2D surveys along Yarran Road	Install and baseline prior to start of LW S3A. Survey at end of LW S3A. Weekly 2D surveys for pegs within active subsidence zone commencing as per below: LW S4A: start after 200m extraction LW S5A: start after 200m extraction LW S6A: start after 200m extraction Continue if ongoing adverse movements are observed. End of LW S4A-S6A.	Tahmoor Coal (SMEC)
				Conduct 2D surveys along Great Southern Road	Install and baseline prior to start of LW S3A. Survey at end of LW S3A. Weekly 2D surveys for pegs within active subsidence zone commencing as per below: LW S4A: start after 200m extraction LW S5A: start after 200m extraction LW S6A: start after 200m extraction Continue if ongoing adverse movements are observed. End of LW S4A-S6A.	Tahmoor Coal (SMEC)
				Conduct Local 3D survey of structure and ground marks on the Main Southern Railway Viaduct over the Bargo River as per Drawing No. MSEC1193-03-02, with one mark on the Viaduct to be surveyed in Absolute 3D.	Install and baseline survey prior to LW S1A. Monthly surveys between 1000m and one month after end of extraction of LWs S1A to S3A and continue if ongoing adverse movements are observed. End of LW S1A-S3A.	Tahmoor Coal (SRS)
				Visual inspection of Main Southern Railway Viaduct over the Bargo River	Baseline inspection prior to LW S1A Monthly inspections between 1000m and one month after end of extraction of LWs S1A to S3A and continue if ongoing adverse movements are observed. End of LW S1A to S3A	Tahmoor Coal
				Conduct Local 3D survey of structure and ground marks on the Bargo River Road Bridge over tributary to Bargo River and Bargo River Road Bridge over Main Southern Railway as per Drawing No. MSEC1193-03-03, with one mark on each Bridge to be surveyed in Absolute 3D	Install and baseline survey prior to LW S1A. Monthly surveys between 1000m and one month after end of extraction of LWs S1A to S3A and continue if ongoing adverse movements are observed. End of LW S1A-S3A.	Tahmoor Coal (SRS)
				Visual inspection of Bargo River Road Bridges	Baseline inspection prior to LW S1A Monthly inspections between 1000m and one month after end of extraction of LWs S1A to S3A and continue if ongoing adverse movements are observed. End of LW S1A to S3A	Tahmoor Coal (BIS)
				Detailed visual inspections of local roads, culverts, embankments and cuttings along the routes of the water mains	Weekly for areas within the active subsidence zone during LWs S1A to S6A and continue if ongoing adverse movements or impacts are observed until one month after the extraction of each LW.	Tahmoor Coal (BIS)
				Inform Sydney Water Call Centre of mining in area and possible issues.	Completed	Sydney Water
				Notify residents of potential mine subsidence impacts and contact numbers.	Completed	Tahmoor Coal
				Analyse and report results to IMG, including information on the position of the longwall face.	Weekly during LW S1A-S6A after the length of the extraction exceeds 200 metres.	Tahmoor Coal
			Non-conventional ground movement detected	Notify Sydney Water	Within 24 hours	Tahmoor Coal
				Infrastructure Management Group (IMG) meets to consider whether any additional management measures should be undertaken, including: - increasing the frequency of surveys and visual inspections in vicinity of the non-conventional movement; - investigating for potential of damage occurring to Sydney Water infrastructure; and/or - relieving stresses on the pipes by locally excavating and exposing the pipes in the affected area.	As agreed between Tahmoor Coal and Sydney Water	IMG
			Leakage of water observed	Notify all stakeholders, including Sydney Water, Tahmoor Coal, Subsidence Advisory NSW and Resources Regulator	Within 24 hours	Tahmoor Coal
				Repair leak.	As per Sydney Water procedures (target within 24 hours for 450 mm dia water main)	Sydney Water
				Provide alternative water supply to customers	As required	Tahmoor Coal
				Consider increasing the frequency of surveys and visual inspections in vicinity of water leak, if appropriate.	As agreed between Tahmoor Coal and Sydney Water	Tahmoor Coal

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
Potable water infrastructure	Impacts to Sydney Water potable water infrastructure	Low to High	A hazard has been identified that involves potential serious injury or illness to a person or persons on public property or, or in vicinity of potable water infrastructure and cannot be controlled	IMG, Tahmoor Coal and Sydney Water meet to decide whether any additional management measures are required, including: - emergency evacuation of hazardous area - demarcation to prevent people entering hazardous area	Immediately	Tahmoor Coal and Sydney Water
				Notify SRG of trigger exceedance and any management decisions undertaken (incl Subsidence Advisory NSW, Resources Regulator)	Within 24 hours of decision	Tahmoor Coal
			Closure between abutments on Main Southern Rail Viaduct over Bargo River exceeds 7 mm or Closure between GNSS units at ends of Main Southern Rail Viaduct over Bargo River exceeds 7 mm or Closure between abutments Bargo River Road Bridge exceeds 5 mm	Notify Sydney Water	Within one week	MSEC
				Sydney Water and IMG meet and consider whether any additional management measures are required, which may include: - increase monitoring frequency and reporting procedures - install temporary bypass pipeline over creek crossing at Bargo River (Viaduct) or tributary to Bargo River (Bargo River Road Bridge)	Within one week	IMG
				Report trigger exceedance and actions taken to IMG, Sydney Water, SA NSW & MSO in Status Report	Within one week	Tahmoor Coal

5.1. Consultation, co-operation and co-ordination

Substantial consultation, co-operation and co-ordination has taken place between Tahmoor Coal and Sydney Water prior to the development of this Management Plan, as detailed in Section 1.3.1.

The following procedures will be implemented during and after active subsidence of the property to ensure the continued effective consultation, co-operation and co-ordination of action with respect to subsidence between Tahmoor Coal and Sydney Water:

- Reporting of observed impacts to Tahmoor Coal either during the weekly visual inspection or at any time directly to Tahmoor Coal;
- Distribution of monitoring reports, which will provide the following information on a weekly basis during active subsidence:
    - Position of longwall;
    - Summary of management actions since last report;
    - Summary of consultation with Sydney Water since last report;
    - Summary of observed or reported impacts, incidents, service difficulties, complaints;
    - Summary of subsidence development;
    - Summary of adequacy, quality and effectiveness of management process;
    - Any additional and/or outstanding management actions; and
    - Forecast whether there will be any subsidence impacts to the health and safety of people due to the continued extraction of LW S1A-S6A.
- Convening of meetings between Tahmoor Coal and Sydney Water at any time as required, as discussed in Section 5.2;
- Arrangements to facilitate timely repairs, if required; and
- Immediate contact between Tahmoor Coal and Sydney Water if a mine subsidence induced hazard has been identified that involves potential serious injury or illness to a person or persons on public property or Sydney Water property and may require emergency evacuation, entry restriction or suspension of work activities.

5.2. IMG meetings

The IMG undertakes reviews and, as necessary, revises and improves the risk control measures to manage risks to health and safety, and potential impacts to infrastructure.

The reviews are undertaken weekly during the period of active subsidence based on the results of the weekly surveys and visual inspections and summarised in the monitoring reports, as described in Section 5.1.

The purpose of the reviews is to:

- Detect changes, including the early detection of potential impacts on health and safety and impacts to Sydney Water infrastructure;
- Verify the risk assessments previously conducted;
- Ensure the effectiveness and reliability of risk control measures; and
- Support continual improvement and change management.

IMG meetings may be held between Tahmoor Coal and Sydney Water for discussion and resolution of issues raised in the operation of the Management Plan. The frequency of IMG Meetings will be as agreed between Tahmoor Coal and Sydney Water.

IMG Meetings will discuss any incidents reported in relation to the relevant infrastructure, the progress of mining, the degree 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 mine subsidence impact is observed, any party may call an emergency IMG Meeting, with one day's notice, to discuss proposed actions and to keep other parties informed of developments in the monitoring of the infrastructure.

6.0 AUDIT AND REVIEW

This Management Plan has been agreed between parties and can be reviewed and updated to continually 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 business or property 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 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. The Management Plan shall be audited for compliance with ISO 31000, or alternative standard agreed with Sydney Water.

7.0 RECORD KEEPING

Tahmoor Coal will keep and distribute minutes of any IMG Meeting.

8.0 CONTACT LIST

Organisation	Contact	Phone	Email
NSW Department of Planning and Environment – Resources Regulator	Ray Ramage	(02) 4063 6485 0442 551 293	ray.ramage@planning.nsw.gov.au
	Phil Steuart	(02) 4063 6484	phil.steuart@planning.nsw.gov.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 Project Manager	Ross Barber*	(02) 4640 0028 Mob: 0419 466 143	ross.barber@simecgfg.com
SIMEC Mining Tahmoor Coal Approvals Specialist	April Hudson	(02) 4640 0022 0466 380 992	April.Hudson@simecgfg.com
Sydney Water	Emergency Line	13 20 90	
Sydney Water – Systems Delivery Officer Area Team West	Troy Cooper*	(02) 8763 8622	troy.cooper@sydneywater.com.au

* denotes member of Infrastructure Management Group

APPENDIX A. Drawings and Supporting Documentation

The following supporting documentation is provided in Appendix A.

Drawings

Drawing No.	*Description*	*Revision*
MSEC1193-01-01	Monitoring plan	A
MSEC1193-04-01	Water Infrastructure	A
MSEC1193-03-02	MSR Rail Viaduct & Remembrance Drive Bridge over Bargo River	B
MSEC1193-03-03	Bargo River Road Bridges	B
MSEC1193-03-07	Remembrance Drive Embankment over Teatree Hollow over LW S3A (RE4)	B
MSEC1193-03-08	Remembrance Drive Cutting and Embankment north of Yarran Road over LWs S4A and S5A (RE3)	B
MSEC1193-03-09	Remembrance Drive Embankment south of Yarran Road over LW S5A (RE2)	B
MSEC1193-03-10	Remembrance Drive Embankment at Wellers Road intersection beyond LW S6A (RE1)	B
MSEC1193-03-11	Remembrance Drive Cutting north of Yarran Road over LW S4A and S5A (RC1)	B

Supporting Documentation

Tahmoor Coal (2022) *Risk Assessment Report – Infrastructure. Tahmoor Underground – Sydney Water – Sewer and Potable Water*. Tahmoor Coal, October 2022.

I:\Projects\Tahmoor South\MSEC1193 - LW S1A-S6A Management Plans\MSEC1193-01 General\AcadData\MSEC1193-01-01 Subsidence Monitoring.dwg

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TAHMOOR SOUTH PROJECT EXTRACTION PLAN LW S1A TO LW S6A

SUBSIDENCE MONITORING

DATE:	SCALE:	DRAWING No:	Rev No
6 Sep 2022	1:25000	MSEC1193-01-01	A

Series of survey marks (one on each side of bank) above previously extracted longwalls, subject to access by land owners & available lines of sight.

GNSS subject to access by landowners

Refer to MSEC1193-11-02 for Wollondilly Anglican College

Refer to MSEC1193-01-02 for Bridges over Bargo River

Refer to MSEC1247-01 for Tahmoor Mine

Refer to MSEC1193-03 for Wellers Rd Bridge

STUDY AREA

LW S1A
LW S2A
LW S3A
LW S4A
LW S5A
LW S6A

S01 S02 S03 S04 S05 S06 S07 S08 S09 S10 S11 S12 S13 S14 S15 S16

TT9 TT12

Teatree 2
Teatree 3

Railway Viaduct
Wollondilly Anglican College
Tahmoor Colliery
Along Tahmoor Mine property boundary
Poultry Sheds
Wrecker
Igloos
Service Station
Tahmoor Garden Centre
Australian Wildlife Sanctuary
Concrete materials plant
NBN Tower
Picton Weir
Wellers Rd Bridge
Hidden creek

BARGO RIVER ROAD
REMEMBRANCE DR
MAIN SOUTHERN RAILWAY
STRATFORD RD
ROCKFORD ROAD
BARGO RIVER
OLIVE GROVE
FIRE ROAD NO P1
CALOOLA ROAD
TEATREE HOLLOW
YARRAN ROAD
CHARLIES POINT RD
GREAT SOUTHERN RD
ANTHONY ROAD
WELLERS RD
CLAREMONT DRIVE
HOGANS DRIVE
ASHBY CL
LLOYDS WAY
ELVY STREET
HAMBRIDGE ROAD
IRONBARK ROAD
WATTLE STREET
DYMOND ROAD
GOVERNMENT ROAD
MIMOSA STREET
KADER STREET
CAMBALAN STREET
RADNOR ROAD
GWYNN HUGHES
NOONGAH ST
BARGO ROAD
DOG TRAP CK

278 000
276 000
6 208 000
6 206 000

LEGEND

- WATER MONITORING SITE
- PROPOSED MONITORING LINES
- PROPOSED MONITORING PEGS
- PROPOSED CREEK MONITORING PEGS
- PROPOSED CREEK CROSSLINES
- PROPOSED GNSS
- INSTALLED GNSS
- CRITICAL POLES MONITORING WATERCOURSE

Grid to MGA co-ordinates

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TAHMOOR SOUTH PROJECT MANAGEMENT PLAN LW S1A TO LW S6A

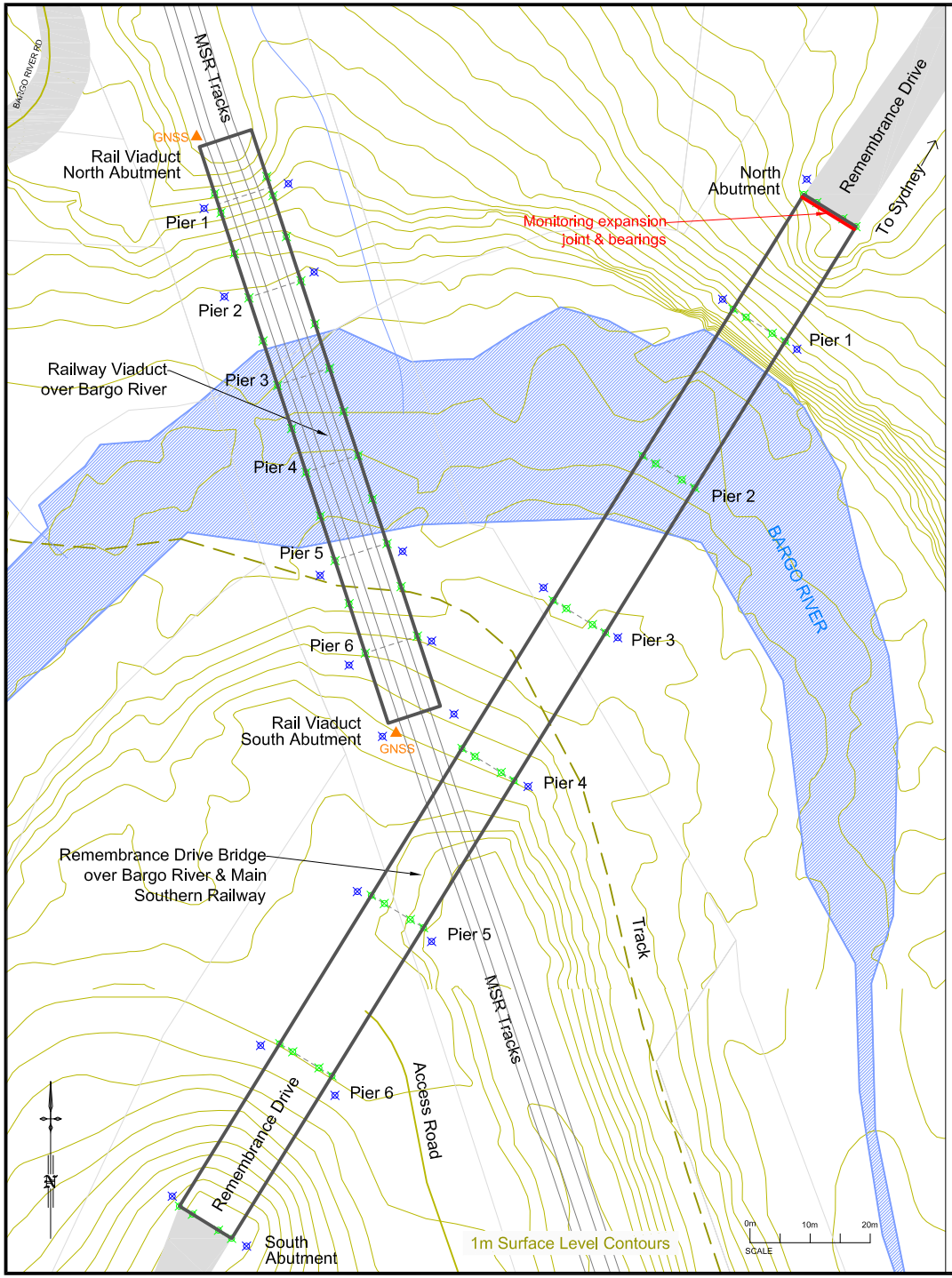
SYDNEY WATER
POTABLE WATER INFRASTRUCTURE

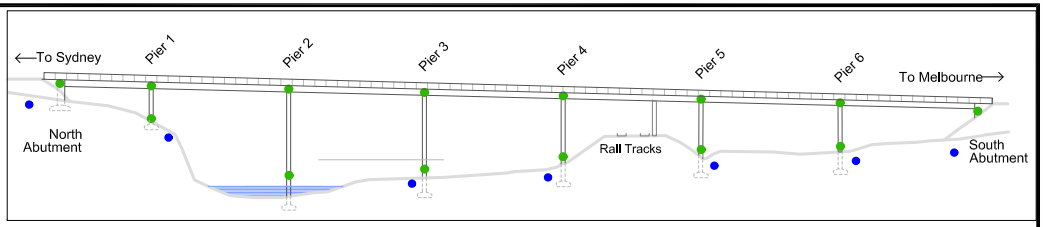
DATE:	SCALE:	DRAWING No:	Rev No
21 Oct 2022	1:25000	MSEC1193-04-01	A

PIPE SIZE
- 100 mm Ø
- 150 mm Ø
- 200 mm Ø
- 250 mm Ø
- 300 mm Ø
- 375 mm Ø
- 450 mm Ø
- 500 mm Ø
- 600 mm Ø
- Stop Valves

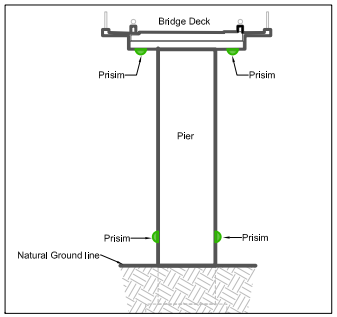
STUDY AREA
LW S1A
LW S2A
LW S3A
LW S4A
LW S5A
LW S6A
Hidden Creek
Hidden Creek
TEATREE HOLLOW
TRIBUTARY OF TEATREE HOLLOW
TRIBUTARY 2 OF DOG TRAP CREEK
TRIBUTARY 1 OF DOG TRAP CREEK
BARGO RIVER
DOGTRAP CK
TANK
Bargo River Rd over Railway
Railway Viaduct
Bargo River Rd over tributary
Remembrance Drive Bridge
Wellers Rd Bridge (WR-BR1)
Kader St bridge (KS-BR1)
PICTON DAM WALL
(D-section) Type: DICL Size: 375mmØ Size: 100mmØ
Type: CICL Size: 450mmØ
(T-section) Type: SCL Size: 450mmØ
Type: CICL Size: 100mmØ
Type: CICL Size: 200mmØ
Type: DICL Size: 100mmØ
Type: CICL Size: 100mmØ
Type: DICL Size: 100mmØ
(T-section) Type: CICL Size: 150mmØ
Type: DICL Size: 200mmØ
BYRON
STOKES
REMEMBRANCE
NOORAMEMA
STRATFORD
ROCK
HAWKI
276 000
278 000
6 208 000
6 206 000
6 204 000
JUMBUNNA
OLIVE
REMEMBRANCE DR
CALOOLA
YARRAN
CHARLIES POINT
WELLERS
CLAREMONT
FLORENCE
NORMA
ASHLEY
DOVES
ELY
HOGANS
SCOT
THORNCROFT
HAMBRIDGE
LOANE
AUSTIN
HUDSON
ROSS
PHILLIPA
LAURA
JACQUELINE
BIART
KADER
DAINE
GWYNN HUGHES
MIMOSA
CAMBRIAN
PANORAMA
MANOR
MAHOGANY
BERRICO
NGONG
GREAT SOUTHERN
ANTHONY
IRONBARK
WATTLE
GOVERNMENT
RAYMOND
BARGO
N
Grid to MGA co-ordinates

I:\Projects\Tahmoor South\MSEC1193 - LW S1A-S6A Management Plans\MSEC1193 Bridges\AcadData\MSEC1193- Monit Bridges Rail Viaduct & Remebrance Dr.dwg

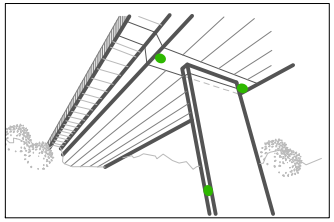




ELEVATION - REMEMBRANCE DRIVE BRIDGE OVER BARGO RIVER

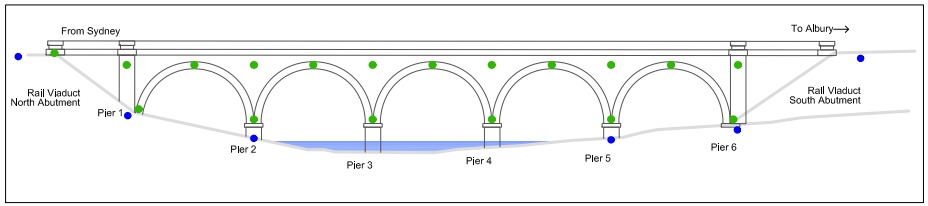


TYPICAL PIER (nts)



DIAGRAM

- PROPOSED STRUCTURE PRISMS
- PROPOSED GROUND PEGS



ELEVATION - RAIL VIADUCT OVER BARGO RIVER

LEGEND

- PROPOSED STRUCTURE PRISMS
- PROPOSED GROUND PEGS
- PROPOSED GNSS

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TAHMOOR SOUTH PROJECT
LWS1A TO LWS6A
MSR RAIL VIADUCT &
REMEMBRANCE DRIVE BRIDGE
OVER BARGO RIVER

DATE:	SCALE:	DRAWING No:	Rev No
19 Oct 2022	as shown	MSEC1193-03-02	B

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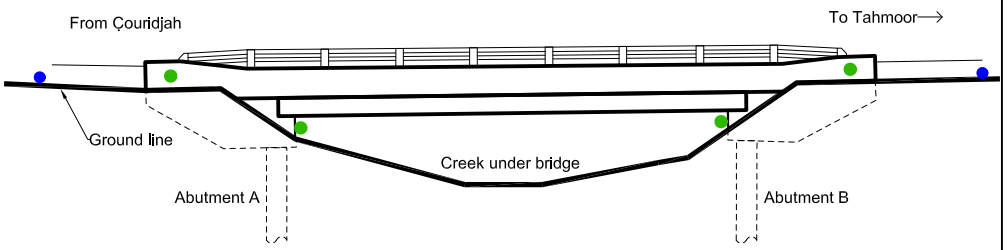
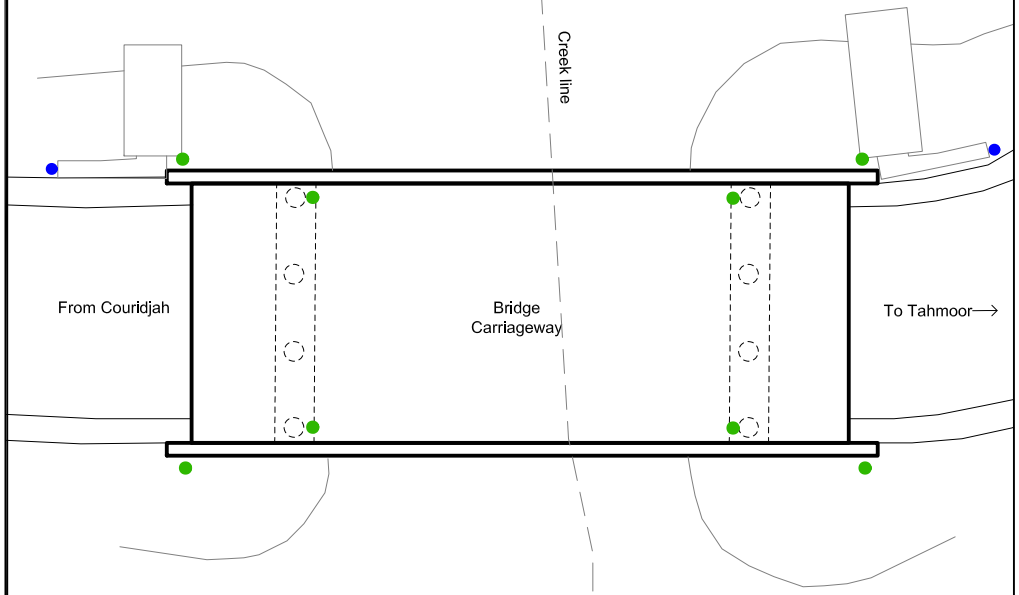
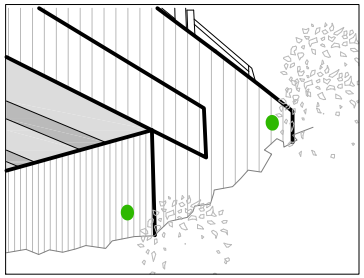


ELEVATION BRIDGE OVER CREEK

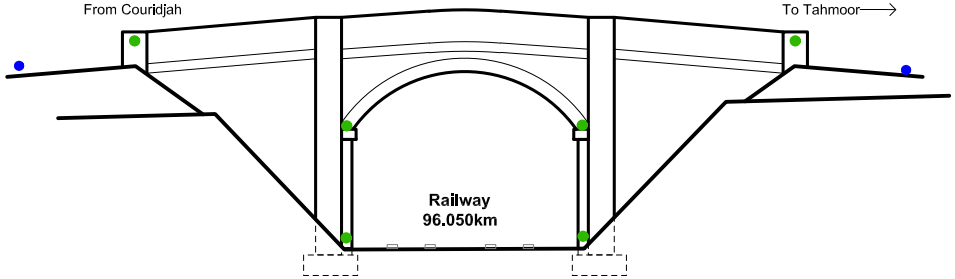


PLAN VIEW BRIDGE OVER CREEK

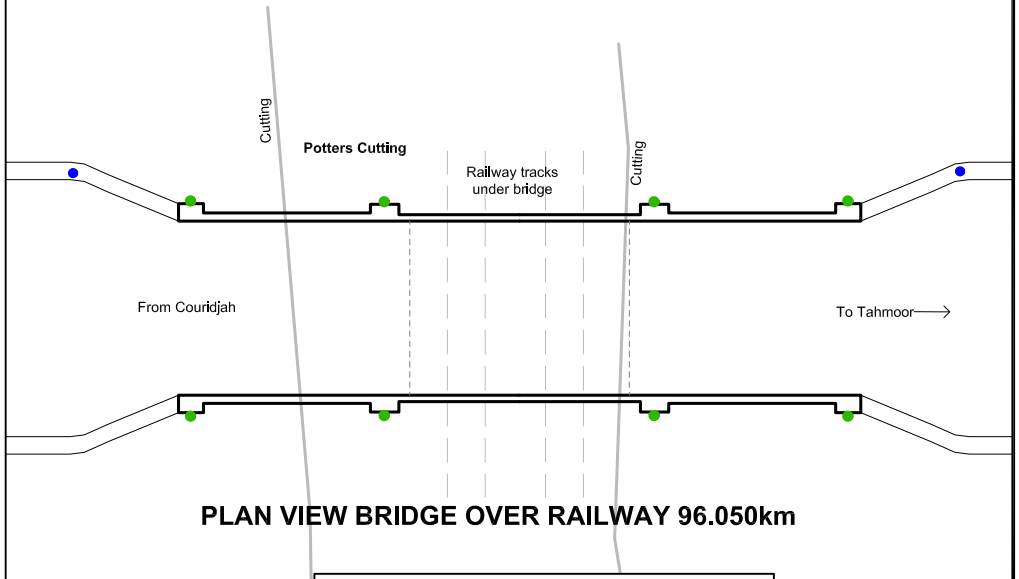
BARGO RIVER ROAD BRIDGE OVER TRIBUARY OF BARGO RIVER



TYPICAL



ELEVATION BRIDGE OVER RAILWAY



PLAN VIEW BRIDGE OVER RAILWAY 96.050km

BARGO RIVER ROAD BRIDGE OVER MAIN SOUTHERN RAILWAY

LEGEND

- PROPOSED STRUCTURE PRISMS
- PROPOSED GROUND PEGS

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BARGO RIVER ROAD BRIDGES

DATE:	SCALE:	DRAWING No:	Rev No
19 Oct 2022	nts	MSEC1193-03-03	B

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TAHMOOR SOUTH PROJECT
LWS1A TO LWS6B

REMEMBRANCE DRIVE EMBANKMENT OVER
TEATREE HOLLOW OVER LW S3A (RE4)

DATE:	SCALE:	DRAWING No:	Rev No
19 Oct 2022	as shown	MSEC1193-03-07	B

LEGEND
- ANCHOR POINTS
- STRAIN GAUGES
- SWITCHES
- MONITORING PEGS
- EMBANKMENT MONITORING PEGS
- EMBANKMENT MONITORING LINES
- BOREHOLES
- CULVERTS
- 1m SURFACE LEVEL CONTOURS

LEGEND
- 11kV POWERLINES
- GAS PIPELINE
- WATER PIPELINE
- SEWER PIPELINE
- OPTICAL FIBRE CABLES

0m 25m 50m
SCALE

N

853038

798853

LW S3A

LW S2A

ES4

AP4

99.460

99.500

99.560

Culvert 99.338

bus shelter

CALOOLA RD

SEWER PIPELINE

GAS PIPELINE

11kV POWERLINES

WATER PIPELINE

REMEMBRANCE DRIVE

Teatree Hollow

99.4 km

99.5 km

OPTICAL FIBRE CABLES

Main Southern Railway

EMBANKMENT 99.338 km

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TAHMOOR SOUTH PROJECT LWS1A TO LWS6B

REMEMBRANCE DRIVE EMBANKMENT NORTH OF YARRAN RD OVER LW S4A & LW S5A (RE3)

DATE:	SCALE:	DRAWING No:	Rev No
19 Oct 2022	as shown	MSEC1193-03-08	B

LEGEND
- ANCHOR POINTS
- STRAIN GAUGES
- SWITCHES
- MONITORING PEGS
- EMBANKMENT MONITORING PEGS
- EMBANKMENT MONITORING LINES
- BOREHOLES
- CULVERTS
- 1m SURFACE LEVEL CONTOURS

LEGEND
- 11kV POWERLINES
- GAS PIPELINE
- WATER PIPELINE
- SEWER PIPELINE
- OPTICAL FIBRE CABLES

0m 25m 50m
SCALE

CUTTING

LW S4A

LW S5A

11kV POWERLINES

GAS PIPELINE

EMBANKMENT
100.121 km

Culvert 100.121

AP6

EMBANKMENT

WATER PIPELINE

SEWER PIPELINE

REMEMBRANCE DRIVE

OPTICAL FIBRE CABLES

Main Southern Railway

100 km

100.1 km

100.2 km

100.3 km

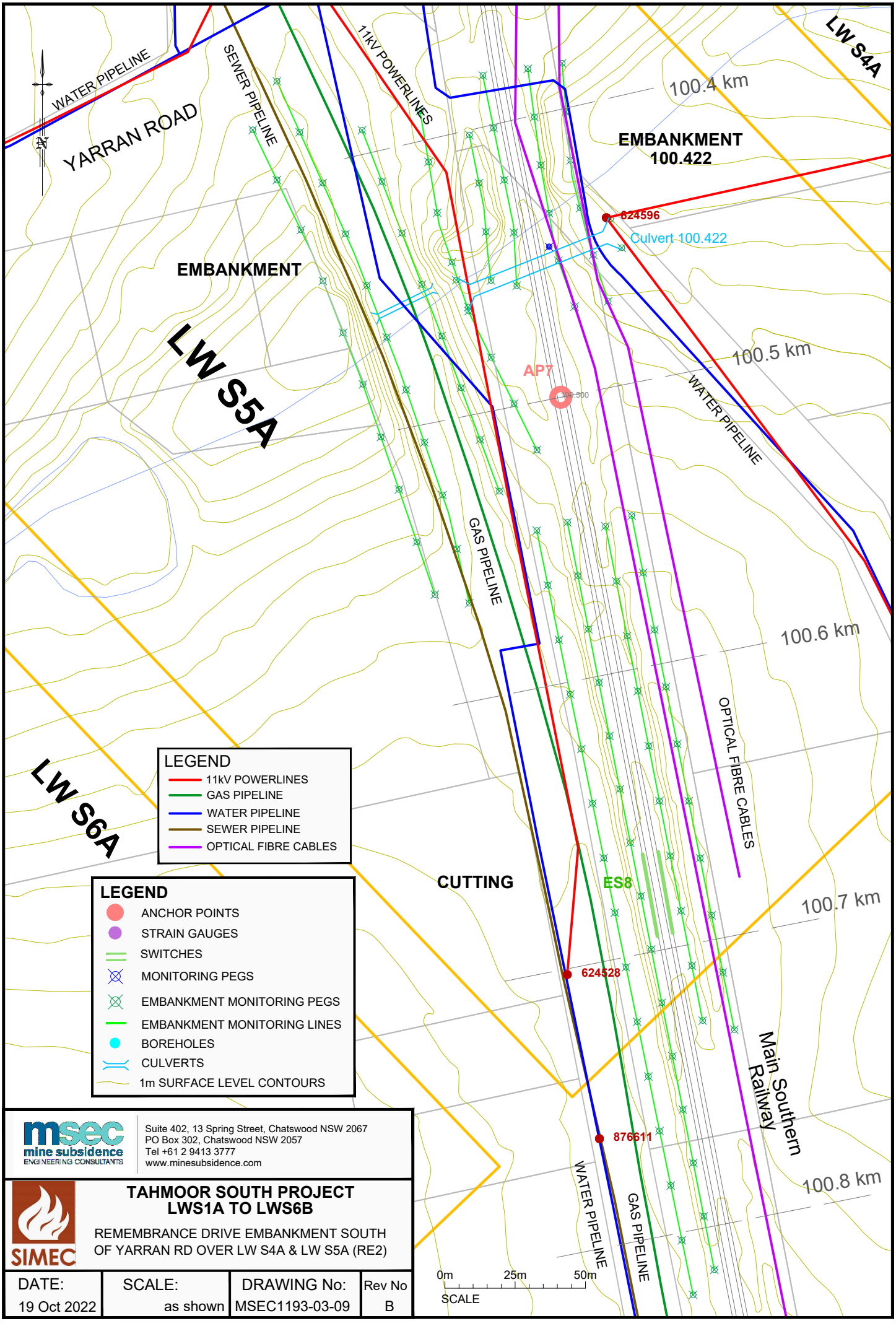
772375

ES7

To Yarran Rd

N

I:\Projects\Tahmoor South\MSEC1193 - LW S1A-S6A Management Plans\MSEC1193-03 Wollondilly Shire Council\AcadData\MSEC1193-03-09 Embkmt_Remembrance Dv_Yarran Road_LW S5A (RE2).dwg



LEGEND
- 11kV POWERLINES
- GAS PIPELINE
- WATER PIPELINE
- SEWER PIPELINE
- OPTICAL FIBRE CABLES

LEGEND
- ANCHOR POINTS
- STRAIN GAUGES
- SWITCHES
- MONITORING PEGS
- EMBANKMENT MONITORING PEGS
- EMBANKMENT MONITORING LINES
- BOREHOLES
- CULVERTS
- 1m SURFACE LEVEL CONTOURS

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TAHMOOR SOUTH PROJECT
LWS1A TO LWS6B

REMEMBRANCE DRIVE EMBANKMENT SOUTH OF YARRAN RD OVER LW S4A & LW S5A (RE2)

DATE:	SCALE:	DRAWING No:	Rev No
19 Oct 2022	as shown	MSEC1193-03-09	B

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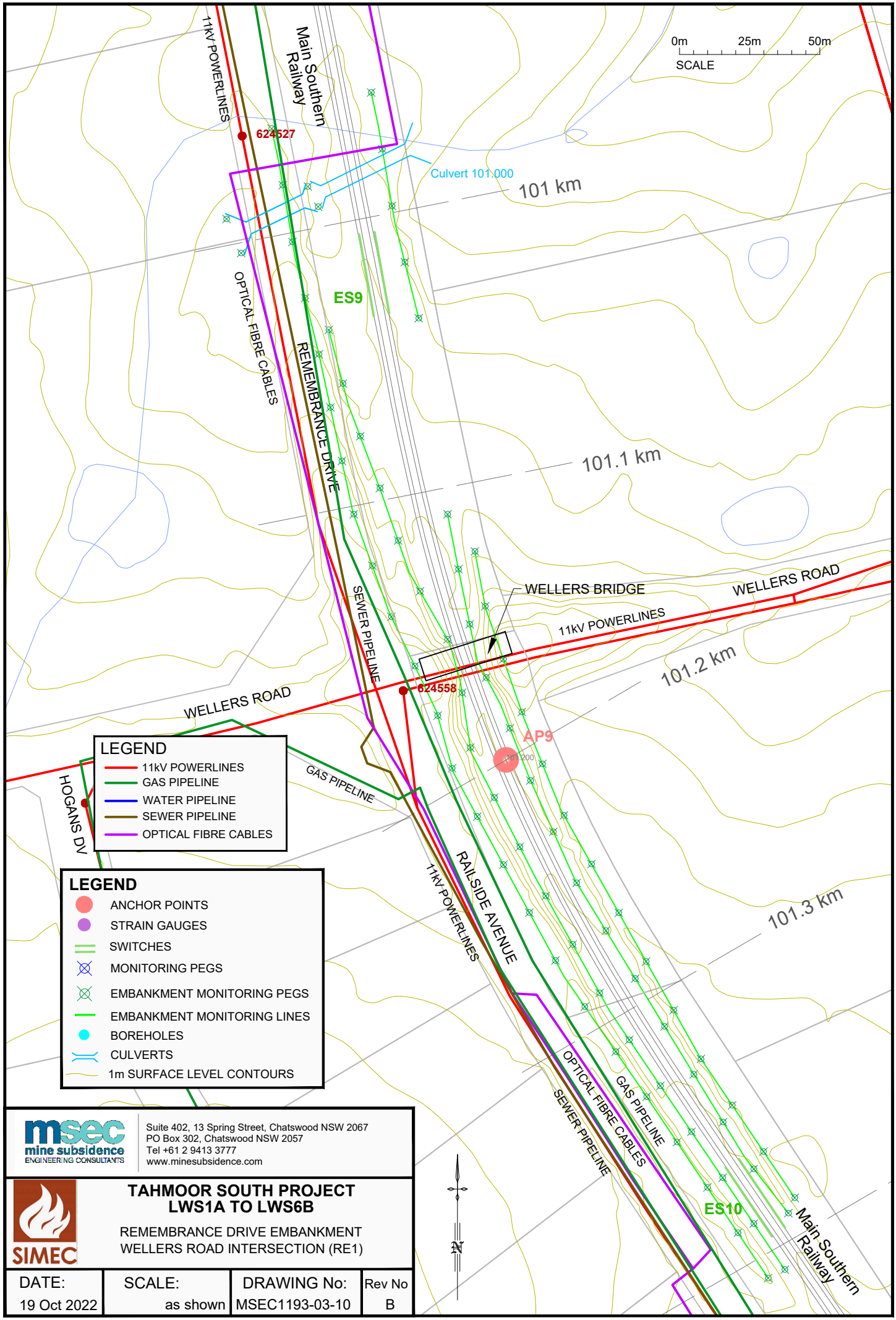

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TAHMOOR SOUTH PROJECT LWS1A TO LWS6B

REMEMBRANCE DRIVE EMBANKMENT
WELLERS ROAD INTERSECTION (RE1)

DATE:	SCALE:	DRAWING No:	Rev No
19 Oct 2022	as shown	MSEC1193-03-10	B

I:\Projects\Tahmoor South\MSEC1193 - LW S1A-S6A Management Plans\MSEC1193-03 Wollondilly Shire Council\AcadData\MSEC1193-03-11 Remembrance Dv Cutting_LW S4A.dwg

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TAHMOOR SOUTH PROJECT
LWS1A TO LWS6B

REMEMBRANCE DRIVE CUTTING NORTH OF YARRAN RD OVER LW S4A & LW S5A (RC1)

DATE:	SCALE:	DRAWING No:	Rev No
19 Oct 2022	as shown	MSEC1193-03-11	B

LEGEND
- 11kV POWERLINES
- GAS PIPELINE
- WATER PIPELINE
- SEWER PIPELINE
- OPTICAL FIBRE CABLES

LEGEND
- ANCHOR POINTS
- STRAIN GAUGES
- SWITCHES
- MONITORING PEGS
- EMBANKMENT MONITORING PEGS
- EMBANKMENT MONITORING LINES
- BOREHOLES
- CULVERTS
- 1m SURFACE LEVEL CONTOURS

0m 25m 50m SCALE

LW S3A
LW S4A
LW S5A
CUTTING
CUTTING
EMBANKMENT
100.121 km
GAS PIPELINE
SEWER PIPELINE
11KV POWERLINES
WATER PIPELINE
OPTICAL FIBRE CABLES
REMEMBRANCE DRIVE
Main Southern Railway
ES5
ES6
AP5
AP6
857627
396228
99.6 km
99.7 km
99.8 km
99.9 km
100 km
100.1 km
Culvert 100.121
To Yarran Rd
N

Equipment Risk Assessment: Tahmoor Underground - Sydney Water - Sewer and Potable Water

	Step 2: Assess Type; Key Elements-These change depending on TYPE of Risk Assessment			Step 3: Identify the risks, causes and potential consequences			Step 4: Identify the existing controls to manage the identified risks	Step 5: Determine RCE	Steps 6, 7 & 8: Determine the Expected Consequence / Likelihood applicable to the Expected Consequence / Current level of risk			Step 10: PMC		Step 11: Treat the Risks			
Appendix B	Type of Risk Assessment	Key Element (CURA Context/Category)	Sub Key Element (If applicable)	Risk Description - Something happens……	Consequence - resulting in:	Causes - Caused by	Existing Control Description	Risk Control Effectiveness	Expected Consequence Category	Expected Risk Consequence	Risk Likelihood	Current Risk Rating	Potential Maximum Consequence	Potential Maximum Category	Treatment plans/tasks (Description)	Task Owner	Due Date	Comments
Tahmoor Underground	Equipment	Sydney Water Sewer Main	Within Tahmoor South Study Zone and far field service crossings	Sydney Water Sewer PE180mm Pipe running along Remembrance Drive effected by Subsidence	Potential interruption / blocking of sewer service	1 Mining Induced Ground Movement 2 Potential Valley Closure 3 Leakage from cracked or blocked pipe	Inherent Control: 1. Public Notification of service issues direct to Sydney Water 2. Designed PE Pipe for Main Supply - designed to handle subsidence impacts. 3. All domestic residence within subsidence zone are on contain Septic systems (council). Monitoring Controls as per Tahmoor Coal Sydney Water SEWER Management Plan: 4. Survey Monitoring plan 5. Visual Inspections and reporting 6. Geotechnical inspections and reporting during active mining subsidence of embankments and cuttings. 7. Review, Report and Technical meetings to review and assess trending data. Trigger Response Action Plan: Trigger Response Action Plan: 8. Contained within the Management is a staged Trigger response to potential high strain locations including excavating / uncoupling pipe to relieve pressure.	2	Health & Safety	3	E	6	3	Health & Safety	Seek advice on the potential installation of a pressure monitoring device on the pipe line to monitor pressure drops to pick up any ruptures/leaks etc. Post LW S1A.	Ross Barber		Tahmoor Coal has developed and implemented measures to successfully manage potential impacts on pipe services
Tahmoor Underground	Equipment														Confirm locations of valves / cross connections within the mining area and consider additional management measures.	Ross Barber		
Tahmoor Underground	Equipment			Sydney Water Sewer PE180mm Pipe running along Remembrance Drive effected by Subsidence	Environmental Impact	Rupture escape of sewer	Inherent Control: 1. Public Notification of service issues direct to Sydney Water 2. Designed PE Pipe for Main Supply - designed to handle subsidence impacts. 3. All domestic residence within subsidence zone are on contain Septic systems (council). Monitoring Controls as per Tahmoor Coal Sydney Water SEWER Management Plan: 4. Survey Monitoring plan 5. Visual Inspections and reporting 6. Geotechnical inspections and reporting during active mining subsidence of embankments and cuttings. 7. Review, Report and Technical meetings to review and assess trending data. Trigger Response Action Plan: 8. Contained within the Management is a staged Trigger response to potential high strain locations including excavating / uncoupling pipe to relieve pressure.	2	Environment	3	E	6	3	Environment	Confirm location of pipe along the road corridor to determine high risk locations to assist with contingency planning.	Ross Barber		Tahmoor Coal has developed and implemented measures to successfully manage potential impacts on pipe services
Tahmoor Underground	Equipment			Sydney Water Sewer 150mm (DICL) Pipe running on far field bridges effected by Subsidence	Environmental Impact	Rupture escape of sewer	Inherent Control: 1. Public Notification of service issues direct to Sydney Water 2. Designed Expansions / Bellows in Pipe for Main Supply - designed to handle subsidence impacts. 3. All domestic residence within subsidence zone are on contain Septic systems (council). Monitoring Controls as per Tahmoor Coal Sydney Water SEWER Management Plan: 4. Survey Monitoring plan 5. Visual Inspections and reporting 6. Geotechnical inspections and reporting during active mining subsidence of embankments and cuttings. 7. Review, Report and Technical meetings to review and assess trending data. Trigger Response Action Plan: 8. Contained within the Management is a staged Trigger response to potential high strain locations including excavating / uncoupling pipe to relieve pressure.	2	Environment	3	E	6	3	Environment	Investigate with Sydney Water the sensor on the Remembrance drive bridge supply is monitoring			
Tahmoor Underground	Equipment	Sydney Water Domestic road supply Services (not 450mm) (CICL) and (DICL)	Yarran Road 100mm & 200mm Coloola 100mm Remembrance Drive 100m	Sydney Water Potable 100 - 200mm Water Pipe running along streets to a series of houses effected by Subsidence	Potential interruption or damage to water supply to local residences	1 Mining Induced Ground Movement 2 Potential Valley Closure 3 Leakage from cracked or blocked pipe	Inherent Control: 1. Public Notification of service issues direct to Sydney Water 2. Inherent controls with spigot and socket joints Monitoring Controls as per Tahmoor Coal Sydney Water, Potable Management Plan: 3. Survey Monitoring plan 4. Visual Inspections and reporting 5. Review, Report and Technical meetings to review and assess trending data. Trigger Response Action Plan: 6. Contained within the Management is a staged Trigger response to potential high strain	2	Health & Safety	2	D	5	2	Health & Safety	Confirm locations of valves within the mining area and consider additional management measures.	Ross Barber		Tahmoor Coal has developed and implemented measures to successfully manage potential impacts on pipe services
Tahmoor Underground	Equipment	Sydney Water Domestic road supply Services	450mm (CICL) Water supply pipe running along Remembrance drive - under the MSR - along Great South Rd (Excluding Creek Crossings and Under MSR and Under Remembrance Drive)	Sydney Water 450mm Pipe running along Remembrance Drive effected by Subsidence	Potential interruption or damage to water supply to local residences Resulting in - Loss of water to Picton, Thirlmere, Buxton and Oakdale Reservoir's, supply issue - Damage to road reserve infrastructure form pipe failure	1. Mining Induced Ground Movement 2. Potential Valley Closure 3. Leakage from cracked or blocked pipe	Inherent Control: 1. Public Notification of service issues direct to Sydney Water 2. Inherent controls with spigot and socket joints 3. Sydney Water to maintain reservoirs above 90% during active subsidence to provide 24 / 48 hour repair time. Monitoring Controls as per Tahmoor Coal Sydney Water, Potable Management Plan: 3. Survey Monitoring plan 4. Visual Inspections and reporting 5. Review, Report and Technical meetings to review and assess trending data. Trigger Response Action Plan: 6. Contained within the Management is a staged Trigger response to potential high strain locations	2	Health & Safety	3	D	9	3	Health & Safety	Confirm locations of valves within the mining area and consider additional management measures.	Ross Barber		Tahmoor Coal has developed and implemented measures to successfully manage potential impacts on pipe services
Tahmoor Underground	Equipment		450mm (CICL) Water supply pipe running along Creek Crossings	Sydney Water 450mm Pipe running along Creek Crossings effected by Subsidence	Potential interruption or damage to water supply to local residences Resulting in - Loss of water to Picton, Thirlmere, Buxton and Oakdale Reservoir's, supply issue - Damage to road reserve infrastructure form pipe failure	1. Mining Induced Ground Movement 2. Potential Valley Closure 3. Leakage from cracked or blocked pipe	Inherent Control: 1. Public Notification of service issues direct to Sydney Water 2. Inherent controls with spigot and socket joints 3. Sydney Water to maintain reservoirs above 90% during active subsidence to provide 24 / 48 hour repair time. Monitoring Controls as per Tahmoor Coal Sydney Water, Potable Management Plan: 3. Survey Monitoring plan 4. Visual Inspections and reporting 5. Review, Report and Technical meetings to review and assess trending data. Trigger Response Action Plan: 6. Contained within the Management is a staged Trigger response to potential high strain	2	Community / Reputation	3	B	17	3	Community / Reputation	Investigate options for creek crossing mitigation (Teatree hollow and tributary's) prior to S3A to determine mitigation controls.	Ross Barber		
Tahmoor Underground	Equipment		450mm (CICL) Water supply pipe running along Remembrance drive - under the MSR - along Great South Rd	Sydney Water 450mm Pipe running Remembrance Drive Road Crossing and Rail Service Crossings effected by Subsidence	Potential interruption or damage to water supply to local residences Resulting in - Loss of water to Picton, Thirlmere, Buxton and Oakdale Reservoir's, supply issue - Damage to road reserve infrastructure form pipe failure	1. Mining Induced Ground Movement 2. Potential Valley Closure 3. Leakage from cracked or blocked pipe	Inherent Control: 1. Public Notification of service issues direct to Sydney Water 2. Inherent controls with spigot and socket joints Monitoring Controls as per Tahmoor Coal Sydney Water, Potable Management Plan: 3. Survey Monitoring plan 4. Visual Inspections and reporting 5. Review, Report and Technical meetings to review and assess trending data. Trigger Response Action Plan: 6. Contained within the Management is a staged Trigger response to potential high strain	2	Community / Reputation	4	D	14	4	Community / Reputation	Investigate options for mitigating impacts at crossings including temporary bypass lines and additional joints / flexible joints prior to mining LWS4A.	Ross Barber		
Tahmoor Underground	Equipment		450mm (CICL) Water supply pipe running along Bargo Riverbed	Sydney Water 450mm Pipe running across Bargo Riverbed	Potential interruption or damage to water supply to local residences Resulting in - Loss of water to Picton, Thirlmere, Buxton and Oakdale Reservoir's, supply issue - Damage to road reserve infrastructure form pipe failure	1. Mining Induced Ground Movement 2. Potential Valley Closure 3. Leakage from cracked or blocked pipe	Inherent Control: 1. Public Notification of service issues direct to Sydney Water 2. Inherent controls with spigot and socket joints Monitoring Controls as per Tahmoor Coal Sydney Water, Potable Management Plan: 3. Survey Monitoring plan 4. Visual Inspections and reporting 5. Review, Report and Technical meetings to review and assess trending data. Trigger Response Action Plan: 6. Contained within the Management is a staged Trigger response to potential high strain	3	Community / Reputation	4	E	10	4	Community / Reputation				