Centennial Tahmoor

TAHMOOR COLLIERY
LONGWALL 22

END OF PANEL MONITORING REPORT
FOR LONGWALL 22
AT TAHMOOR COLLIERY

Mine Subsidence Engineering Consultants
1/1767 Pittwater Road – Mona Vale – NSW 2103
PO Box 1421 – Mona Vale – NSW 1660
Tel. (02) 9979 1723 Fax. (02) 9979 1726
Email: enquiries@minesubsidence.com

www.minesubsidence.com

REPORT NO. MSEC200-02

September 2005

DOCUMENT REGISTER

Revision	Description	Author	Checker	Date
01	Report at 1200m of Extraction – LW22	DK	AAW	March 2005
02	End of Panel Report – LW22	DK	AAW	Sept 2005

Report produced for:-

Compliance with conditions attached to the s138 Application for The Department of Primary Industries – Minerals

CONTENTS

DOCUMENT REGISTER i

CONTENTS ii

LIST OF DRAWINGS AND ILLUSTRATIONS iii

CHAPTER 1. INTRODUCTION 4

CHAPTER 2. MONITORING LINES 4

2.1. Identification of Non-Systematic Subsidence Movements 4

2.2. Comparison between Predicted and Observed Movements 6

CHAPTER 3. IMPACTS TO SURFACE FEATURES 7

3.1. Summary of Impacts to Surface Features 7

3.2. Impacts to Houses and Public Amenities 9

3.2.1. Comparison between Predicted and Observed Impacts to Houses and Public Amenities 9

REFERENCES 11

LIST OF DRAWINGS AND ILLUSTRATIONS

Drawings

Drawing No.	*Description*	*Rev*
MSEC200-01	Monitoring Lines over Longwall 22	A
MSEC200-02	Impacts Observed over Longwall 22	A

Figures

Figure No.	*Description*	
MSEC200-01	Turner-Denmead	F
MSEC200-02	Thirlmere Way	C
MSEC200-03	Macquarie Place	C
MSEC200-04	Milne Street	B
MSEC200-05	Market Street	B
MSEC200-06	Fraser Street	A
MSEC200-07	Castlereagh Street	P
MSEC200-08	Main Southern Railway	M
MSEC200-09	Byron-Bronzewing	B

CHAPTER 1. INTRODUCTION

This report has been prepared to compare observed and predicted subsidence, tilt and strain profiles along monitoring lines, and observed and predicted impacts on surface features, following the completion of Longwall 22.

CHAPTER 2. MONITORING LINES

As set out in the Surface Safety and Serviceability Management Plan, for Tahmoor Colliery Longwalls 22 and 23, regular subsidence surveys have been conducted along monitoring lines that have been established in selected streets. The monitoring is being undertaken to compare observed movements against predicted movements, and to identify any anomalous movements that might potentially have an adverse effect on surface features.

Eleven (11) monitoring lines have been installed over Longwall 22. These are the Turner-Denmead, Thirlmere Way, Macquarie Place, Milne-Stuart, Market St, Fraser St, Castlereagh St, Main Southern Railway, Byron-Bronzewing, Park-Elphin and Remembrance Drive monitoring lines. The locations of the monitoring lines are shown in Drawing No. MSEC200-01.

The end of panel survey along the monitoring lines was conducted in late July and early August 2005. The observed subsidence profiles are provided in Figs. MSEC200-01 to 200-09. Observed subsidence profiles have not been provided along Stuart Place, Park Street or Remembrance Drive as these monitoring lines have experienced only very small movements.

Comparisons between predicted and observed subsidence, tilt and strain profiles for these lines are provided in the attached figures at the back of this report, and are summarised below.

2.1. Identification of Non-Systematic Subsidence Movements

Irregular, non-systematic subsidence movements are often found in observed subsidence, tilt and strain profiles. The most common causes of irregular movements in monitoring lines are listed below.

- Valley closure and upsidence
- Geological structures
- Change in direction of monitoring line
- Bumped or damaged pegs
- Survey line discontinuities, where survey lines are extended after the subsidence has already occurred
- Survey error

Anomalous movements have been identified by a process of elimination. If a cause behind an irregularity in a subsidence, tilt or strain profile cannot be determined, the irregularity is described as an anomaly.

A total of six (6) locations have been identified where non-systematic movements have occurred, and these are summarised in Table 2.1. The locations of these non-systematic movements are shown in Drawing No. MSEC200-02.

Table 2.1 Locations of Non-Systematic Movement Identified during or following Longwall 22

Monitoring Line	Maximum Upsidence (mm)	Maximum Strain (mm/m)	Maximum Tilt (mm/m)	Type	Impacts to Surface
Turner-Denmead	50	-3.2	2.2	Anomaly	Buckling and cracking to road pavement Cracks in paddock Impact to one house
Thirlmere Way	35	-1.6	2.5	Valley closure	No impacts observed
Macquarie Place	None	+2.0	9.0	Igneous intrusion	Cracking to road pavement Impact to one house
Milne Street	40	-1.9	1.3	Anomaly	Cracking and spalling of concrete kerb and gutter Impacts to eight gates and one house
Fraser Street	30	-1.3	1.4	Anomaly	No impacts observed
Fraser Street	30	+0.3	1.5	Possible anomaly	No impacts observed

A number of observations can be made in relation to the identification of non-systematic movements.

- The majority of anomalous movements appear to have occurred near the centre of the panel. This trend is observed in Denmead, Milne and Fraser Streets. The anomalies are relatively small and the impacts to surface features have been minor, when compared to those that have occurred at previous anomalies over Longwalls 5, 6 and 16 at Tahmoor Colliery and Longwall 5A3 at West Cliff Colliery.
  Whilst anomalous movements have not been observed along the Market Street monitoring line, three houses on this street, which are located near the centre of the panel, have experienced impacts which could also be attributed to anomalous movements.
- There is one possible anomaly on Fraser Street, which is located beyond the goaf edge of Longwall 22. This anomaly demonstrates an upsidence bump of approximately 30 mm, although there is no significant ground strain associated with this bump. Field investigations of the affected pegs do not reveal any damage, although some minor tampering may have occurred on one peg. Tahmoor Colliery will check the survey result with a repeat survey within the next two weeks. If the survey result is confirmed, increased monitoring will be undertaken in the vicinity of this possible anomaly, as Longwall 23A will directly mine beneath this peg,.
- Valley closure and upsidence movements appear to have occurred in a tributary to Myrtle Creek, near the centre of the panel.
- The reduced subsidence observed on Macquarie Place is due to the presence of a substantial igneous intrusion beneath Macquarie Place and Stuart Place. The main effect of the reduced subsidence is an increased tilt into the subsidence bowl of approximately 9 mm/m. The observed strains are less than 2 mm/m. A coal barrier has been introduced in Longwall 23 due to the presence of this intrusion.

2.2. Comparison between Predicted and Observed Movements

The predicted and observed subsidence profiles for each monitoring line are shown in Figs. MSEC200-01 to MSEC200-09. A number of observations have been made following a comparison between these profiles.

- Subsidence has been conservatively predicted in most cases. Maximum observed subsidence has generally been less than maximum predicted subsidence, and the maximum difference is less than 50 mm or 10 % of maximum subsidence, where monitoring lines have crossed above the centre of the longwall panel.
- When systematic movements are compared, the predicted subsidence profiles compare reasonably well with observed profiles. However, it is apparent that observed subsidence profiles are generally steeper than predicted profiles where they enter the subsidence bowl. This has resulted in an under-prediction of tilt profiles by a maximum difference of 1 mm/m. The predicted subsidence profiles in the Incremental Profile Method have subsequently been amended for first panels in a series within the Southern Coalfield, as a result of these observations.
- Observed strains have generally been within the predicted range of 0.3 mm/m tensile and 0.6 mm/m compressive. It is noted that specified survey tolerances are 2 mm over a bay length of 20 metres, which represents a potential error of 0.1 mm/m. Observed strains have exceeded predicted maximum strains in some cases, although these have occurred in isolated locations and most are associated with non-systematic movements, which were identified in Section 2.1.
- Reduced subsidence is evident near the finishing end of Longwall 22, along Castlereagh Street, Bronzewing Street and the Main Southern Railway. A number of potential causes have been discussed in previous reports (MSEC212). The most likely reason is that the ground could be behaving differently due to a redistribution of in-situ horizontal compressive stresses at that location. The redistribution of stress could be occurring near the surface or between the surface and the mined void. It is worth noting that the finishing end is located near a rock mass that is wedged between the mined voids of Longwall 22 to the north, Panels 201 to 204 to the south, and Longwall 3 to the west. This rock mass has progressively been reduced in size as Longwall 22 has been mined, and stress redistribution is likely to have occurred to some extent.
- Far-field vertical movement has been observed around Longwall 22, where the traditional limit of subsidence (20 mm) has been found to be substantially beyond the predicted limit. While this has been observed to some extent previously at Tahmoor Colliery, it appears that these movements have been more prevalent around this panel. For example, subsidence greater than 40 mm has been observed in Park Street and Stuart Place. The subsidence profile in these areas is particularly flat, with observed tilts and strains less than 0.5 mm/m.
- The predicted and observed profiles do not compare well where non-systematic movements have occurred, which is understandable. Non-systematic movements were identified in Section 2.1.

CHAPTER 3. IMPACTS TO SURFACE FEATURES

3.1. Summary of Impacts to Surface Features

A comparison between predicted and observed impacts to surface features is summarised in Table 3.1 below. It can be seen from that the impacts to surface features have been relatively minor. The predicted and observed impacts to surface features compare reasonably well, with the exception of locations where non-systematic movements have occurred.

Table 3.1 Summary of Predicted and Observed Impacts

SURFACE FEATURE	PREDICTED IMPACTS	OBSERVED IMPACTS
NATURAL FEATURES		
Myrtle Creek	Potential cracking in creek bed. Potential surface flow diversion. Potential reduction in water quality during times of low flow. Potential increase in ponding.	No impacts observed.
Aquifers or Known Groundwater Resources	See Farmland and Facilities - Wells and Bores	No impacts observed.
Natural Vegetation	No impacts anticipated.	No impacts observed.
PUBLIC UTILITIES		
Railways	Ground movements unlikely to impact operation of railway.	No impacts observed.
Roads (All Types)	Minor cracking and buckling may occur in isolated locations.	Cracking and buckling observed in one location on Denmead Street. Cracking observed in one location on Macquarie Place. Cracking and spalling of concrete kerb and gutter on corner of Milne and King Streets.
Water Pipelines	Minor impact to pipelines, particularly older cast iron pipes with lead joints.	Two leakages observed at connection to consumer lines. Observed frequency of incidences similar to those in areas not affected by mine subsidence.
Gas Pipelines	Ground movements unlikely to adversely impact pipelines.	No impacts observed.
Sewerage Pipelines	Mining induced tilt may reduce gradient of some pipes to less than that required for self-cleansing.	Changes in tilt have occurred within predicted range. Observed frequency of incidences similar to those in areas not affected by mine subsidence.
Electricity Transmission Lines or Associated Plants	Ground movements unlikely to adversely impact electrical infrastructure.	No impacts observed.
Telecommunication Lines or Associated Plants	Ground movements unlikely to adversely impact telecommunications infrastructure.	Air leakage observed in old lead junction cable on Thirlmere Way.
PUBLIC AMENITIES	Negligible impacts predicted for all public amenities.	No impacts observed.

Table 3.1 Summary of Predicted and Observed Impacts (continued)

SURFACE FEATURE	PREDICTED IMPACTS	OBSERVED IMPACTS
FARMLAND AND FACILITIES		
Farm Buildings or Sheds	Negligible impacts predicted for all farm buildings and sheds.	No impacts observed.
Fences	No impact assessment provided in Report No. WKA137.	Impacts to fences or gates observed on 11 properties (1 rural, 10 urban).
Farm Dams	Potential cracking and leakage. Ground movements unlikely to result in overflowing or reduction in dam capacity.	No impacts observed.
Wells or Bores	Potential differential horizontal movements.	No impacts observed.
INDUSTRIAL, COMMERCIAL & BUSINESS ESTABLISHMENTS	Negligible impacts predicted for all business and commercial establishments.	No impacts observed.
AREAS OF ARCHAEOLOGICAL OR HERITAGE SIGNIFICANCE	No heritage items located within the area impacted by Longwall 22.	
ITEMS OF ARCHITECTURAL SIGNIFICANCE	No items of architectural significance located within the area impacted by Longwall 22	
PERMANENT SURVEY CONTROL MARKS	Ground movement predicted at identified survey marks.	Ground movement occurred.
RESIDENTIAL ESTABLISHMENTS		
Houses	Tilt Impact Category A for all houses due to systematic mine subsidence movements. Strain impact Category 1 for 7 houses due to systematic mine subsidence movements. Potential for non-systematic movement to occur. All structures expected to remain safe, serviceable and repairable during and following mining.	Some impacts observed for 21 houses, although most are negligible to very slight (sticky doors, minor cracks to internal finishes) 2 houses require adjustment to some roof gutters (Tilt Impact Cat B). 2 houses with Category 1 crack to external wall (Strain Impact Cat 1). 3 houses with Category 2 crack to external wall (Strain Impact Cat 2). All structures were safe, serviceable and repairable during and following mining.
Retirement or Aged Care Villages	Negligible impacts predicted for Macquarie Grove Retirement Village.	No impacts observed.
Associated Structures such as Workshops, Garages, On-Site Waste Water Systems, Water or Gas Tanks, Swimming Pools or Tennis Courts	Potential impact to pipes connected to in-ground septic tanks. Negligible impacts predicted for non-residential domestic structures, including swimming pools and tanks.	No impacts observed to in-ground septic tanks or other tanks. Tilt impact observed at 1 pool. Tilt impact observed at 1 clothesline.
External Residential Pavements	No impact assessment provided in Report No. WKA137.	Impacts to pavements observed on 8 urban properties.

3.2. Impacts to Houses and Public Amenities

As set out in the Surface Safety and Serviceability Management Plan, Revision C (SSSMP), for Tahmoor Colliery Longwalls 22 and 23, a field investigation program has been implemented to monitor impacts on a number of buildings that will be affected by Longwalls 22 and 23. The timing and frequency of ground and building surveys around buildings is set out in Appendix B of the SSSMP.

The Stage 1 Report (Report No. MSEC184-02) documented the findings of the pre-mining field investigations of 119 buildings. Since that report, an additional building (a new child care centre) has been added to the sample, which revises the total to 120 buildings. In accordance with the SSSMP, these buildings were re-inspected after the longwall passed each building by between 150 and 300 metres and when it was clear that subsidence movements due to Longwall 22 had essentially ceased.

Impacts have also been reported by residents who did not take part in the field investigation program.

3.2.1. Comparison between Predicted and Observed Impacts to Houses and Public Amenities

Predicted impacts for buildings are generally based upon those provided in Report No. MSEC156.

Predictions for strain impacts were subsequently revised for the houses and public amenities that took part in the field investigation program. The impacts were re-assessed based upon maximum plan dimensions and building heights that were measured during the field investigations. The findings were reported in Report No. MSEC184-02.

Details of revised strain predictions for each building, after the extraction of Longwall 22, were not included in Report No. 184-02. However, it is advised that five buildings were predicted to experience Strain Category 1 impacts (Ref. F35, L10, M02a, M09a, P33a). When these revised predictions are compared to the original predictions in Report No. MSEC156, it can be seen that two additional buildings were predicted to experience Strain Category 1 impacts (Ref. M09a and P33a).

In the case of predicted tilt impacts, an alternative prediction was provided where the observed pre-mining tilts were added as a vector sum to the predicted mining tilts. However, this revised prediction was considered to be very conservative and has not been used for comparison with observed impacts. It is noted, as an aside, that no impacts were observed for a house that was found to have Category C pre-mining uniform tilt, even though the tilts were observed to increase following extraction of Longwall 22.

A summary of predicted impacts for houses and public amenities, following the completion of Longwall 22 is provided in Table 3.2. The count of houses and public amenities includes only those buildings that were predicted to experience more than 20 mm of subsidence due to the extraction of Longwall 22. The remaining houses and public amenities that were identified in Report No. WKA137 or Report No. MSEC156 were not included in this comparison.

Table 3.2 Summary of Predicted Impacts to Houses and Public Amenities due to Longwall 22

	Impact Assessment in Report No. MSEC156 due to Longwall 22 (No.)	No. of amendments following pre-mining field investigation in Report No. MSEC184-02 due to Longwall 22 (No.)	Revised Impact Assessment due to Longwall 22 (No.)
Tilt Impacts			
Tilt Impact Category A	426	Nil	426
Tilt Impact Category B	0	Nil	0
Strain Impacts			
Strain Impact Category 0	419	-2	417
Strain Impact Category 1	7	+2	9
Strain Impact Category 2	0	Nil	0

It is noted that two (2) of the buildings that were predicted to experience Category 1 strain impacts were public amenity buildings.

Observed tilt impacts have been categorised, based upon a classification of tilt-related impacts as described in Report No. WKA137. Observed strain impacts are based upon a measurement of maximum vertical crack width in external walls, as the empirical method of strain impact assessment was based upon this objective measurement. A summary of impacts is provided in Table 3.3.

Table 3.3 Comparison between Predicted and Observed Impacts

	Predicted (No.)	Observed (No.)
Tilt Impacts		
Tilt Impact Category A	426	424
Tilt Impact Category B	0	2
Strain Impacts		
Strain Impact Category 0	417	421
Strain Impact Category 1	9	2
Strain Impact Category 2	0	3

It is noted that one (1) house, which has experienced Category B tilt impacts, has also experienced a Category 2 crack. A total of six (6) houses have therefore experienced impacts greater than Tilt Category A or Strain Category 0.

It is further advised that an additional 15 houses have experienced minor impacts that have not resulted in a classification of impact greater than Tilt Category A or Strain Category 0. These impacts include door jams, slight door swings, minor cracks to internal linings or floor finishes.

It can be seen from the above summary that the great majority of the observed impacts compare well with predicted impacts, although there are some buildings that have experienced greater impacts than previously predicted. On an overall basis, fewer buildings have experienced impacts greater than Tilt Impact Category A or Strain Impact Category 0 when compared to predicted impacts.

The locations of affected houses are shown in Drawing No. MSEC200-02. It can be seen from this drawing that many of the houses are located near the centre of the longwall panel, where small anomalous movements have been consistently observed along monitoring lines. Both of the houses that have experienced Category B tilt impacts are located near non-systematic movements. It is therefore concluded that whilst some houses have experienced greater impacts when compared to their predicted impact assessments, the impacts are mainly due to non-systematic movements, which were not expected to occur prior to the commencement of Longwall 22.

It is also noted that the igneous intrusion beneath Macquarie Place has substantially reduced the amount of subsidence, tilt and strain for a number of houses, compared to the predictions. This includes houses at the end of Macquarie Place, the entire Macquarie Grove Retirement Village, Stuart Place and Robyn Place. Although these houses were predicted to experience Category A tilt impacts and Category 0 strain impacts, the amount of subsidence for many of these houses has reduced from over 100 or 200 mm to less than 50 mm.

There were also nine structures where preventive works or additional monitoring during mining were recommended due to non-conformance to Australian Standards or potential vulnerability to subsidence impacts. Only one of these identified structures, House M09a, has reported any adverse impacts. This house is likely to have been affected by non-systematic movements. It was recommended that a bulkhead be monitored during mining, and it is reported that cracking has occurred to the internal linings around this bulkhead. However, the cracking does not pose a hazard to the safety of the residents.

REFERENCES

Waddington, A.A., Kay, D.R. and Kay, D.J. (2004). *Challenges for Assessment of Tilt Impacts due to Mining a Series of Longwalls*, Proceedings of the 6th Triennial Conference on Mine Subsidence, Maitland, November 2004.

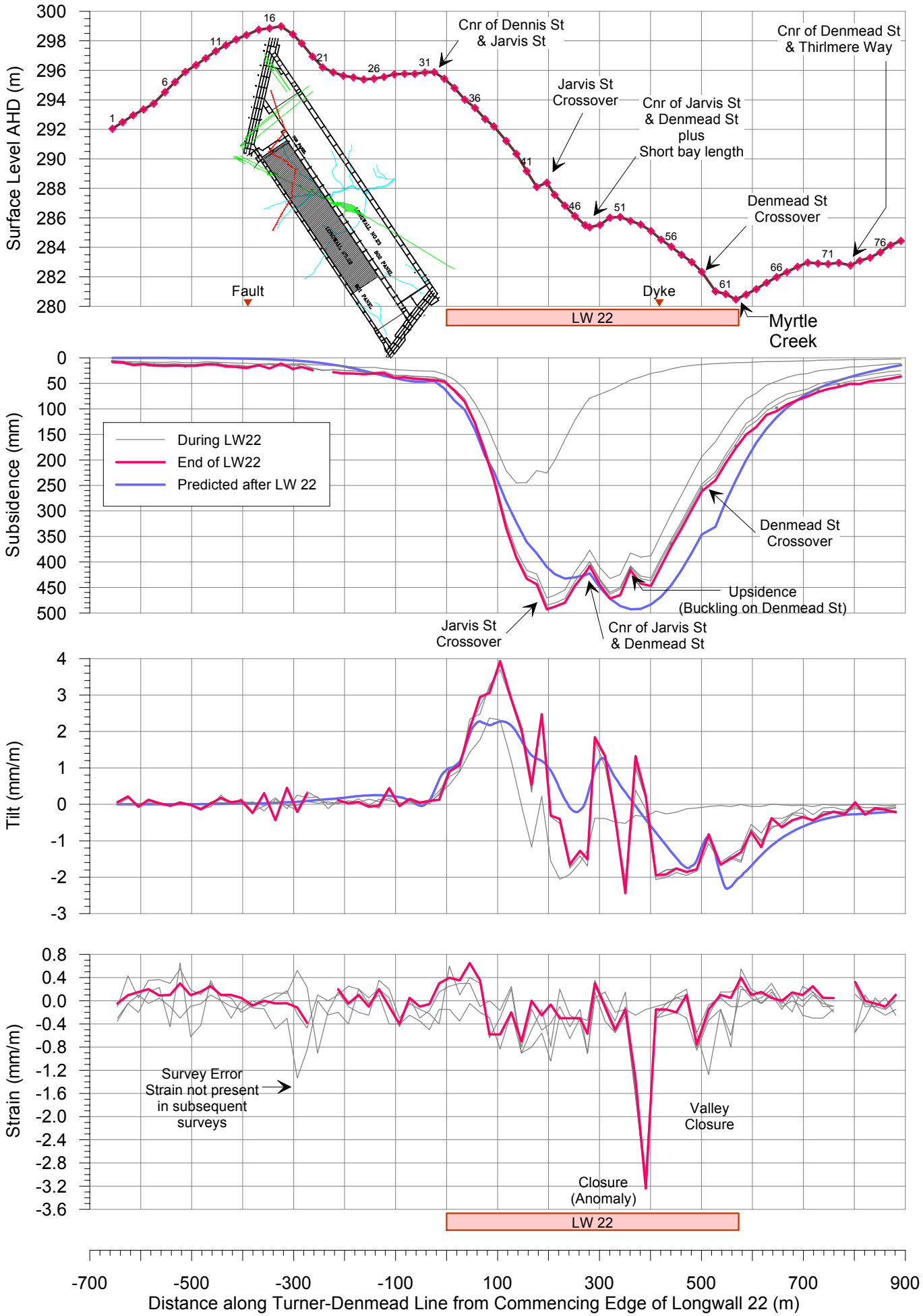
Mine Subsidence Engineering Consultants, (2004). *Tahmoor North Longwalls 22 & 23 Report on the Prediction of Subsidence Parameters and the Assessment of Subsidence Impacts on Structures identified in Report No. WKA137 due to the extraction of Longwalls 24 and 25 (in support of a Section 138 Application).* Report No. MSEC156, February 2004.

Mine Subsidence Engineering Consultants, (2004). *Stage 1 Report on Site Investigation of Structures that will be affected by Mine Subsidence due to extraction of Longwalls 22 and 23 at Tahmoor Colliery.* Report No. MSEC184-02, December 2004.

Tahmoor Colliery, (2004). *Surface Safety and Serviceability Management Plan,* Revision C, December 2004.

Waddington Kay & Associates, (2003). *Tahmoor North Longwalls 22 & 23 Report on the Prediction of Subsidence Parameters and the Assessment of Subsidence Impacts on Natural Features and Surface Infrastructure (in support of a Section 138 Application).* Report No. WKA137, October 2003.

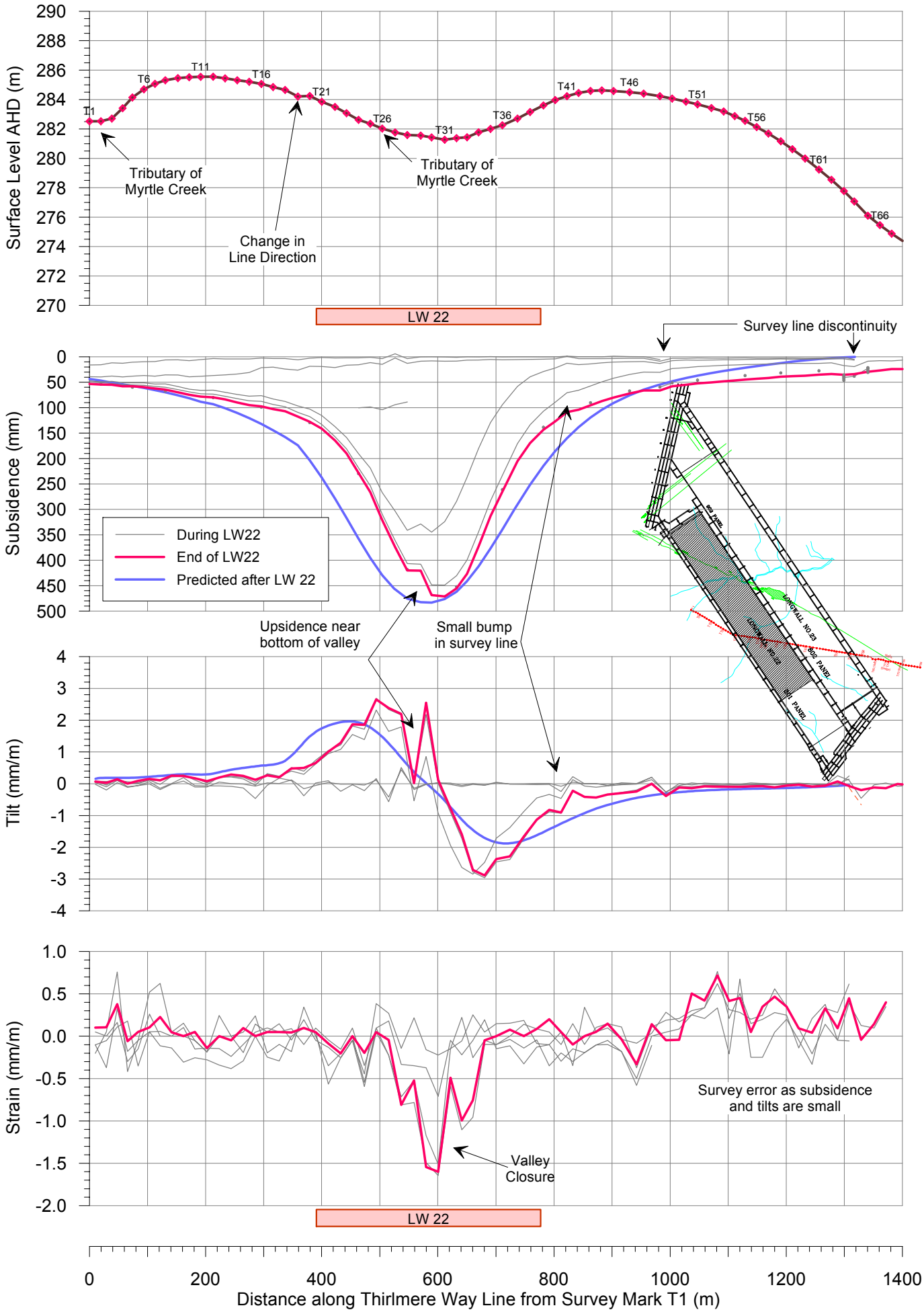
Tahmoor Colliery - Observed Subsidence, Tilt & Strain along Turner-Denmead Monitoring Line



Mine Subsidence Engineering Consultants

Fig. MSEC200-01 Rev F

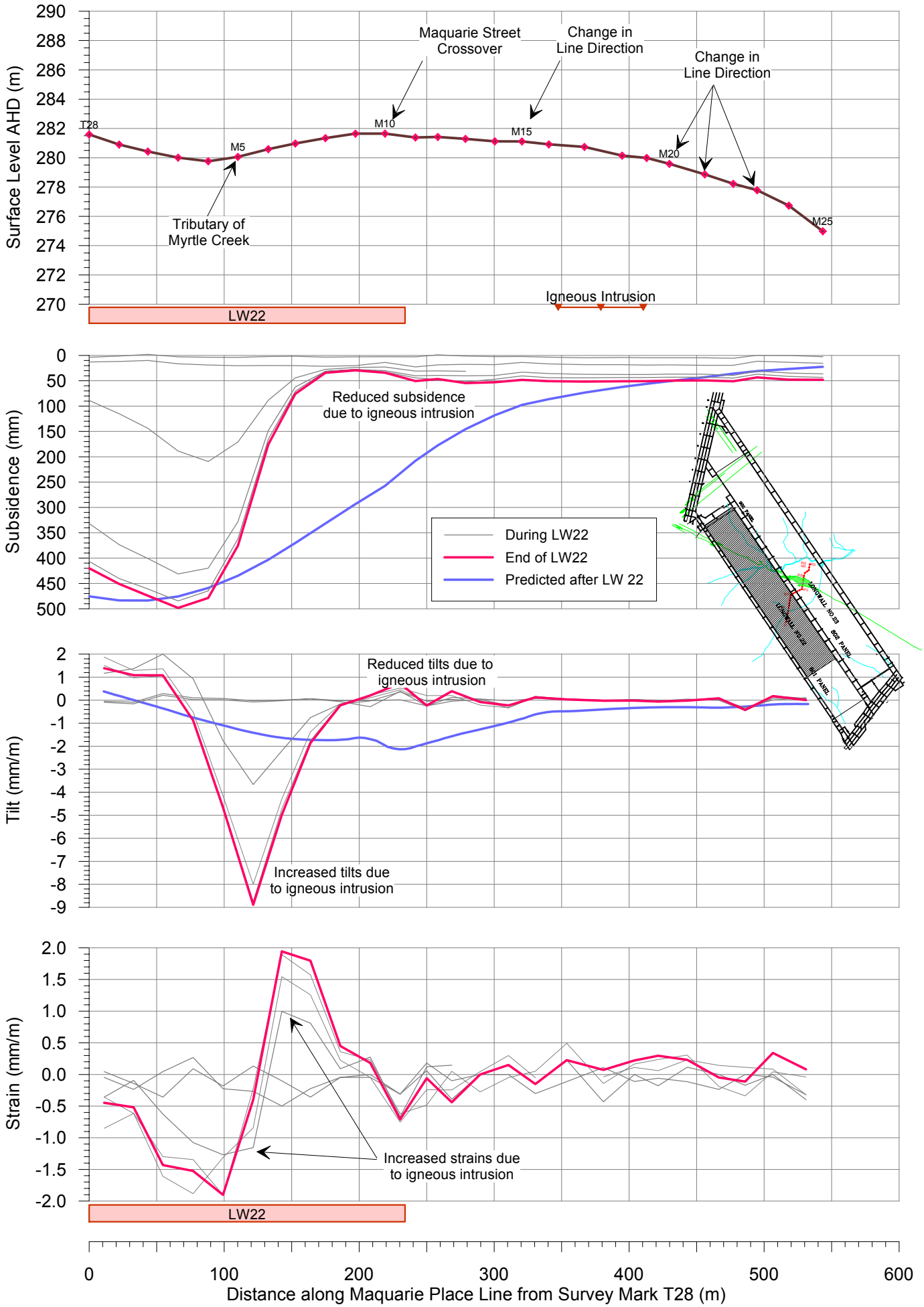
Tahmoor Colliery - Observed Subsidence, Tilt & Strain along Thirlmere Way Line



Mine Subsidence Engineering Consultants

Fig. MSEC200-02 Rev C

Tahmoor Colliery - Observed Subsidence, Tilt & Strain along Macquarie Pl Monitoring Line

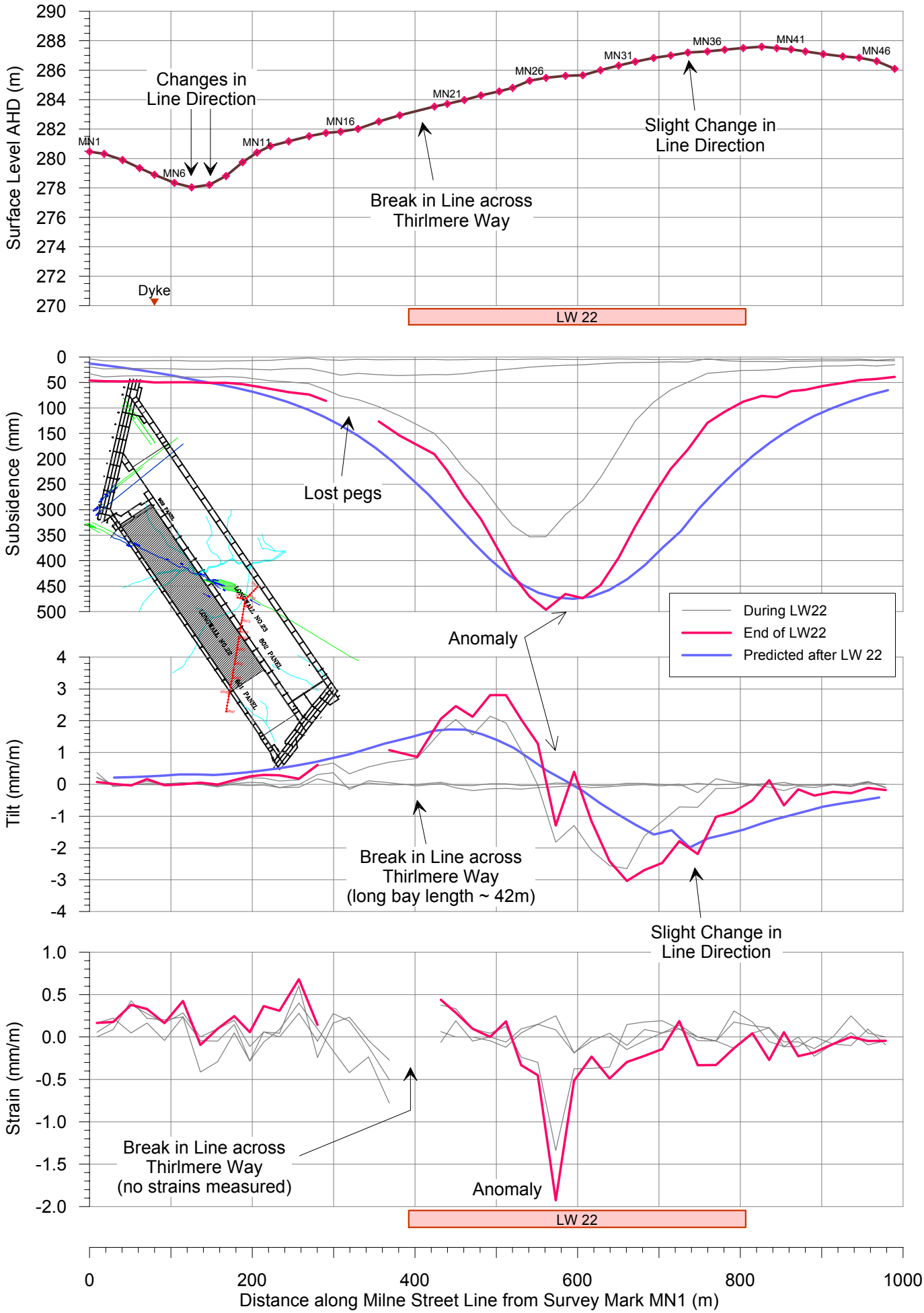


Mine Subsidence Engineering Consultants

Fig. MSEC200-03 Rev C

S:\TAHMOOR\SurveyData\Milne-Stuart\Milne.grf 26-Sep-05

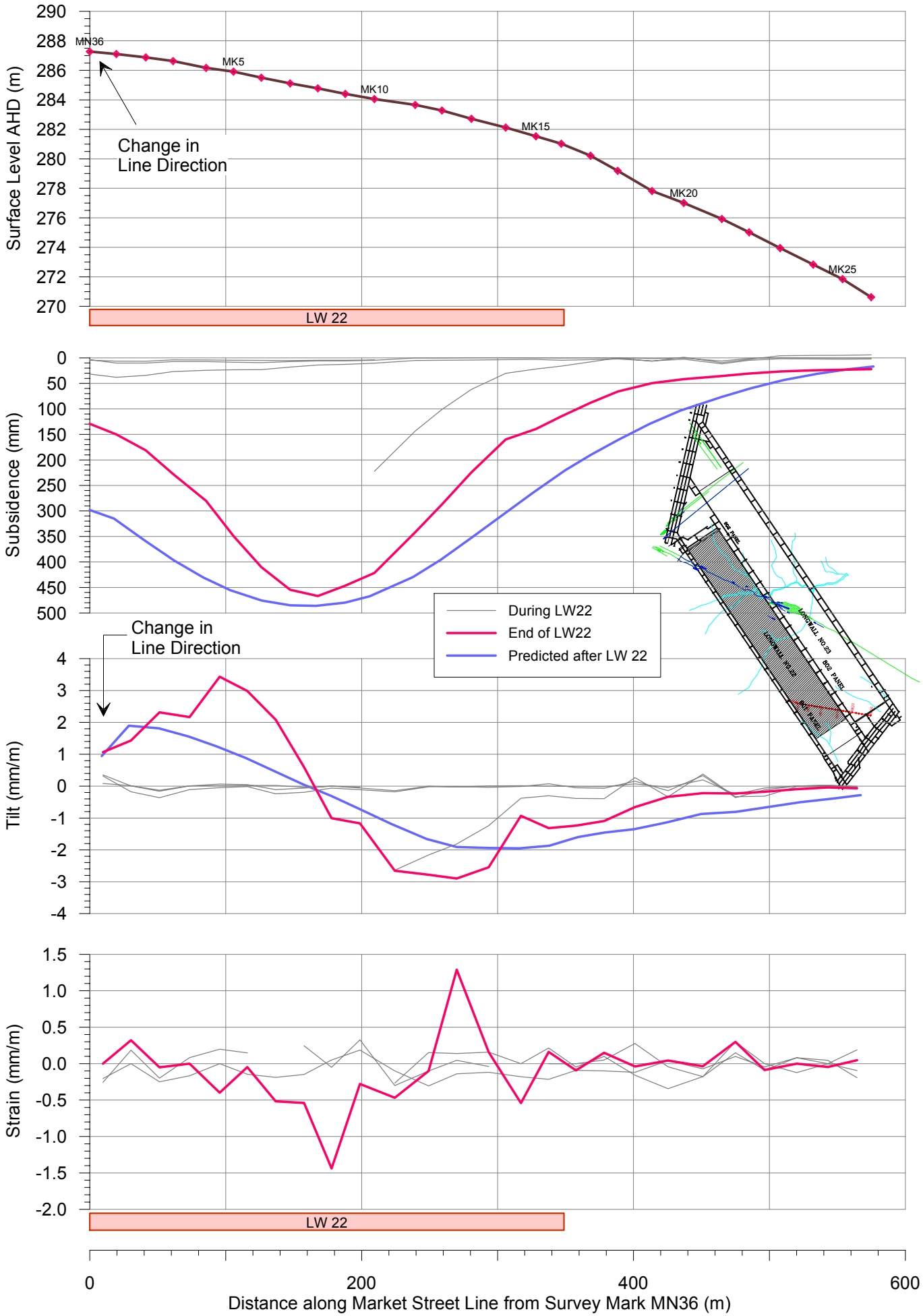
Tahmoor Colliery - Observed Subsidence, Tilt & Strain along Milne Street Line



Mine Subsidence Engineering Consultants

Fig. MSEC200-04 Rev B

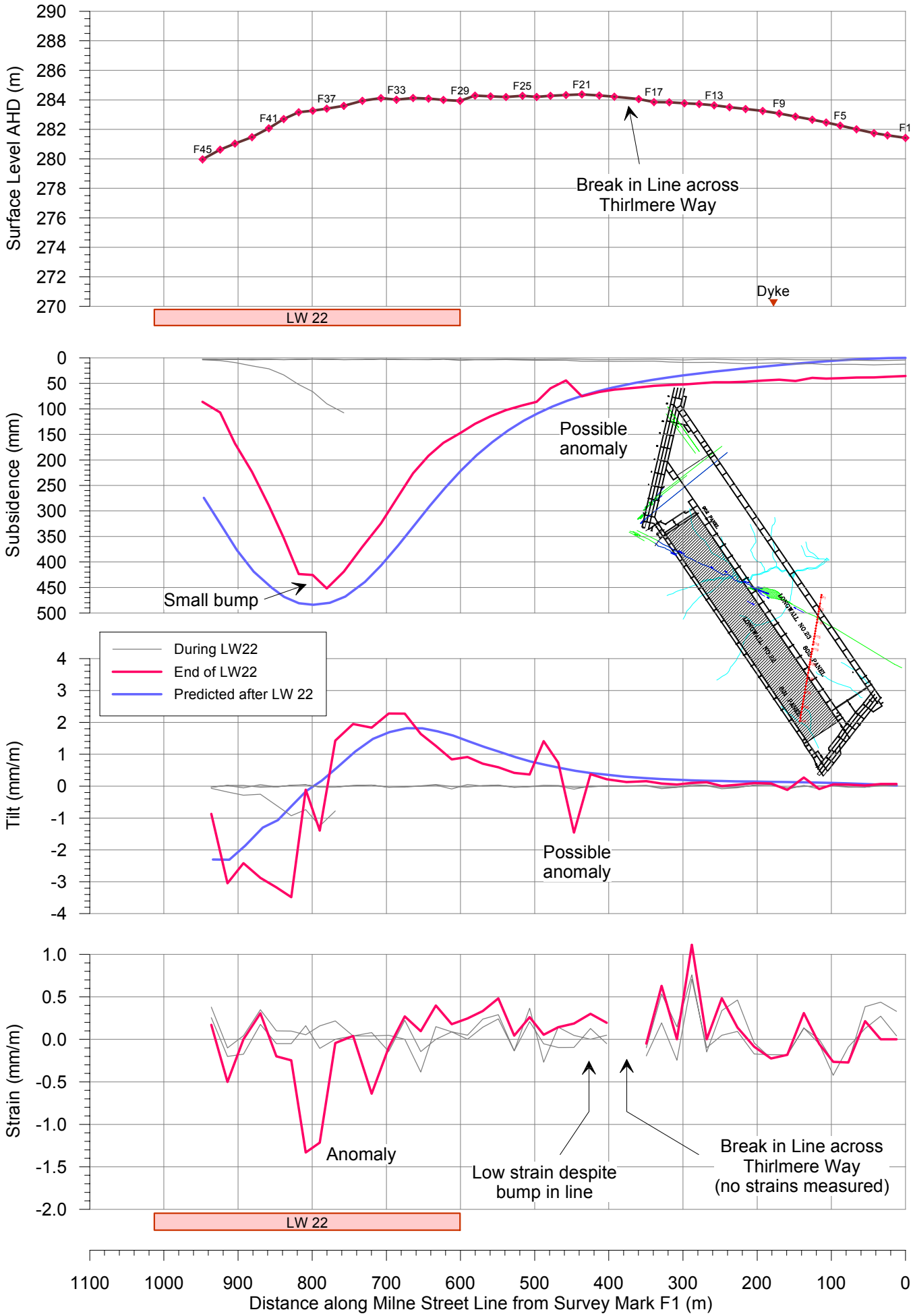
Tahmoor Colliery - Observed Subsidence, Tilt & Strain along Market Street Line



Mine Subsidence Engineering Consultants

Fig. MSEC200-05 Rev B

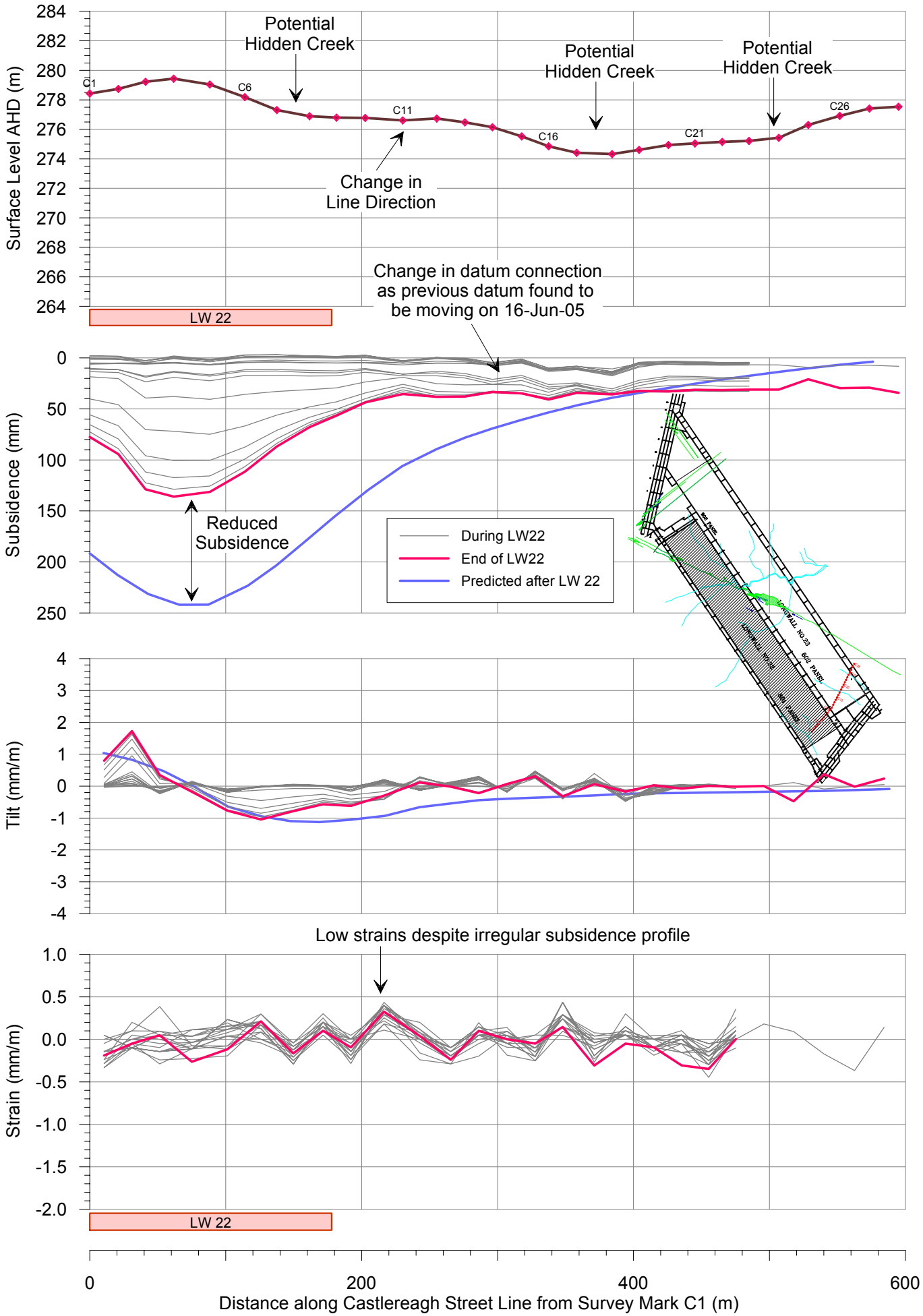
Tahmoor Colliery - Observed Subsidence, Tilt & Strain along Fraser Street Line



Mine Subsidence Engineering Consultants

Fig. MSEC200-06 Rev A

Tahmoor Colliery - Observed Subsidence, Tilt & Strain along Castlereagh Street Line

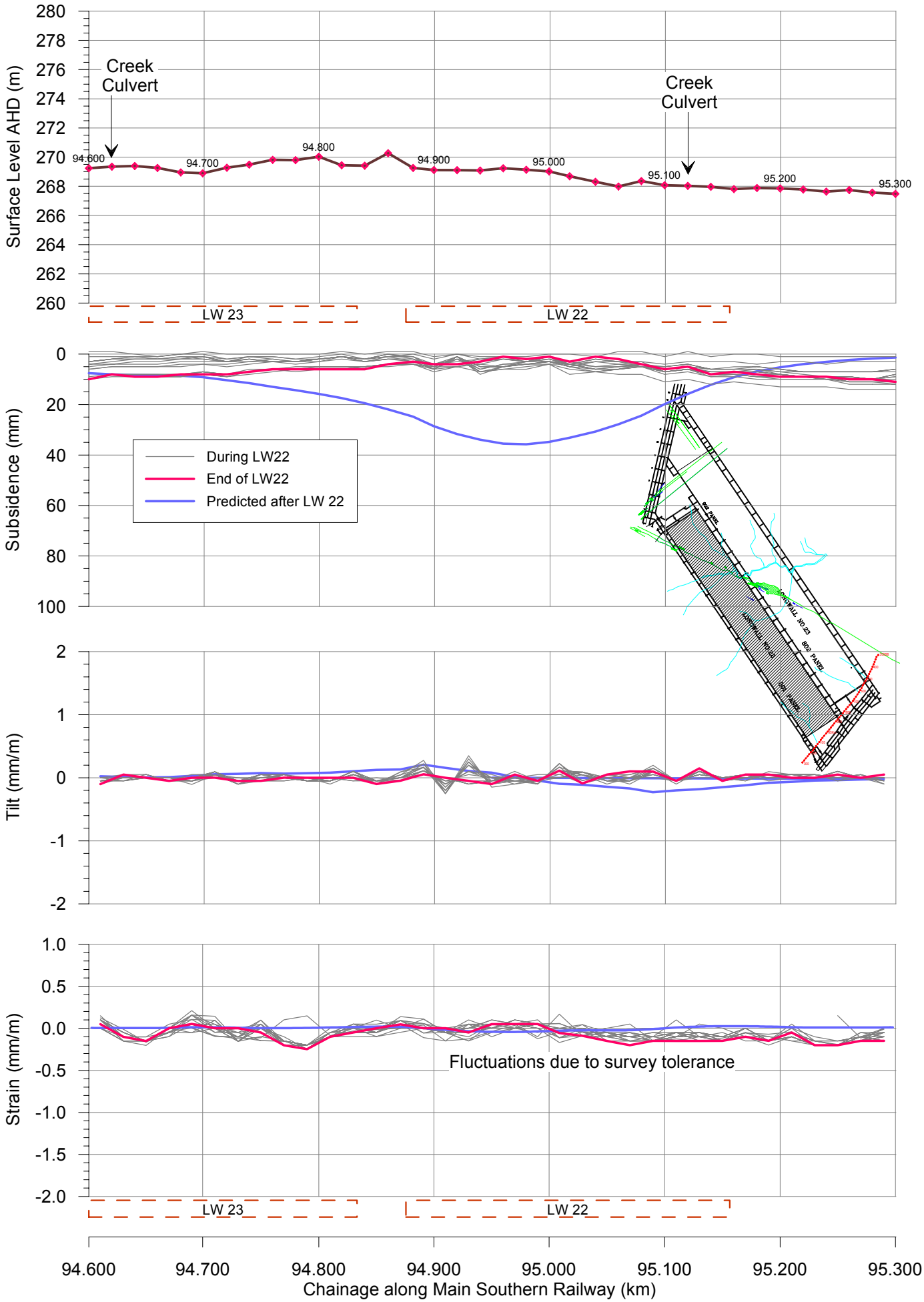


Mine Subsidence Engineering Consultants

Fig. MSEC200-07 Rev P

S:\TAHMOOR\SurveyData\Main Southern Railway\Railway Line\Main Southern Railway.grf 26-Sep-05

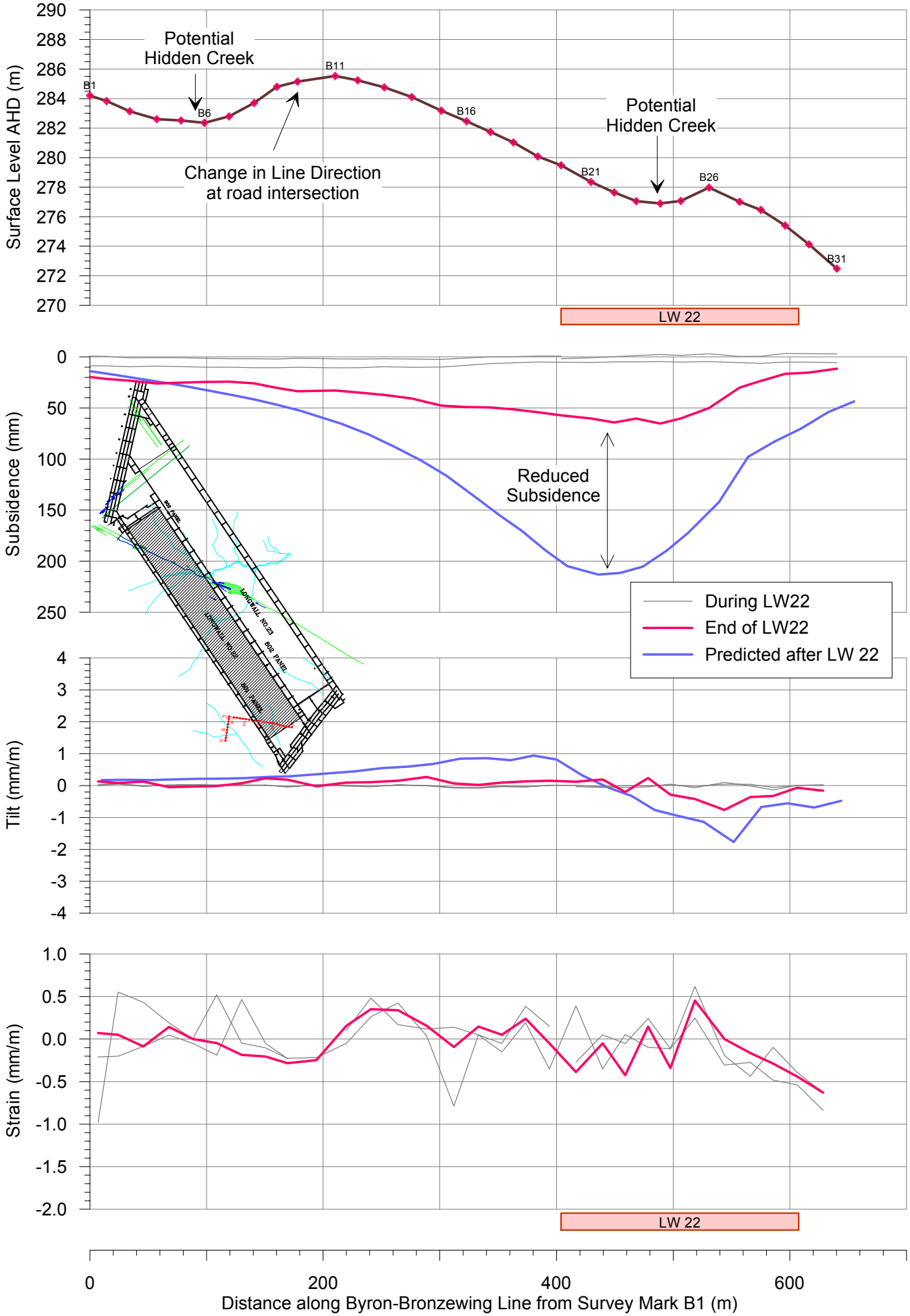
Tahmoor Colliery - Observed Subsidence, Tilt & Strain along Main Southern Railway Line



Mine Subsidence Engineering Consultants

Fig. MSEC200-08 Rev M

Tahmoor Colliery - Observed Subsidence, Tilt & Strain along Byron-Bronzewing Line



Mine Subsidence Engineering Consultants

Fig. MSEC200-09 Rev B

C:\ACADData\Tahmoor\MSEC200-01 Layout.dwg

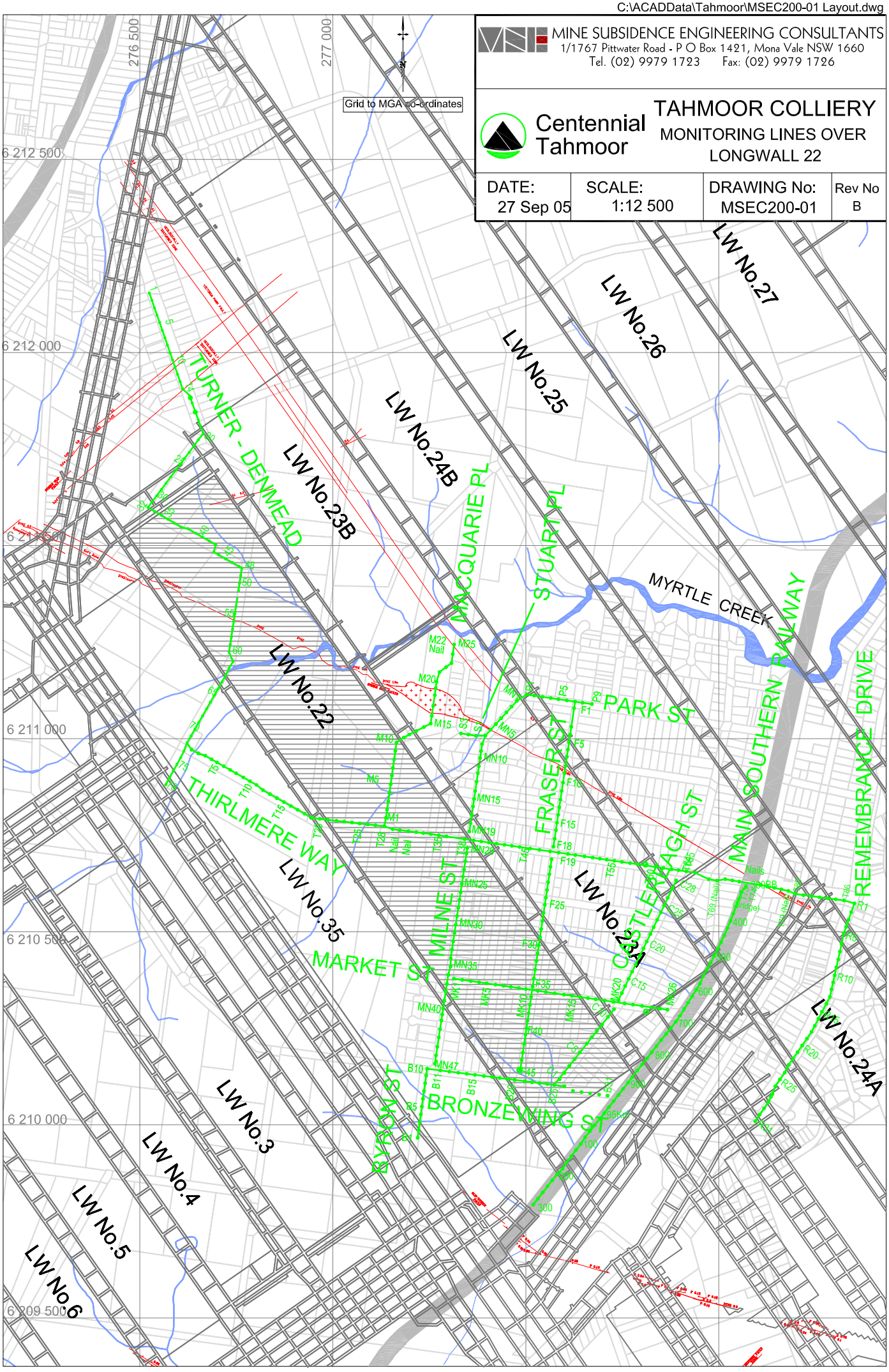
MINE SUBSIDENCE ENGINEERING CONSULTANTS
1/1767 Pittwater Road - P O Box 1421, Mona Vale NSW 1660
Tel. (02) 9979 1723 Fax: (02) 9979 1726

Centennial Tahmoor

TAHMOOR COLLIERY

MONITORING LINES OVER LONGWALL 22

DATE:	SCALE:	DRAWING No:	Rev No
27 Sep 05	1:12 500	MSEC200-01	B



C:\ACADData\Tahmoor\MSEC200-01 Layout.dwg

MINE SUBSIDENCE ENGINEERING CONSULTANTS
1/1767 Pittwater Road - P O Box 1421, Mona Vale NSW 1660
Tel. (02) 9979 1723 Fax: (02) 9979 1726

Centennial Tahmoor

TAHMOOR COLLIERY

IMPACTS OBSERVED OVER LONGWALL 22

DATE:	SCALE:	DRAWING No:	Rev No
27 Sep 05	1:12 500	MSEC200-01	B

Grid to MGA co-ordinates

Reduced Subsidence due to Igneous Intrusion

Anomaly

Valley Closure and Upsidence

Anomaly

Reduced Subsidence

- Strain Impact Category 2
- Strain Impact Category 1
- Tilt Impact Category B
- Minor impact(s) observed to house
- Impact(s) observed to fence gates or external pavements only
- Non-systematic movement