msec mine subsidence ENGINEERING CONSULTANTS

SIMEC

SIMEC Mining:

Tahmoor North Western Domain Longwalls West 3 and West 4

Management Plan for potential impacts to Sydney Water Sewer Infrastructure

Sydney WATER

 | REPORT NUMBER: MSEC1173-09 | REVISION B

AUTHORISATION OF MANAGEMENT PLAN

Authorised on behalf of Tahmoor Coal:	
Name:	Zina Ainsworth
Signature:	
Position:	Environment and Community Manager
Date:	2nd Feb 2022

Authorised on behalf of Sydney Water:	
Name:	David Cantlon
Signature:	
Position:	/ Operations Lead, West
Date:	02/02/22

DOCUMENT REGISTER

Date	Report No.	Rev	Comments
Oct-21	MSEC1173-09	A	Draft for submission to Sydney Water
Jan-22	MSEC1173-09	B	Final for submission to Sydney Water

References:-

AS/NZS 4360:1999 Risk Management

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

MSO (2017) Managing risks of subsidence – Guide | WHS (Mines and Petroleum Sites) Legislation, NSW Department of Planning & Environment, Resources Regulator, Mine Safety Operations, February 2017.

MSEC (2021) Tahmoor Coal - Longwalls W3 and W4 - Subsidence Predictions and Impact Assessments for Natural and Built Features due to the extraction of the proposed Longwalls W3 and W4 in support of the Extraction Plan Application. (Report No. MSEC1112, Revision 4, March 2021), prepared by Mine Subsidence Engineering Consultants.

Sydney Water (2018) Risk and Opportunity Matrix, Sydney Water, Version 7.0

Tahmoor Coal (2020) Risk Assessment Report – Infrastructure. Tahmoor North – Western Domain, Longwalls West 3 and West 4, September 2020.

CONTENTS

LIST OF TABLES AND FIGURES

Tables

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

Figures

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

Drawings

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

Drawing No.	***Description***	***Revision***
MSEC1173-00-01	Monitoring plan	03
MSEC1173-09-01	Sewerage Infrastructure	C

1.1. Background

Tahmoor Mine is located approximately 80 km south-west of Sydney in the township of Tahmoor NSW. It is managed and operated by SIMEC Mining. Tahmoor Coal has previously mined 34 longwalls to the north and west of the mine's current location.

Longwalls West 1 and West 2 (LW W1-W2) were the first two longwalls to be mined in the Western Domain, located northwest of the Main Southern Railway and between the townships of Thirlmere and Picton.

Longwalls West 3 and West 4 (LW W3-W4) are the final two longwalls to be mined in the Western Domain. Sewer infrastructure owned by Sydney Water is located within this area.

A summary of the dimensions of LW W3-W4 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 W3	1552	283	39
LW W4	722	285	44

This Management Plan provides detailed information about how the risks associated with mining beneath Sydney Water's sewer 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 sewer assets potentially affected by LW W3-W4

The locations of Sydney Water's Sewer infrastructure in relation to LW W3-W4 are shown in Drawing No. MSEC1173-09-01.

The proposed longwalls do not mine directly beneath Sydney Water's sewerage infrastructure. The sewerage infrastructure comprises buried 100 mm and 150 mm diameter PVCPW pipelines along Thirlmere Way, alongside the Main Southern Railway corridor and behind properties on Hill Street, Picton. Buried 225 mm diameter PVC pipelines are located beneath Thirlmere Way and Rumker Street North, with a short 300 mm diameter length beneath the Main Southern Railway. A 300 mm diameter, PVC rising main is located in west Picton between Lumsdaine Street and Wild Street, approximately 640 metres to the east of LW W4 at closest point.

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-W2 (for potable water), and regular reporting of subsidence movements and impacts.

Details regarding consultation and engagement are outlined below:

- Provision of the draft Subsidence Management Plan for LW W3-W4 to Morteza Mousaviara (Sydney Water) in October 2021.
- Provision of final Subsidence Management Plan for LW W3-W4 following feedback provided by Morteza Mousaviara and Mohammed Islam (Sydney Water) during a meeting with Daryl Kay (MSEC) on 10 January 2022.

Tahmoor Coal will continue to consult regularly with Sydney Water during the extraction of LW W3-W4 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, Jemena, Telstra, NBN, TfNSW, Transport Heritage NSW and ARTC 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. MSEC1112 by Mine Subsidence Engineering Consultants (MSEC, 2021). Predictions are based on the planned configuration of LW W1-W2 at Tahmoor Coal (as shown in Drawing No. MSEC1173-09-01), 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 MSEC1112 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 sewer 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:

- Sewer pipelines

The pipelines are shown in Drawing No. MSEC1173-09-01, classified by pipe size and by pipe type.

The Management Plan only covers the sewer 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 W3-W4 only, and the rising main between Lumsdaine Street and Wild Street. The management plan does not include other sewer infrastructure owned by Sydney Water which lies outside the extent of this area. The management plan does not include sewer infrastructure that is owned and operated by Stonequarry Estate, which is located directly above LW W3.

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

1.7. Proposed mining schedule

It is planned that LW W3-W4 will extract coal working south from the northern end. This Management Plan covers longwall mining until completion of mining in LW W4 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 W3	September 2021 (commenced)	March 2022
LW W4	April 2022	August 2022

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.

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.

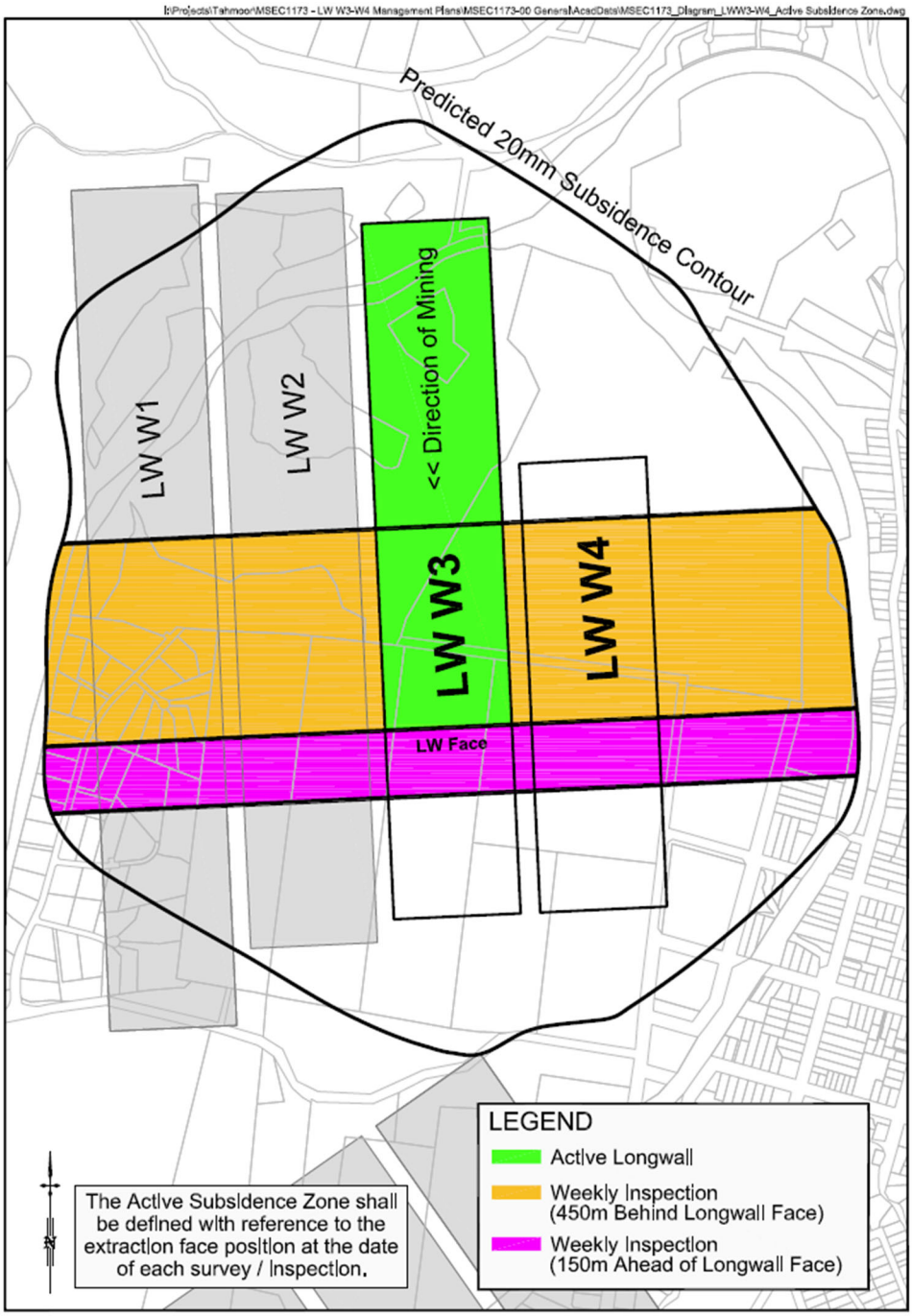


Fig. 1.1 Diagrammatic Representation of Active Subsidence Zone

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.subsideneadvisory.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 W3-W4 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.

The assessment was repeated using Sydney Water's risk criteria (2018), which is attached to the Appendix.

3.1. Maximum predicted conventional subsidence parameters

Predicted mining-induced conventional subsidence movements were provided in Report No. MSEC1112, which was prepared in support of Tahmoor Coal's Extraction Plan for LW W3-W4. A summary of the maximum predicted total subsidence parameters over the Study Area due to the extraction of LW W3-W4 are provided in Table 3.1.

Table 3.1 Maximum predicted conventional subsidence parameters for LW W3-W4

Longwall	Maximum predicted subsidence (mm)	Maximum predicted tilt (mm/m)	Maximum predicted hogging curvature (1/km)	Maximum predicted sagging curvature (1/km)
LW W3	950	5.0	0.06	0.10
LW W4	1025	5.0	0.06	0.10

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 for LW W1-W2

Predictions using MSEC's Incremental Profile Method have been continually tested and refined during the mining of previous Longwalls 22 to 32, as described in Report No. MSEC1112.

In this case, LW W1-W2 have been extracted in a new longwall series, which is located to the north of the completed LW 32.

LW W1

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 study on observed subsidence above previously extracted single panels at Tahmoor Mine was conducted by MSEC, with results provided in Report No. MSEC1112.

Ground surveys during the mining of LW W1 have found that subsidence has been substantially less than predicted (approximately 50%). The experience is new for Tahmoor Mine but it has been previously observed for nearby longwalls at Appin Colliery, including LW901 and the southern section of LW703.

A comparison between measured and predicted profiles of vertical subsidence along the Picton-Mittagong Loop Line are provided in Fig. 3.1 after the extraction of LW W1.

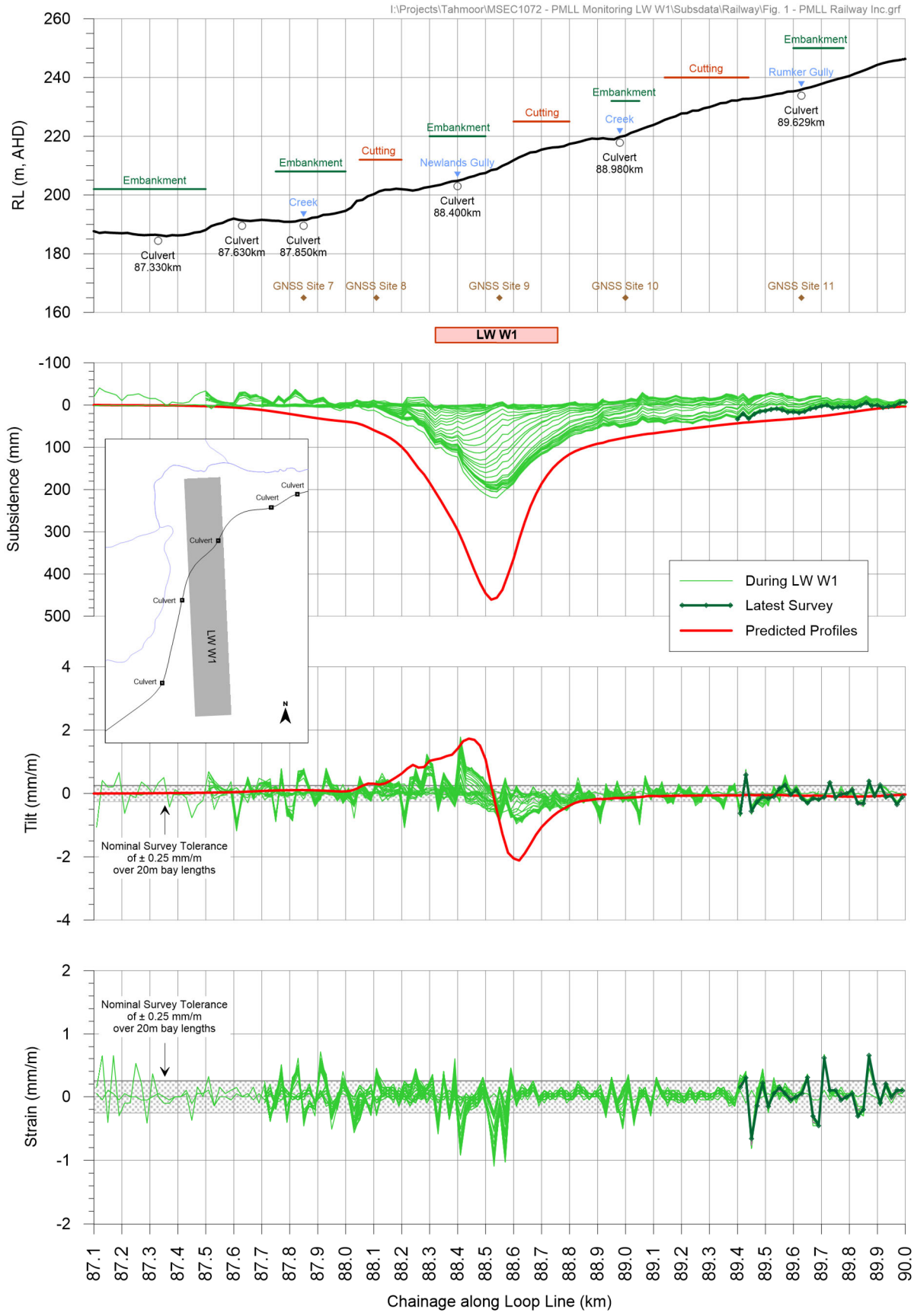


Fig. 3.1 Observed subsidence along Picton-Mittagong Loop Line during the mining of LW W1

LW W2

As of 1 June 2021, subsidence surveys above LW W2 have measured less subsidence than predicted. Observed subsidence along the Picton-Mittagong Loop Line after the extraction of LW W2 is shown in Fig. 3.2. Observed subsidence along the LW W1 W2 crossline after the extraction of LW W2 is shown in Fig. 3.3.

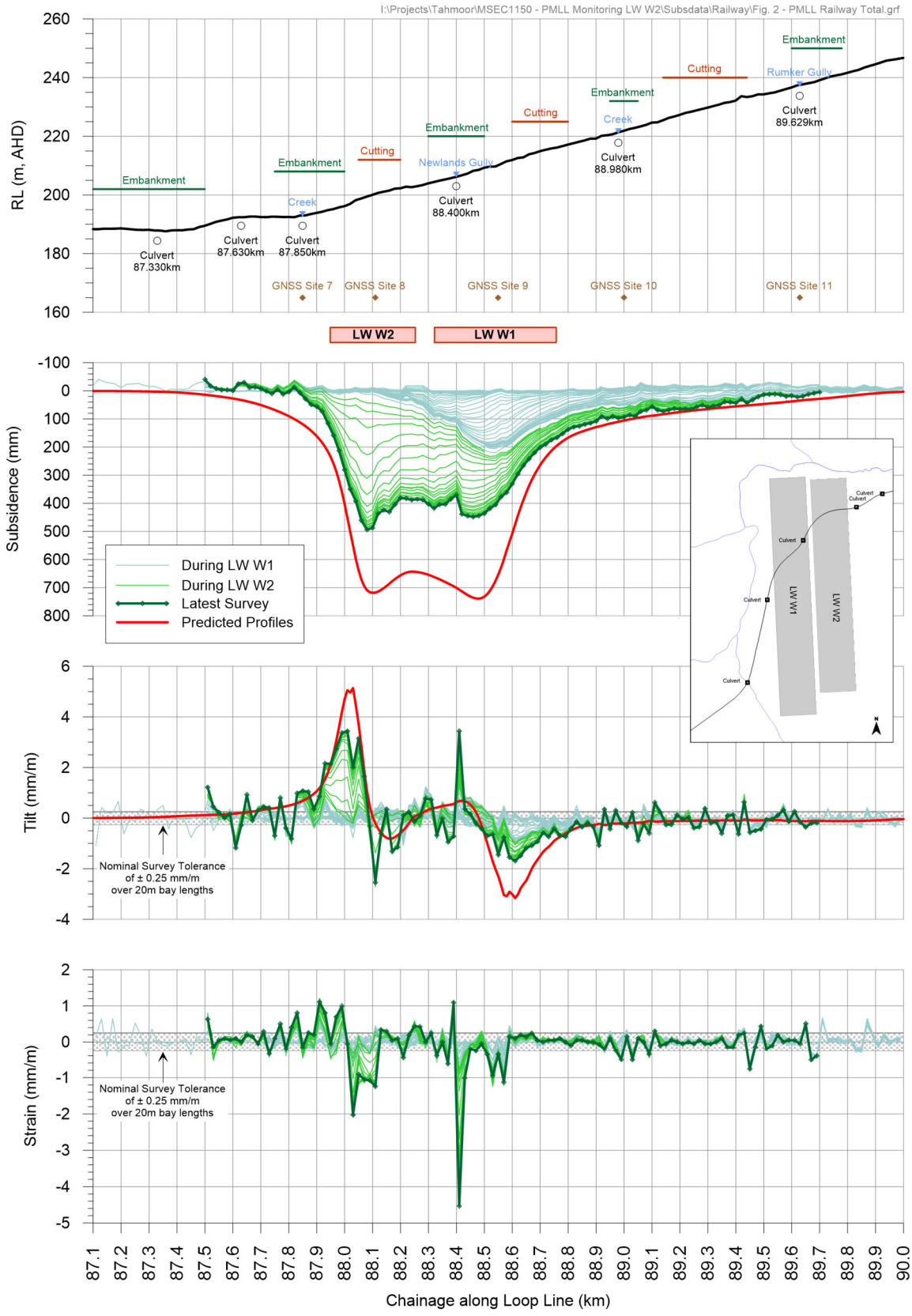


Fig. 3.2 Observed subsidence along Picton-Mittagong Loop Line during the mining of LW W1-W2

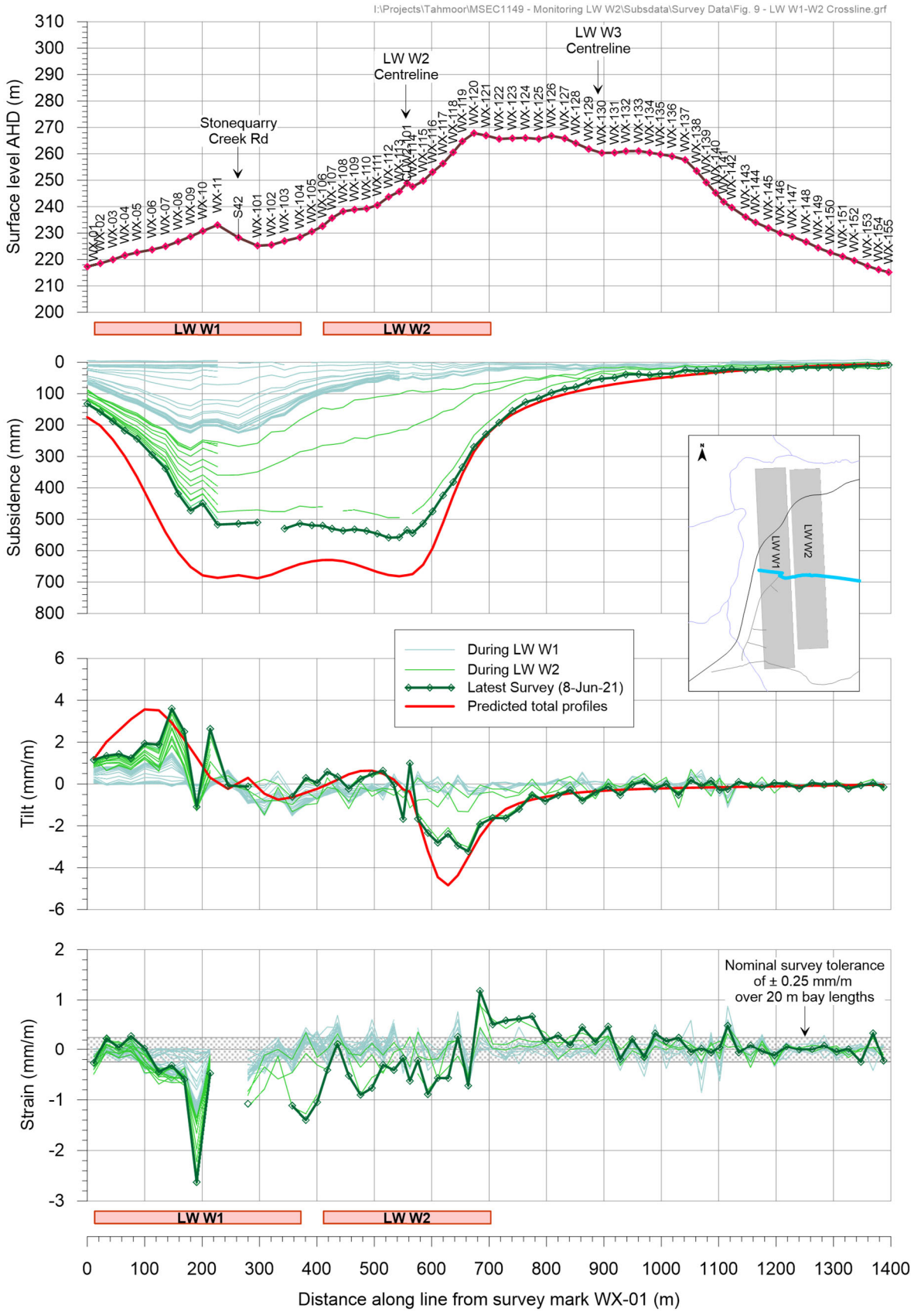


Fig. 3.3 Observed subsidence along LW W1-W2 crossline during the mining of LW W1-W2

Whilst observed subsidence above LW W1 and LW W2 was less than predicted, subsidence due to the extraction of LW W3-W4 may not follow the same pattern, and may return to normal levels. Subsidence may also be greater than predicted.

It is therefore planned to monitor the development of subsidence during the extraction of LW W3-W4 to compare observations with predictions. Measures have been developed in this Management Plan to manage potential impacts on Sydney Water's sewer infrastructure, even when actual subsidence is substantially greater than the magnitudes that have been predicted above LW W3-W4.

3.3. Nepean Fault

3.3.1. Identification of geological structures associated with the Nepean Fault

LW W3-W4 will be extracted alongside the Nepean Fault, which is a well-known regional scale geological feature that is an extension of the Lapstone Monocline.

The Nepean Fault is located east of the mining area. TC commissioned an engineering geologist from Strata Control Technology in 2018 (SCT, 2018a and 2018b) to undertake site inspections and mapping of the Nepean Fault. The investigations in 2018 examined a 12 kilometre section of the Nepean Fault Complex and focussed on the commencing end (southeastern end) of Longwall 32. This work has provided detailed information on the nature and location of the Nepean Fault and second order geological structures associated with the fault.

TC commissioned SCT to conduct a second detailed investigation of the Nepean Fault Complex in the vicinity of LW W4, specifically around the Picton Tunnel on the Main Southern Railway. SCT conducted field mapping and inspections in November 2020.

The geological structures as mapped by SCT (2020) have been overlaid with surface features within and adjacent to LW W3-W4. These are shown in Drawing No. MSE1163-01.

The Nepean Fault is mapped as "*an en-echelon distribution of first order faults with major offsets. Ramps are developed between these en-echelon fault surfaces. Numerous first order north-south faults, each of limited extent, step across the area investigated.*" (SCT, 2018a and SCT, 2020).

SCT (2018a) further advise that the fault zone is sub-vertical from surface to seam, based on site investigations and geological information gathered by Tahmoor Coal since 2014. The cross-section provided by SCT (2018a) has been reproduced in Fig. 3.4.

In addition to the mapped first order faults, SCT has mapped second order faults, which are described as "*mainly conjugate sets of strike slip faults and splay faults being observed between the en-echelon first order faults*" (SCT, 2018a and SCT, 2020).

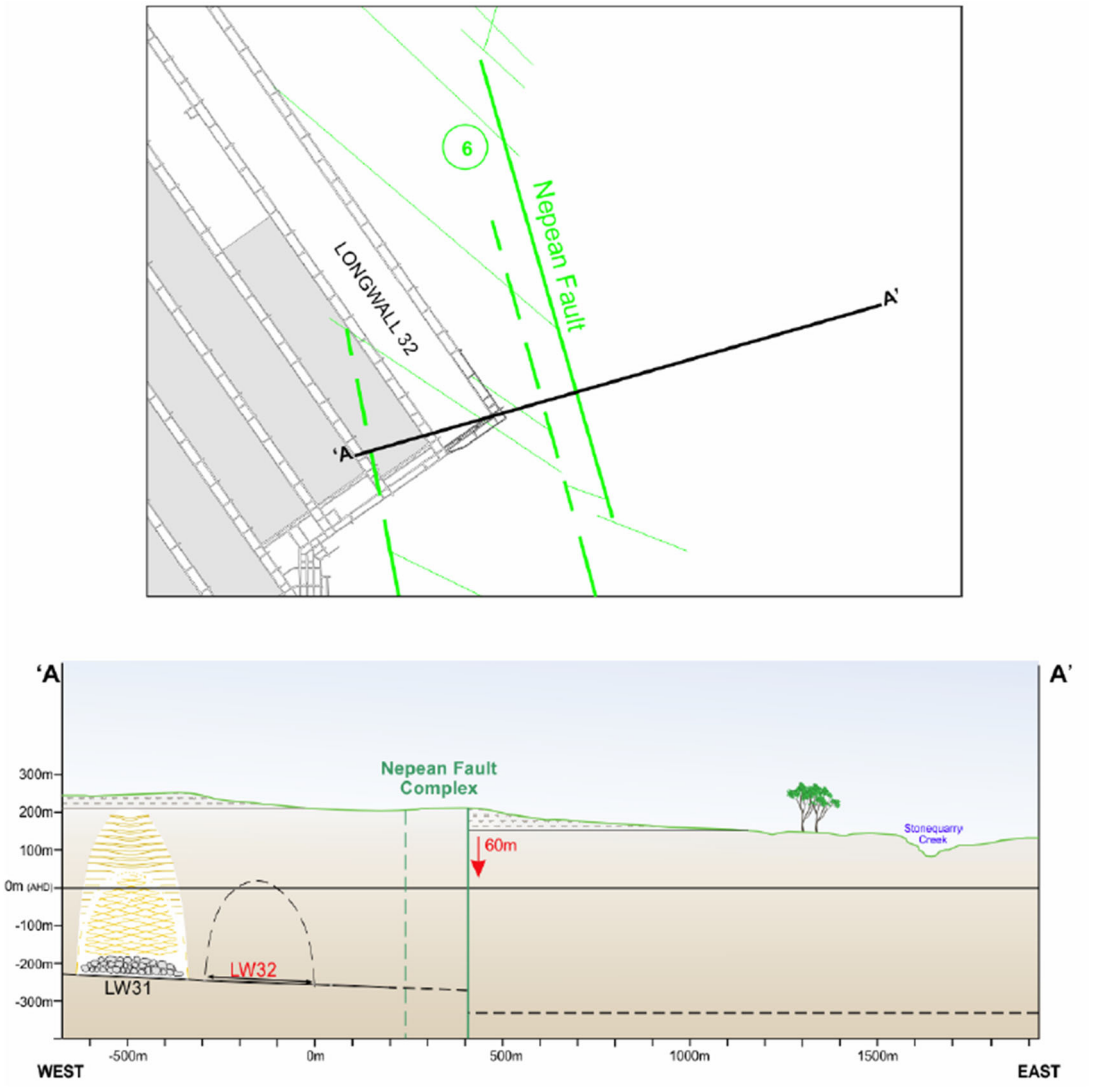


Fig. 3.4 Cross-section of Nepean Fault near Longwall 32 by SCT (2018a)

An updated map of the Nepean Fault Complex has been developed by SCT (2020), which has been reproduced in Fig. 3.5. SCT (2020) has summarised the results of the investigations:

- The Nepean Fault Complex is projected to pass through the Picton Tunnel and the Rising Main. The Picton Tunnel and Rising Main area is located within a fault ramp area.
- The structures in this area mainly comprises the terminal ends of the north-south trending fault segments, with minimal offsets distributed among the fault planes that are present. This is supported by visual inspections by an engineering geologist, observations of the terrain around the Picton Tunnel and a review of geotechnical coring investigations that have recently been completed alongside the Tunnel in December 2020.
- Field observations found no indication of disturbance of the strata immediately surrounding the Tunnel. Fault displacements were not readily observed in the area of the Tunnel, which is consistent with an interpretation that the first order faults have transitioned into multiple fault segments that have dispersed the fault displacements.
- The nature of the faulting within the Picton Tunnel area strongly indicates that the Nepean Fault Complex has formed in a tensile, “extensional”, environment.

The geological structures, as mapped by SCT (2020), have been overlaid with built structures within and adjacent to LW W3-W4. These are shown in Drawing No. MSEC1173-09-01.

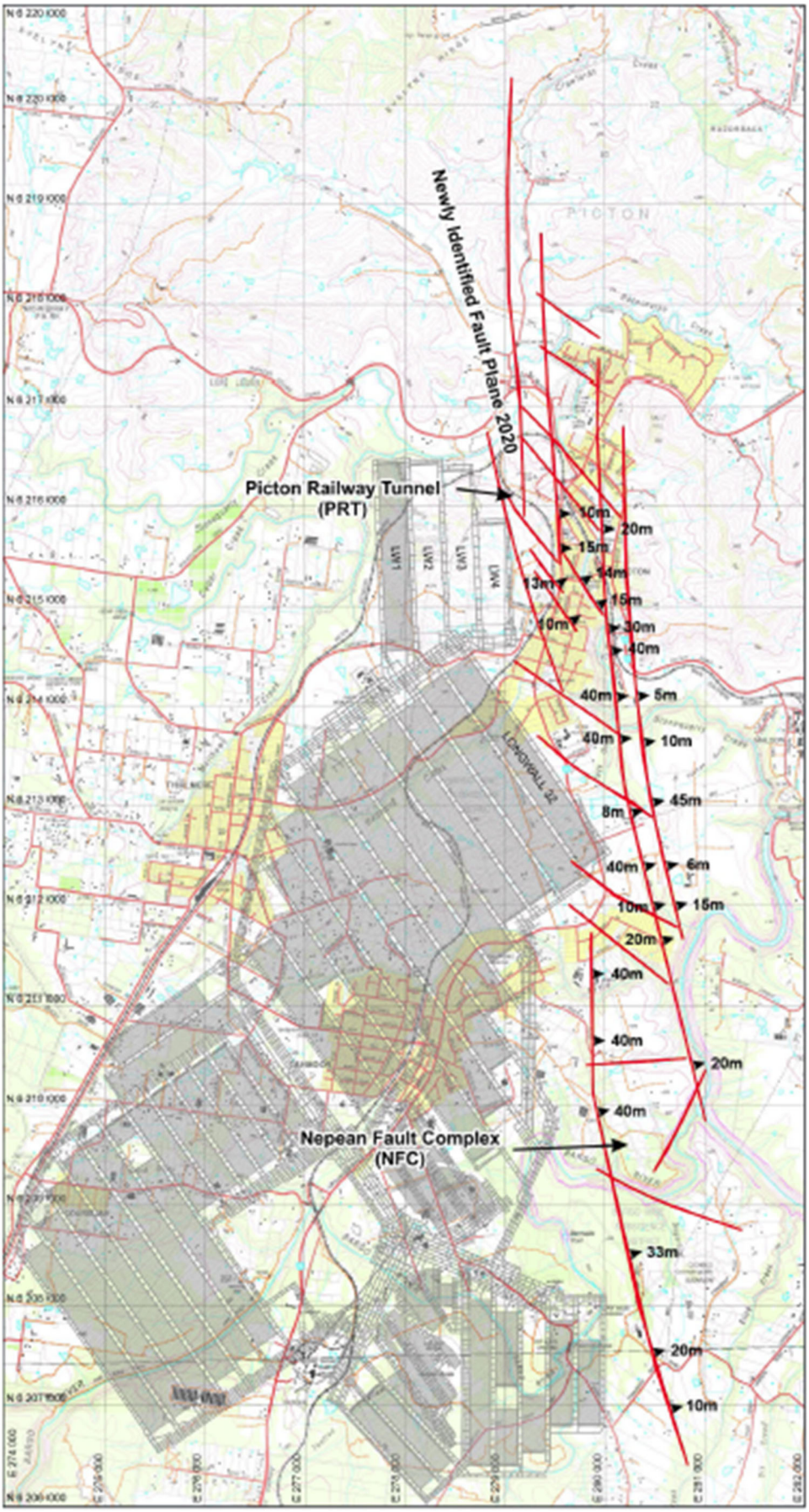


Fig. 3.5 Nepean Fault mapping superimposed on 1:25,000 topographic map (courtesy SCT, 2020)

Tahmoor Coal drilled an angled borehole in May 2021. The borehole was drilled from the top of the Picton Tunnel at a 45 degree vertical incline at a bearing of approximately 240 degrees. The location of borehole at the surface (Hole C) and the bearing is shown Fig. 3.6 and a photograph of the drilling operation is shown in Fig. 3.7.

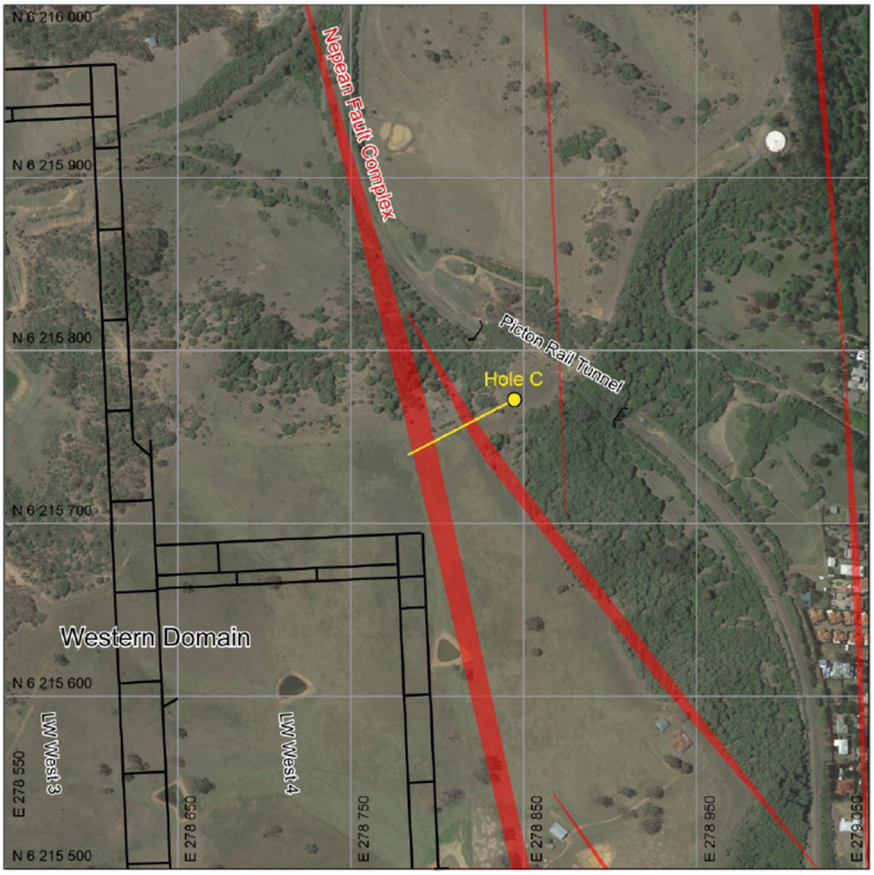


Fig. 3.6 Location and bearing of angled borehole at Picton Tunnel (courtesy SCT, 2021b)

Fig. 3.7 Drilling of borehole at Picton Tunnel

The fully cored borehole was supervised by a structural geologist from SCT (2021b). The aim of the angled borehole was to intersect and log the geological defects through two of the geological structures that were previously mapped to be associated with the Nepean Fault Complex.

SCT (2021b) advise that the borehole investigations have confirmed previously reported investigations. Two distinct zones of joints were identified in the core, corresponding to previously interpreted surface expressions of the Nepean Fault Complex.

SCT (2021b) plotted the position of the defects along the profile of the borehole and the result is shown in Fig. 3.8. The approximate position of the Picton Tunnel has been included for context.

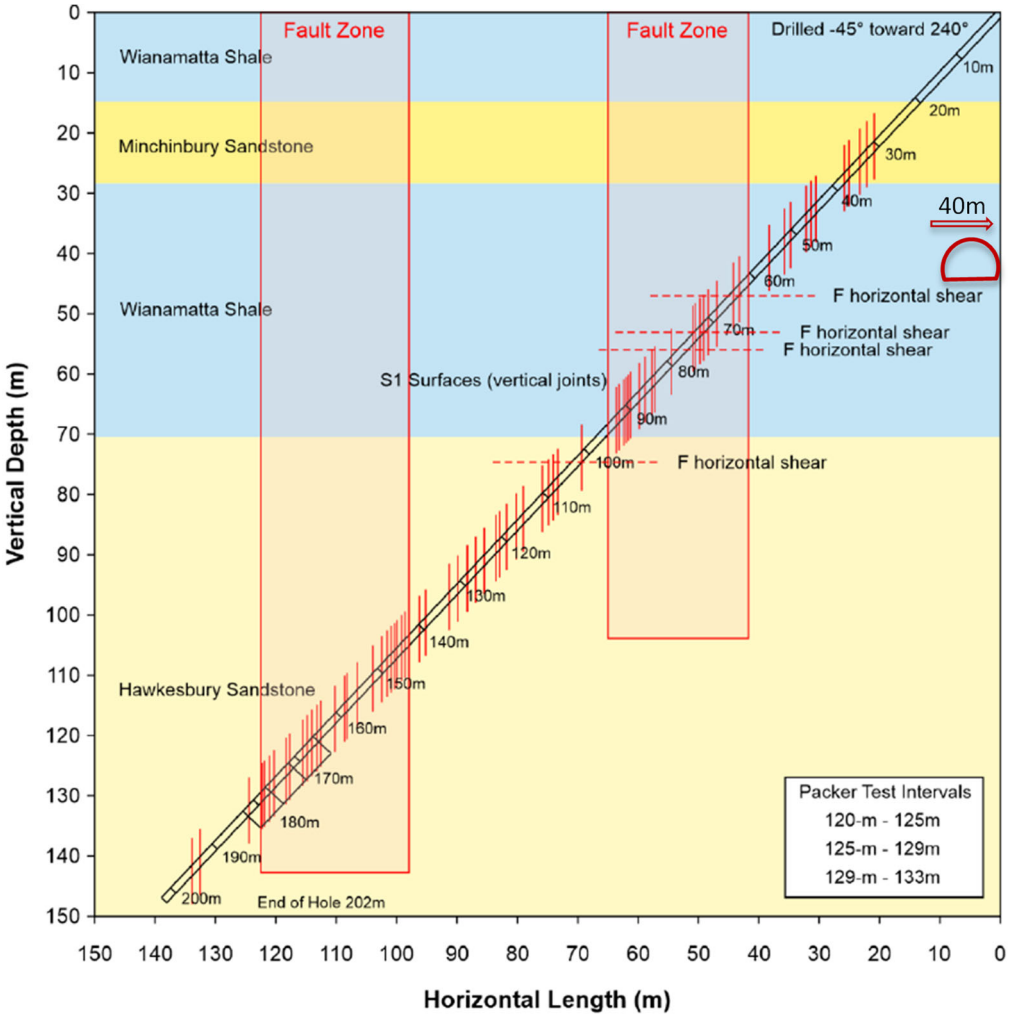


Fig. 3.8 Mapped defects along angle borehole (courtesy SCT, 2021b) with approximate elevation of Picton Tunnel included for context

Multiple sub-parallel, vertical joints were identified in the borehole, running parallel to the Nepean Fault Complex trends. The concentration of the joint surfaces correspond with the geomorphological weathered surface expression that was used to determine the fault positions.

The structures mapped as F in the log were found to be horizontal bedding slip planes. Three corresponded to one of the Nepean Fault complex structure zones and the fourth was most likely related to the interface between the Wianamatta Shale – Hawkesbury Sandstone formations.

SCT (2021b) conclude that the frequency, orientation and location of the vertical jointing locations within the borehole demonstrate that there is abundant potential for mining-induced movements from the extraction of LW W3-W4 to be dispersed as slip movements between the longwalls and the Picton Tunnel.

3.3.2. Experience of subsidence movements between previously extracted longwalls and Nepean Fault at Tahmoor Mine

Tahmoor Coal has surveyed subsidence along many streets during the mining of previous Longwalls 24A to 32. Some of these monitoring lines are located over solid, unmined coal, between the extracted longwalls and the Nepean Fault.

The survey lines cross first order faults to the side of Longwall 32 within the Picton Water Recycling Plant. The surveys also cross mapped second order conjugate faults including Stilton Dam Line, Remembrance Drive East Line and the Tahmoor and Picton Rising Mains.

A study has been completed to ascertain whether irregular subsidence have occurred along the survey lines.

The locations of the survey lines relative to the Nepean Fault and associated geological structures is shown in Fig. 3.9.

The monitoring lines examined included:

- LW24 Draw Line, due to the extraction of LWs 24A and 25;
- LW25-XS1 Line, due to the extraction of LWs 25 and 26;
- Greenacre Drive, due to the extraction of LWs 25 and 26;
- Tahmoor Road Line, due to the extraction of LWs 25 to 27;
- Myrtle Creek Avenue, due to the extraction of LWs 25 to 28;
- Moorland Road, due to the extraction of LWs 25 to 28;
- River Road South, due to the extraction of LWs 27 and 28;
- Park Avenue, due to the extraction of LWs 25 to 28;
- River Rd, due to the extraction of LWs 26 to 28;
- Stilton Dam Northern Line, due to the extraction of LWs 29 to 31;
- Remembrance Drive East, due to the extraction of LW31 and 32;
- Nepean Fault Line 1, due to the extraction of LW32 (refer Fig. 3.10);
- Nepean Fault Line 2, due to the extraction of LW32 (refer Fig. 3.11;
- Nepean Fault Line 3, due to the extraction of LW32 (refer Fig. 3.12);
- Picton Water Recycling Plant and Picton Rising Main, due to the extraction of LW32;
- Picton High School cross lines, due to the extraction of LW32;
- Coachwood Crescent, due to the extraction of LW32; and
- Wonga Road, due to the extraction of LW32.

The study found no increased subsidence, tilt or strains were measured along the survey lines that were located over unmined, solid coal areas between the extracted longwalls and the Nepean Fault.

A histogram of the maximum observed tensile and compressive strains measured along the selected survey lines for survey bays located over solid coal between previously extracted longwalls at Tahmoor Mine and the Nepean Fault is provided in Fig. 3.13. It can be seen from Fig. 3.13 that observed ground strains have been relative minor.

Three survey lines within the Picton Water Recycling Plant were installed to measure subsidence, tilt and strain across the Nepean Fault. As shown in Fig. 3.10 to Fig. 3.12, observed differential movements were relatively minor. No impacts were observed to the Plant structures.

The experiences observed to date have shown no significant differential movements across the Nepean Fault complex. While the possibility for significant differential movement across the Nepean Fault complex to the side of proposed LW W3-W4 cannot be ruled out, the likelihood is considered to be very low based on the experiences observed to date. This is supported by the assessment provided by SCT (2021).

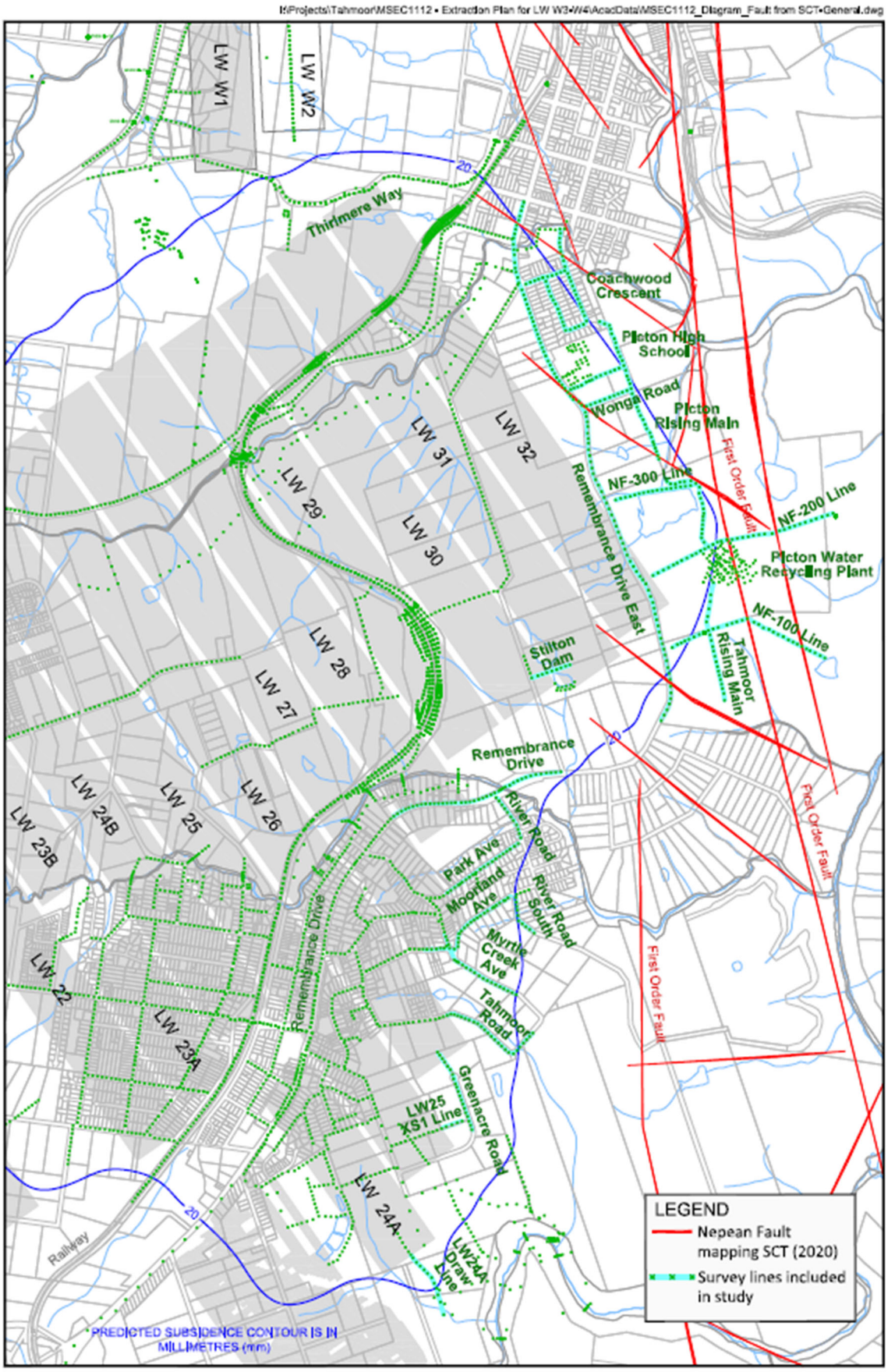


Fig. 3.9 Locations of ground survey lines in relation to the mapped geological structures by SCT (2018a and 2020) and streams

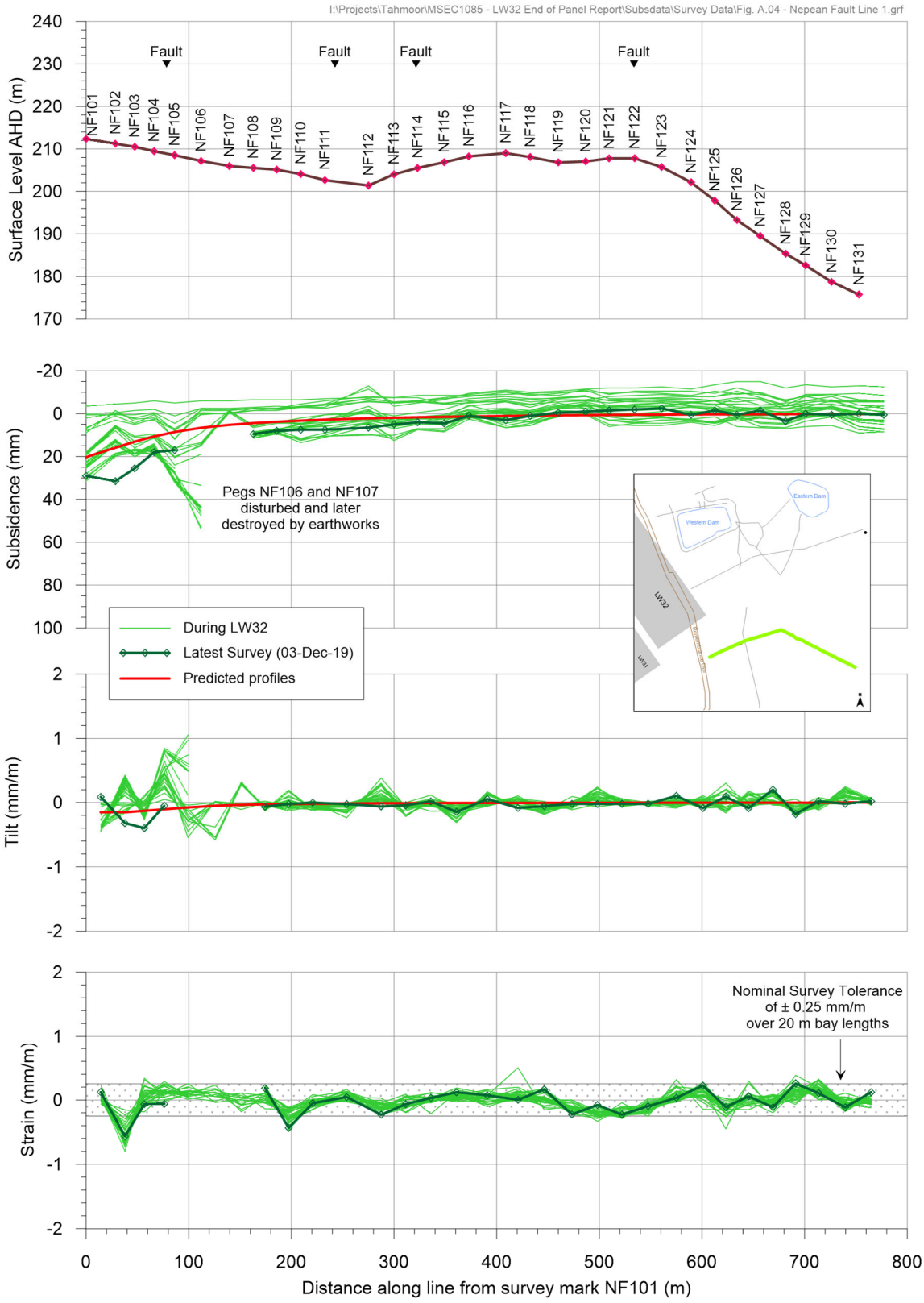


Fig. 3.10 Observed subsidence along the Nepean Fault Line 1 during the mining of LW32

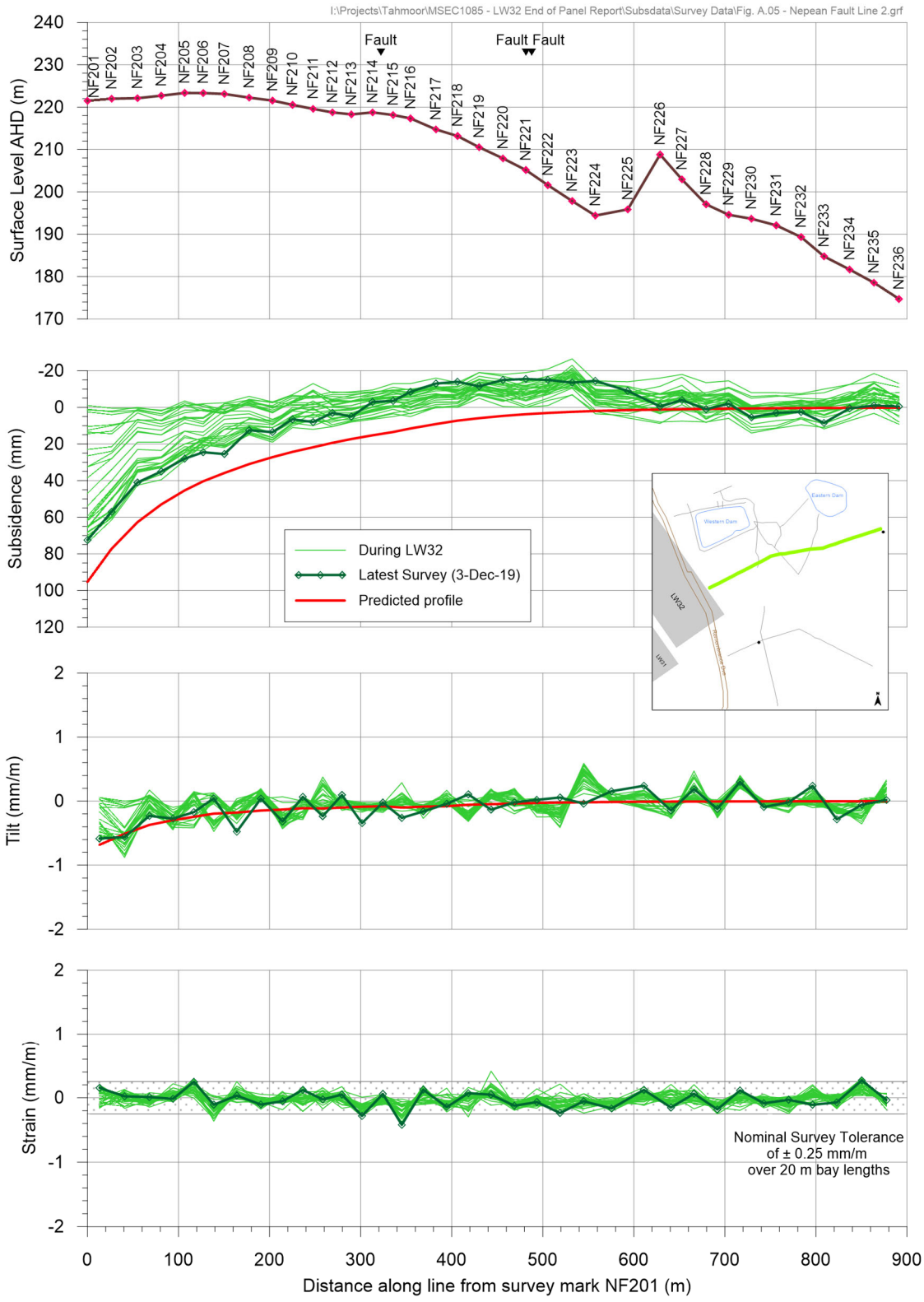


Fig. 3.11 Observed subsidence along the Nepean Fault Line 2 during the mining of LW32

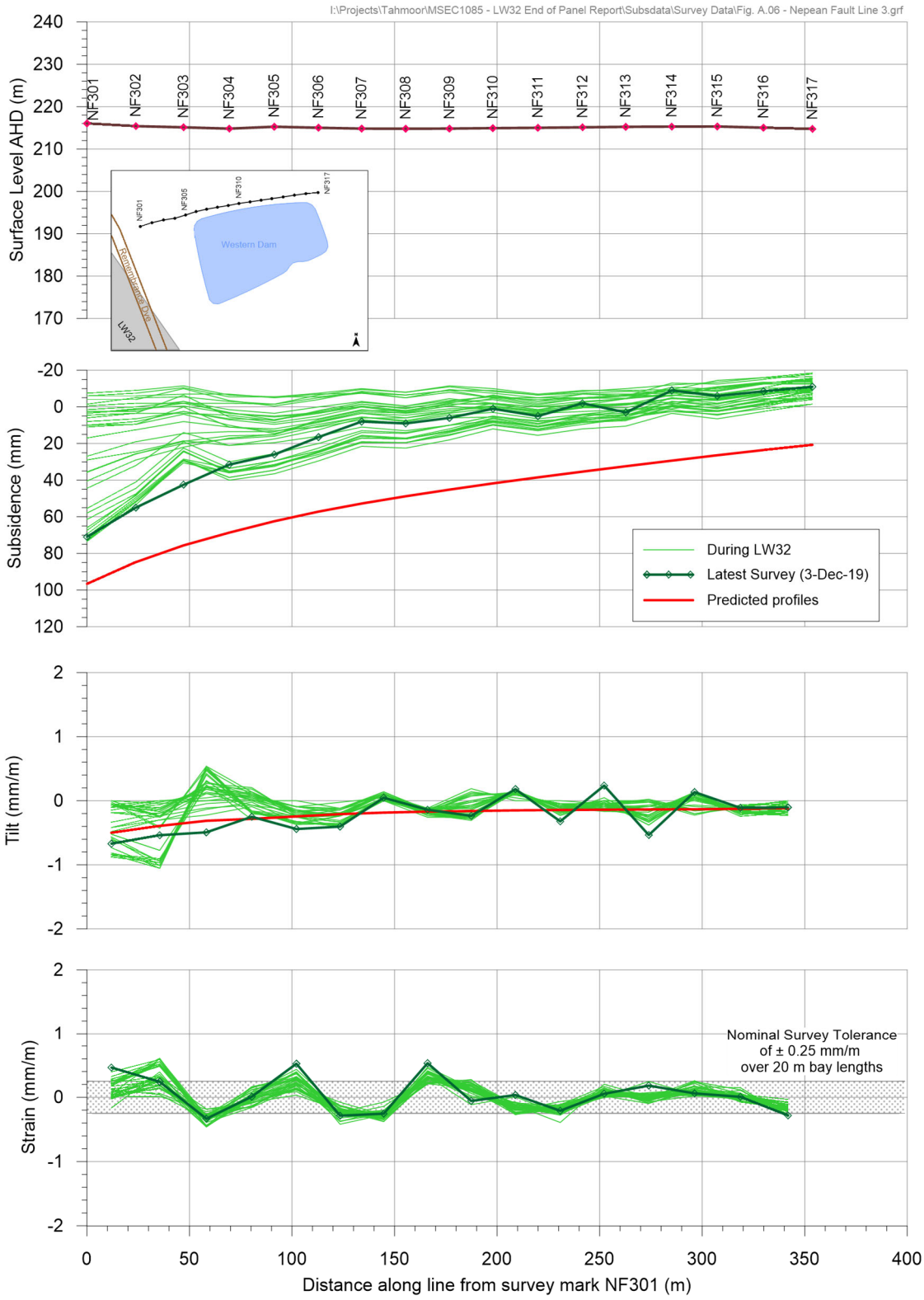


Fig. 3.12 Observed subsidence along the Nepean Fault Line 3 during the mining of LW32

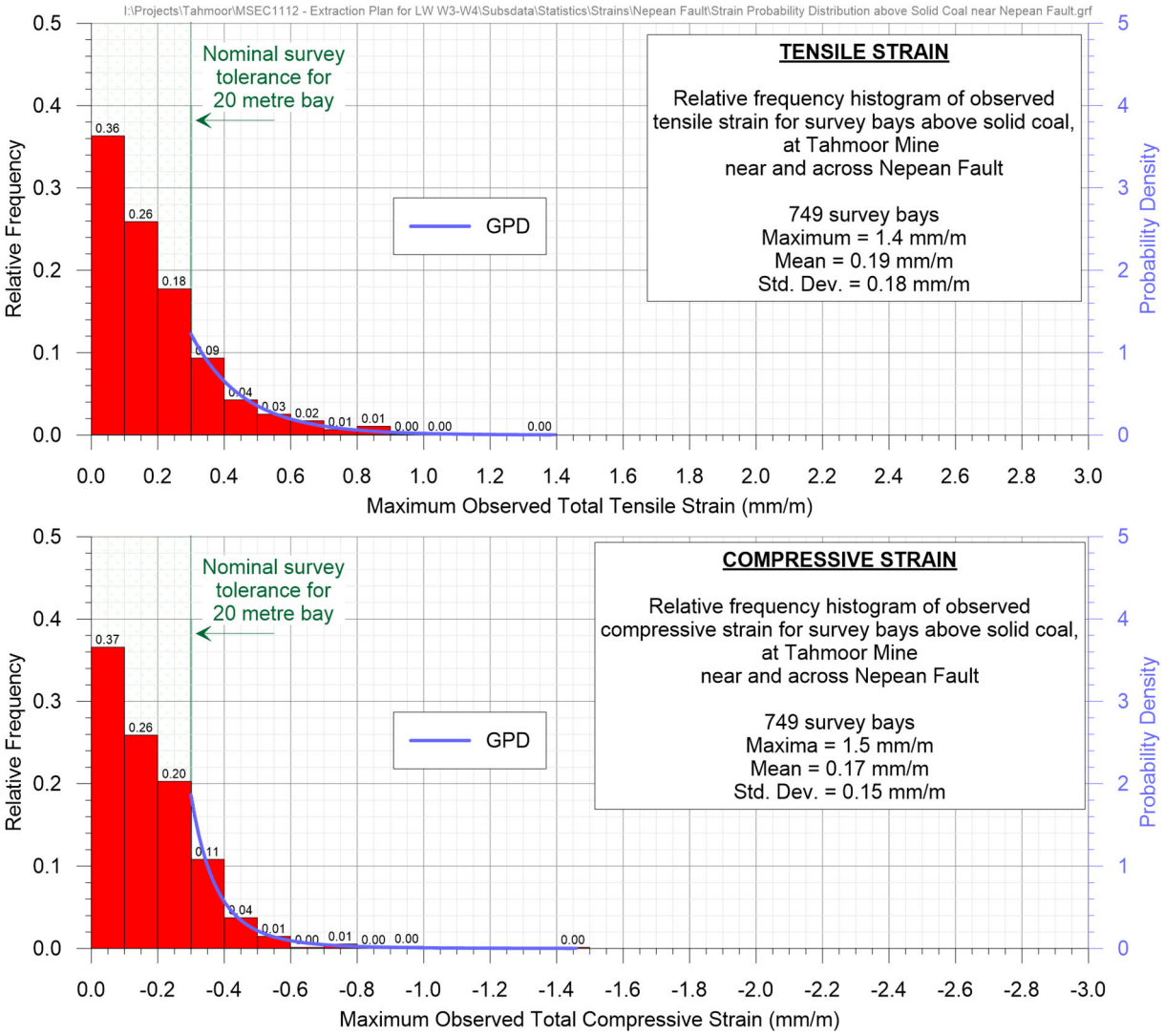


Fig. 3.13 Distributions of the measured maximum tensile and compressive strains for bays located over solid coal at Tahmoor Mine near and across the Nepean Fault

3.3.3. Experience of subsidence movements within the Nepean Fault Complex during the mining of Tahmoor LWs W1 to W3

Tahmoor Coal installed a far-field monitoring survey network around LW W1-W3, some of which commenced monitoring during the mining of LW 31.

The far field monitoring network includes a combination of traditional ground survey marks, whose positions were surveyed on a monthly basis and Global Navigation Satellite System (GNSS) units, which are fixed survey stations that continuously measure their absolute horizontal and vertical positions in real time.

The locations of the survey locations and the observed cumulative horizontal movements since the commencement of LW W1-W2 are shown in Fig. 3.14.

The ground has generally moved towards LW W1 during the mining of LW W1 and towards LW W2 during the mining of LW W2. Whilst greater horizontal movements have been observed on the western side of LW W1, it is noted that there are no survey locations to compare with at equivalent offset distances on the eastern side of LW W2.

With respect to the monitoring sites along the Main Southern Railway, the observed movements have been very small, within expectations and generally directed towards LW W1-W2. No measurable differential movements have been observed.

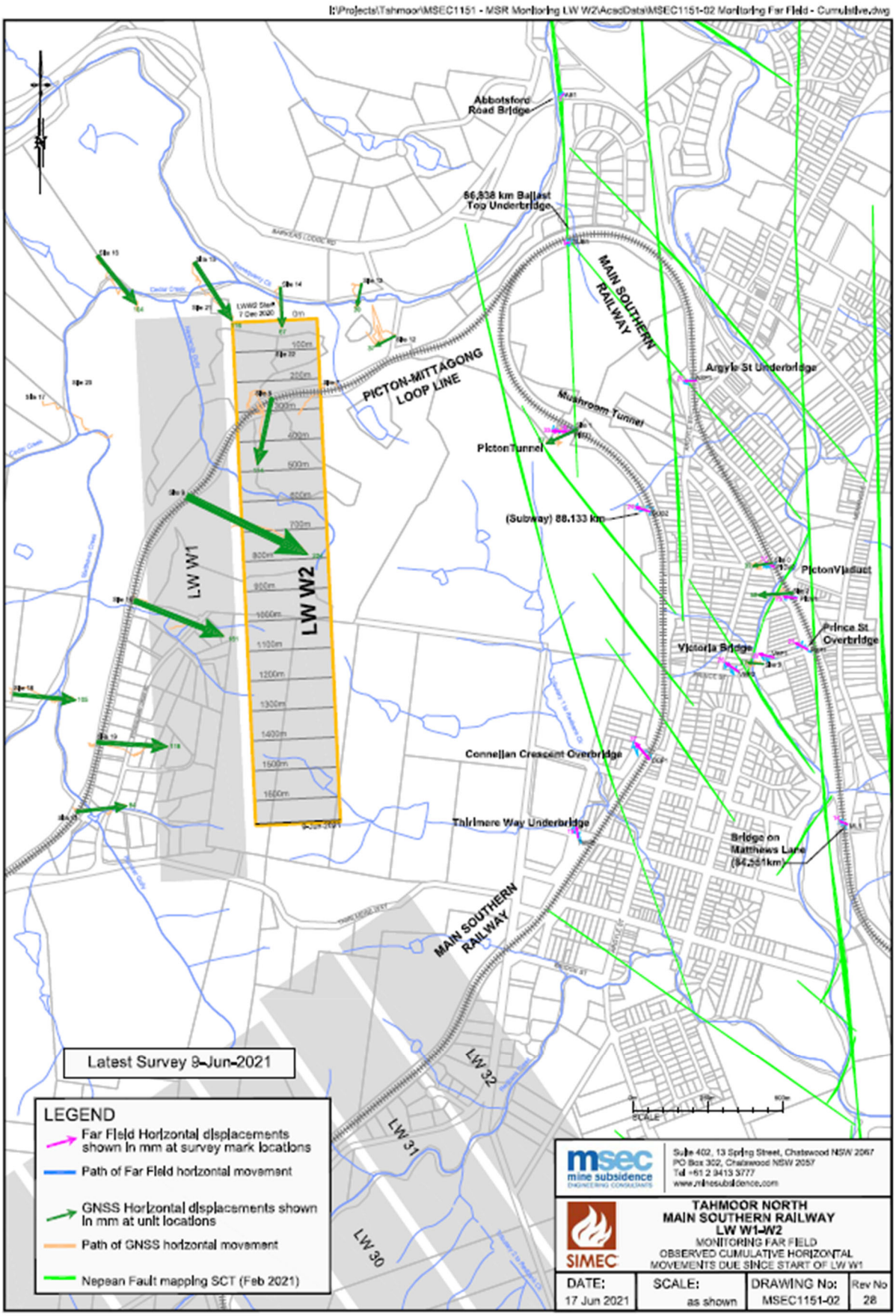


Fig. 3.14 Observed cumulative movements during the mining of LW W1-W2

Additional monitoring has been conducted during the first 1000 metres of extraction of LW W3, particularly along the Main Southern Railway, which lies between LW W3 and Sydney Water's Rising Main.

As shown in Fig. 3.15 and Fig. 3.16, very little horizontal movement, subsidence, tilt or strain has developed along the Railway during the mining of LW W3.

Extensive monitoring is also being conducted along the Main Southern Railway, including continuously operating rail stress gauges stationed every 120 metres along the track, weekly surveys of track geometry along the track at spacings and daily visual inspections. No adverse changes have been observed to date during the mining of LW W3.

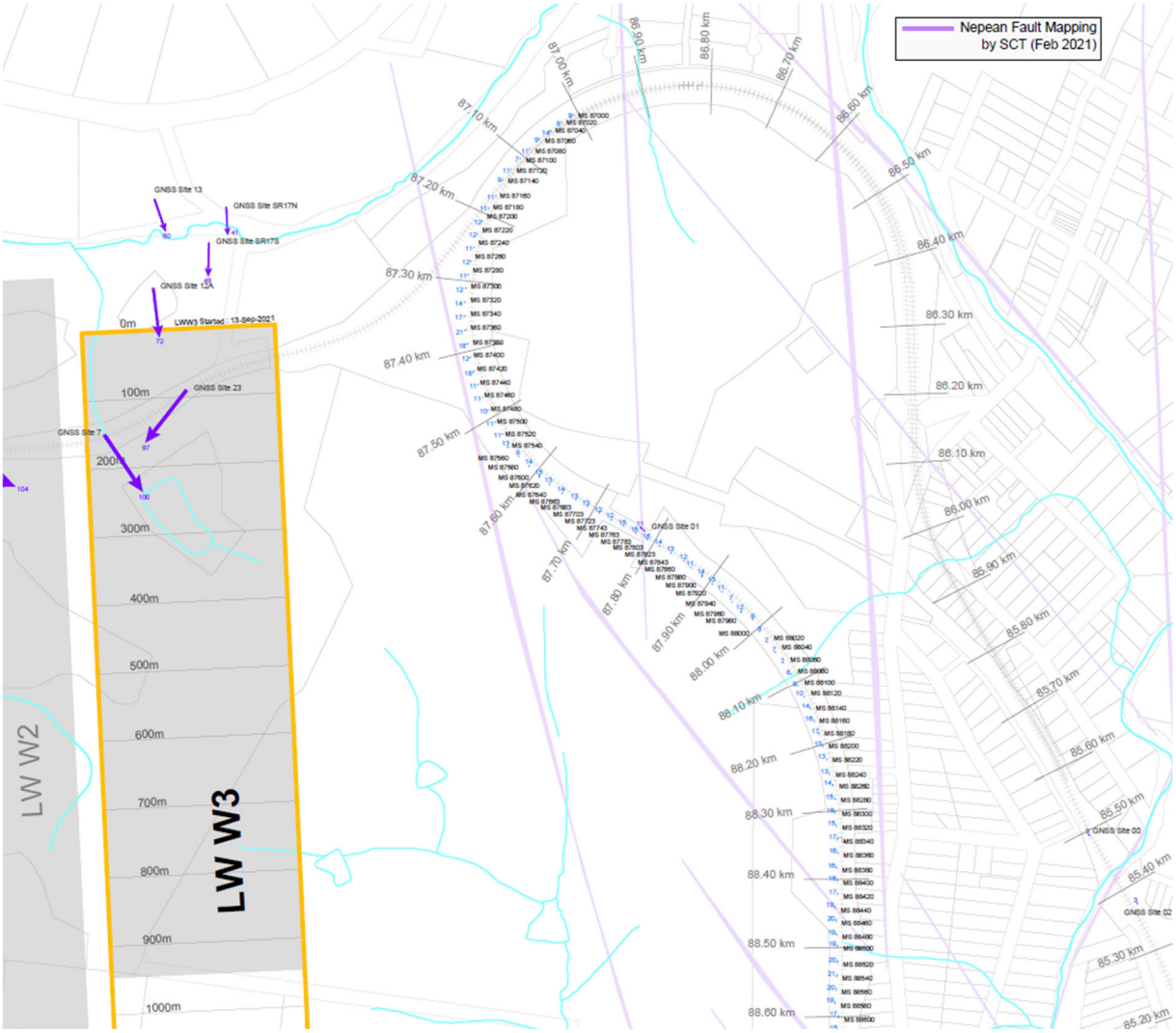


Fig. 3.15 Observed incremental horizontal movements during the mining of LW W3 as at 4 January 2022, at length of extraction of 946 metres

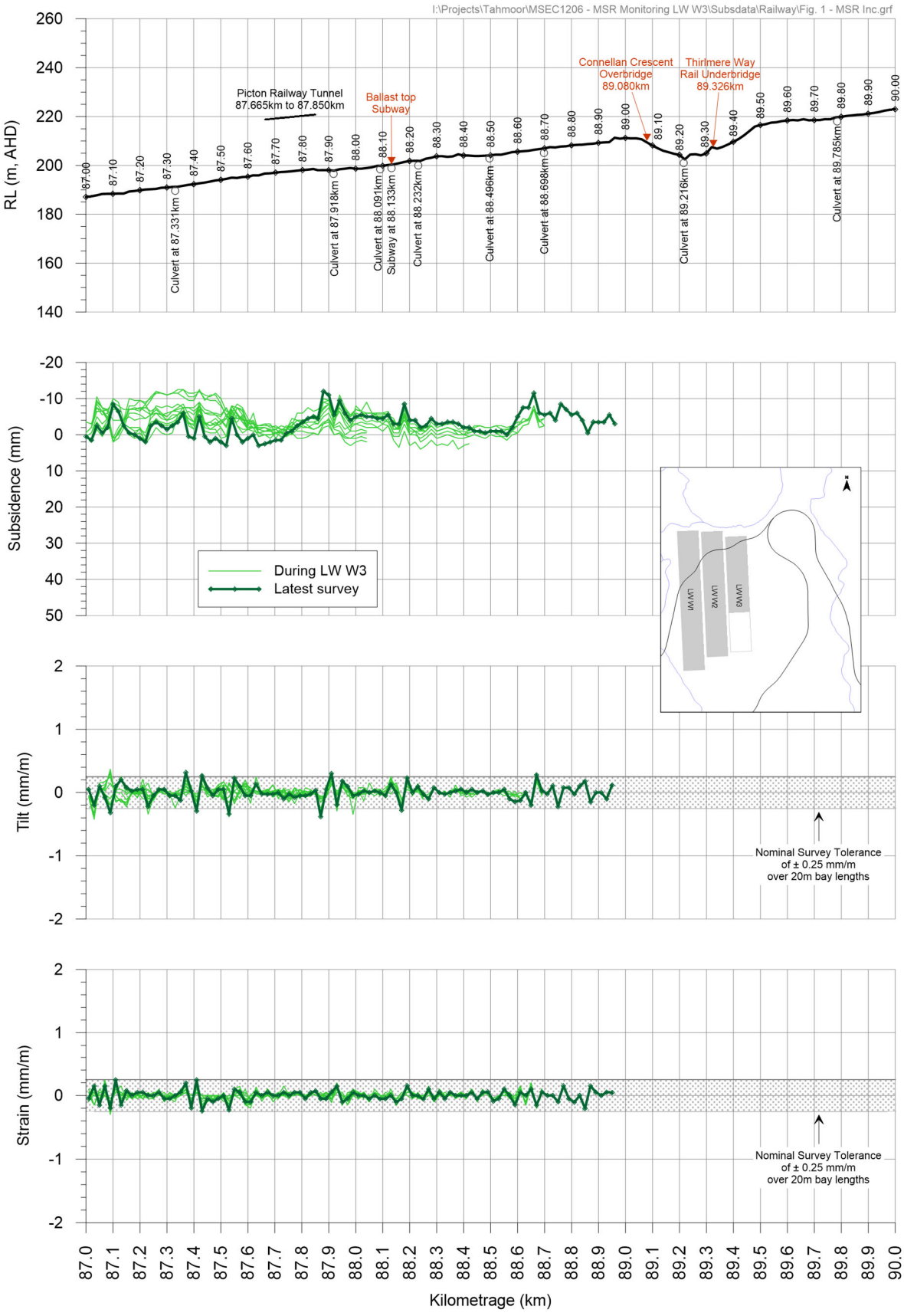


Fig. 3.16 Observed incremental subsidence, tilt and strain along the Main Southern Railway during the mining of LW W3 as at 4 January 2022, at length of extraction of 946 metres

Monitoring at Picton Railway Tunnel

The Picton Railway Tunnel is located approximately 760 metres southwest from the Rising Main. Tahmoor Coal has monitored movements above and within the Picton Tunnel since December 2017 when the length of extraction of LW31 was approximately 900 metres. A survey peg was installed in the natural ground above the Picton Tunnel to measure changes in its absolute position. A continuously operating Global Navigation Satellite System (GNSS) unit was installed on a small shed adjacent to the survey peg to continuously measure changes in its absolute position.

The observed changes in easting, northing and height of the ground mark and the GNSS unit are shown in Fig. 3.17.

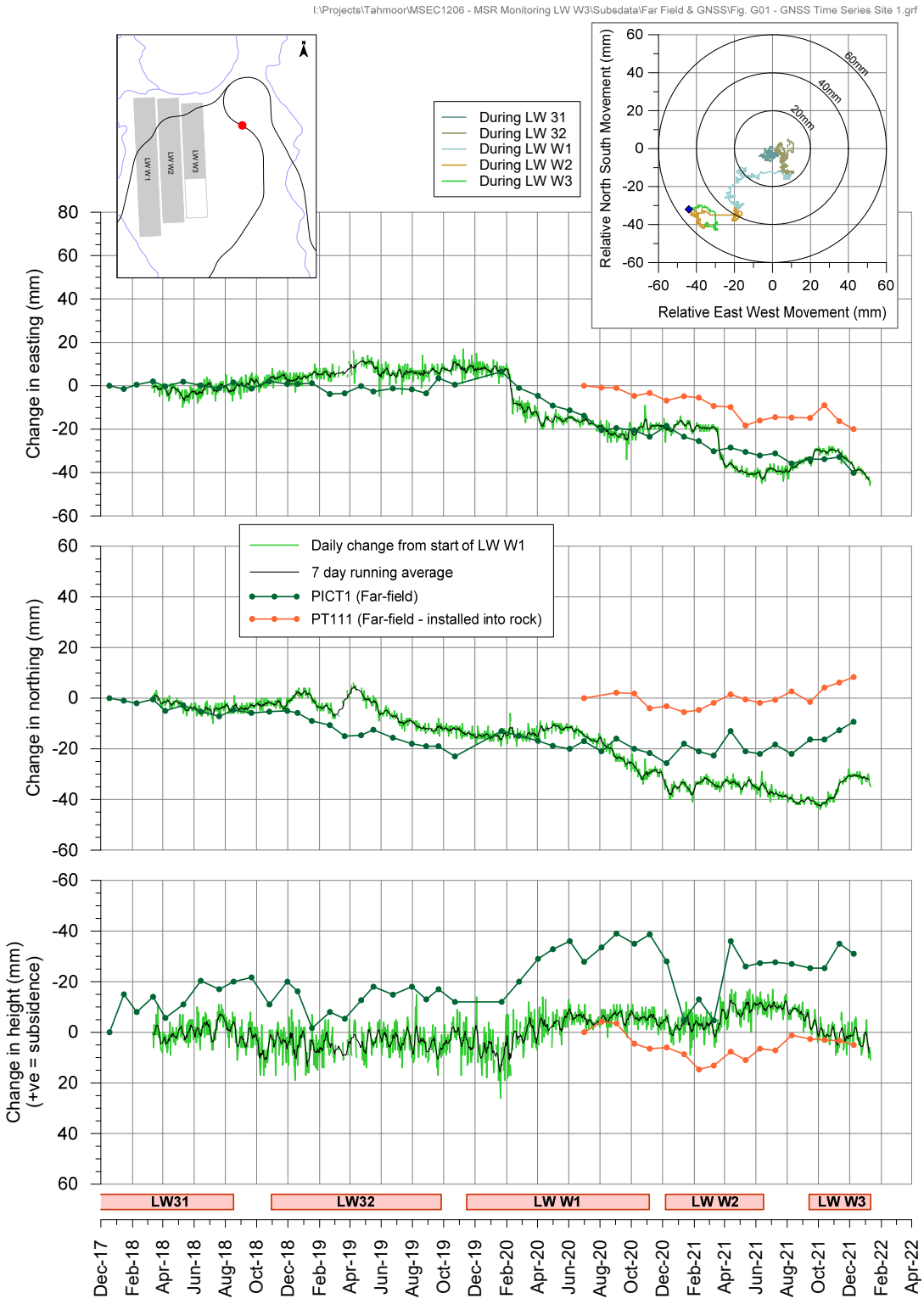


Fig. 3.17 Far-field movements at Picton Railway Tunnel

Minor horizontal movements to the west and to the south were observed during the mining of LW 32 and LW W1. The greatest changes occurred following a large rain event on 7 to 9 February 2020. The ground peg was observed to rise upwards during this time due to swelling.

It can be seen that the Picton Tunnel moved predominantly to the south during the mining of LW 32, with a small trend of movement towards the east also observed. Small additional movements continued in December 2019, with very minor changes observed in January and February 2020. The GNSS unit moved west following a heavy rainfall event in February 2020 with a corresponding rise in height of the ground peg.

Following confirmation that the ground peg was founded in clay soil, an additional ground survey mark was installed into rock in July 2020. Minor ongoing horizontal movements were observed to the west and to the south during the mining of LW W1. Minor changes were observed to the west during LW W2 until March 2021 when the unit was measured to move west following a significant rainfall event. The new peg set in rock did not rise upwards in response.

Minor changes have been observed to date during the mining of LW W3.

Extensive monitoring has been conducted within the tunnel, with no measurable changes observed. A vertical inclinometer has also been measured on a monthly basis with no measurable changes observed.

Monitoring at Picton Viaduct and Victoria Bridge

The Picton Viaduct on the Main Southern Railway is located approximately 90 metres to the east of the Rising Main. Absolute 3D surveys have been conducted on a monthly basis at the Picton Viaduct since December 2017 when the length of extraction of LW31 was approximately 900 metres. Absolute 3D surveys have been conducted at both ends of the Picton Viaduct. Two GNSS units, one at each of the Viaduct continuously measure their absolute horizontal and vertical position in real time. The units are located near the ground survey marks.

The observed changes in easting, northing and height of the ground marks and the GNSS units are shown in Fig. 3.18. It can be seen that minor horizontal movements to the west were observed during the mining of LW W1 and LW W2. There is a clear reduction in the rates of movement in September 2020 as LW W1 travelled past the Viaduct by a distance of approximately 500 metres. The westerly movement recommenced in January 2021 during the mining of LW W2 when the length of extraction was approximately 200 metres. Very little movement has been measured in the northerly direction.

A gradual fall in height was measured by the GNSS unit at the northern end of the Viaduct during the warmer months of 2018/2019, which was inconsistent with the survey results at the ground mark. As a precautionary measure, the structure surveys were re-measured and the results confirmed that the Viaduct had not experienced any measurable differential vertical movements. A site inspection of the GNSS unit found that it had been fixed to the post via U-bolts and the U-bolts had gradually slipped down the post due to vibration from passing trains. Screws have since been installed and no further movement has been observed.

Very little change has been observed to date during the mining of LW W3. Extensive monitoring has been conducted at the Viaduct, with no measurable changes observed. Vertical inclinometers have also been measured on a monthly basis with no measurable changes observed.

Observed movements at Victoria Bridge are also relevant to the Rising Main. Victoria Bridge is located approximately 40 metres to the east of the Rising Main at its closest point.

The observed changes in easting, northing and height of the ground marks and the GNSS unit are shown in Fig. 3.19. Victoria Bridge has moved to the west very slightly towards LW W1-W2 during mining. Surveys of survey marks fixed to the Bridge and ground have been conducted on a monthly basis. Very little change has been observed to date during the mining of LW W3.

Extensive monitoring has been conducted at the Bridge, with no measurable changes observed.

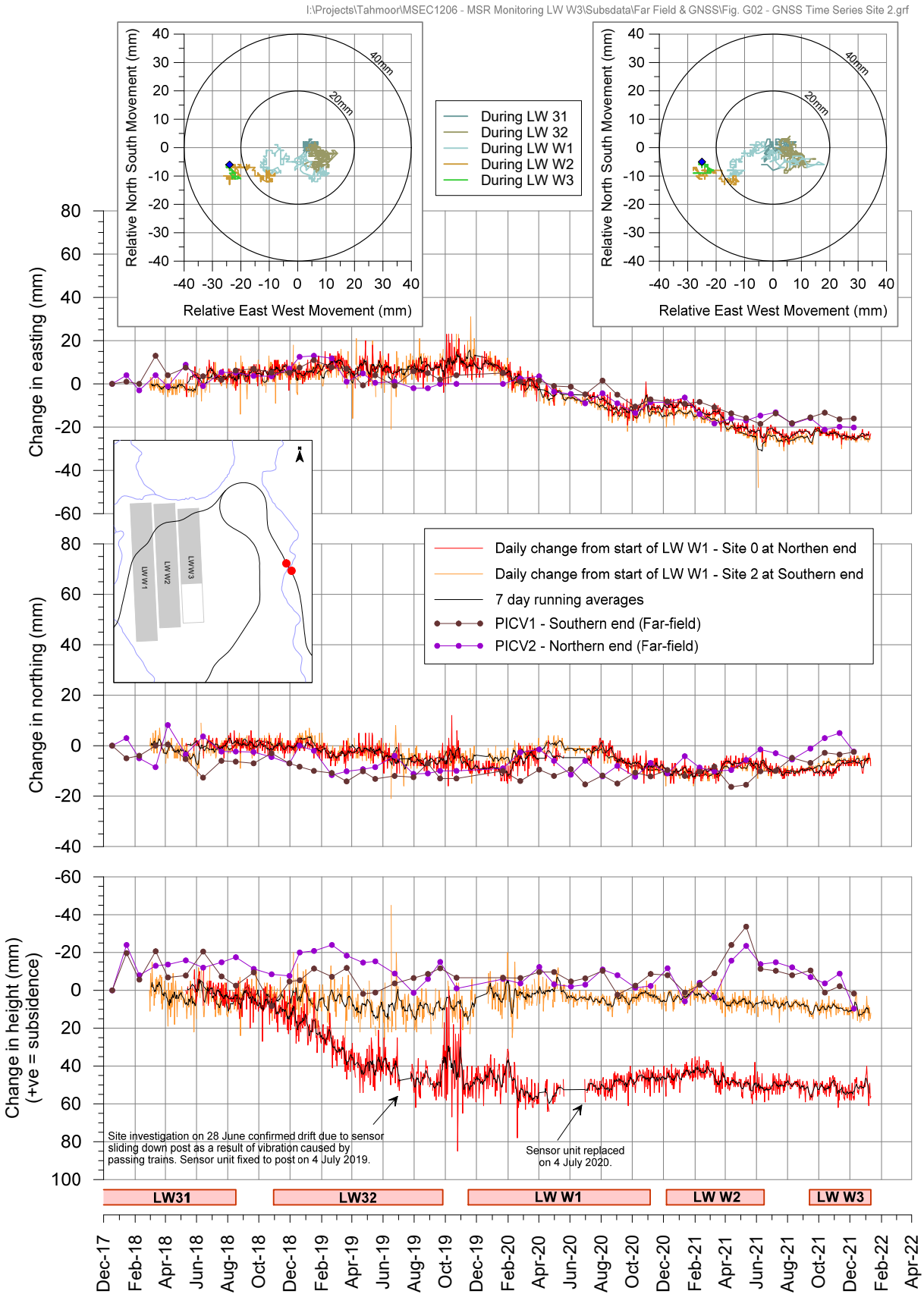


Fig. 3.18 Far-field movements at Picton Viaduct

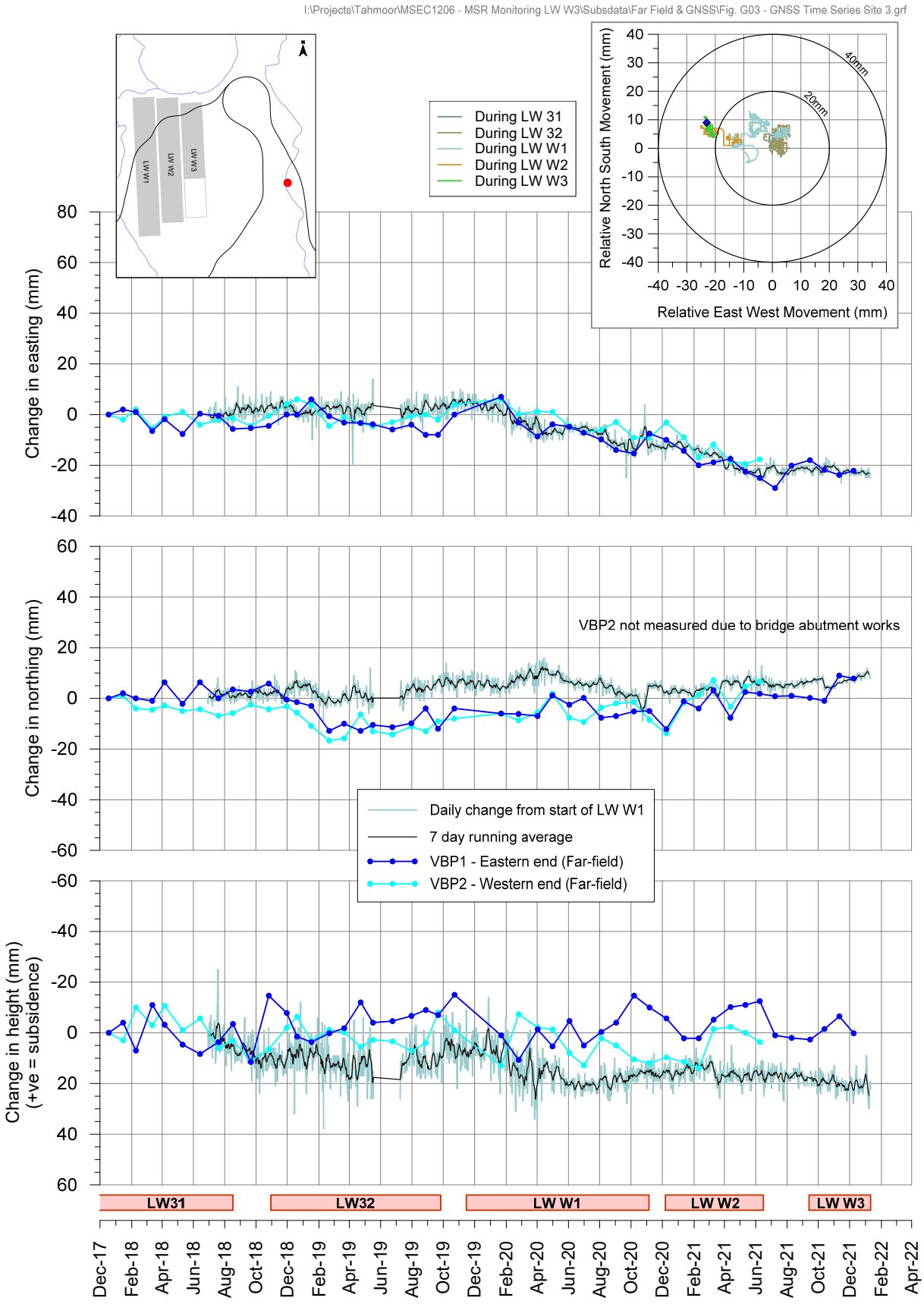


Fig. 3.19 Far-field movements at Victoria Bridge

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, which are discussed separately in the impact assessments for the natural and built features provided in Chapters 5 and 6. 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

The survey database has been analysed to extract the maximum tensile and compressive strains that have been measured at any time during the extraction of Longwalls 22 to 32 and LW W1 at Tahmoor Mine, for survey bays that were located directly above goaf or the chain pillars that are located between the extracted longwalls, which has been referred to as "***above goaf***".

A histogram of the maximum observed total tensile and compressive strains measured in survey bays above goaf at Tahmoor Mine is provided in Fig. 3.20. A number of probability distribution functions were fitted to the empirical data. It was found that a *Generalised Pareto Distribution (GPD)* provided a good fit to the raw strain data, and this is also shown in this figure.

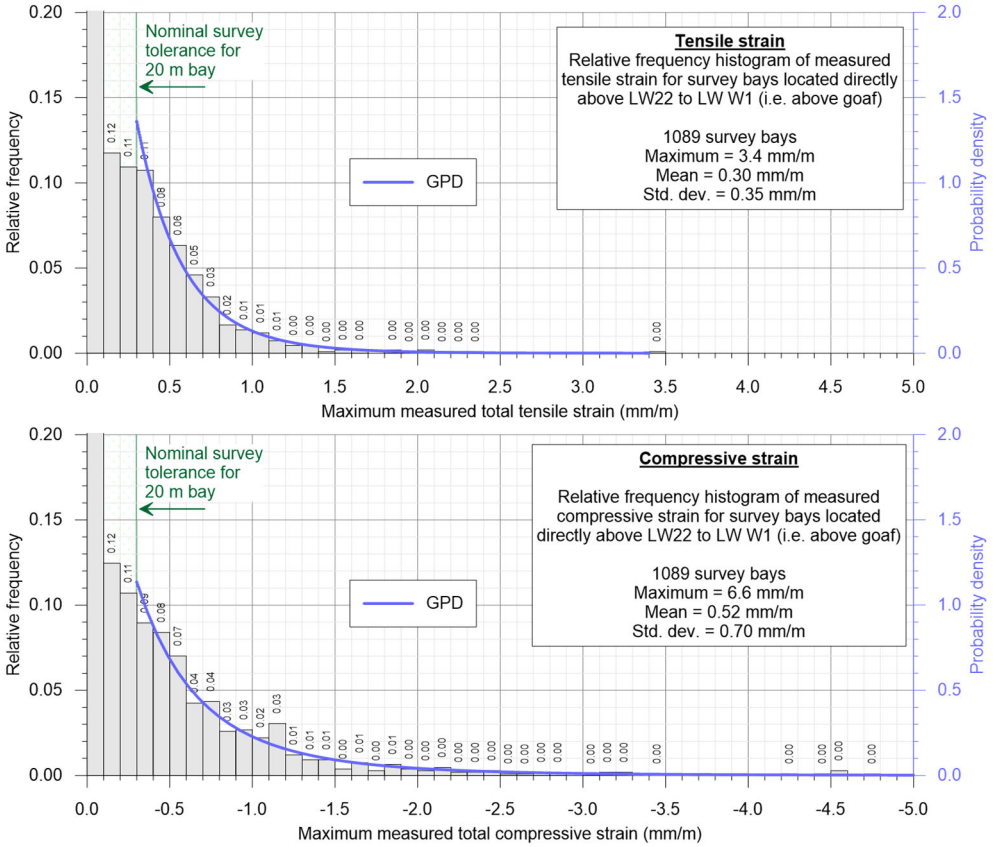


Fig. 3.20 Distributions of the maximum measured tensile and compressive strains during the extraction of previous longwalls for survey bays located above goaf

The 95 % confidence levels for the maximum total strains that the individual survey bays above goaf experienced at any time during mining were 1.0 mm/m tensile and 1.7 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 were 1.5 mm/m tensile and 3.3 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 previous longwalls at the mine, for survey bays that were located outside and within 250 m of the nearest longwall goaf edge, which has been referred to as "*above solid coal*".

A histogram of the maximum observed tensile and compressive strains measured in survey bays above solid coal at Tahmoor Mine is provided in Fig. 3.21. The probability distribution functions, based on the fitted GPDs, have also been shown in this figure.

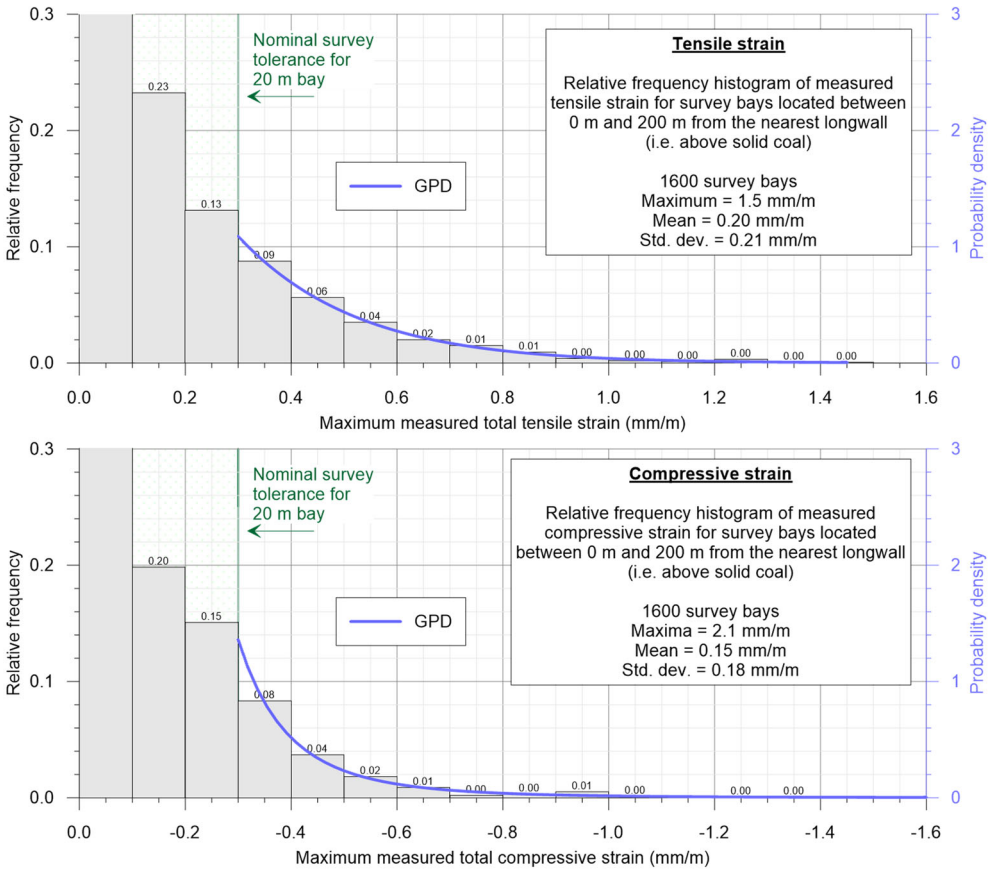


Fig. 3.21 Distributions of the maximum measured tensile and compressive strains during the extraction of previous longwalls for survey bays located above solid coal

The 95 % confidence levels for the maximum total strains that the individual survey bays above solid coal experienced at any time during mining were 0.6 mm/m tensile and 0.5 mm/m compressive. The 99 % confidence levels for the maximum total strains that the individual survey bays above solid coal experienced at any time during mining were 1.0 mm/m tensile and 0.8 mm/m 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 at the mine, is provided in Fig. 3.22.

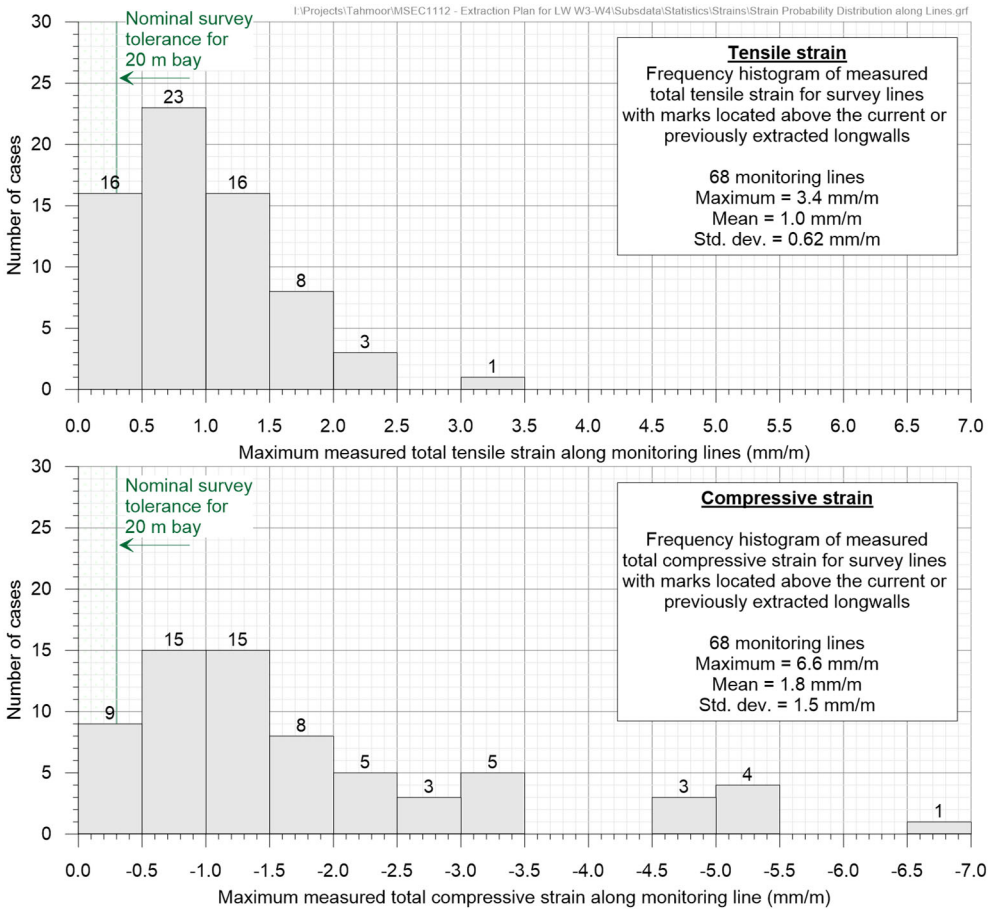


Fig. 3.22 Distributions of maximum measured tensile and compressive strains along monitoring lines during the extraction of previous longwalls at the mine

It can be seen from the above figure, that 39 of the 68 monitoring lines (i.e. 57 %) had recorded maximum total tensile strains of 1.0 mm/m or less, and that 63 monitoring lines (i.e. 93 %) had recorded maximum total tensile strains of 2.0 mm/m or less. It can also be seen, that 47 of the 68 monitoring lines (i.e. 69 %) had recorded maximum compressive strains of 2.0 mm/m or less, and that 60 of the monitoring lines (i.e. 88 %) had recorded maximum compressive strains of 4.0 mm/m or less.

3.5. Managing public safety

The primary risk associated with mining beneath sewer 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-W2. The management strategy has been reviewed and updated based on experiences gained during the mining of these longwalls, and the strategy for LW W3-W4 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. 3.23.

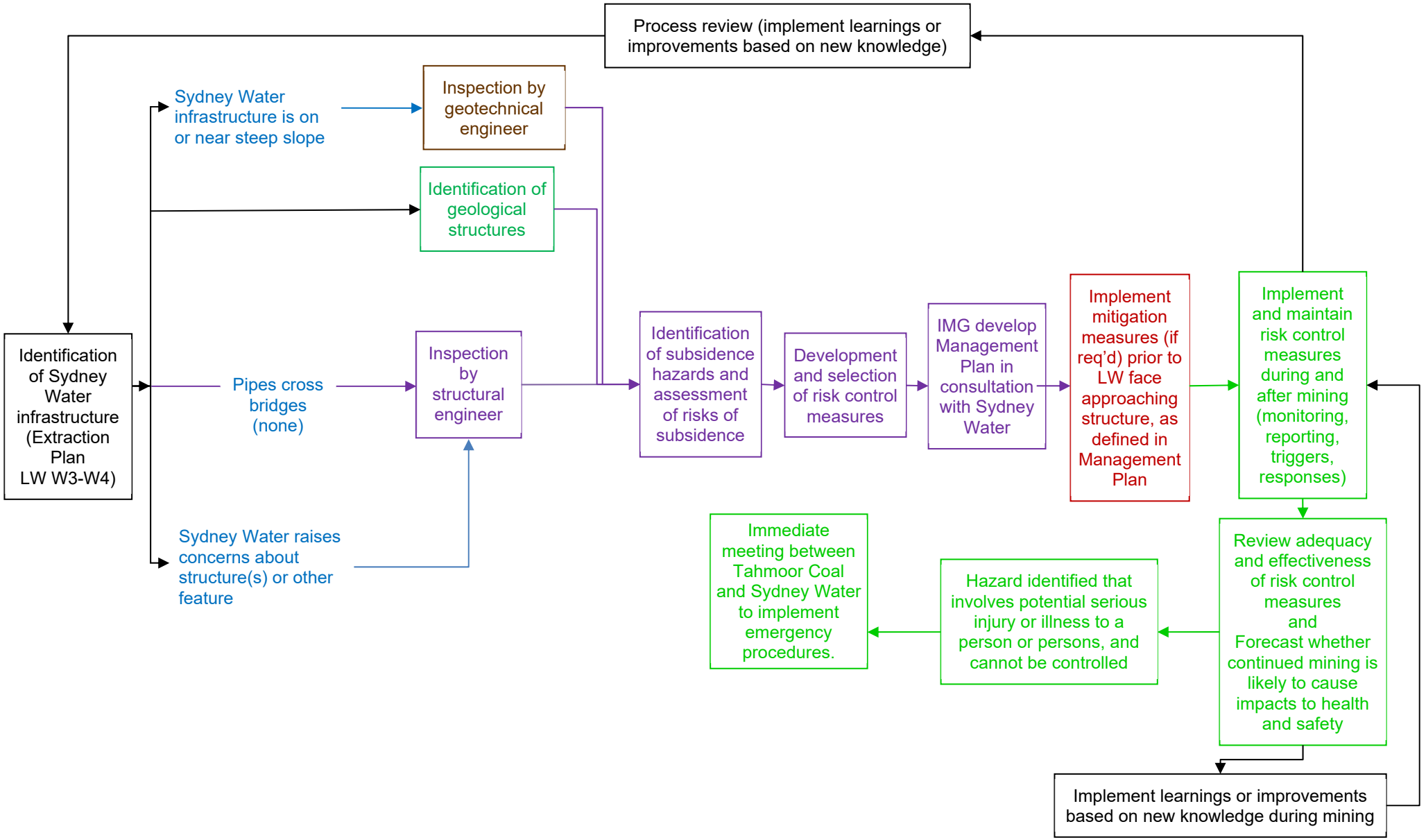


Fig. 3.23 Flowchart for Subsidence Impact Management Process

3.6. Summary of potential impacts

A summary of potential impacts on Sydney Water's Sewer infrastructure is provided in Table 3.2. The summary is consistent with the risk assessment undertaken by Tahmoor Coal (2020), and was separately assessed according to Sydney Water's Risk Criteria (Sydney Water, 2018). The results of the risk assessment are included in the Appendix.

Table 3.2 Summary of Potential Mine Subsidence Impacts

Risk	Likelihood	Consequence	Level of Potential Impact
Tahmoor Coal Assessment			
Leakage of the joints	UNLIKELY	NEGLIGIBLE	LOW
Sydney Water Assessment			
Leakage of the joints	UNLIKELY	NEGLIGIBLE	LOW
Leakage of the Rising Main	RARE	MODERATE	LOW

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 sewer 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:

- Local gravity sewerage network;
- Sewer pipelines at creek crossings and across mapped geological structures; and
- Rising Main between Lumsdaine Street and Wild Street, Picton.

The following mine subsidence hazards were identified that could give rise to risks to health and safety due to the extraction of LW W3-W4:

- Leakage of joints.

The identification and risk assessment process took into account the location of infrastructure relative to LW W3-W4 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 sewer 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. Gravity sewer pipelines

There are a number of gravity sewer pipelines that are located adjacent to LW W3-W4, as shown in Drawing No. MSEC1173-09-01:

- 150 mm diameter PVCPW gravity sewer mains
  As shown in Drawing No. MSEC1173-09-01, 150 mm diameter PVCPW gravity sewer mains are located along Thirlmere Way and beneath properties on the western side of Argyle Street.
- 100 mm diameter PVCPW gravity sewer mains
  As shown in Drawing No. MSEC1173-09-01, 100 mm diameter PVCPW gravity sewer mains are located along Thirlmere Way, alongside the Main Southern Railway and beneath properties on the northern side of Hill Street.
- 100 mm diameter PVCPW property connection sewer mains
  As shown in Drawing No. MSEC1173-09-01, 100 mm diameter CICL PVCPW property connection sewer mains are located along the southern side of Thirlmere Way.
- 225 mm diameter PVC gravity sewer mains
  As shown in Drawing No. MSEC1173-09-01, 225 mm diameter PVC gravity sewer mains are located along the northern side of Thirlmere Way and along Rumker Street North.
- 300 mm diameter PVC gravity sewer main
  As shown in Drawing No. MSEC1173-09-01, a 300 mm diameter PVC gravity sewer main is located along Thirlmere Way beneath the Main Southern Railway.

3.8.1. Predicted subsidence movements

The sewer pipelines are predicted to experience less than 20 mm subsidence due to the extraction of LW W3.

The sewer pipelines located adjacent to LW W4 generally follow the alignments of the local roads and the Main Southern Railway.

The predicted profiles of conventional subsidence, tilt and curvature for the sewer mains along Thirlmere Way are shown in Fig. 3.24. Less than 20 mm subsidence is predicted to occur along the 100 mm diameter pipeline due to the extraction of LW W3-W4.

The predicted profiles of conventional subsidence and changes in grade along the Main Southern Railway are shown in Fig. 3.25. 100 mm and 150 mm diameter sewer lines run along the rail corridor on either side of the Connellan Crescent Overbridge. Less than 20 mm subsidence is predicted to occur along the sewer lines due to the extraction of LW W4.

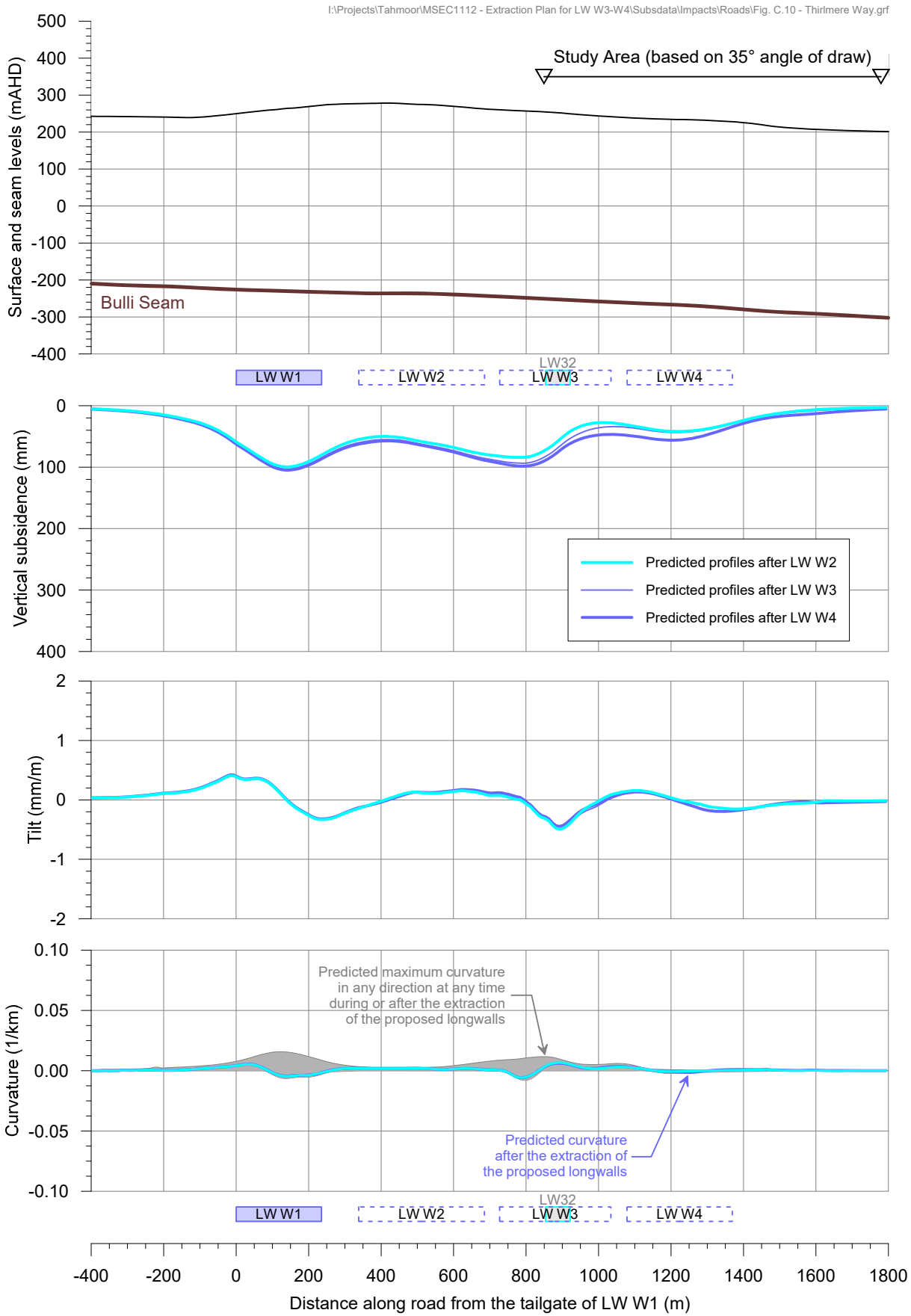


Fig. 3.24 Predicted profiles of total subsidence, tilt and curvature along Thirlmere Way after the mining of LW W3-W4

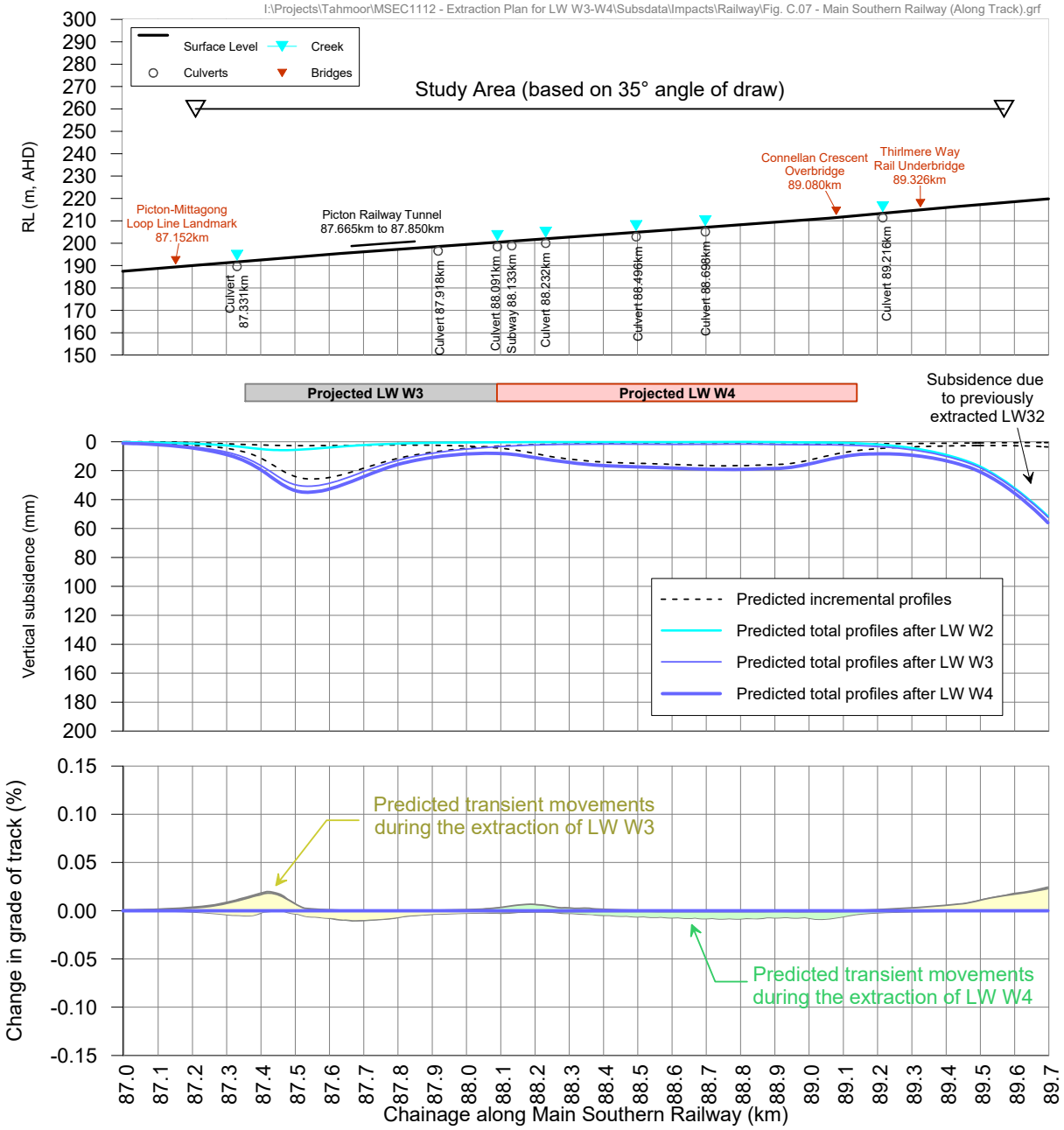


Fig. 3.25 Predicted profiles of total subsidence and changes in grade along the Main Southern Railway after the mining of LW W3-W4

3.8.2. Potential subsidence impacts on gravity sewer pipelines

Longwalls 22 to 32 have directly mined beneath approximately 30.5 km of sewer pipelines with only minimal adverse impacts on the distribution network. Pipes remained safe and serviceable and repairs were undertaken where required. No impacts have been observed to Sydney Water sewerage infrastructure when it has been located beyond the longwall footprint. There was no sewerage infrastructure owned by Sydney Water affected by LW W1-W2.

The proposed LW W3-W4 do not mine directly beneath any sewerage infrastructure. Given that the infrastructure is located at the outer margins of the Study Area and is predicted to experience very minor subsidence movements, the likelihood of impacts to the sewerage infrastructure is considered to be very low. Any impacts are expected to be of a minor nature that could be readily repaired.

Tahmoor Coal has 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.

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 manage potential issues associated with damage to pipelines resulting in damage to sewer pipelines during the extraction of LW W3-W4 by implementing the following measures:

- Regular ground surveys along streets and the Main Southern Railway located within the active subsidence zone;
- 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;
- CCTV inspections of potentially damaged sewer pipes, if triggered by monitoring results and
- In the worst case, repair of damaged pipeline.

3.9. Rising Main between Lumsdaine Street and Wild Street

A 300 mm diameter, PVC rising main is located in west Picton between Lumsdaine Street and Wild Street, approximately 640 metres to the east of LW W4 at closest point.

The Rising Main is predicted to experience less than 20 mm of conventional subsidence, with negligible mining-induced curvature. The likelihood of impacts from conventional subsidence is extremely low. This is assessment is supported by the experience of mining previously extracted Longwall 25 directly beneath the rising main that runs from the pumping station SP1045 at Castlereagh Street without any impacts.

There is a rare likelihood that the Rising Main may experience impacts from non-conventional subsidence movements during the mining of LW W4. The Rising Main crosses mapped second order geological structures associated with the Nepean Fault near the creek crossing, as shown in Drawing No. MSEC1173-09-01. The Rising Main also crosses two small creeks along Lumsdaine Street.

Sewage from the eastern half of Picton is pumped via the Rising Main from a sewage pumping station (SPS Ref. SP0918) that is located near the end of Picton Avenue at Picton, located approximately 900 metres from LW W4.

Whilst the likelihood of mining-induced adverse impacts on the Rising Main is considered to be rare, the consequence of impacts without early warning includes leakage of sewage potentially near Stonequarry Creek. The SPS has approximately 4 hours storage capacity and incoming flows can be collected by tanker trucks and transported wastewater collected directly to Sydney Water's Picton Water Recycling Plant.

Potential impacts on the Rising Main will be managed by a combination of ground surveys and visual inspections during the mining of LW W4. Ground survey pegs will be installed and surveyed every 100 metres along its route from Lumsdaine Street to Wild Street. Survey results along the Main Southern Railway will also be used to provide an early warning of potential impacts. The frequency of surveys and visual inspections will be increased if adverse changes are observed. The monitoring will provide Sydney Water with adequate time to implement its emergency procedures for the Rising Main.

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 W3-W4.

4.3. Selection of risk controls for sewer 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.

Isolation

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

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.

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 sewer 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:
    - Local 2D surveys along local roads and the Main Southern Railway as shown in Drawing No. MSEC1173-00-01;
    - Local 2D surveys along the Rising Main, with pegs nominally spaced every 100 metres, as shown in Drawing No. MSEC1173-00-01;
    - Visual inspections along the streets within the active subsidence zone;
    - Visual inspections along streets above the Rising Main;
    - Additional surveys and/or inspections, if triggered by monitoring results;
    - CCTV inspections, if triggered by monitoring results;
    - Regular consultation with the community to report potential impacts;
    - In the event of damage to the gravity sewerage pipelines, implement Sydney Water's emergency procedures, which include isolation of the pipeline and installation of a temporary bypass pipe to transfer wastewater around the affected section of pipe;
    - In the event of damage to the Rising Main, implement Sydney Water's emergency procedures for the Sewage Pumping Station (SPS) SP0918 at Picton.
      This includes stopping flows from the affected rising main at the pumping station while the repairs are undertaken. Each SPS has approximately 4 hours storage capacity and incoming flows can be collected by tanker trucks and transported wastewater collected directly to Sydney Water's Picton Water Recycling Plant; and
    - In the worst case, repair of damaged pipeline.

4.4. Monitoring measures

A number of monitoring measures will be undertaken during mining.

4.4.1. Ground Surveys along streets and centrelines of LW W3-W4

A survey line has been installed along the centreline of LW W3, and a survey line has been installed along the centreline of LW W4, as shown in Drawing No. MSEC1173-00-01.

The purpose of the survey lines is to establish the general magnitude and shape of surface subsidence along the centrelines of LW W3-W4. The observed subsidence movements will be used to provide early subsidence information to inform Tahmoor Mine and affected stakeholders prior to built surface features experiencing active subsidence, the majority of which are located at the northern to southern end of LW W3. The information will assist Tahmoor Mine and affected stakeholders in considering whether any additional measures are required to manage potential impacts on the built features.

The information will also be used by Tahmoor Mine as part of its ongoing review of subsidence effects on natural features.

The survey lines will consist of pegs spaced nominally every 20 metres, where access is available, noting that the centrelines pass through private property and close to building structures. Surveys will measure levels and horizontal distances between adjacent pegs.

Survey lines have been installed along Thirlmere Way, Connellan Crescent and along the Main Southern Railway, as shown in Drawing No. MSEC1173-00-01. The survey pegs will be surveyed during the period of active subsidence of these features during the extraction of LW W3-W4.

In the case of the Rising Main between Lumsdaine Street and Wild Street, survey pegs will be installed nominally every 100 metres, as shown in Drawing No. MSEC1173-00-01. The survey pegs will be surveyed when they are 150 metres in front of the longwall face until they 450 metres behind the longwall face, unless adverse changes are observed.

The surveys measure changes in height and changes in horizontal distances between adjacent pegs

4.4.2. 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;
- Visual inspections along streets above the Rising Main.

4.4.3. Changes to monitoring frequencies

Monitoring frequencies will continue while Sydney Water infrastructure is experiencing active subsidence due to the extraction of LW W3-W4. 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;
- CCTV inspections;
- Repair of impacts, if required;
- Installation of a temporary bypass pipe to transfer wastewater around an affected section of pipe;
- Collect wastewater at SP 0918 by tanker trucks and transport to Picton Water Recycling Plant; 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 sewer 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 W3-W4, 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 leakage of sewerage from a pipe joint could possibly give rise to the need for an emergency response. 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 sewer 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 Coal LW W3-W4

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
Sewer infrastructure	Impacts to Sydney Water sewer infrastructure	Low	None	Install Initial Goaf GNSS unit (located approximately 100 m inside the commencing end of LW W3-W4)	Install GNSS unit above start position of LW W3 (complete). Continuous readings, with data averaged over 24 hours and recorded once per day until end of LW W3. Prior to commencement of LW W3, relocate GNSS unit above start of LW W4. Continuous readings, with data averaged over 24 hours and recorded once per day until end of LW W3.	Tahmoor Coal (GNSS Monitoring)
				2D survey lines along centrelines of LW W3-W4	Baseline survey above LW W3 complete. Monthly survey for pegs located above LW W3 within active subsidence zone after 20 mm of vertical subsidence is measured by the Initial Goaf GNSS unit, or the length of the extraction of LW W3 exceeds 200 m, whichever occurs first. Install and baseline survey above LW W4 for at least 600 m of extraction prior to commencement of LW W4. Install and baseline survey remaining pegs prior to LW W4 approaching within 400 m of pegs. Monthly survey for pegs located within active subsidence zone after 20 mm of vertical subsidence is measured by the Initial Goaf GNSS unit, or the length of the extraction of LW W4 exceeds 200 m, whichever occurs first. Full length at end of LW W3-W4.	Tahmoor Coal (SMEC)
				Conduct visual inspections for surface deformations and sewerage leaks along local roads within active subsidence zone.	Weekly within active subsidence zone during period of active subsidence and continue if ongoing adverse movements are observed.	Tahmoor Coal
				Conduct surveys along Main Southern Railway	Baseline survey complete Weekly surveys within active subsidence zone during the mining of LW W3-W4 and continue if adverse movements are observed. Full length at end of LW W3-W4.	Tahmoor Coal
				Conduct surveys along Connellan Crescent	Install and baseline survey prior to LW W3 approaching within 400m of street. Weekly surveys within active subsidence zone during the mining of LW W3-W4 and continue if adverse movements are observed. Full length at end of LW W3-W4.	Tahmoor Coal (SMEC)
				Conduct surveys along Thirlmere Way	Baseline survey complete. Weekly after 1650 m of extraction until one month after completion of LW W1 and LW W2 until one month after completion of each LW, unless ongoing adverse movements are observed Full length at end of LW W3-W4.	Tahmoor Coal (SMEC)
				Conduct surveys along Rising Main	Install and baseline survey prior to start of LW W4 Weekly surveys for pegs that are at least 150m in front of LW face and 450m behind the LW face, commencing after 20 mm of vertical subsidence is measured by the Initial Goaf GNSS unit, or the length of the extraction of LW W4 exceeds 200 m, whichever occurs first and continue if adverse movements are observed. Full length at end of LW W4.	Tahmoor Coal (SMEC)
				Visual inspections along Rising Main	Weekly during LW W4, commencing after 20 mm of vertical subsidence is measured by the Initial Goaf GNSS unit, or the length of the extraction of LW W4 exceeds 200 m, whichever occurs first.	Tahmoor Coal
				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 W3-W4 after 20 mm of vertical subsidence is measured by the Initial Goaf GNSS unit, or the length of the extraction of LW W3-W4 exceeds 200 metres, whichever occurs first.	Tahmoor Coal

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
			Non-conventional ground movement detected	Notify Sydney Water	Within 24 hours	Tahmoor Coal
				Notify Sydney Water and convene an IMG meeting. Consider additional monitoring and mitigation measures based on observed monitoring results, which may include: - increase frequency of ground surveys at affected site - increase frequency of visual inspections - undertake additional CCTV inspections of affected pipes - excavate to expose pipe and reduce distortion or strain on pipe - arrange on standby temporary bypass pump sewage around affected area - installation of temporary internal full length or patch lining to pipes - installation of containment lines and signage - increase frequency of SMG meetings - any other additional management actions	As required by IMG	Tahmoor Coal
			Blockage or leakage of sewage observed	Contact Sydney Water as per contact protocol. Clear blockage as required.	As required by Sydney Water	Sydney Water
				Investigate cause of sewage leak to ascertain whether leak might be due to subsidence	Within 24 hours	Sydney Water
				If blockage is subsidence related, notify all stakeholders, including Sydney Water, Tahmoor Coal, Subsidence Advisory NSW and Resources Regulator	Within 24 hours	Tahmoor Coal
				Convene IMG meeting to consider additional monitoring and mitigation measures based on observed monitoring results, which may include: - increase frequency of surveys along streets - increase frequency of visual inspections - undertake additional CCTV inspections - increase frequency of reporting of results, including calculation of sewer grades - arrangement of equipment to be made available on call for daily tanker flush or high pressure jetting of sewer lines or bypass pump around affected pipe, as per Sydney Water advice for each site - gully pit inspections for any potentially affected property - installation of containment lines and signage - increase frequency of SMG meetings - any other additional management actions	As required by IMG	Tahmoor Coal
			Leakage of sewage from Rising Main	Contact Sydney Water as per contact protocol. Repair damage as required.	As required by Sydney Water	Sydney Water
				Investigate cause of sewage leak to ascertain whether leak might be due to subsidence	Within 24 hours	Sydney Water
				If leakage is subsidence related, notify all stakeholders, including Sydney Water, Tahmoor Coal, Subsidence Advisory NSW and Resources Regulator	Within 24 hours	Tahmoor Coal
				Implement Sydney Water emergency procedures Sewage Pumping Station (SPS) SP0918 at Picton - Stop flows at pumping station - Collect wastewater by tanker trucks and transport to PWRP - Remove spillage and clean affected site - Repair connection	As per Sydney Water plan for SP0918 (Picton)	Sydney Water
			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 sewer 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

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 W3-W4.
- 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 are 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	Phil Steuart	(02) 4063 6484	phil.steuart@planning.nsw.gov.au
	Gang Li	(02) 4063 6429 0409 227 986	gang.li@planning.nsw.gov.au
	Ray Ramage	(02) 4063 6485 0442 551 293	ray.ramage@planning.nsw.gov.au
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	Morteza Mousaviara*	0466 329 766	Morteza.Mousaviara@sydneywater.com.au

* denotes member of Infrastructure Management Group

APPENDIX A. Drawings and Supporting Documentation

The following supporting documentation is provided in Appendix A.

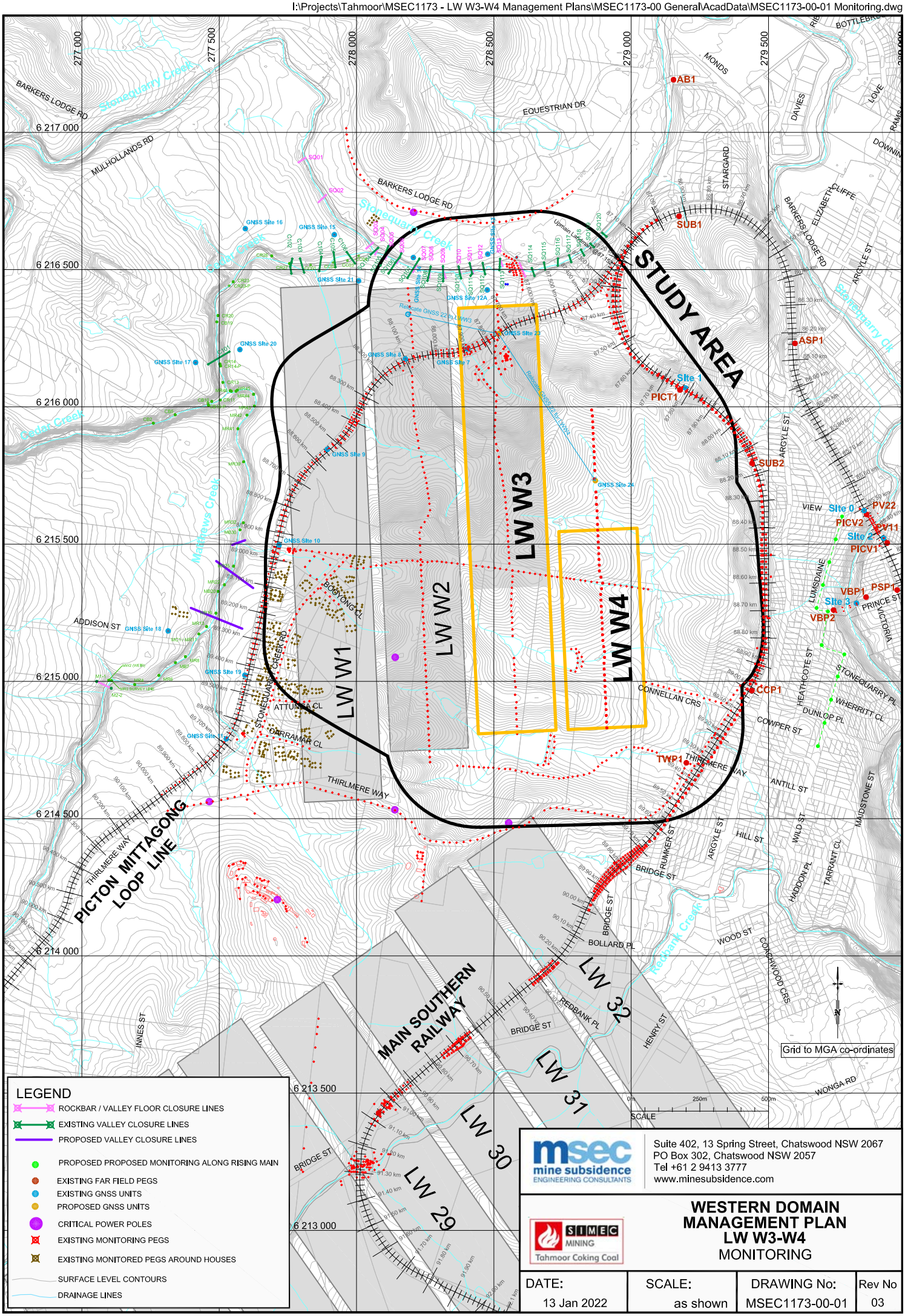
Drawings

Drawing No.	*Description*	*Revision*
MSEC1173-00-01	Monitoring plan	03
MSEC1173-09-01	Sewer Infrastructure	C

Supporting Documentation

Sydney Water (2018)	Risk and Opportunity Matrix, Sydney Water, Version 7.0
Tahmoor Coal (2020)	Risk Assessment Report – Infrastructure. Tahmoor North – Western Domain, Longwalls West 3 and West 4, September 2020.

I:\Projects\Tahmoor\MSEC1173 - LW W3-W4 Management Plans\MSEC1173-00 General\AcadData\MSEC1173-00-01 Monitoring.dwg



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

SIMEC MINING
Tahmoor Coking Coal

WESTERN DOMAIN MANAGEMENT PLAN LW W3-W4 MONITORING

DATE:	SCALE:	DRAWING No:	Rev No
13 Jan 2022	as shown	MSEC1173-00-01	03

I:\Projects\Tahmoor\MSEC1173 - LW W3-W4 Management Plans\MSEC1173-09 SW Sewer\AcadData\MSEC1173-09-01 Sydney Water - Sewer.dwg

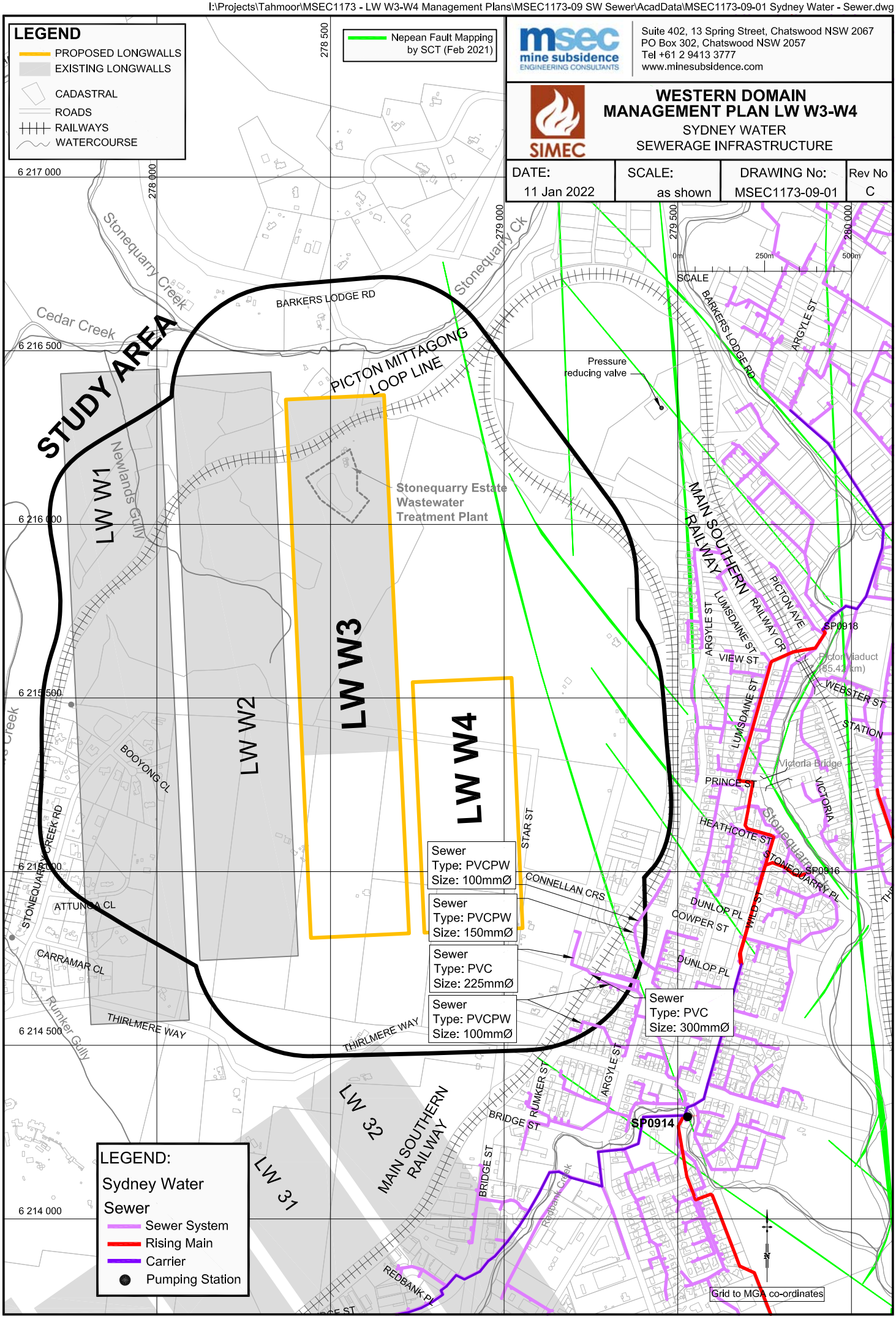
msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

SIMEC

WESTERN DOMAIN MANAGEMENT PLAN LW W3-W4

SYDNEY WATER
SEWERAGE INFRASTRUCTURE

DATE:	SCALE:	DRAWING No:	Rev No
11 Jan 2022	as shown	MSEC1173-09-01	C



Major Project Risk Assessment: Tahmoor Underground - Extraction Plan LW W3-W4

	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

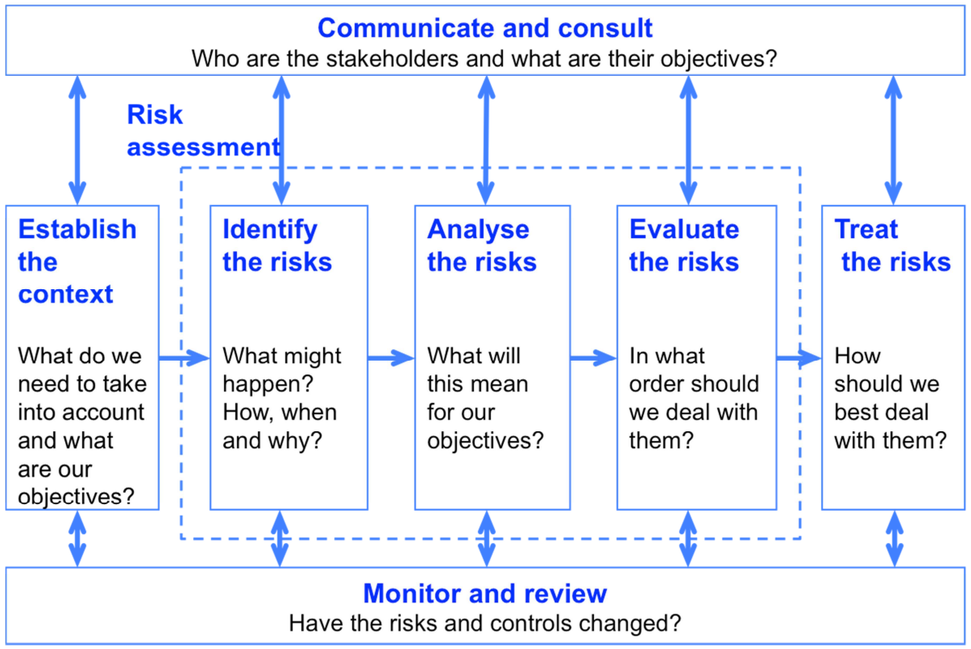
☑ Appendix B

Site	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	Major Project		Sydney Water Sewer Infrastructure	Leakage of the joints	Leakage of sewage requiring repair or replacement	Subsidence	* Management Plans prepared for previous longwalls (AC) * Previous ground survey and visual inspection as part of LW 22-32 management (AC) * Previous consultation, coordination and cooperation with Sydney Water (AC) * PVC pipes reduces potential for breakage (EC)	2	Property Damage	1	D	2	1	Property Damage	Complete Sydney Water Sewerage Management Plan including TARP	April Hudson	01-May-22	
	1			1	1	Subtotal CountA (ignoring hidden values)		1				1	1					
Tahmoor Underground	Broad Brush											#N/A						
Tahmoor Underground	Life of Mine											#N/A						
Tahmoor Underground	Business																	
Tahmoor Underground	Major Project											#N/A						
Tahmoor Underground	Environmental/Health/Process											#N/A						
Tahmoor Underground	Equipment											#N/A						

Risk and Opportunity Matrix

Consequence table										Likelihood table (interpret percentages across one year period)					
	Public health	**Safety**	**Reputation**	**Environment**	**Compliance**	**Financial**	**Community**	**Customers**	**Performance**	**Rare** Less than once in 50 years <2%	**Very Unlikely** Once in 10 to 50 years 2% to 10%	**Unlikely** Once in 5 to 10 years 10% to 20%	**Possible** Once in 2 to 5 years 20% to 50%	**Likely** Once in 1 to 2 years 50% to 90%	**Very Likely** Several times per year >90%
Catastrophic or Exceptional	Potential for widespread illness. Declared outbreak.	Single fatality / Multiple fatalities	Government enquiry with extended, continuous national / international media coverage > 1 week.	Widespread, irreversible impact on a highly sensitive receiving environment.	Loss of operating licence. High impact prosecution due to wilful act e.g. Tier 1 POEO Act offence or major SafeWork NSW criminal offence.	Cost change > $100m. Revenue change >$250m. Equivalent cost of program or project schedule change.	Damage / disruption to people, property, business and transport >$100m.	Loss of unplanned service >200,000 customer days.	Significant performance change against corporate objectives or KPIs.	Medium 4	High 2	Very high 1	Very high 1	Very high 1	Very high 1
Critical	Isolated individual cases of illness potentially attributable to Sydney Water.	Permanent disabling injury or impairment.	Ministerial intervention with extended, continuous national / Sydney metro and social media coverage > 3 days.	Widespread impact on a highly sensitive receiving environment. Requires extensive remediation, or >10 years to recover naturally.	Severe sanction and statutory fines. High-profile prosecution due to negligence e.g. Tier 1 POEO Act offence or SafeWork NSW criminal offence.	Cost change $20m to $100m. Revenue change $50m to $250m. Equivalent cost of program or project schedule change.	Damage / disruption to people, property, business and transport $20m to $100m.	Loss of unplanned service 40,000 to 200,000 customer days.	Significant performance change against group / portfolio objectives or KPIs.	Medium 5	Medium 4	High 3	High 2	Very high 1	Very high 1
Major	Widespread, short-term failure to meet guideline values for health parameters e.g. for multiple delivery systems.	Non-disabling injury/illness causing temporary impairment and/or, time off work/ alternative duties for > 1month	Ministerial interest with unbalanced, primarily Sydney metro and social media coverage > 24 hours. Widespread complaints.	Localised impact on highly sensitive receiving environment (including heritage sites), or Widespread impact on sensitive receiving environment. Requires substantial remediation, or 1-10 years to recover naturally.	Enforceable undertaking, regulatory sanction or prosecution e.g. Tier 2 POEO Act offence or SafeWork NSW prosecution.	Cost change $5m to $20m. Revenue change $12.5m to $50m. Equivalent cost of program or project schedule change	Damage / disruption to people, property, business and transport $5m to $20m.	Loss of unplanned service 10,000 to 40,000 customer days.	Significant performance change against functional area / program objectives or KPIs.	Low 6	Medium 5	Medium 4	High 3	High 2	High 2
Moderate	Localised, short-term failure to meet guidelines values for health parameters. e.g. single reservoir zone.	Injury or illness causing temporary impairment and/or, time off work/ alternative duties for 1 to 30 days	Local MP interest and local media coverage > 24 hours. Multiple and repeated customer complaints.	Localised impact on sensitive environment. Requires some remediation, or < 1 year to recover naturally.	Ministerial direction or statutory fine e.g. Tier 3 POEO Act or SafeWork NSW penalty infringement notice.	Cost change $2m to $5m. Revenue change $5m to $12.5m. Equivalent cost of program or project schedule change.	Damage / disruption to people, property, business and transport $2m to $5m.	Loss of unplanned service 4,000 to 10,000 customer days.	Significant performance change against business unit / project objectives or KPIs.	Low 6	Low 6	Medium 5	Medium 4	High 3	High 3
Minor	Isolated samples above guideline values. No trend.	Injury or illness causing temporary impairment. Able to return to full duties or undertake alternate duties for no more than one full shift / work day	One-off media report. Balanced coverage that includes Sydney Water's position < 24 hours. Some customer complaints.	Localised impact on natural environment. Short lived (less than 1 week).	Minor corrective action or additional business requirement.	Cost change $100,000 to $2m. Revenue change $250,000 to $5m. Equivalent cost of program or project schedule change.	Damage / disruption to people, property, business and transport $100,000 to $2m.	Loss of unplanned service 200 to 4,000 customer days.	Moderate performance change against business unit / project objectives or KPIs.	Low 6	Low 6	Low 6	Medium 5	Medium 4	Medium 4
Negligible	Within guideline values.	No discernible injury	Minimal public concern and no media interest.	No impact on natural environment.	Technical compliance breach with no material impact.	Cost change Less than $100,000. Revenue change Less than $250,000. Equivalent cost of program or project schedule change.	Damage / disruption to people, property, business and transport < $100,000.	Loss of unplanned service <200 customer days.	Very minor impact on objectives or KPIs.	Low 6	Low 6	Low 6	Low 6	Low 6	Medium 5

Consequence table – Scenarios (as examples only)									
	Public health	**Safety**	**Reputation**	**Environment**	**Compliance**	**Financial**	**Community**	**Customers** *(Note: 1 Customer = ~ 2.5 people)*	**Performance**
Catastrophic = Board / MD focus	Flint, USA Lead Poisoning Walkteron Canada town's water supply polluted by cattle faeces – multiple deaths and widespread sickness 1993 Waterborne Cryptosporidium Outbreak, Milwaukee, Wisconsin USA. 69 Deaths, 400,000 people with symptoms	Death of a person/s	1998 Cryptosporidium Water Quality Crisis ongoing international media coverage	Entire population of native protected/ endangered fauna or flora killed	EPA v Gardner 1997 Karuah Caravan Park Intentional, unlawful, secret discharge of untreated sewage into the environment		Endeavour Energy power line caused the 2013 Blue Mountains bushfire – 159 homes destroyed =$200M damages Disruption to major services for the entire Sydney CBD for 1 day @ $235m/day	Loss of service for Prospect (~1.4m customers) for 4 hours Illawarra (~100,000 customers) for 2 days Macarthur (~100,000 customers) for 2 days Bankstown (~50,000 customers) for 4 days	Failure of customer focus strategy due to reduce brand scores
Critical GM focus	Individual swimmer in contact with wet weather overflow Contaminated main connected to drinking water Fluoride overdose above acute levels	Amputation of limb,	Illawarra taste and odour complaints (2007) "Poo Marches" against shoreline outfalls at Bondi, Malabar, North Head (Late 1980's)	Local population of native fauna or flora killed	Caltex Banksmeadow loss 157,000 litre of flammable petrol into bund (2013)	CIBS Project	Disruption to services in Sydney due to 1998 Boil water notice >$20M	Loss of service for Bankstown (~50,000 customers) for 1 day Blue Mountains (~25,000 customers) for 2 days North Richmond (~17,500 customers) for 3 days	
Major L3 focus	Toledo – weekend exposure to algal toxin over chronic guideline value Cyanobacterial toxin release from Prospect above chronic guidelines	Loss of tip of finger	ICAC Plumbing Inspector Bribing Investigation (2010)	Significant cutting/clearing protected flora outside of defined work boundaries	Malabar Cliff face leak due to failure to maintain pipe (2013) Sewage leak from a rising main at Rydalmere (2015)		Disruption to flights at Sydney Airport for 1 day @ $5-10m/day	Loss of service for Bankstown (~50,000 customers) for 6 hours Nepean (~10,000 customers) for 1 day Helensburgh (~3,000 customers) for 4 days	
Moderate	Recycled water individual cross-connection under high standard of treatment THM exceedance for a reservoir zone	Partial disabled back movements	Bellevue Hill, 2009, Sydney Water incorrectly identified leak location. Caused landslip and significant safety issues. Road closure for several days. Several days of media.	Major wastewater overflow eg. Malabar effluent pipeline leak (2013)	Glenfield WRP discharge due to faulty valve (2013) Asbestos disturbance of asbestos containing material during construction works (2014)		Disruption to services at RNS/Westmead Hospital for 1 day @ $3m/day Bellevue Hill landslip and road closures ~$2,5M	Loss of service for Nepean (~10,000 customers) for 12 hours Helensburgh (~3,000 customers) for 2 days Cowan North (~800 customers) for 5 days	
Minor	Spot reading of pollutant during water quality test above chronic guideline value	Minor cuts or sprains	Traffic media report on main break. No continued coverage. Petersham burst trunk watermain (500mm) 2016, media for one day only.	Small wastewater overflow into creek Noise or odour issues/complaints	Woolooware Bay pollution with raw sewage due to power loss at pumping station (2015) Dry weather sewer overflow at Badwell Creek		Petersham burst trunk watermain (500mm) 2016, damage to property < $0.5m	Loss of service for Helensburgh (~3,000 customers) for 2 hours Cowan North (~800 customers) for 6 hours	
Negligible	In specification water			Immediate clean-up of leak without spilling onto soil or reaching a waterway				Voyager Point (~500 customers) for 6 hours	



Guideline A Risk management process

Control effectiveness rating (*Analyse the risks*)

CE	Interpretation
Fully effective	Controls are as good as realistically possible, both well conceived and implemented as well as they can be
Substantially effective	Controls are generally well designed and well implemented but some improvement is possible in their design or in how effectively they are implemented
Partially effective	Controls are well conceived but some are not implemented effectively or While the implementation is diligent, it is clear that better controls could be devised
Ineffective	There are significant gaps in the design or in the effective implementation of controls – much more could be done
None or totally ineffective	Virtually no credible control relative to what could be done

This document is only a quick reference to the *Guideline A Risk management process*, and should not be used unaided.

Priority for attention (*Evaluate the risks*)

Current level of risk	Topic	Detail
Very high	Action	Do not start the activity that could trigger the risk, or stop the activity if it has started already, until actions have been taken to reduce the level of risk
	Timing	Take action at once
	Reporting	Report at once to the immediate line manager
	Escalation	Notify the Board via the Managing Director at once Notify the Head of Corporate Public Affairs and Risk at once
	Authority	Activities that could trigger the risk must not start or continue without explicit approval from the Managing Director
High	Action	Take actions to reduce the level of risk to as low as is cost-effective
	Timing	Take action within 3 months
	Reporting	Report at once to the immediate line manager
	Escalation	Notify General Manager as soon as possible Notify the Head of Corporate Public Affairs and Risk as soon as possible
	Authority	Activities that could trigger the risk must not start or continue without explicit approval from the appropriate General Manager
Medium	Action	Take actions to reduce the level of risk to as low as is cost-effective
	Timing	Take action within 12 months
	Reporting	Report to the immediate line manager
	Escalation	Notify the immediate line manager if satisfactory risk action plans cannot be agreed, if additional resources are needed or if additional coordination is required
Low	Action	Monitor. Take action if cost-effective to do so.

Risk treatment options (*Treat the risks*)

Follow this sequence
• Choosing to do something different, either to avoid a risk with detrimental consequences by deciding not to proceed with the activity likely to create risk where this is practicable, or to pursue an opportunity for positive consequences
• Changing the likelihood of the risk, to enhance the likelihood of beneficial outcomes and reduce the likelihood of negative outcomes
• Changing the consequences, to increase the gains and reduce the losses; this may include business continuity, emergency response, contingency and disaster recovery plans
• Sharing the risk, usually through some form of contractual or insurance arrangement
• Tolerating the risk without further treatment, involving an explicit decision to retain risk