ANNEX B

Subsidence Assessment
(SCT, 2007)

Strata Control Technology

REPORT TO:

ENVIRONMENTAL RESOURCE MANAGEMENT AUSTRALIA PTY LTD

Subsidence Assessment for Part 3A Application Longwalls 10-17 at Integra Coal

ERM3196

Mining Research and Consulting Group
SCT Operations Pty Ltd PO Box 824 Wollongong NSW 2520 Australia
sctnsw@sctaust.com

REPORT TO	Joanne Woodhouse Environmental Scientist ERM Australia Pty Ltd PO Box 71 THORNTON NSW 2322
SUBJECT	Subsidence Assessment for Part 3A Application Longwalls 10-17 at Integra Coal
REPORT NO	ERM3196
PREPARED BY	Ken Mills
DATE	27 February 2007

Ken Mills
Senior Geotechnical Engineer

Winton J. Gale
Managing Director

SUMMARY

Integra Coal Operations is proposing to mine Longwalls 10-17 as a continuation of their current series of longwall panels. Environmental Resources Management Australia Pty Ltd commissioned SCT Operations Pty Ltd to make a subsidence assessment suitable for submission as part of a Part 3A application. This report presents the results of our subsidence assessment for the surface area above Longwalls 10-17.

Subsidence monitoring results from Longwalls 1-6 provide a basis for estimating subsidence over future longwalls at the mine. It is considered likely that future monitoring will allow these estimates to be refined somewhat, once several of the 257m wide panels have been mined adjacent to each other and full subsidence has developed. Until subsidence monitoring data becomes available from these wider longwall panels, a deliberately conservative approach to estimating subsidence has been taken for all subsidence parameters. Subsidence has been estimated using a range of subsidence methods and the most conservative of these has been adopted wherever there is a range. Actual maximum subsidence values (vertical subsidence, tilt, and strain) are likely to be in the range 50 – 80% of the maximum values used for assessment purposes, but additional monitoring is required to confirm this.

Our assessment indicates that maximum subsidence of up to 1.6m (for a 2.4m mining section) may develop within the project area. Full subsidence is likely to develop at any given point only after several adjacent longwall panels have been mined. Subsidence in the final subsidence profile is likely to vary locally across each panel, being greater in the centre of each panel and less over the chain pillars. Subsidence in the centre of Longwall 10 is expected to be up to 1.6m and subsidence over the chain pillars up to about 1.2m. This variation across individual panels is expected to decrease in the later longwalls because of the increasing overburden depth so that subsidence in the centre of Longwall 16 may reach up to 1.6m while the subsidence over the chain pillars is expected to be some 0.1m less than in the centre of the panel.

Tilts of up to a maximum of 12mm/m are expected based on experience of mining at similar depths in the Southern Coalfield. Horizontal strains of up to a maximum of 6mm/m in tension and 9mm/m in compression are expected based on extrapolation from previous monitoring over Longwalls 1-6, however it is likely that horizontal strains will be somewhat lower because it would appear that all the high strain values in previous monitoring relate to one particular survey and are not reproduced in later surveys. Horizontal movements of up to about 150mm in any one direction are expected to develop gradually across a broad front of several hundred metres.

The Mt Owen Rail Line and associated infrastructure has been identified as the main surface improvement that is likely to be impacted by mining subsidence within the project area. It is considered likely that the Rail Line would be able to remain serviceable throughout the period of mining with frequent monitoring and restressing of the rails from time to time likely to

be required. A specific Rail Line Management Plan for Longwalls 10-17 is currently being developed in consultation with the owners, operators and maintainers of the rail line. Additional detailed subsidence monitoring over Longwalls 7-9 is expected to provide confirmation of the subsidence behaviour in advance of mining under the section of rail line located over Longwalls 10-17.

A dual rail and road bridge over Bettys Creek is expected to require a specific Subsidence Management Plan. The nature of this structure is such that it is likely to be able to accommodate anticipated maximum subsidence movements with only relatively minor works required. It is understood that the monitoring and management of this structure will be addressed in the Rail Line Management Plan.

The rail line traverses several embankments that would have the potential to spread laterally when subsided. Monitoring of this effect during mining under embankments over Longwalls 7-9 is expected to provide an indication of its potential significance for the embankments located over Longwalls 10-17.

Other items of surface improvements identified within the project area include, an unsealed public road (Forest Road), various farm access tracks, fences in various states of repair, a disused dwelling, a buried Telstra cable and an aerial electricity transmission line servicing the disused dwelling, a light-weight steel framed farm shed and a number of farm dams. We understand that the owners of these improvements are being consulted by mine representatives and appropriate management plans are being developed.

Bettys Creek and its associated tributaries have been identified as the main natural feature within the project area. We understand that an independent assessment of the mining impacts on Bettys Creek is being undertaken.

Future developments in the area include a proposal by Xstrata to open cut mine the Eastern Rail Pit above Longwalls 13-17, and Ravensworth East and Glendell Open Cuts just on the fringe of the project area. Some associated works including an overburden storage dump for Glendell Open Cut, the Glendell haul road, a tailings emplacement dam and Bettys Creek diversion works would extend into the project area.

Specific assessments of the impacts of underground mining on these various mining developments are recommended once the final geometries are known and the timing of mining and rehabilitation has been finalised. They are all considered to be manageable based on experience at other sites, but are likely to require cooperation between the surface and underground operations in terms of sequencing and general management of subsidence impacts.

Temporary and permanent diversions of Bettys Creek around the edge of the Eastern Rail Pit are expected to experience mining subsidence of up to 1.6m. Depending on the relative timing of surface and underground mining, subsidence of this magnitude may result in some ponding within the diversion channel and some increased potential for bank instability and erosion. A specific assessment of the impacts of mining on these slopes is recommended once the final diversion channel geometries are known and the timing of mining and rehabilitation has been finalised.

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1. INTRODUCTION

Integra Coal Operations is proposing to mine Longwalls 10-17 as a continuation of their current series of longwall panels. Environmental Resources Management Australia Pty Ltd commissioned SCT Operations Pty Ltd to make a subsidence assessment suitable for submission as part of a Part 3A application. This report presents the results of our subsidence assessment for the surface area above Longwalls 10-17.

The report is structured to provide:

1. A description of the project area including the proposed mining geometry, overburden depth and other parameters of relevance to a subsidence assessment.

2. Specific detail of the features, both natural and man-made that have been identified as likely to be impacted by mining subsidence.

3. A review of the results of previous subsidence monitoring data at Integra Coal Operations.

4. Subsidence estimates based on the previous subsidence monitoring at Integra Coal Operations and elsewhere and an assessment of the likely accuracy of these estimates.

5. Specific assessments of the surface features identified.

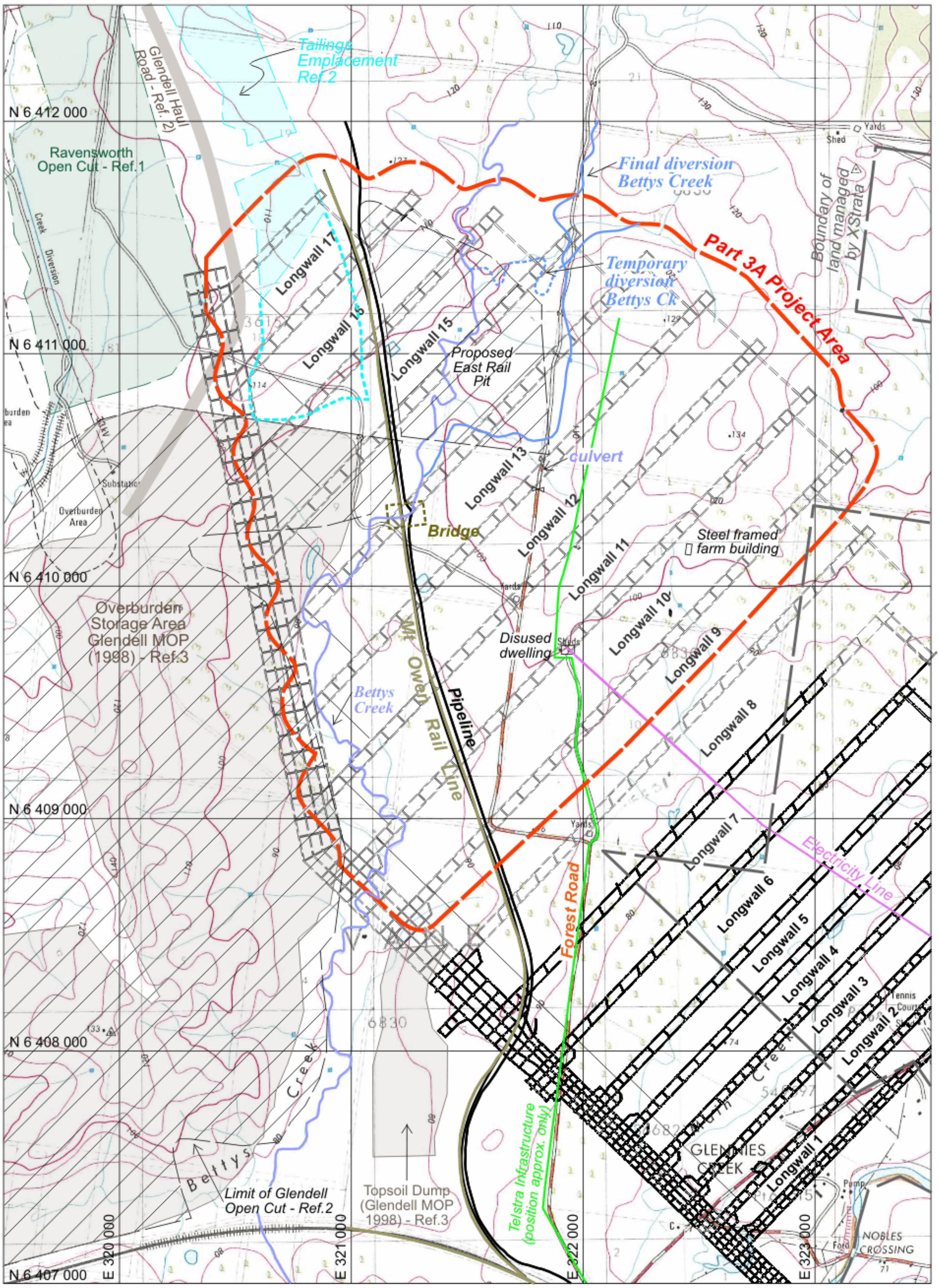
6. Recommendations for subsidence monitoring programs and strategies to manage the subsidence impacts identified.

2. SITE DESCRIPTION

Figure 1 shows a plan of the longwall area, the project area defined by a 26.5° angle of draw from the extraction areas, and the location of surface features superimposed onto a 1:25,000 topographic series map of the area that predates the construction of the Mt Owen Rail Line and areas of adjacent open cut mining.

2.1 Surface Features

Figure 2 shows a panorama of the general area taken from a point above the inbye end of Longwall 1.



References ***1***. *XStrata Drawing 01539 dated 15th May 2006.*

2. *Co-Resources Pty Ltd Plan 00674 Revision A for XStrata dated 18th July 2005.*

3. *Latest Glendell Mine Operating Plan dated 1998 on display at DPI Offices Maitland (expired 2004).*

Figure 1 Site plan showing mine layout and main features superimposed on 1:25,000 topographic series map

Note location of Mt Owen operations is approximate only having been transposed from several sources (see References 1-3). It is noted there are discrepancies between them.

Figure 2 Panoramic view of surface above Integra Coal Underground Operations.

The surface is predominantly agricultural grazing land owned by Xstrata through its various subsidiary companies. Most of the area comprises open grazing land, but there are areas of scattered trees and patches of bush located mainly around stream channels.

The surface topography is gently undulating ranging from a reduced level of about RL85m in the southern corner of the project area to a high point of RL134m over the centre of Longwall 11. There are numerous ephemeral watercourses draining from this high point and the ridge to the north east. These watercourses flow into Bettys Creek in the west and Main Creek in the east. There are numerous small, stock water dams located along and adjacent to the ephemeral watercourses in the area.

The main surface improvement in the project area is the Mt Owen Rail Line and its associated infrastructure. The rail line is the main coal haulage corridor from Mt Owen Mine with up to 12 trains per day currently using the line. A concrete bridge carries the rail line across Bettys Creek. A buried water supply line servicing Mt Owen Mine, a buried communications cable and a maintenance road run alongside the rail line. The maintenance road crosses Bettys Creek on a separate concrete bridge which shares the same foundations as the rail bridge.

Xstrata owns and operates a complex of open cut mines immediately to the north of the project area. The pits and associated infrastructure located within the project area that may be impacted by mining subsidence include:

1. Mt Owen Eastern Rail Pit which is located above Longwalls 13-16 on the eastern side of the Mt Owen Rail Line.

2. A permanent diversion of Bettys Creek around the Mt Owen Eastern Rail Pit will be constructed prior to the commencement of mining the Eastern Rail Pit. This diversion is located over Longwalls 13-16.

3. Ravensworth East Pit located mainly outside the project area but the southern tailings pit (TP2) is located within the north western portion of the project area.

4. Glendell Mine has planning approval for mining approximately 22 hectares within the project area. The Glendell haul road runs across the corner of the project area.

5. The proposed Mt Owen West Dump is located partly over the project area.

Other surface improvements include an unsealed public road (Forest Road), several private access roads, a disused dwelling, numerous fences, an overhead electricity transmission line and a phone line servicing the disused dwelling and a steel framed farm shed.

2.2 Mine Layout

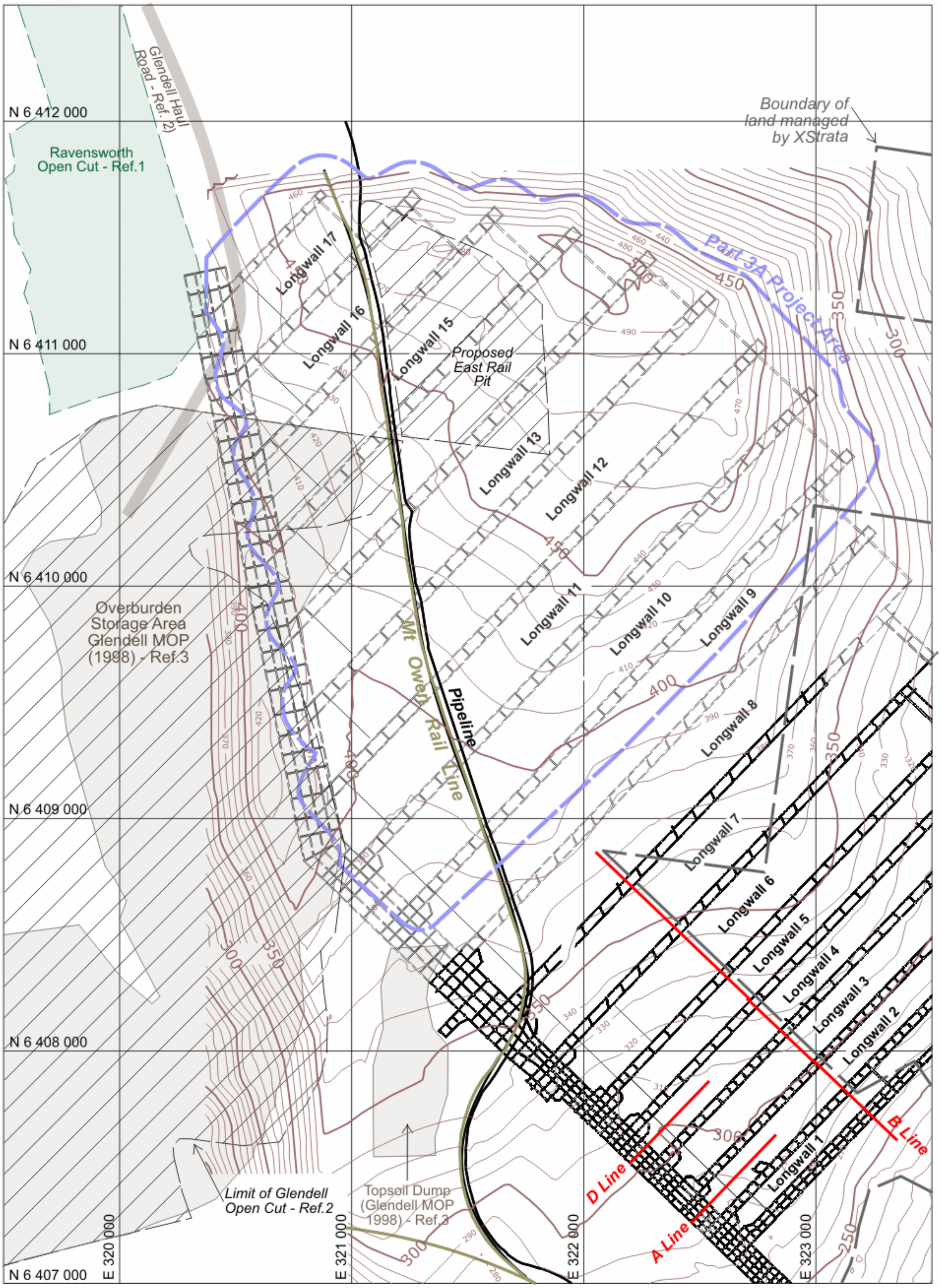
Integra Coal underground operations are currently mining the Middle Liddell Seam. The mining section ranges from 1.9m to 2.8m over the project area but is typically in the range 2.2m to 2.4m and averages 2.3m. A value of 2.4m has been used for all the subsidence estimations made in this report. The thicker mining section occurs in the northwest where final subsidence is controlled mainly be panel geometry rather than seam thickness.

Longwalls 10-17 are all planned to be 256.5m wide (measured across the final void) and range in length from 2555m to 472m long. The chain pillars separating adjacent panels range from 42m to 48m wide (measured rib to rib) as shown in Table 1 with cut-throughs nominally at 100m centres.

Table 1: Summary of Overburden Depth and Panel Geometries

LW	Void Width (m)	M/G Pillar Width (m rib to rib)	Cut-through Spacing (m centres)	Overburden Depth Used (m)	Overburden Depth Range (m)
1	100	30	35	280	270-290
2	141	30	45	290	280-300
3	167	30	45	310	290-320
4	151	35	100	320	300-330
5	147	35	100	325	300-350
6	242	35	100	335	300-360
7	257	38	100	355	310-380
8	257	40	100	370	320-400
9	257	42	100	390	320-420
10	257	42	100	400	380-450
11	257	45	100	410	390-470
12	257	46	100	420	400-480
13	257	48	100	430	400-500
14	257	48	100	440	410-500
15	257	46	100	450	410-490
16	257	48	100	460	430-490
17	257	30	100	465	430-490

Figure 3 shows isopachs of the overburden depth to the Middle Liddell Seam. The overburden varies mainly as a consequence of seam dip to the northwest. The project area is located within a basin type structure that dips generally northwest and rises sharply at either end of the longwall blocks to define the effective panel geometries. Overburden depth ranges from about 380m over Longwall 10 to about 500m over Longwalls 13 and 14. The depth ranges for each panel and the overburden depth used for subsidence calculation purposes are summarised in Table 1.



References **1**. *XStrata Drawing 01539 dated 15th May 2006.*

2. *Co-Resources Pty Ltd Plan 00674 Revision A for XStrata dated 18th July 2005.*

3. *Latest Glendell Mine Operating Plan dated 1998 on display at DPI Offices Maitland (expired 2004).*

Figure 3 Plan of mine layout showing overburden depth and location of subsidence lines.
Note location of Mt Owen operations is approximate only having been transposed from several sources (see References 1-3). It is noted there are discrepancies between them.

3. DESCRIPTION OF NATURAL FEATURES AND SURFACE IMPROVEMENTS

The natural features and surface improvements within the project area have been identified on the basis of several site visits to walk over the surface, discussion with mine personnel and discussion with other specialist groups working for the mine. In this section, these features and improvements are described in greater detail to provide a context for the assessment of likely subsidence impacts.

3.1 Mt Owen Rail Line

The Mt Owen Rail Line is a single track spur line that provides rail access to and from the Mt Owen Mine primarily for coal haulage purposes. It is understood that up to 12 coal trains per day currently use the line, but the frequency varies depending on when ships are in port.

Figure 4 shows a photograph of the rail line where it crosses into the project area in a shallow cutting 2-3m deep and continues along a low embankment. The maintenance road that runs alongside the track can also be seen.

Figure 4 Mt. Owen Rail Line on southern edge of Project Area.

Figure 5 shows where the rail line and the maintenance road cross Bettys Creek on two separate bridges that share the same foundations. Figure 6 shows the rail line on a low embankment to the north of Bettys Creek over Longwalls 14 and 15 immediately north of the bridge.

3.2 Concrete Bridges over Bettys Creek

Figures 7 and 8 show the nature of the construction of the two concrete bridges that cross Bettys Creek, one carrying the rail line and the other carrying the maintenance road. Detailed construction drawings have not been sighted, but the bridge construction would appear to comprise a number of concrete piles, cast in situ concrete pile caps and pre-stressed concrete beams as the bridge deck. The road bridge is similarly constructed but with lighter concrete beams for the deck.

3.3 Buried Rail Communication Cables

Communication cables for signalling and other purposes are laid alongside the rail line. It is understood from the Australian Rail Track Corporation that the cables are most likely to be direct buried, possibly in sand, covered by at least a danger marking tape and possibly a “vinedex” type barrier. Depth of burial could range from approximately 0.5m to greater than 1m. All of the cables are of the PVC insulated copper type.

3.4 Rail Maintenance Road

The rail maintenance road located alongside the rail line is shown in Figures 4 to 6. It is a single lane, unsealed road. It is not a public road, but it is accessible from a public road at the corner of Forest Road.

3.5 Buried Water Supply Pipeline

Figure 1 shows the route of a buried water supply pipe that services the Mt Owen Mine. It is understood that the pipeline is used only infrequently but is nevertheless required to remain serviceable. The pipe is understood to be welded polyethylene pipe with an outside diameter of 355mm buried to a depth of approximately 0.5 – 1m. It is located adjacent to the rail line. At the suction end, the grade is PN12, which reduces to PN10 in the middle section and PN8 at the outlet end.

Figure 5 Mt Owen Rail Line at Bettys Creek crossing.

Figure 6 Mt Owen Rail Line north of Bettys Creek crossing.

Figure 7 Road and rail bridge crossing Bettys Creek.

Figure 8 Foundations of road and rail bridge.

3.6 Forest Road

Forest Road is a public road that crosses the project area from Longwalls 9-12. There is a locked gate limiting access from near the northern edge of Longwall 12. Although the road continues on from this point to the top corner of Longwall 14, this section is not accessible to the public.

Figure 9 shows the nature of Forest Road within the project area. It is a single lane, unsealed road with a comfortable travelling speed of approximately 40–60km/hr.

3.7 Fences

The fences within the project area range in condition from barely serviceable to reasonably robust. Figure 10 shows two examples of fences that cover the range that is fairly typical of the condition of the fences in the area generally.

3.8 Disused Dwelling

Figure 11 shows the disused dwelling and adjacent structures that are located over Longwalls 10 and 11. This dwelling is not built to contemporary standards for residential dwellings. It is founded on a concrete slab.

3.9 Electricity Transmission Line

Figure 12 shows the overhead electricity transmission line that services the disused dwelling. The conductors are supported on single wooden poles and are attached through fixed conductors onto wooden cross beams.

Whilst the dwelling that the transmission line services is not currently occupied, it is understood from Energy Australia that the line is currently active. There is a possibility that the line may be required in the future to service a building that may be constructed on the site.

3.10 Buried Telecommunication Cable

A buried Telstra telecommunications cable traverses Longwalls 10-13 within the project area. It terminates at an old farmhouse site overlying Longwall 13 and previously serviced the disused dwelling described in Section 3.8. This line is currently not in use and it is expected that it would be regarded by Telstra as being “left in situ”.

Figure 9 View of Forest Road looking north from southern edge of Project Area.

Figure 10 Two examples of boundary fences within the Project Area.

Figure 11 Disused dwelling and associated buildings.

Figure 12 Electricity transmission line servicing disused dwelling.

3.11 Farm Building

Figure 13 shows a steel frame farm building that is located over Longwall 10, approximately 50m from the maingate chain pillar. The structural framing for this building is founded on individual concrete footings. It has an earth floor and was empty at the time of inspection.

3.12 Pipe Culvert

Figure 14 shows a pipe culvert where Forest Road crosses a tributary of Bettys Creek on the inaccessible side of the locked gate mentioned in Section 3.6. There has clearly been ongoing erosion at the downstream edge of this culvert causing the road to be deviated upstream.

3.13 Farm Dams

There are numerous farm dams located along tributaries of the various ephemeral watercourses in the area. Some examples of these are shown in Figure 15.

The dam walls are generally insubstantial structures of less than 2-3m high. They appear to be constructed by scraping the near surface soil into an embankment. There are several examples where the capacity of the dams has been significantly reduced as a result of piping failures through the dam wall.

Figure 16 shows two examples of these types of failure. These types of failure would be consistent with the soil from which the dam walls are constructed being of a dispersive nature.

Several of the dams support reed and other aquatic plant populations.

3.14 Bettys Creek

Bettys Creek is an ephemeral, meandering watercourse that is incised some 2-3m below the general flood plain. At the time of inspection in December 2005, the channel was generally dry except for occasional short sections of ponded water. Figures 17 and 18 show examples of Bettys Creek on the western side of the project area.

There are several ponds located on the general flood plain that appear to be remnants of the river channel isolated as the main channel has cut down to its current level. These ponds support reeds and other aquatic vegetation. Figures 19 and 20 show examples of these types of ponds.

Figure 13 Steel framed farm buildings.
(Inset - Earth floor and concrete footings)

Figure 14 Eroded culvert on an inaccessible part of Forest Road over Longwall 12/13 chain pillar.

Figure 15 Examples of farm dams located within the Project Area.

Figure 16 Two examples of piping failures in dam walls.

Figure 17 Bettys Creek near southern end of Longwall 11.

Figure 18 Another section of Bettys Creek approximately 100m upstream of Figure 17.

Figure 19 Isolated section of river channel meander now formed into a pond (near southern end of Longwall 10).

Figure 20 Isolated section of river channel meander now formed into a pond (near southern end of Longwall 14).

3.15 Eastern Rail Pit, Bettys Creek Diversion and West Dump

The proposed Mt Owen Eastern Rail Pit is located above Longwalls 13-16 and will mine the shallow Piercefield (Ravensworth) Seam to 35m below the surface on the eastern side of the Mt Owen Rail Line.

Mining in the Eastern Rail Pit is described in the Mt Owen EIS (Umwelt, 2003) and was approved by the Minister for Planning on 8 December 2004. Mining is planned to continue for approximately three years with backfilling of the pit as mining progresses. Overburden from the initial mining area of the Eastern Rail Pit is planned to be placed within the West Dump.

The approved rehabilitation method for the Eastern Rail Pit involves backfilling of the pit to ground level and reshaping to approximate the pre-mining contours. However, the final use of the Eastern Rail Pit may be as a tailings dam, although it is noted that this has yet to be confirmed and is currently not approved.

This assessment assumes that the Eastern Rail Pit will either be backfilled with waste rock as approved or tailings.

Mining in the Eastern Rail Pit will require the prior construction of diversion works for Bettys Creek, that subject to regulatory approval is expected to be permanent (Mount Owen Complex MOP, January 2006). The Bettys Creek diversion is expected to be completed by the end of 2007.

Based on the information provided by Xstrata, this assessment assumes the existing natural environment including the vegetation and some archaeological features will no longer be intact by the time longwall extraction commences within the southern part of the project area.

The Mt Owen Complex Mining Operations Plan (MOP) dated January 2006 indicates that the area of the West Dump overlying the SMP project area will be rehabilitated in 2009/2010. In this instance, the West Dump would not be impacted by mining subsidence.

Although it is difficult to project with confidence the timing of either the surface or underground operations, the projected finish of the Eastern Rail Pit would appear to be in 2009/2010 with the projected start of Longwall 13 being mid 2010. It is therefore considered possible that mining subsidence may not impact on the open cut operation, the West Dump or the Bettys Creek diversion until surface mining is complete.

3.16 Glendell & Ravensworth East Open Cuts

Glendell Mine is owned by Xstrata. It has planning approval for mining across approximately 22 hectares of the project area. In the absence of further detail from Xstrata, information supplied within their latest "Application to Carry Out Open Cut Mining Operations" dated February 1998, but which expired in 2004, is used as the basis of this assessment.

The Glendell haul road runs across the corner of the project area, although it does not cross any of the longwall panels. The haul road will enable the Mt Owen CHPP to receive and process ROM coal from both Ravensworth East and Glendell Mines. The haul road is planned to be approximately 30m wide and constructed from existing overburden (Umwelt, 2003).

Detail of the proposed Glendell and Ravensworth East Open Cuts is based on Xstrata Drawing No 01539 dated 15 May 2006. Glendell Haul Road and tailings dams are based on Co-Resources Pty Ltd Plan 00674, Revision A for Xstrata dated 18 July 2005.

These plans are not entirely consistent, but the detail is likely to change before Integra Coal underground operations reach the area in about 2011 or 2012. It is recommended to conduct a more detailed assessment of the likely subsidence impacts in this area once the layout of surface mining is finalised.

The proposed Ravensworth East Open Cut extends into the very top corner of the project area, but does not extend over the corner of Longwall 17. Ravensworth East has mined a shallow tailings pit up to 35m below the surface in the north of the project area. The tailings pit (TP2) is located over Longwalls 15-17.

The Mt Owen Complex MOP (2006) has identified the southern tailings pit as an emplacement area until 2010. The proposed GCCM operations are not planned to undermine this area until late 2011, but the final use of the southern tailings pit at that date cannot be confirmed.

An overburden storage dump proposed in 1998 extends over Longwalls 14 and 15.

4. REVIEW OF THE REQUIREMENTS FOR SUBSIDENCE PREDICTIONS IN SMP APPROVAL PROCESS

The subsidence estimates provided in this report are intended to be used in the context of the Director General's Requirements under Section 75F of the Environmental Planning and Assessment Act 1979 for the key issue of subsidence.

The requirements with respect to subsidence are:

"Subsidence – including detailed subsidence modelling for the area potentially affected by subsidence; detailed analysis of the impact of subsidence on land use, surface improvements and infrastructure, and the natural and social/cultural environment; and contingency strategy which details the measures proposed to monitor, manage and remediate subsidence and subsidence-related impacts."

Our assessment is aimed to address each of these issues in the following sections. Four different subsidence prediction methodologies are described to show the range of subsidence that would be expected using different approaches. The assumptions and reliability of each of these approaches is discussed. Factors that affect the development of subsidence over the project area are described. Previous subsidence monitoring experience is reviewed and compared against the various prediction methodologies to provide an indication of the applicability of each to the project area.

5. PREDICTION METHODOLOGIES AND DISCUSSION OF ASSUMPTIONS

Three methods for predicting subsidence over Longwalls 10-17 are used in this assessment to give an indication of the range of subsidence that different approaches might give. These methods are:

1) An empirical method for estimating subsidence over multiple panels forwarded by Holla (1988) based on observations of subsidence in NSW generally.

2) A semi-empirical method for estimating subsidence over multiple panels in the Southern Coalfield forwarded by Holla and Barclay (2000) which is considered appropriate given the overburden depths at Integra Coal are approaching those typical of coal mining on the South Coast.

3) A method based on consideration of mechanics of subsidence, in particular consideration of the sag subsidence over individual panels added to the compression of the chain pillars and surrounding strata (Mills 1998).

Once the maximum subsidence has been estimated, maximum strains, tilts and curvatures are predicted on the basis of empirical relationships developed from observations in the Southern Coalfield using the approach forwarded by Holla (1985). This empirical dataset has been chosen because the overburden depth range at Integra Coal is more typical of the Southern Coalfield than of the 80-220m depth range on which the Newcastle guidelines are based (Holla 1987).

The empirical method for estimating subsidence over multiple panels forwarded by Holla (1988) has been widely used as the basis for subsidence prediction. It has proved effective in terms of providing a reasonable estimate of the upper limit subsidence provided the environment for which the predictions are being made is similar to the environment from which the empirical data has been drawn. Overburden depth and seam thickness need to be similar to the dataset from which the empirical dataset has been derived. Both overburden depth and seam thickness at Integra Coal Operations would be within the range of the base dataset, so this method is expected to be applicable there.

The semi-empirical approach forwarded by Holla & Barclay (2000) has not yet been widely applied so its use at Integra Coal is predicated on its ability to back calculate the subsidence over the earlier longwall panels.

Subsidence prediction using an understanding of the mechanics of subsidence behaviour is based on the recognition that longwall subsidence comprises two essentially independent components: sag subsidence and elastic chain pillar compression (Mills 1988). These two components can be independently calculated based on panel geometry, pillar size and overburden depth taking into account the pillar loadings involved and the spans across individual panels. Total subsidence can be estimated by adding the two components together. This approach has been found to be generally conservative compared to measured subsidence but provides a broad based estimate of subsidence that can be used in situations that are outside the normal range of subsidence experience.

6. REVIEW OF THE RESULTS OF PREVIOUS SUBSIDENCE MONITORING

Subsidence monitoring has been conducted at Integra Coal Operations using levelling and peg to peg chainage on pegs spaced more or less uniformly at 15m centres. The results of the monitoring conducted to the end of Longwall 6 are presented in this section. The locations of the subsidence lines referred to in this section are shown in Figure 3.

The existing subsidence monitoring data is considered likely to provide a sound basis for initial estimates of subsidence over the proposed mining area. However, as additional subsidence monitoring data comes to hand, particularly the results from Longwalls 7, it is anticipated that improved estimates of subsidence over future panels will become possible.

6.1 A Line

A Line is located over the finishing rib of Longwall 2. The overburden depth is approximately 290m. The surface topography is essentially flat. The seam thickness mined is approximately 2.3m.

Figure 21 shows the subsidence measured on A Line. Maximum subsidence measured is approximately 840mm reached at a distance from the goaf edge of approximately 1.1-1.2 times depth (although the line is not quite long enough to confidently establish the distance to maximum subsidence).

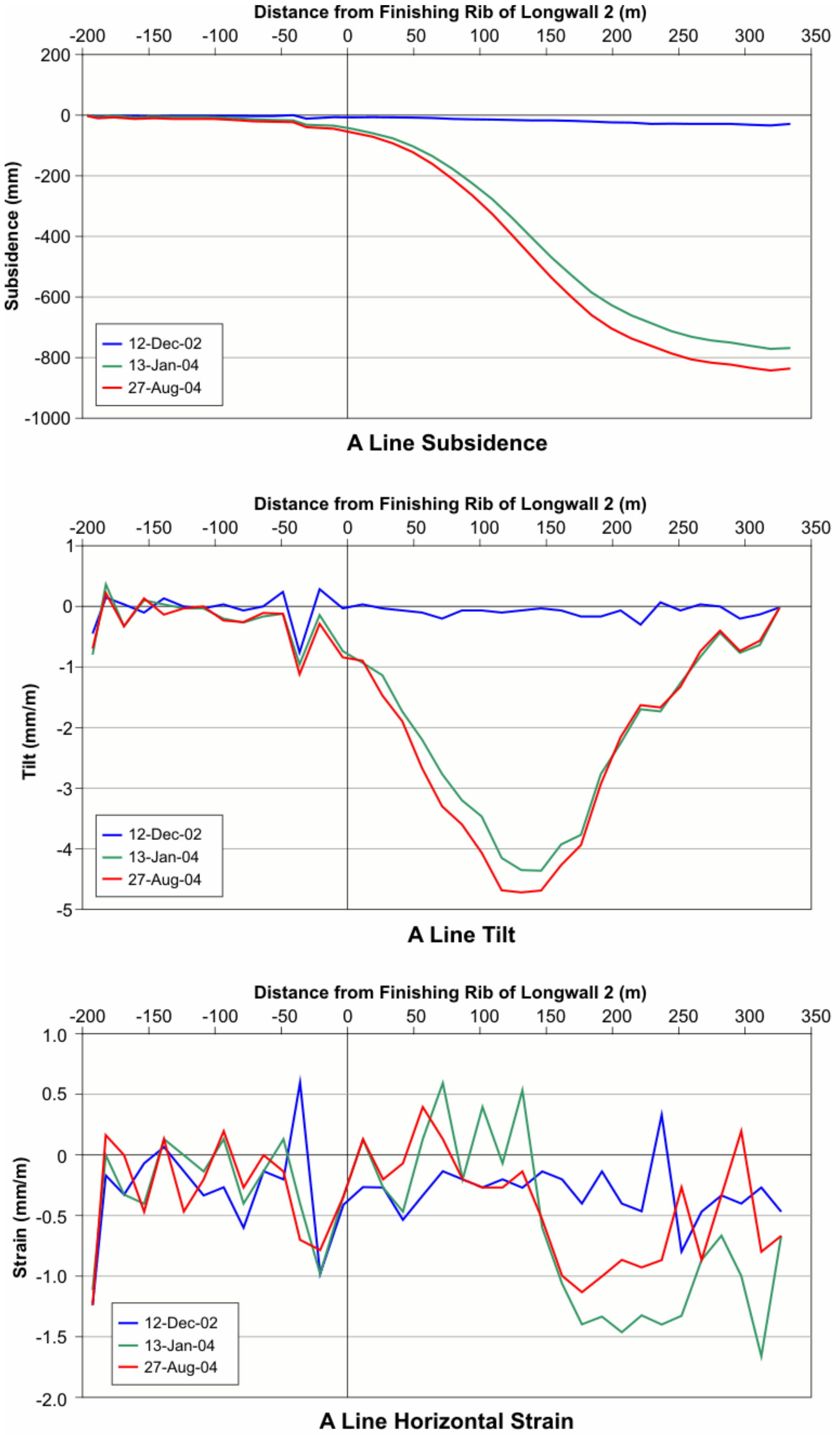


Figure 21 Subsidence measured on A Line at the end of Longwall 2.

Goaf edge subsidence is approximately 53mm. The angle of draw is approximately 14°. It should be noted, the actual positions of the pegs have not been surveyed in three dimensions so their positions relative to the workings are estimated rather than measured and may be offset somewhat from their assumed positions. Nevertheless, for practical purposes, the values of goaf edge subsidence and angle of draw are considered reasonable estimates.

Maximum strains of 0.5mm/m in tension and 1.5mm/m in compression have been measured. Maximum tilt measured was approximately 5mm/m for maximum subsidence of 0.84m at 290m deep.

6.2 D Line

D Line is located over the finishing rib of Longwall 4. The overburden depth at the rib edge is approximately 300m. The surface topography is essentially flat. The seam thickness mined is approximately 2.3m.

Figure 22 shows the subsidence measured on D Line. Maximum subsidence measured on the line is approximately 430mm, but this maximum was measured on the last peg indicating that larger subsidence has occurred beyond the end of the line.

Goaf edge subsidence is approximately 50mm. The angle of draw is approximately 12°. As with A Line, the actual positions of the pegs have not been surveyed in three dimensions so their positions relative to the workings are estimated rather than measured and may be offset somewhat from their assumed positions.

Maximum strains of 1mm/m in tension and 0.5mm/m in compression were measured. Maximum tilt measured was 2mm/m for maximum subsidence estimated from B Line of about 0.5m at 300m depth of overburden.

6.3 B Line

B Line is the main cross line across all the panels. The line is numbered from east to west, B45 to B1 and then B46 onwards. The overburden depth increases from 280m over Longwall 1 to 330m over Longwall 5, mainly as a result of seam dip. The surface topography is essentially flat.

Figure 23 shows the subsidence measured on B Line. The development of surface subsidence in the monitoring results to date shows the effect of interactions between multiple panels. It is noted that subsidence associated with Longwall 1 was not measured.

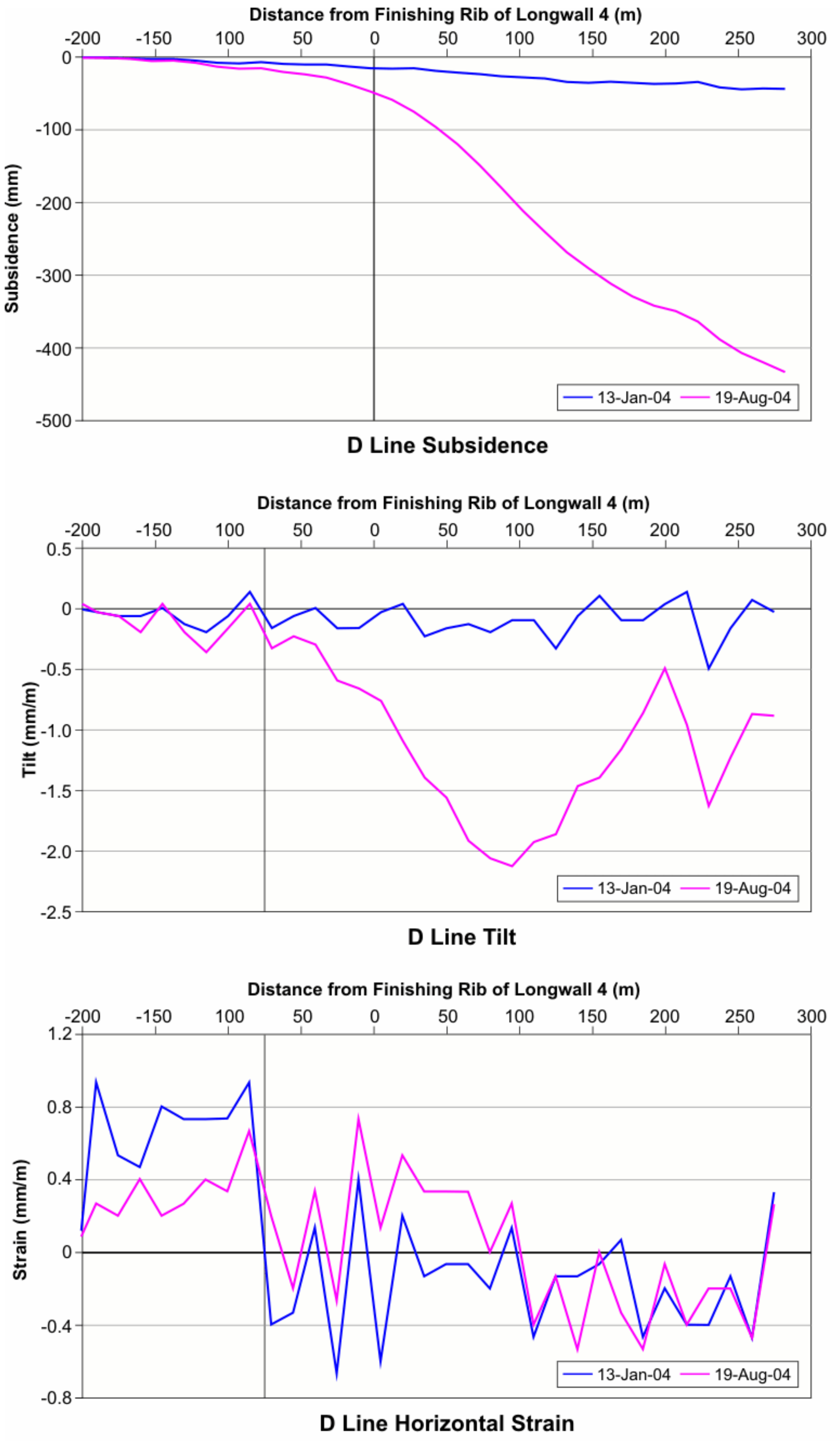


Figure 22 Subsidence measured on D Line at the end of Longwall 4.

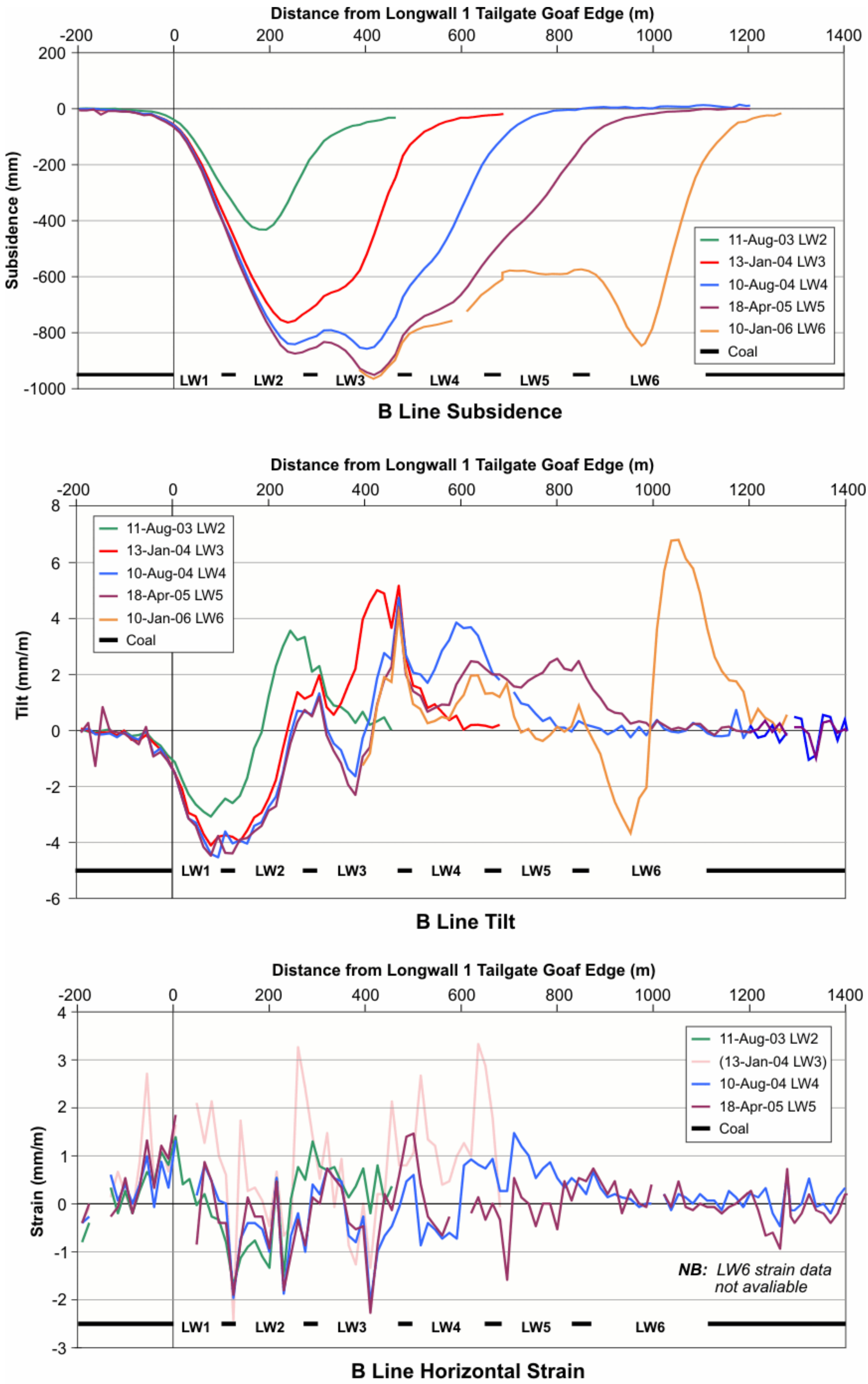


Figure 23 Subsidence measured on B Line crossing Longwalls 1-6.

Maximum subsidence after Longwalls 1 and 2 were complete was measured to be 451mm on 11 August 2003. Maximum subsidence increased to 763mm (over the centre of Longwall 2) at the completion of Longwall 3, to 857mm (over the centre of Longwall 3) when Longwall 4 was complete and 950mm at the completion of Longwall 5.

Longwall 6 is the first of the 256m wide longwall panels. At the completion of Longwall 6, subsidence over Longwall 5 increased to 590mm and peak subsidence in the centre of Longwall 6 reached 840mm. It is anticipated that this maximum will increase by 600-800mm as Longwall 7 is mined.

The location of the chain pillars is apparent in the subsidence profile, indicating that some sag subsidence is occurring over individual panels. Over the first five panels, the relatively small magnitude of this sag subsidence compared to the maximum subsidence measured is consistent with strata compression above and below the chain pillars being the main contributor to and control of, surface subsidence in the panels mined so far.

The subsidence behaviour is controlled by a super-panel effect of multiple panels with the maximum subsidence controlled mainly by strata compression. The subsidence profile from Longwall 6 shows the development of greater levels of sag subsidence (up to about 500mm).

Maximum strains of 1.5mm/m in tension and 2.5mm/m in compression have been measured on most of the surveys except for the survey on 13 January 2004, which shows peak tensile strains up to 3.3mm/m. Given that this single survey is the only survey that shows these peaks, it is considered possible that some difference in survey or the environmental conditions at the time of the survey has contributed to the higher values and so they may not be real.

Maximum tilt measured at the completion of Longwall 5 was approximately 5mm/m for maximum subsidence of 0.95m at an average overburden depth of about 305m. Maximum tilt at the completion of Longwall 6 is approximately 7mm/m with goaf edge subsidence of 170mm and an angle of draw of 22°.

6.4 Goaf Edge Subsidence Profiles

Figure 24 shows the goaf edge profiles for A Line, D Line and B Line overlain on the same plot. Three of the independent profiles show a very consistent pattern of goaf edge subsidence behaviour and provide a strong basis for estimating subsidence as a function of distance from the goaf edge. Goaf edge subsidence ranges 50-60mm. These values are consistent with experience at numerous other sites where goaf edge subsidence is typically in the range 50-100mm.

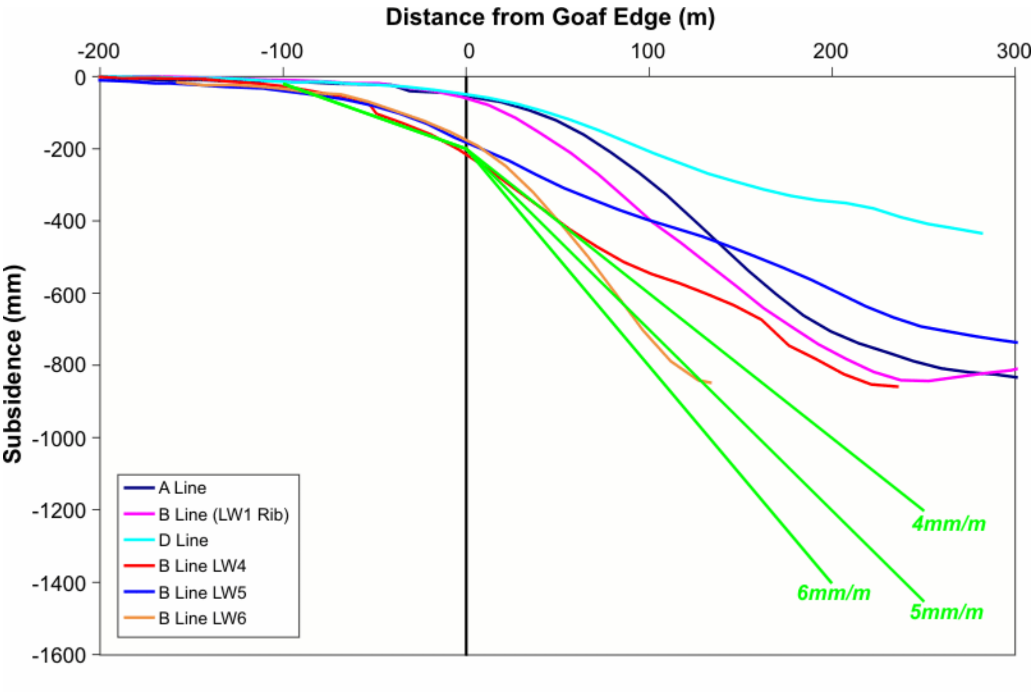


Figure 24 Goaf edge subsidence profiles.

Goaf edge subsidence above the solid edge of Longwalls 4, 5 and 6 main gates have different characteristics to the other three profiles. A range of factors are thought to have contributed to this apparent behaviour, but the effect is greater goaf edge subsidence (up to 200mm) and a generally lower level of average ground tilt, although the tilt has increased somewhat over Longwall 6.

For practical purposes, the goaf edge subsidence profile can be defined to be less than the envelope formed by two line segments, one that extends from 20mm at the angle of draw (approximately 14° or 0.26 times depth) to 200mm at the goaf edge, and a second that extends from 200mm at the goaf edge at a rate of 1m of subsidence every 200-250m of horizontal distance to whatever the maximum subsidence value is. It is likely that this average tilt (equal to 4-5mm/m) would increase to 6mm/m if the maximum subsidence were to increase to 1.6m, notwithstanding the potential for peak values of tilt to occur over short distances because of geological and other subsidence anomalies.

7. SUBSIDENCE PREDICTIONS

In this section, the subsidence is estimated for each of the proposed longwall panels.

7.1 Vertical Subsidence

Maximum vertical subsidence calculated using the first three methods described in Section 5 is summarised in Table 2. A profile of subsidence across all the panels is shown in Figure 25.

Table 2: Maximum Subsidence Predicted Using Three Difference Approaches and the Measured Subsidence Over the First Five Longwall Panels

Longwall Panel	Maximum Subsidence (m) Based on Holla (1988)	Maximum Subsidence (m) Holla & Barclay (2000)	Maximum Subsidence (m) Mills (1998)	Measured Subs (m) as Panel is Mined (after subsequent panels mined)
1	0.58	0.24	0.24	
2	0.89	0.41	0.76	0.45 (0.87)
3	1.01	0.58	0.96	0.76 (0.95)
4	0.85	0.41	0.82	0.51 (>0.75)
5	0.81	0.41	0.82	0.42 (0.60)
6	1.30	0.94	1.55	0.840 (N/A)
7	1.30	1.01	1.56	
8	1.27	1.01	1.47	
9	1.24	1.01	1.56	
10	1.22	1.06	1.56	
11	1.21	1.01	1.56	
12	1.18	1.01	1.56	
13	1.15	0.98	1.56	
14	1.12	1.01	1.56	
15	1.08	1.08	1.56	
16	1.06	1.06	1.56	
17	0.53	0.53	0.78	

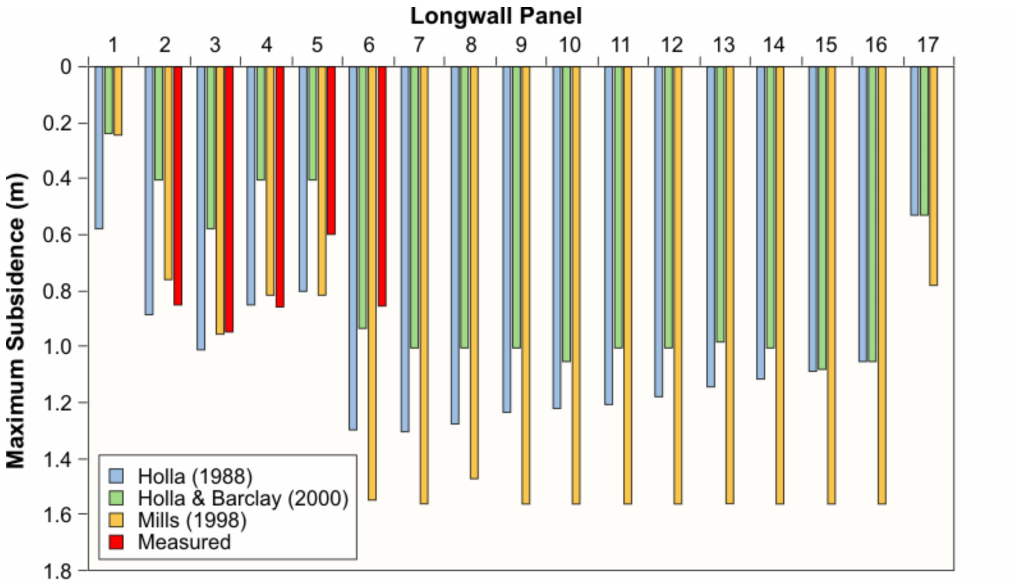


Figure 25 Comparison of different methods with measured subsidence.

The three subsidence prediction methodologies used to determine the maximum subsidence shown in Table 2 and Figure 25, predict the maximum subsidence after multiple adjacent panels have been extracted on the basis of the mining geometry being regular. At Integra Coal, the geometries of the initial panels change significantly from panel to panel and full subsidence does not develop until after the next two or three longwall panels have been mined. These effects need to be recognised when comparing predicted and measured maximum subsidence over each individual panel.

For instance, as shown in Figure 23, maximum subsidence from mining Longwall 5 has so far occurred over the centre of Longwall 3 (0.95m) but this maximum value actually relates to the geometry of Longwall 3 (predicted to be up to 0.94m) rather than the 0.6m that has so far been measured over Longwall 5. Likewise the 0.6m of subsidence measured over Longwall 5 is predicted to increase up to about 0.8m, but only when further panels have been mined. Similarly, the maximum subsidence over Longwall 6 is likely to increase from 0.8 to somewhere in the range 1.3-1.6m when subsequent panels have been mined.

The Holla (1998) method provides an indication that the maximum subsidence over Longwalls 10-17 is likely to be about 1.2m. The Holla & Barclay (2000) method indicates a maximum of about 1.1m. The maximum values of subsidence calculated based on consideration of subsidence mechanics (Mills 1998) predict a maximum value of 1.6m over Longwalls 10-16 and 50% of this over Longwall 17. The 1.6m maximum subsidence value is determined from 65% of the assumed 2.4m seam section mined, recognising that previous subsidence experience in NSW indicates that maximum subsidence would be less than 65% of seam thickness mined if there were no chain pillars at all. Since the chain pillars are likely to support some proportion of the overburden load, the actual maximum subsidence is expected to be somewhat less than this maximum value of 1.6m.

As subsidence data becomes available from the monitoring over Longwalls 7-9, the magnitudes of maximum subsidence and other subsidence parameters over the remaining longwall panels will be able to be refined. For the purposes of estimating maximum subsidence parameters in this SMP study, a maximum value of 1.6m has been assumed. Strains, tilts and curvature are based on this value.

Figure 26 shows a cross-section profile estimated from combination of strata compression subsidence and sag subsidence after each longwall panel has been mined. The main characteristics of these subsidence profiles are:

1. Individual longwall panels are evident in the subsidence profile once adjacent mining is complete.
2. Maximum subsidence does not occur over any single panel until one or more adjacent panels have been mined.
3. Greater levels of final subsidence are expected from Longwall 6 onward.

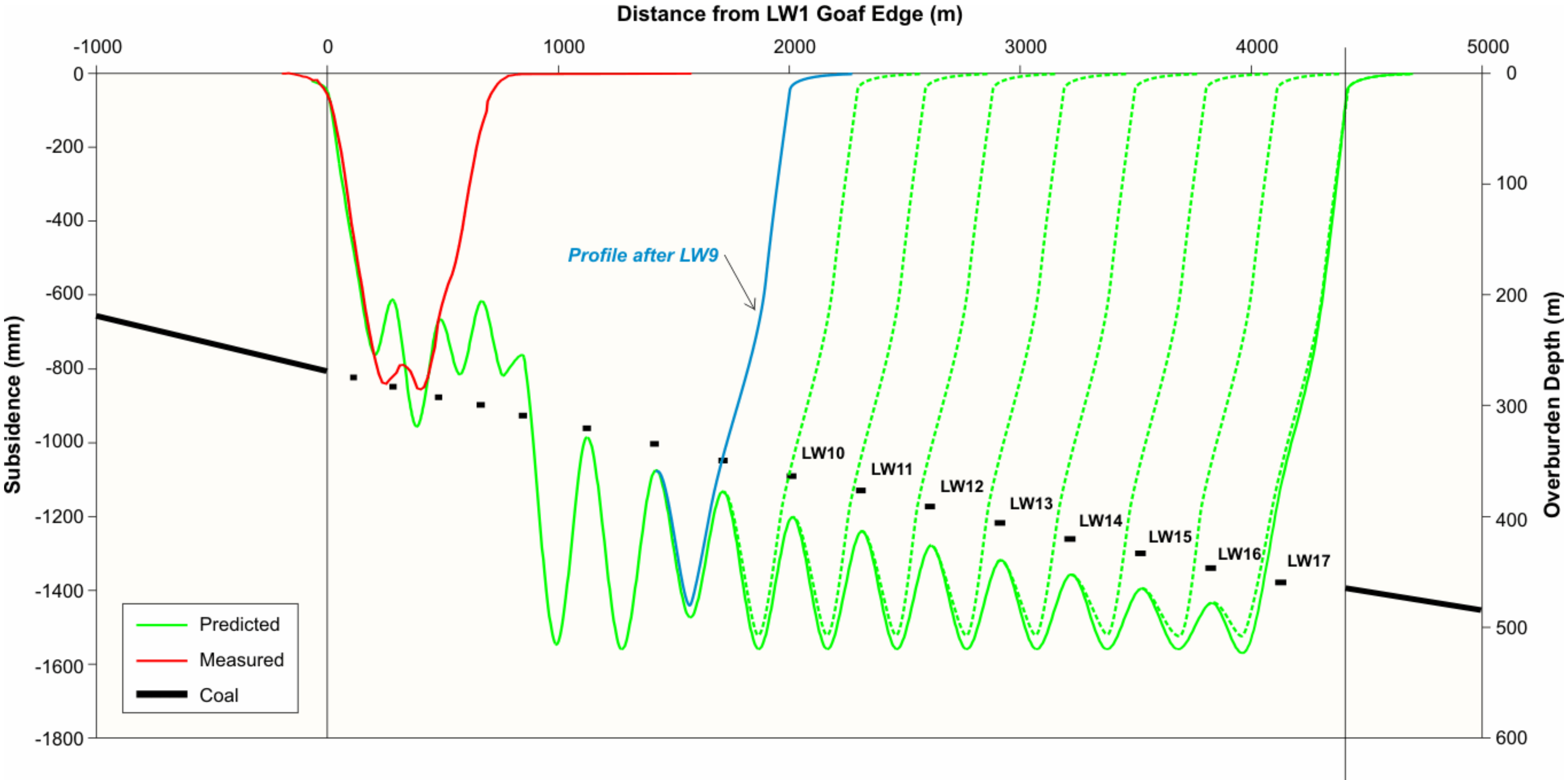


Figure 26 Subsidence profiles measured and predicted over Longwalls 1-17 at Integra Coal.

7.2 Horizontal Strain, Tilt and Curvature

Strain, tilt and curvature are estimated using empirical relationships presented by Holla (1985) for the Southern Coalfield. These relationships are used in preference to the guidelines presented for the Newcastle Coalfield (Holla 1987) and the Western Coalfield (1991) because the depth range at Integra Coal is more consistent with the depth range in the Southern Coalfield than the 80-220m depth range on which the Newcastle guidelines are based and the surface terrain at Integra Coal is not as steep as the terrain that is characteristic of the Western Coalfield. In reality, the differences between the various guidelines are not considered all that substantial when the characteristics of each coalfield are considered and compensated for.

The relationships used to calculate maximum strain and tilt are:

$$+E_{max} = 1000 \times K1 \times S_{max} / D$$
$$-E_{max} = 1000 \times K2 \times S_{max} / D$$
$$G_{max} = 1000 \times K3 \times S_{max} / D$$

Where $+E_{max}$ is maximum tensile strain, $-E_{max}$ is maximum compressive strain, G_{max} is maximum tilt, S_{max} is maximum subsidence, D is depth, K1, K2 and K3 are constants based on the ratio of effective panel width to overburden depth ratio (W/D). Maximum subsidence and therefore strains and tilts are generated as a result of multiple panel extraction, so the combined width of extraction is appropriate to use. Values of K1 equal to 0.5, K2 equal to 1.0 and K3 equal to 3.0 are used.

The overburden depth ranges from approximately 380m to 500m over Longwalls 10-17 with an average overburden depth estimated to be about 460m. A value of 380m is used to provide an upper limit on the maximum values of strain and tilt.

On this basis, maximum tensile strain in the project area is estimated to be 2mm/m, maximum compressive strain 4mm/m, and maximum tilt 12mm/m. However, the maximum strains expected are upgraded to 6mm/m in tension and 9mm/m in compression on the basis of previous measurements at Integra Coal as discussed below.

The actual maximum strains measured to date over Longwalls 1-6 have been up to 1.5mm/m in tension and 2.5mm/m in compression, apart from the one survey on 13 January 2004 (when maximum tensile strains reached 3.3mm/m in several places), and maximum tilts have been in the range 5-7mm/m.

Assuming a representative depth of 300m and a maximum subsidence of 0.95m for this area, back calculated values would be maximum strains of 1.6mm/m in tension, 3.2mm/m in compression, and maximum tilts of 5mm/m which closely approximates the general subsidence behaviour measured.

The tilt values measured to date would appear to be generally consistent with the systematic tilts predicted using the Southern Coalfield guidelines, but the measured tensile strains, at least on the 13 January 2004 survey are higher than predicted.

The maximum strains calculated for 380m and 1.6m of subsidence would be 2.1mm/m and 4.2mm/m but these are increased to 6mm/m in tension and 9mm/m in compression on the basis of the 13 January 2004 results, to be conservative for initial assessment purposes, until more data is available.

It should be recognised that these strain estimates represent the maximum systematic strains and tilts. The term systematic strain and tilt refers to the essentially predictable strain and tilt that is caused by subsidence and which occurs generally and systematically across the subsidence area. Non-systematic strains and tilts occur as a result of surface topography and geological structure. These are localised effects that are largely unpredictable either because the presence and influence of geological structure is difficult to predict or because of the complex interactions of surface topography with mining direction and geological stratigraphy.

Higher values of tilt and strain are often observed in steeper terrain and in the vicinity of geological structures. In the Southern Coalfield, non-systematic strains of up to 3 times maximum systematic tensile strain and 4 times maximum compressive systematic strain have been observed. Non-systematic tilts have generally been less than 1.5 times the maximum tilts calculated.

The gently rolling nature of the surface terrain at Integra Coal would tend to be more consistent with systematic strains and tilt behaviour than some of the areas in the Southern Coalfield.

Curvature is the second differential of subsidence, or the rate of change of tilt. Empirical data suggests that it can be broadly correlated with maximum strain. A relationship presented in Holla & Barclay (2000) suggests that for maximum predicted strains of 4mm/m and overburden depth of about 450m, a minimum radius of curvature of approximately 5km is expected.

7.3 Extent of Subsidence Impacts

The project area has been defined on the basis of an angle of draw of 26.5° (half depth) outside of the total extraction area. Observations of angle of draw at Integra Coal from the six longwall panels that have been completed to date indicate that maximum angle of draw to 20mm of subsidence is typically in the range 12° to 22°. For practical purposes, subsidence impacts are therefore expected to be limited to well within the project area. The effective limit of subsidence impacts is shown in Figure 27 with allowance made for the bridging effects that would be expected around the corners of individual longwall panels.

7.4 Factors Affecting Subsidence Behaviour

The subsidence behaviour predicted over the longwall panels at Integra Coal is expected to be controlled primarily by compression of the chain pillars and surrounding strata. Individual panels are of subcritical width in subsidence engineering terms, so that full subsidence is not developed over individual panels, but rather full subsidence develops as a result of the interaction of multiple adjacent panels.

Maximum subsidence near the centre of individual panels is expected to be sensitive to increases in the ratio of panel width to overburden depth. Overburden depth increases to the north, so there is likely to be a variation in maximum subsidence both along each panel and across adjacent panels.

Areas where the surface terrain is steeper, and particularly where the slope is in the direction of mining, are expected to experience larger horizontal movements and consequentially larger horizontal strains. However, the total topographic relief within the project area is less than 50m maximum and generally less than 20m over large areas, so downslope movement is not expected to be a major factor.

Compression of chain pillars and the adjacent strata is expected to increase with panel width and overburden depth and is likely to be the main component of subsidence in most of the panels proposed at Integra Coal. The subsidence associated with strata compression is sensitive to cut-through spacing and pillar width. If cut-through spacing is reduced from the 100m centres proposed or the chain pillar widths are reduced, then pillar compression would be expected to increase under most circumstances. However, since the maximum subsidence is close to the maximum subsidence commonly found in New South Wales (i.e. 65% of seam thickness mined), it is possible that maximum subsidence may be less sensitive to a reduction in chain pillar size than would be the case if expected subsidence was less.

8. ASSESSMENT OF SUBSIDENCE IMPACTS

In this section, the impacts of subsidence on the natural features and surface improvements are assessed and described.

8.1 Assessment of Subsidence Impacts along Mt Owen Rail Line

The Mt Owen Rail Line and associated infrastructure traverse all eight longwall panels in the project area. The distance of the Mt Owen Rail Line from the finish line of all the longwall panels is more than 300m on the tailgate side of each panel and more than 500m on the maingate side of each panel. Corner or panel end effects are unlikely to influence the final subsidence profiles at these distances, so the maximum subsidence values shown in Table 2 and Figure 25 are expected to be realised. Full subsidence

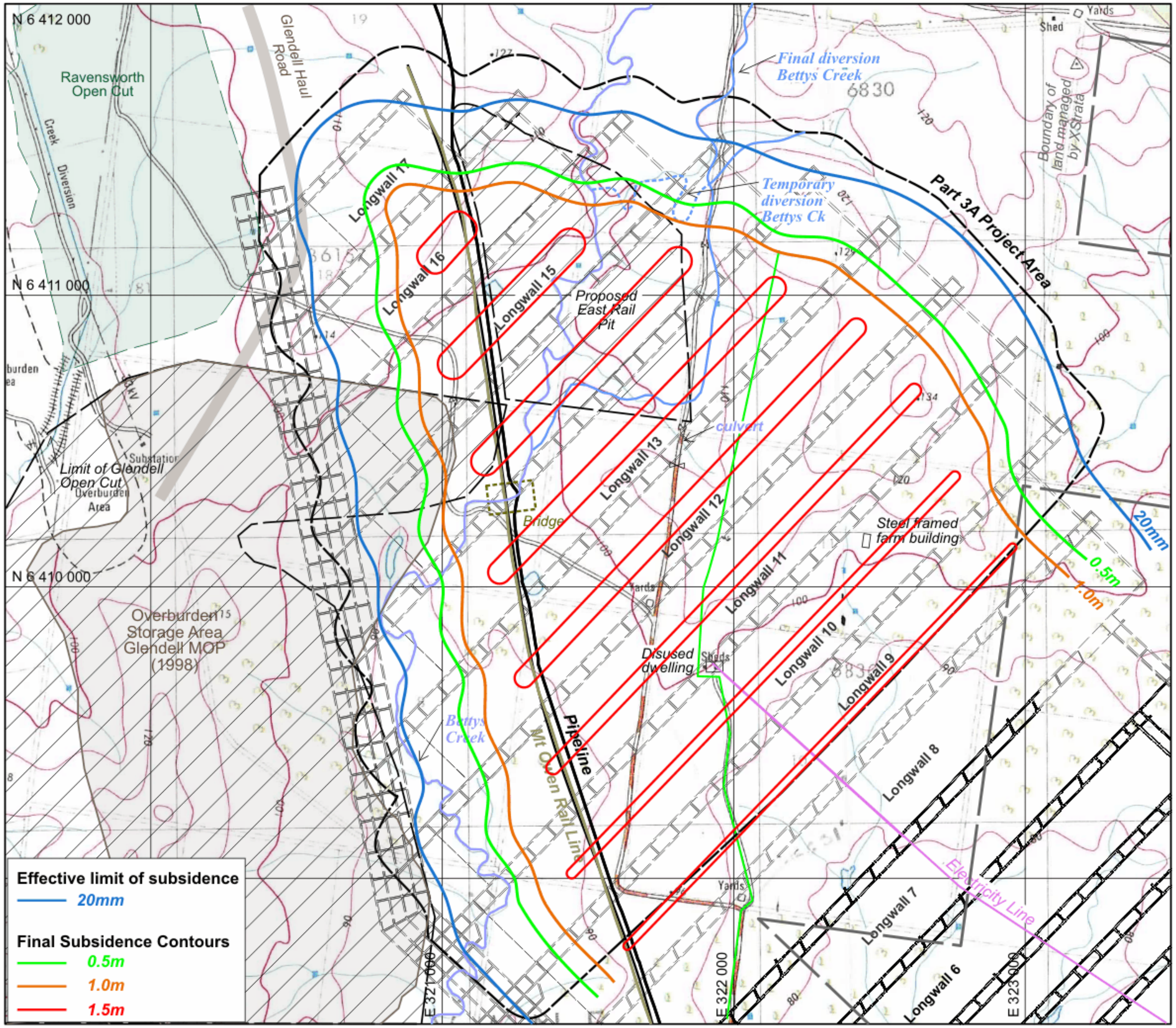


Figure 27 Contours of final subsidence and effective limit of subsidence
Note location of Mt Owen operations is approximate only.

is not expected to develop until after at least one, and most likely two, adjacent longwall panels have also been mined. Figure 28 shows the maximum final subsidence profile that would be expected along the rail line.

A program of monitoring during the mining of Longwalls 7-9 is expected to provide detail of the timing and nature of subsidence movements about the corner of longwall panels as mining proceeds. This program is described in Section 9 of this report. It is envisaged that initial monitoring on the rail line will also provide further confirmation of the three dimensional movements that will be experienced generally in subsequent panels.

8.1.1 Expected Subsidence Movements

The following expectations of subsidence movements are provided for initial impact management purposes on the basis of experience at other sites. Refinement of these estimates will be made when data from more detailed monitoring over Longwalls 7-9 becomes available.

Subsidence movements are likely to develop gradually in small increments as mining proceeds. It is likely that subsidence movements will begin to become apparent as each longwall face approaches within half depth (about 200m) of the rail line and will not cease until the face is approximately 500m past (which equates to the panels either finishing or being close to finishing in most panels).

Most of the movements would be expected in the interval between the longwall passing directly under any given point and the longwall being 300m past. It is likely that the same section of track will be affected by up to three longwall panels with full subsidence being reached at any given point only after the two subsequent longwall panels have been mined.

Maximum vertical subsidence of up to about 1.6m is expected to develop over two longwall panels, with half this maximum value developed over the tailgate (south-eastern) side of each panel as it is mined and most of the rest occurring as the next adjacent panel is mined. As each panel is mined, the section of the rail line that is likely to experience subsidence movements will include the section directly over the panel being mined and the section of the rail line up to about 160m (0.4 times depth) from the goaf edge over the next panel to be mined. This distance equates to about 200m along the line from a point directly above the goaf edge.

The bridging that is expected about the corner of each panel will mean that the maingate (north-western) corner of the panel being mined is likely to be directly under the rail line before vertical subsidence begins to develop. Vertical subsidence movements associated with each panel are likely to be essentially complete by the time that panel finishes. Subsidence movements will however resume again when the next panel approaches and passes under the rail line, with a small amount occurring when the subsequent panel is mined.

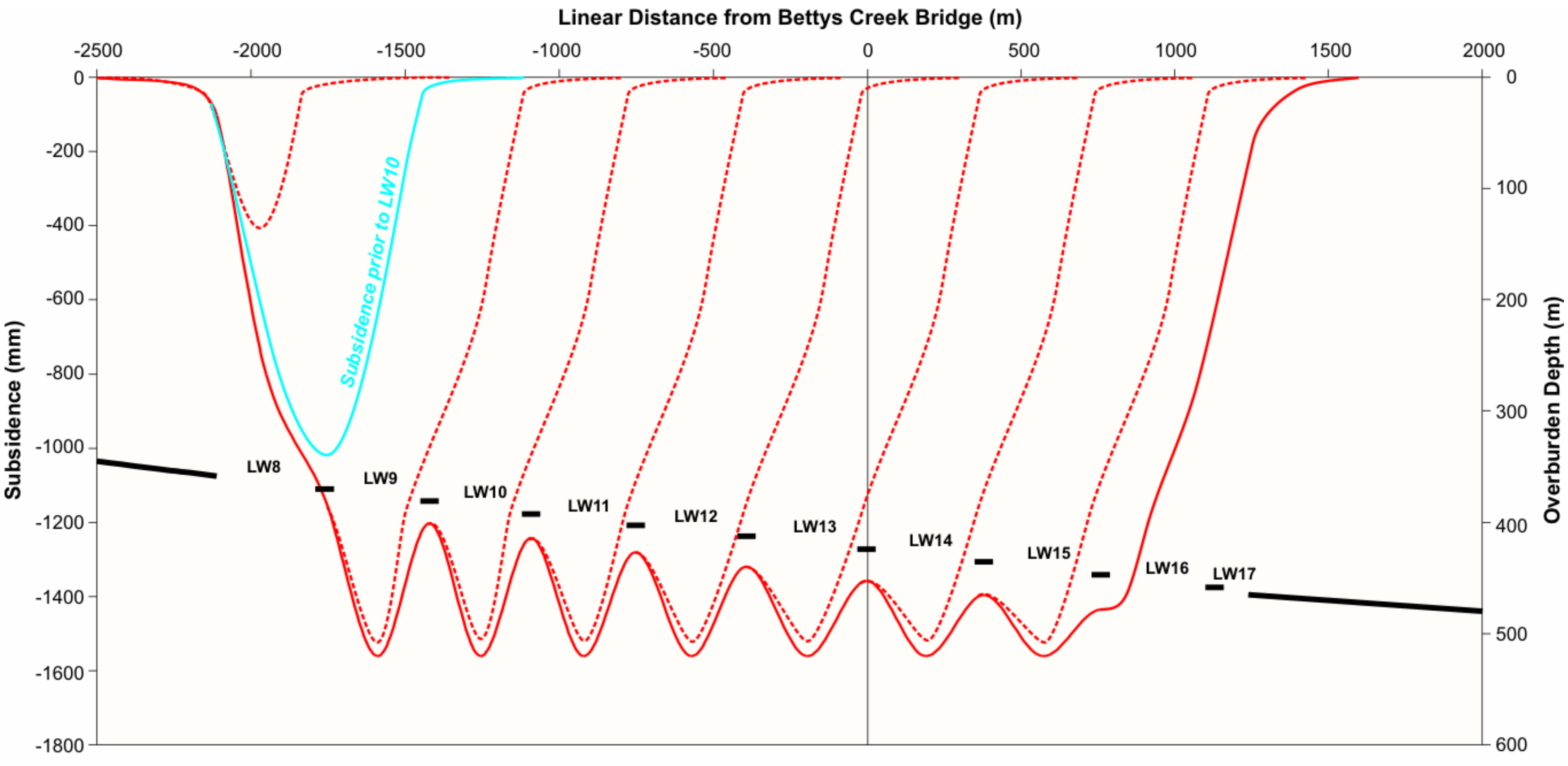


Figure 28 Subsidence profiles predicted along the Rail Line.

On this basis, the rail line can be divided up into overlapping sections for subsidence management purposes. The section of the rail line likely to be affected by subsidence from any particular longwall panel extends from 200m north of the maingate (north-western) edge of the panel to 800-1000m south of the maingate edge. Subsidence movements will occur predominantly in the period from when the maingate corner of the retreating longwall passes under the rail line to the finish of that panel. Subsidence movements on that section of line are expected to resume again when the next panel passes through the equivalent window and should be substantially complete by the time this second panel finishes. However, subsidence movements are expected to be effectively complete on that section of line only after the third panel has been mined.

Maximum local tilts of up to about 12mm/m are expected along the rail line. As each panel mines under the rail line, the initial direction of tilting would be across the track giving a differential subsidence across the standard 1.435m track gauge of up to about 17mm. As each subsequent panel is mined, the tilt becomes predominantly longitudinal causing the grade of the track to increase locally by about 10mm/m or 1 in 100. The point of maximum cross-tilt is expected to occur about 70-100m south of the maingate (north-western) edge of each panel. A second episode of cross-tilting is expected at approximately the same location when the subsequent panel is mined.

Horizontal ground strains of generally up to 2.1mm/m (but possibly up to 6mm/m) in tension are initially expected in a direction across the rail line as each panel mines under the rail line and up to about 100m past. As the panel retreats further, maximum tensile strains are expected to rotate to be in a longitudinal direction along the rail line. Longitudinal compression strains of up to 4.2mm/m (but possibly as high as 9mm/m) are likely to develop further to the south of the tensile strain peaks. Both the tensile and compression strain peaks are expected to occur over a 15-20m length of the rail line, with lower levels of tension and compression on either side of these peaks.

The minimum radius of curvature is expected to be of the order of 5km.

Horizontal ground movements have not been routinely measured at Integra Coal because of the nature of the subsidence monitoring technique used. Changes in the monitoring program are proposed so that future subsidence monitoring is undertaken using three dimensional surveying techniques to provide direct measurement of horizontal movements.

On the basis of experience at other sites, horizontal movements of up to about 150mm are anticipated to develop gradually and evenly over the area being subsided and the adjacent panels. Initial movements of approximately 100mm are expected in a direction toward the approaching longwall panel. Movements are expected to continue in this direction until the longwall face is about 100m past. From this point on, subsequent movements occur in a direction toward the retreating longwall face, eventually leaving a permanent offset of 50-100mm in the direction of mining.

Figure 29 shows a diagrammatic representation of the directions of horizontal movements that would be expected for various points around a single longwall panel. Downslope movements are superimposed onto these systematic horizontal movements, but in the terrain within the project area, downslope movements are expected to be small compared with the systematic horizontal movements. These horizontal movements are likely to cause the alignment of the track to be laterally offset over each panel, but the effects are expected to develop gradually and over long distances rather than abruptly at defined locations.

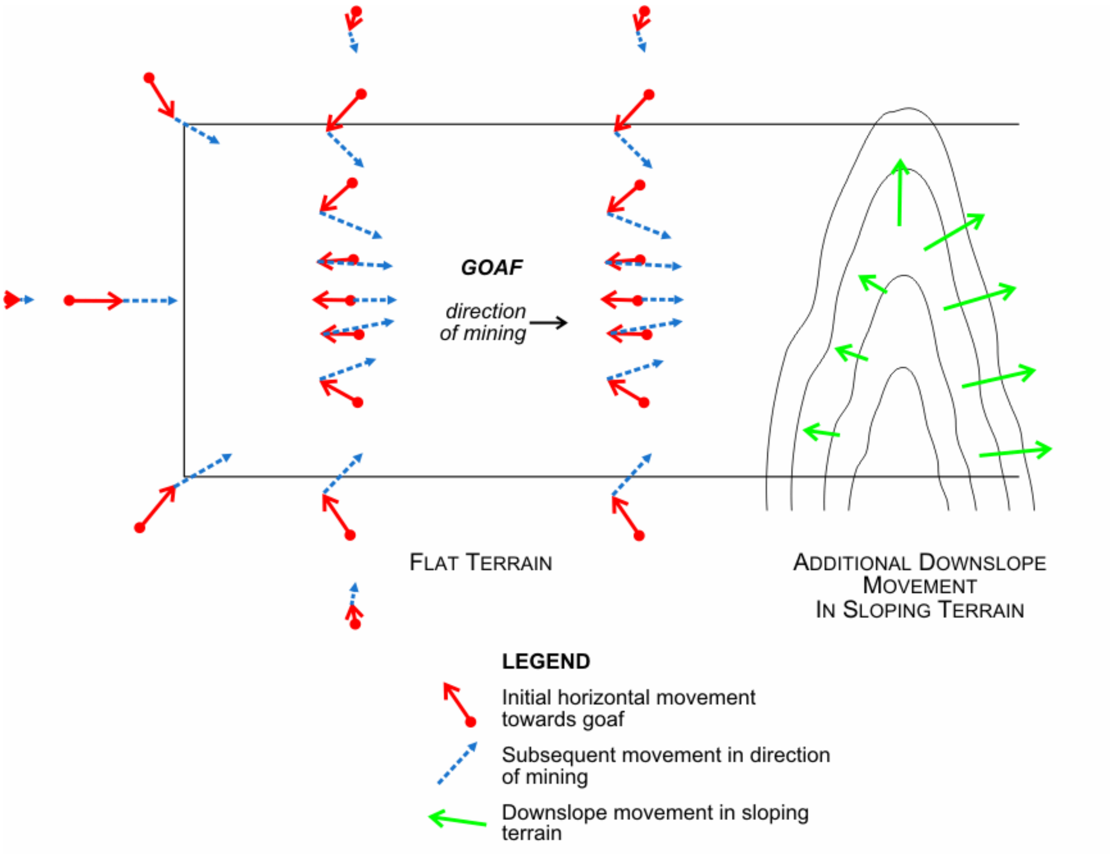


Figure 29 The form of horizontal movements observed over longwall panels.

In the absence of major geological structures, lateral offsetting of the track due to differential horizontal movements is expected to occur over the solid ground ahead of mining at a rate of about 100mm over 500m and at a rate of up to about 100mm over 300m above the mined area. If there are any major geological structures that extend through the overburden strata below the rail line, it is possible that differential horizontal movements may concentrate on these structures. For the type of geological structure that could reasonably be expected to occur at Integra Coal, the magnitude of any offset associated with mining in flat terrain would be expected to be less than a few tens of millimetres at any one time.

8.1.2 Assessment of Impacts

Waddington and Barbato (2004) report that, "from an engineering standpoint, there are no insurmountable problems in regard to undermining railways and there are no reasons why mining can not be safely carried out beneath railways, so long as adequate plans for the management of the mining impacts and appropriate financial guarantees are put in place before mining".

Vertical subsidence movements are not expected to be significant with maximum grades over short distances of 1 in 100 being within the capacity of normal rail operations.

It would appear from Waddington and Barbato's paper that cross tilt can vary from design by up to 21mm/m before there is a need for speed restrictions, so the expected tilts of 10mm/m are not expected to impact on the operation of the rail line. It is understood that the Mt Owen Rail Line operates under a 25km/hr speed limit for normal operations in any case.

Maximum anticipated strains of 2.1mm/m (but possibly up to 6mm/m) in tension and 4.2mm/m (but possibly up to 9mm/m) in compression would have the potential to cause buckling of rails, so it is recommended that the Rail Line Subsidence Management Plan provide a system for identifying and relieving the rail stresses. Waddington and Barbato report that this can be achieved using line force transducers and when stresses need to be relieved, by cutting, re-aligning, re-tensioning and welding the rails.

Vann & Griffin (1998) report that ballast substantially isolates the tracks and sleepers from a high proportion of the underlying horizontal subsidence movements. When Longwalls 7-9 are mined, the survey monitoring results obtained will be at ground level adjacent to the track. These monitoring results are likely to be conservative in terms of managing horizontal subsidence movements because they will be larger than the movements on the rail track which are partly isolated by the ballast.

It is anticipated on the basis of the information available to date that mining under the Mt Owen Rail Line can be successfully managed with restressing of the tracks from time to time being the only critical intervention likely to be required.

A specific Rail Line Management Plan for Longwalls 10-17 is currently being developed by Integra Coal in consultation with the owners, operators and maintainers of the rail line. Additional detailed subsidence monitoring over Longwalls 7-9 is expected to provide confirmation of the subsidence behaviour in advance of mining under the section of rail line located over Longwalls 10-17.

8.1.3 Embankments and Culverts

The rail line passes over several embankments. Most of these are only a few metres high. A much higher embankment is located on the northern edge of the project area but this is substantially outside of the area affected by subsidence movements. Mining subsidence is expected to cause the embankments to spread laterally and to settle vertically a small amount as a result. The magnitude of this spreading is likely to be a function of embankment height and compaction of the fill material. It is recommended to monitor the potential for embankment spreading by monitoring the length of culverts located under the rail formation over earlier longwall panels.

The formation of the Eastern Rail Pit on one side of the rail line and the tailings emplacement on the other side, assuming the emplacement is cut down into the natural ground, has the effect of forming an embankment in natural rock between the two excavations. Mining subsidence would be expected to cause lateral movement of this rock embankment with potential to cause additional vertical movements at the level of the rail line. While changes in track geometry associated with additional vertical movements are not expected to compromise the movement of trains, inclusion of monitoring and review of this issue in the Rail Line Subsidence Management Plan for this area is recommended.

The potential for lateral spreading is likely to be reduced if the Eastern Rail Pit has been refilled and there is a barrier between the Rail Line and the side wall of the open cut.

8.2 Rail and Road Bridge over Bettys Creek

The rail and road bridge located above the chain pillar between Longwalls 13 and 14 is expected to experience full vertical subsidence, but is located such that it may not experience the full range of horizontal subsidence movements.

Vertical subsidence of up to 1.6m is not, of itself, expected to impact on the serviceability of the bridge structure because the surrounding ground would also be lowered by a similar amount. However, the subsidence trough developed would have the effect of lowering the level of the bridge deck relative to flood levels in Bettys Creek. These flood levels are controlled by the downstream section of Bettys Creek and this area will not be subsided. The flood levels will therefore increase relative to the bridge deck (and the Rail Line generally) by an amount equal to the vertical subsidence.

Across the 10m footprint of the bridge structure, maximum strains of 2.1-4.2mm/m (but possibly up to 6-9mm/m) and maximum tilts of 12mm/m have the potential to cause peak differential horizontal movements of up to 90mm and tilting of 120mm. However, the bridge is located at a point where maximum tensile strains and compressive strains are unlikely to develop. A better indication of the strains and tilts will be available from monitoring of previously undermined sections of the Rail Line by the time that mining subsidence impacts on the bridge structure.

The articulated structure of the bridge with deck beams supported on pile caps is such that the peak horizontal and tilt movements are likely to be able to be accommodated without undue difficulty. The structural details of the bridge would need to be inspected to confirm how much relative movement can be accommodated. However, apart from the nib walls on the pile caps at either end of the bridge deck, which are likely to need removing to accommodate compressive movements, it is anticipated that the dual bridge structure would be able to be undermined without unduly affecting its serviceability.

8.3 Buried Rail Communication Cables

Australian Rail Track Corporation has indicated that the rail communication cables are most likely to be direct buried, possibly in sand. Depth of burial could range from approximately 0.5m to greater than 1m. All of the cables are of the PVC insulated copper type.

While it is anticipated that peak strains of 2.1-4.2mm/m (but possibly up to 6-9mm/m) may be sufficient to cause cables buried in trenches to become overloaded, particularly at cable joints and plugs, we understand that experience on the South Coast of undermining similar cables has not caused any problems (Waddington pers comm.).

Monitoring of the communications cable during the mining of Longwalls 7-9 is expected to provide an indication of the sensitivity of the buried communications system and, given the South Coast experience, there would not appear to be any need to bypass the section of cable being undermined.

8.4 Rail Maintenance Road

Mining subsidence is not expected to significantly affect the serviceability of the unsealed rail maintenance road that parallels the Mt Owen Rail Line. If cracks or compression humps develop, crack filling and regrading may be required. Inspections associated with maintaining the serviceability of the Rail Line are expected to identify areas where any remediation is likely to be required along the maintenance road.

8.5 Buried Water Supply Pipeline

A buried water supply pipe that services the Mt Owen Mine runs adjacent to the Rail Line. It is understood that the pipeline is used only infrequently but is nevertheless required to remain serviceable. The pipe is understood to be welded polyethylene pipe with an outside diameter of 355mm buried to a nominal depth of 0.7m. At the suction end, the grade is PN12, which reduces to PN10 in the middle section and PN8 at the outlet end.

The wall thicknesses of the three grades of pipe are nominally 22mm, 27mm and 34mm respectively for PN8, PN10 and PN12 grades. Back-calculation of the working pressures, indicates working stresses for the polyethylene is nominally 5.5MPa, giving axial load capacities of 13 tonnes, 15 tonnes and 18 tonnes respectively. Assuming an elastic modulus of 0.5-1GPa indicated in material property handbooks for polyethylene, the safe working strain would be about 6-10mm/m. Maximum predicted strains of 6mm/m in tension along the length of the pipeline would suggest that the pipe is close to its working strength in axial tension and compression under the predicted subsidence.

Peng (1992) reports findings from Kratzsch (1983) that show that axial loads of 5 tonnes/m are able to be generated in 300mm diameter pipes that do not have bituminous coating and are buried in a sand matrix. Assuming that all of the predicted strain is concentrated on one or two cracks, instead of spread out across the standard 15m bay length used for subsidence monitoring, the cracks would be up to 75mm wide. Assuming that the ground is capable of generating 5 tonnes/m, the ground movements would be able to generate sufficient axial load within the pipe to overstress it every 6-8m or twice in each bay length.

On the basis of these calculations, it would appear that the pipe is likely to remain serviceable, particularly for the level of strain generally expected (rather than strains based on the 13 January 2004 survey) but if subsidence movements are concentrated at large cracks or compression humps, there would be potential for the pipeline to become overloaded. It is noted that subsidence cracks have not been observed on the surface at Integra Coal to date, so the potential for 75mm cracks to develop would appear limited.

A failsafe strategy would involve exposing the buried pipeline so that shear could not be generated between the soil and the pipe. However, given the infrequent use of the pipe, an alternative strategy might involve monitoring the pipeline closely as it is undermined to see whether or not it remains serviceable. If necessary, a backup facility could be established to bypass the line through a second pipe laid on the surface should the serviceability of the buried pipe become compromised. This strategy could then be revised on the basis of experience over Longwalls 7-9.

8.6 Forest Road

Within the project area, Forest Road is an unsealed public road that leads only to locked gates used to access Xstrata land adjacent to, or associated with, the Mt Owen Mine. Mining subsidence has the potential to cause surface cracking, compression humps and local changes in grade, both along and across the road. Based on observations of the surface over the area of Longwall 6 that has so far been undermined, it is considered unlikely that the serviceability of Forest Road will be significantly affected by mining within the project area.

Experience of undermining the road over Longwalls 7-9 will provide an indication of the level of signage and remediation that is necessary. Signage indicating caution because of surface cracking that might result from ongoing mining subsidence is recommended. Remediation would be expected to be within the scope of normal routine maintenance activities.

8.7 Fences

Fences within the project area are expected to experience the full range of subsidence movements. Relative movements of up to an estimated 250mm may be experienced along sections of fence up to 300m long. This level of relative movement may be sufficient to cause wires on well maintained fences to become over-tensioned or slack enough to compromise stock control. However, most of the fences are in such poor condition that relative movements of 250mm would not cause any change in their current level of serviceability.

Regular inspection during the period of undermining is recommended for those sections of fence considered to be of significance from a stock control perspective.

8.8 Disused Dwelling

The disused dwelling located over the chain pillar between Longwalls 10 and 11 is in poor condition and is understood to be earmarked for demolition before it is due to be undermined. If it is still standing when undermined, mining subsidence may cause minor cracking and tilting of the concrete slab. Other subsidence movements would not be expected to significantly change the current status of the structure.

8.9 Electricity Transmission Line

An aerial electricity transmission line services the disused dwelling discussed in the previous section. This line crosses Longwalls 7-10 and terminates adjacent to the disused dwelling. Mining subsidence typically does not affect the serviceability of electricity transmission lines supported on single pole structures. However, with tilts of up to 12mm/m, relative lateral movements at the top of 5m poles of up to 60mm from tilt and 250mm from relative horizontal ground movements, the changes in conductor tension that would result may warrant the placement of individual conductors in sheaves during the period of undermining to prevent overloading of the conductor fixing points and/or timber cross members.

Consultation with the electricity authority responsible for the maintenance of the line, and with the owners of the building is recommended to determine the most appropriate course of action, given that the line is now effectively no longer in use and may not ever be used unless another structure is built on the site.

8.10 Buried Telecommunication Cable

A buried Telstra telecommunications cable traverses Longwalls 10-13 within the project area. It is understood that the status of this line is officially "left in situ". We are advised that there is currently an agreed management plan for this cable to manage subsidence impacts as a result of mining Longwalls 7-9, which also undermine the cable. It is anticipated that subsidence impacts associated with mining Longwalls 10-13 will be no greater than those associated with mining in Longwalls 7-9. If the line remains serviceable at the completion of Longwall 9, with the appropriate monitoring and management process in place, it is likely to remain so at the completion of Longwall 13. If not, the options for reconnecting the service would need to be evaluated at the time that reconnection is required.

8.11 Farm Building

A steel framed farm building is located over the inbye end of Longwall 10 as described in Section 3.11. The footprint of this building is 20-25m by about 8m wide, and it is 4-5m high. It is likely that relative subsidence movements would range up to about 250mm vertically and 200mm horizontally from one end of the building to the other for maximum tilts and strains. Curvature of 5km would suggest that 25mm of closure or stretching at the eaves line relative to the floor could be expected.

At this level of movement, it is likely that the cladding on the building would be perceptibly impacted and the framing stretched but not necessarily rendered unserviceable. Given the lightweight nature of the structure, the two options that would seem most viable, would be to:

1) leave it in place and monitor its behaviour with a view to repairing it or totally replacing it if it became unserviceable,

2) disassemble it and reconstruct it again after subsidence is complete with temporary cover provided for storage in the interim.

Repair of this structure is expected to be covered by the Mine Subsidence Board. It is recommended that a management plan for this building is developed in consultation with the MSB and the building's owners prior to undermining.

8.12 Pipe Culvert

The pipe culvert under the fenced off section of Forest Road is currently undergoing erosion where the discharge on the downstream side is undercutting the road formation. This erosion has been ongoing and is likely to continue irrespective of mining impacts, and some form of remedial action is likely to be required before it is impacted by Longwall 13. Mining is expected to temporarily flatten current stream channel gradients by up to 1 in 100, but this change is unlikely to be significant in terms of halting the ongoing erosion at this culvert.

An assessment of the effects of mining subsidence on stream channels and their erosion potential has been undertaken independently of this report.

8.13 Farm Dams

There are numerous farm dams located within the project area. These dams appear to be constructed from dispersive clays as evidenced by the several that show piping type failures through the dam wall. Mining subsidence has the potential to cause vertical tension cracking and horizontal cracking in areas where the dam wall is laterally compressed. It is anticipated that water leaking through any mining induced cracks would tend to promote erosion of the dispersive soils and piping failures similar to those which can already be observed.

Within the project area, the volumes of water retained in any one dam are too small to be of significance from a downstream safety perspective, even if all the water were released in a short timeframe. Remediation may require excavation and re-compaction of sections of the dam wall affected by piping failure, but apart from any approval processes that may be required to allow such work to be undertaken, the remediation work itself would be relatively straight forward. Some arrangements may need to be negotiated with respect to water supply in the short term.

8.14 Bettys Creek

Bettys Creek is the subject of an independent study of the impacts of mining on watercourses within the project area. During the mining of Longwalls 10-13, it is anticipated that some sections of Bettys Creek will experience vertical subsidence up to an estimated 0.4m. The effect of this subsidence is likely to be greater ponding in those sections of the river channel that are lowered, but this may not be particularly significant given the 2-3m high banks on either side of the main channel.

Where Bettys Creek crosses Longwalls 14 and 15, general lowering of the ground surface up to 1.6m is expected. The changes in grade associated with this subsidence have been assessed independently by others.

Based on observations of water ponded in Main Creek where mining has occurred previously, there would appear to be sufficient clay in the surface strata to limit inflows through the overburden strata that might result from mining induced fracturing to insignificant levels.

There may be some increased potential for ponding to occur during flood events in areas where the surface gradient is less than about 1 in 80 toward Bettys Creek. Areas on the western side of the Mt Owen Rail Line that are directly above the longwall panels would appear from the 1:25,000 topographic series map to have grades toward Bettys Creek of about 1 in 100, so it is possible that there may be some potential for ponding in this area once mining is complete, if maximum levels of predicted tilt are observed. However, the general ground tilts are expected to be in the range 4-5mm/m or 1 in 200, so widespread ponding would not be expected.

It is noted that there are currently several ponds in this area that are remnants of old meander channels. As the main river channel has changed course and cut further down into the alluvium, these old channels have been bypassed and have become ponds. We understand that the significance of ponds forming in this area as a result of mining subsidence will be assessed by others.

8.15 Eastern Rail Pit, Bettys Creek Diversion and West Dump

It is recommended that the impacts of mining subsidence on the Eastern Rail Pit are assessed once the mining geometries of the open cut and the timing of the surface and underground mining operations are better defined.

The greatest subsidence impact is likely to occur if the pit has not been backfilled with either rock or tailings. If the pit remains open, there is expected to be some potential for instability of the rock slopes due to mining subsidence impacts. It is anticipated that these would be manageable. The potential impacts based on industry experience, rather than detailed information, are likely to be limited to local slope instability over about 5% of the highwall length (based on experience of mining under sandstone cliff formations). It is recommended that access to the area immediately below the highwalls is restricted during the period of longwall mining in the area.

In the event that the pit is filled with tailings, the potential for subsidence impacts are expected to be greatly reduced. Slope instability is likely to be reduced by the positive back pressure provided by the tailings. Inflows into the overburden are likely to be reduced by sealing of cracks by tailings material as observed at other sites where tailings dams have been mined under. Vertical subsidence may make it necessary to build up the level of embankment control structures if the tailings dam is close to full.

If the pit has been fully rehabilitated, subsidence impacts are likely to be generally imperceptible, but there may be some additional settlement and surface cracking associated with the subsidence process. In general, the subsidence impacts are considered likely to be similar to those which are apparent in undisturbed country.

The impacts of mining subsidence on the Bettys Creek Diversion are expected to be manageable but the details will depend on the relative timing of the two operations. Some remedial earthworks is likely to be required if ponding in the diversion channel and local “knick point” erosion is to be avoided.

Subsidence impacts on the West Dump are likely to be insignificant given that longwall mining is not expected in the area until after it has finished being used and the area has been rehabilitated. In the event that the West Dump is still in use, there may be some potential for lateral spreading and increased surface cracking on the brow of the dump, but it is expected that this could be managed by filling in any cracks that develop, principally to avoid ingress of run-off water into the slope and subsequent slope instability.

8.16 Glendell & Ravensworth East Open Cuts and Associated Works

The subsidence impacts on the Glendell and Ravensworth East Open Cuts are likely to be insignificant and imperceptible for all practical purposes because of their respective locations outside the mining area and largely outside the project area.

The Glendell Haul Road is not expected to be perceptibly affected by mining subsidence. It is located some 60m outside the goaf adjacent to the corner of Longwall 17 at an overburden depth of 420m. Vertical subsidence is expected to be less than 40mm at this location, and horizontal movements insignificant.

The proposed Glendell Open Cut is still subject to various statutory approval processes and it is not certain what the geometry of this pit will be. If open cut mining is ongoing during the period of longwall mining, it is anticipated that subsidence impacts would need to be considered and a management plan developed. Independent underground and open cut operations co-exist at other sites and there would not appear to be any reason why they could not exist here as well with appropriate management measures in place.

The overburden storage dump shown in the Glendell MOP (1998) extends over Longwalls 14 and 15. The edges of this dump would be expected to experience vertical subsidence up to about 1.6m. Some lateral dilation of the dump slopes would be expected and surface cracking may be evident near the top of the slope. If there is considered to be potential for slope instability in this area, inspection and filling of any open cracks is recommended at the completion of each of Longwalls 14-16.

The topsoil dump shown in the Glendell MOP (1998) is located outside of the application area and would not be expected to be impacted by mining subsidence. It is noted that the overburden storage dump and the topsoil dump are not shown in more recent Xstrata plans.

The southern of the two Ravensworth East tailings dams (TP2) is planned to extend over Longwalls 15-17. The proposed Integra Coal longwall operations will not undermine this dam until late 2011, but the final use of the southern tailings pit at that date cannot be confirmed.

If TP2 is still used for tailings emplacement at the time of longwall mining in the area, the main subsidence impact is likely to be the potential for differential vertical subsidence to allow tailings to overtop the perimeter embankments if they are close to full. Slope instability is likely to be reduced by the positive back pressure provided by the tailings. Inflows into the overburden are likely to be reduced by sealing.

There would not appear to be any impediment to managing these impacts through control of the tailings level and building up of the perimeter bunds that may potentially be subject to vertical subsidence.

It is recommended that the potential impacts of mining subsidence are assessed in more detail once the mining geometries of the surface operations have been finalised.

9. RECOMMENDATIONS FOR FUTURE MONITORING

Some improvements to the survey method and the focus of subsequent subsidence monitoring effort are recommended. These recommendations have been discussed with the Integra Coal Mine Surveyor and we understand that they have been and will be implemented.

9.1 Existing Monitoring

The recommendations described in this section are essentially similar to those made in our report relating to the SMP Application for Longwalls 7-9.

We understand that the following monitoring is currently in place.

- B Line is extended to intersect the Rail Line with pegs at 15-20m centres (1/20th depth). All the pegs on B Line are surveyed in three dimensions to an accuracy of better than 10mm at the completion of each longwall panel.

- F Line is installed at approximately 45° to the panels and normal to the Rail Line to monitor the effects on the rail spur of approaching longwall mining. This line is approximately 500m long and is surveyed in three dimensions to an accuracy of better than 10mm.

- A subsidence line (G Line) is installed in an area of steeper topography over Longwalls 10 and 11 to monitor the effects of locally steeper terrain with pegs at 20m intervals.

9.2 Monitoring of the Mt Owen Rail Line

Specific monitoring of the Mt Owen Rail Line is also recommended. Detailed monitoring from a rail management perspective is outlined in the Longwalls 7-9 Mt Owen Rail Line Subsidence Management Plan which was developed in consultation with the owners, operators and maintainers of the rail line. It is expected that a similar monitoring regime would be appropriate during the mining of Longwalls 10-17.

Monitoring of rail stresses is recommended based on the experience reported by Waddington and Barbato, with the expectation that cutting and re-stressing of the rails would be necessary from time to time. We understand from discussions held during development of the Mt Owen Rail Line Subsidence Management Plan for Longwalls 7-9 that the rail maintenance contractor will be required to have the capacity to monitor rail stresses and take appropriate action to ensure the safety and serviceability of the rail line as part of the rail maintenance contract with Xstrata.

A review of likely subsidence impacts on the operation of the rail spur has indicated that changes in geometry associated with predicted mining subsidence is unlikely to cause the track to go outside of normal operating tolerances for the 25km/hr operating speed of the rail line.

The subsidence monitoring envisaged is therefore aimed at confirming that actual subsidence movements are within the range predicted. Xstrata have a requirement for routine subsidence monitoring by the maintenance contractor within their rail maintenance contract. This monitoring is aimed at confirming subsidence movements are consistent with expectation.

The rail line subsidence monitoring recommended for Integra Coal over Longwalls 10-17 is likely to be much reduced from the initial monitoring that is recommended over Longwalls 7-9. We recommend the following for the initial monitoring over Longwalls 7-10.

- Measuring the magnitude of subsidence movements at the rail line (or immediately adjacent to it) as control of the actual subsidence impacts at the Rail Line. H Line has been installed for this purpose.

- Measuring the magnitude of subsidence movements at the completion of each longwall panel at an equivalent location to H Line offset one longwall panel ahead of mining. This monitoring would involve the installation of a subsidence line (M Line in Figure 30) equivalent to H Line, but shifted one panel southeast of H Line so that the new line is offset about 130m from H Line on the parallel section of line. It is likely that once full subsidence develops, after Longwall 11, that this line would no longer be required.

- Determining when subsidence movements are likely to begin impacting on the rail line. L and F Lines are intended for this purpose. It is considered likely that, by the time Longwall 10 is mined, there will be sufficient monitoring data available for there to be confidence in the regularity and predictability of the subsidence behaviour and the intensive monitoring initially required over Longwalls 7-9 will not need to be continued.

The geometry of the monitoring lines recommended over Longwalls 7-9 is shown in Figure 30.

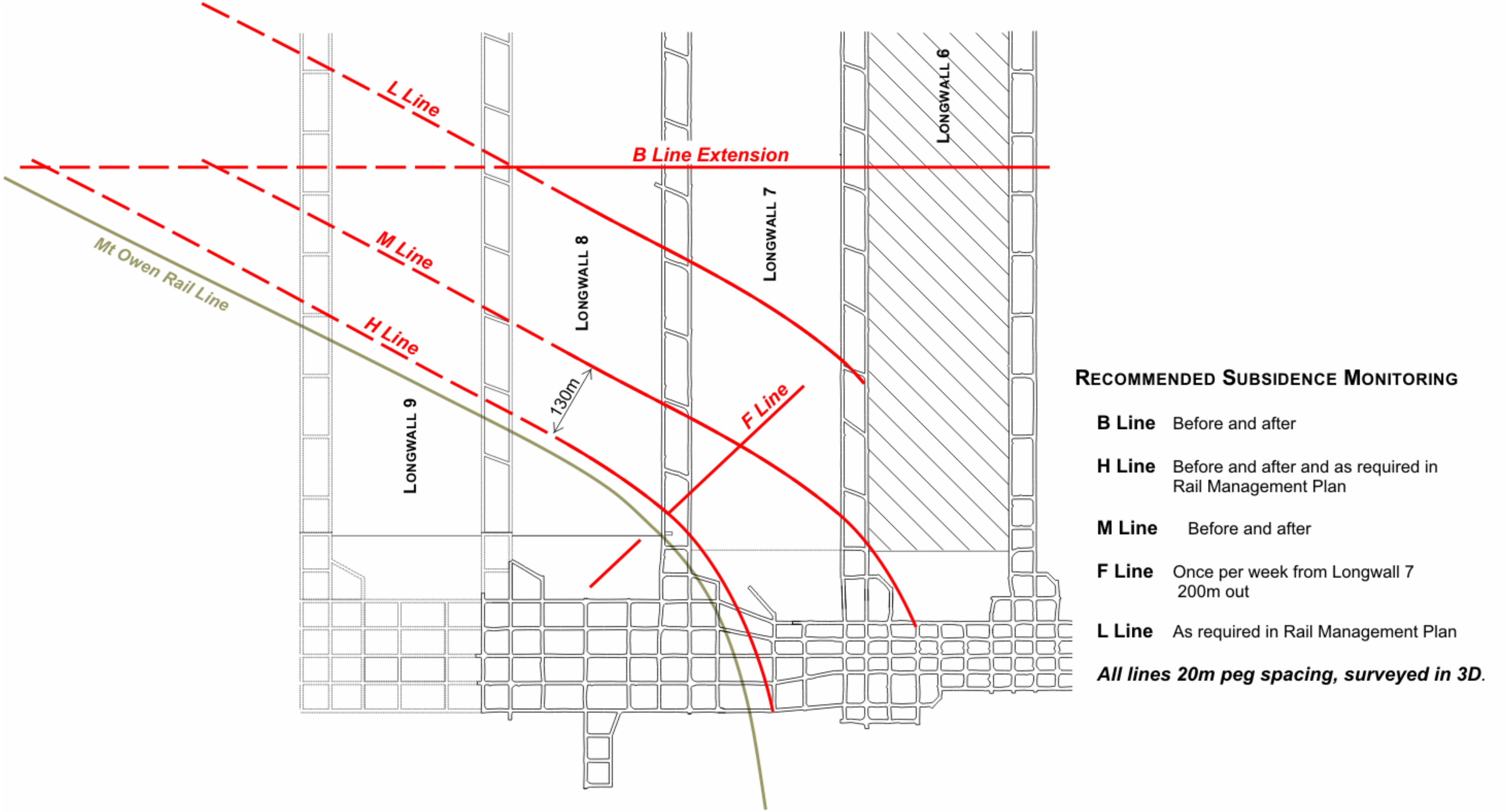


Figure 30 Integra Coal subsidence monitoring recommended for Longwalls 7-10.

10. CONCLUSIONS

Subsidence monitoring results from Longwalls 1-6 provide a basis for estimating subsidence over future longwalls, but it is likely that future monitoring over several of the 257m wide panels will allow these estimates to be refined somewhat. Until subsidence monitoring data becomes available from these wider longwall panels, a deliberately conservative approach to estimating subsidence has been taken for all subsidence parameters.

Subsidence has been estimated using a range of subsidence methods and the most conservative of these has been adopted wherever there is a range. Actual maximum subsidence values (vertical subsidence, tilt, and strain) are likely to be 50-80% of the maximum values used for assessment purposes, with additional monitoring required to confirm this and refine subsidence estimates.

Our assessment indicates that maximum subsidence of up to 1.6m (for a 2.4m mining section) may develop within the project area. Full subsidence is likely to develop at any point only after several adjacent longwall panels have been mined. At the completion of mining, subsidence in the final subsidence profile is likely to vary locally across each panel, being greater in the centre and less over the chain pillars.

Subsidence in the centre of Longwall 10 is expected to be up to 1.6m and subsidence over the chain pillars up to about 1.2m. This 0.4m variation across individual panels is expected to decrease in the later longwalls because of the increasing overburden depth so that subsidence in the centre of Longwall 16 may reach up to 1.6m while the subsidence over the chain pillars is expected to be some 0.1m less than in the centre of the panel.

Tilts of up to a maximum of 12mm/m are expected based on experience of mining at similar depths in the Southern Coalfield. Horizontal strains of generally up to 2.1mm/m (but possibly up to 6mm/m) in tension and 4.2mm/m (but possibly up to 9mm/m) in compression are expected based on extrapolation from previous monitoring over Longwalls 1-6. Relative horizontal movements of up to 150mm in any one direction are expected to develop gradually across a broad front of several hundred metres. The radius of curvature is expected to be greater than 5km.

The Mt Owen Rail Line and associated infrastructure has been identified as the main surface improvement that is likely to be impacted by mining subsidence within the project area. It is considered likely that the rail line would be able to remain serviceable throughout the period of mining with frequent monitoring and restressing of the rails from time to time likely to be required.

A specific Rail Line Management Plan for Longwalls 10-17 is currently being developed by Integra Coal in consultation with the owners, operators and maintainers of the rail line. Additional detailed subsidence monitoring over Longwalls 7-9 is expected to provide confirmation of the subsidence behaviour in advance of mining under the section of rail line located over

Longwalls 10-17. A dual rail and road bridge over Bettys Creek is expected to require a specific Subsidence Management Plan. The nature of this structure is such that it is likely to be able to accommodate anticipated maximum subsidence movements with only relatively minor works required. It is understood that the monitoring and management of this structure will be addressed in the Rail Line Management Plan.

Other items of surface improvements identified within the project area include, an unsealed public road (Forest Road), various farm access tracks, fences in various states of repair, a disused dwelling, a buried Telstra cable and an aerial electricity transmission line servicing the disused dwelling, a light-weight steel framed farm shed and a number of farm dams. We understand that the owners of these improvements are being consulted by colliery representatives and appropriate management plans are being developed.

Bettys Creek and its associated tributaries have been identified as the main natural feature within the project area. We understand that an independent assessment of the mining impacts on Bettys Creek is being undertaken.

Future developments in the area include a proposal by Xstrata to mine an open cut mine known as the Eastern Rail Pit above Longwalls 13-17. It is understood that the Eastern Rail Pit could be developed, mined and possibly rehabilitated before Longwall 13 undermines the site, but the relative timings are likely to be sensitive to a range of operational factors.

Subsidence is considered likely to have potential to impact on the stability of the open cut slopes with potential for rock falls over about 5% of the highwall length (based on experience of undermining sandstone cliff formations). If the Eastern Rail Pit is full of water at the time of longwall mining, the potential for waves associated with highwall instability would need to be considered. If the Eastern Rail Pit is close to full with tailings at the time of longwall mining, the potential for overtopping due to differential vertical subsidence would need to be considered.

Specific assessments of the impacts of mining on these slopes are recommended once the final geometries are known and the timing of mining and rehabilitation has been finalised. These impacts are expected to be manageable.

Mining subsidence of up to 1.6m is expected in the vicinity of temporary and permanent diversions of Bettys Creek around the edge of the Eastern Rail Pit. Depending on the relative timing of surface and underground mining, subsidence of this magnitude may result in some ponding within the diversion channel and some increased potential for bank instability and erosion. A specific assessment of the impacts of mining on these slopes is recommended once the final diversion channel geometries are known and the timing of mining and rehabilitation has been finalised.

Other proposed and possible surface mining activity includes Ravensworth East and Glendell Open Cuts, the Glendell Haul Road, an overburden storage dump, a topsoil dump and a tailing emplacement. The open cuts and the Glendell Haul Road are not expected to be perceptibly impacted by mining subsidence. The overburden storage dump may require some crack filling. The tailings emplacement may require some control of tailings levels and perimeter embankments depending on the nature of the emplacement.

A program of subsidence monitoring is recommended to provide improved understanding of the dynamic subsidence behaviour at Integra Coal about a retreating longwall face and, in particular, the subsidence movements that would be likely to impact on the operation of the Mt Owen Rail Line.

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