Strata Control Technology

REPORT TO:

ASHTON COAL OPERATIONS LTD

Subsidence Assessment for Longwalls 6B to 8 in the Pikes Gully Seam based on the Bowmans Creek Diversion Mine Plan

ASH3687 REVISION 1

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REPORT TO

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SUBJECT

Subsidence Assessment for Longwalls 6B to 8 in the Pikes Gully Seam based on the Bowmans Creek Diversion Mine Plan

REPORT NO

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PREPARED BY

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DATE

10 February 2011

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SUMMARY

Ashton Coal Operations Ltd (ACOL) is proposing to mine Longwalls 6B to 8 (LW6B-8) in the Pikes Gully (PG) Seam as part of their ongoing operations near Camberwell in the Hunter Valley. ACOL commissioned SCT Operations Pty Ltd (SCT) to undertake a subsidence assessment describing the impacts expected from the proposed mining as part of a variation to the approved Subsidence Management Plan (SMP) being prepared on their behalf by AECOM Australia Pty Ltd. This report presents the results of our assessment of the subsidence impacts for the proposed mining of LW6B-8 in the PG Seam.

Our assessment is based on the previous subsidence monitoring at Ashton Coal Mine and general experience of subsidence behaviour in the Hunter Valley and elsewhere. Maximum subsidence over the centre of each longwall panel is expected to be less than 1.6m with maximum tilt of 70mm/m and maximum strain of 30mm/m. Multi-Seam Subsidence impacts for this area have been addressed previously in SCT Report ASH3584.

The proposed mining is located in an area currently below Bowmans Creek. ACOL are proposing to divert sections of Bowmans Creek to allow for more efficient resource recovery of Longwalls 6B to 8. The basis for the creek diversion and the studies that underpin it are reported elsewhere and have not been included in this report. The maximum total subsidence below the alignment of the proposed diversion of Bowmans Creek is likely to be less than 0.1m and in most areas less than 20mm.

Notwithstanding the low levels of subsidence expected at the diversion, nearby subsidence of up to 1.6m at the completion of mining the Pikes Gully Seam is expected to leave the creek diversion elevated above parts of the original creek bed. Water falling as rain in the vicinity of the original creek bed, water flowing as runoff from adjacent areas, and water that overtops Bowmans Creek during a flood event is expected to flow to the lowest point in the landform and pool there. The disturbance to the overburden strata caused by the subsidence may provide sufficient hydraulic connection between the surface and the mine for some of this pooled water to flow down into the mine. The potential for this inflow is addressed by Aquaterra (2009) in their Bowmans Creek Diversion: Groundwater Impact Assessment Report.

SCT understand that filling of subsidence troughs and reshaping of the subsided landform is to be undertaken in some areas to obviate the potential for pooling of water on the surface. This approach is expected to also be effective in reducing inflow into the mine.

The majority of the surface area affected by mining subsidence is owned by ACOL, but there is an area in the northwest that is owned by Macquarie Generation. Some road and mine infrastructure is located in this area.

The impacts of subsidence on power lines traversing the surface above the mining area are likely to be manageable without undue difficulty. Building structures are considered unlikely to remain fully serviceable and will need to be either relocated or monitored to determine if they can be repaired or require demolition. We understand that two domestic structures above Longwalls 4 and 6 have been previously subsided with only minor impacts.

Unsealed access roads are likely to be serviceable for most of the time during the period of active mining, but once subsidence is complete some regrading may be necessary as per previous panels. The sealed section of Brunkers Lane is likely to require remedial work to maintain it in a serviceable condition. Buried water pipes and Telstra Lines are expected to remain serviceable.

Ravensworth Underground Mine (RUM) owned by Xstrata is planning a multi-seam underground longwall operation that shares a lease boundary with the ACOL lease. There is unlikely to be any significant interaction between the two mines for mining operations in the PG Seam. The Ashton Coal Project (ACP) is located up dip of RUM, so there is some potential for mine water that may pond in the underground mine to flow through the barrier into RUM either during operations at ACP or subsequently.

The angle of draw is expected to be generally of the order of 26.5° for mining in the PG Seam. The protection barriers provided to the Narama Dam, the New England Highway and bridge over Bowmans Creek, buried fibre optic cable, and power transmission lines outside the mining area are expected to be sufficient to provide a high level of protection for the proposed mining in the PG Seam.

SCT understand that subsidence impacts associated with archaeological sites are addressed in a separate archaeological heritage report. They are not included in this report.

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1. INTRODUCTION

This Technical Report has been prepared in support of an application by Ashton Coal Operations Limited (ACOL) for Subsidence Management Plan (SMP) Variation for Longwall 7A and an Extraction Plan (EP) Application for Longwall 6B, 7B and 8 in the Pikes Gully Seam (PG) to include the approved Bowmans Creek Diversion Mine Plan.

A general description of the site locality and Application Area is provided in Section 1.1 of the approved SMP Written Report. The Application for SMP Variation describes the operation of the underground mine to date and details of the updated mine plan and creek diversion for PG LW6B-8.

ACOL commissioned SCT Operations Pty Ltd (SCT) to undertake a subsidence assessment describing the impacts expected from the proposed mining as part of a variation to the approved Subsidence Management Plan (SMP) being prepared on their behalf by AECOM Australia Pty Ltd. This report presents the results of SCT's assessment of the subsidence impacts for the proposed mining of LW6B-8 in the PG Seam.

1.1 Scope of Works

The report is structured to provide:

1. A description of the general area including the proposed mining geometry, overburden depth and other parameters of relevance to a subsidence assessment.
2. Subsidence estimates based on the previous subsidence monitoring at the mine and reported experience of multi-seam subsidence.
3. Identification of surface features likely to be impacted by subsidence and specific assessments of the likely subsidence impacts on each of the features identified.
4. Recommendations for subsidence monitoring.

2. EXISTING ENVIRONMENT

The major natural features in the Application Area include Bowmans Creek which lies directly over the proposed panels, the Hunter River to the south outside the proposed mining area, and Glennies Creek to the east of Longwalls 1 to 4 (LW1-4), again outside the mining area considered in this report. ACOL has consent to divert Bowmans Creek to allow more efficient recovery of the coal resource. The proposed mining area is predominantly cattle grazing land on either side of Bowmans Creek.

The major infrastructure within the general area includes the New England Highway in the north including a bridge over Bowmans Creek, a buried fibre optic cable alongside the highway, and three high voltage electricity lines, two alongside the highway and a third that traverses the southern end of the panels.

Other non-mining related infrastructure includes a local area electricity line, two buried Telstra copper wire lines, and a river gauging station on Bowmans Creek. SCT understand that there is a proposal by Xstrata to upgrade Brunkers Lane to a public road as replacement for Lemington Road, but this upgrade is likely to occur after mining in the PG Seam is complete.

Mining related infrastructure that is not owned by ACOL includes a private road that provides secondary access to Macquarie Generation land and Ravensworth Underground as well as access to Ravensworth Open Cut, clay lined sedimentation ponds located on a waste rock spoil pile, an 11kV power line servicing Ravensworth Open Cut, and a large diameter polyline understood to carry fresh water from Narama Dam to Mt Owen Mine.

The Dams Safety Committee (DSC) Notification Area for Narama Dam overlaps the underground mine, although the dam itself is located outside the proposed mining area. A second water storage dam, known as Void 5 or Proposed Ravensworth Void 5 Ash Dam, is planned west of the north-western corner of the underground mine within the timeframe of mining. This dam will also be located outside the mining area, but the DSC Notification Area will overlap with the underground mine.

Ravensworth Underground Mine owned by Xstrata is planning a multi-seam underground longwall operation that shares a lease boundary with the ACOL lease. Although, the two mines are required by law to be separated by a 40m wide barrier, 20m either side of the lease boundary, there is nevertheless some potential for interaction, particularly in relation to flow of mine water.

ACOL owned infrastructure over the underground mine includes several farm buildings and houses, farm dams, farm roads, fences, a fresh water polyline from the Hunter River, the mine pump out polyline from the southern end of the panels, and four polylines that pass under the New England Highway below the bridge over Bowmans Creek.

2.1 Existing Consents

ACOL was granted development consent on 11 October 2002 by the Minister of Planning pursuant to the provisions of the *Environmental Planning and Assessment Act 1979 (NSW)*. ACOL's consent for underground mining includes a series of longwall panels, oriented in a north-south direction. The operation is approved as a multi-seam operation although this application only relates to mining in the PG Seam.

ACOL received approval from the Department of Planning (DoP) for the Bowmans Creek Diversion application and subsequent modification to the existing development consent (DA309-11-2001-MOD6). The modification was approved by DoP on the 24th December 2011 and received by ACOL on the 10th January 2011. As part of the Subsidence Management section of the development consent, the consent has been updated in Condition 3.12 to include Extraction Plans (EP).

2.2 Proposed Mining

Figure 1 shows a plan of the proposed mining area superimposed onto plan of the major surface features and surface topography. Figure 2 shows the proposed mining layout superimposed onto a plan of the natural surface features, surface infrastructure and proposed diversion of Bowman's Creek. Figure 3 shows the same plan superimposed onto contours of overburden depth to the PG Seam. Table 1 summarises the panel dimensions.

Table 1: Proposed Longwall 6 to 8 Panel Dimensions

Panel	Gateroads Nominal	TG Pillar Width Rib to Rib (m)	LW Void Width (m)	LW Length (m)
LW6B	5.4	25	216	1032
LW7A	5.4	30	198	1291
LW7B	5.4	30	198	1141
LW8	5.4	35	134	1256

3. PREVIOUS SUBSIDENCE MONITORING AND PREDICTED SUBSIDENCE BEHAVIOUR

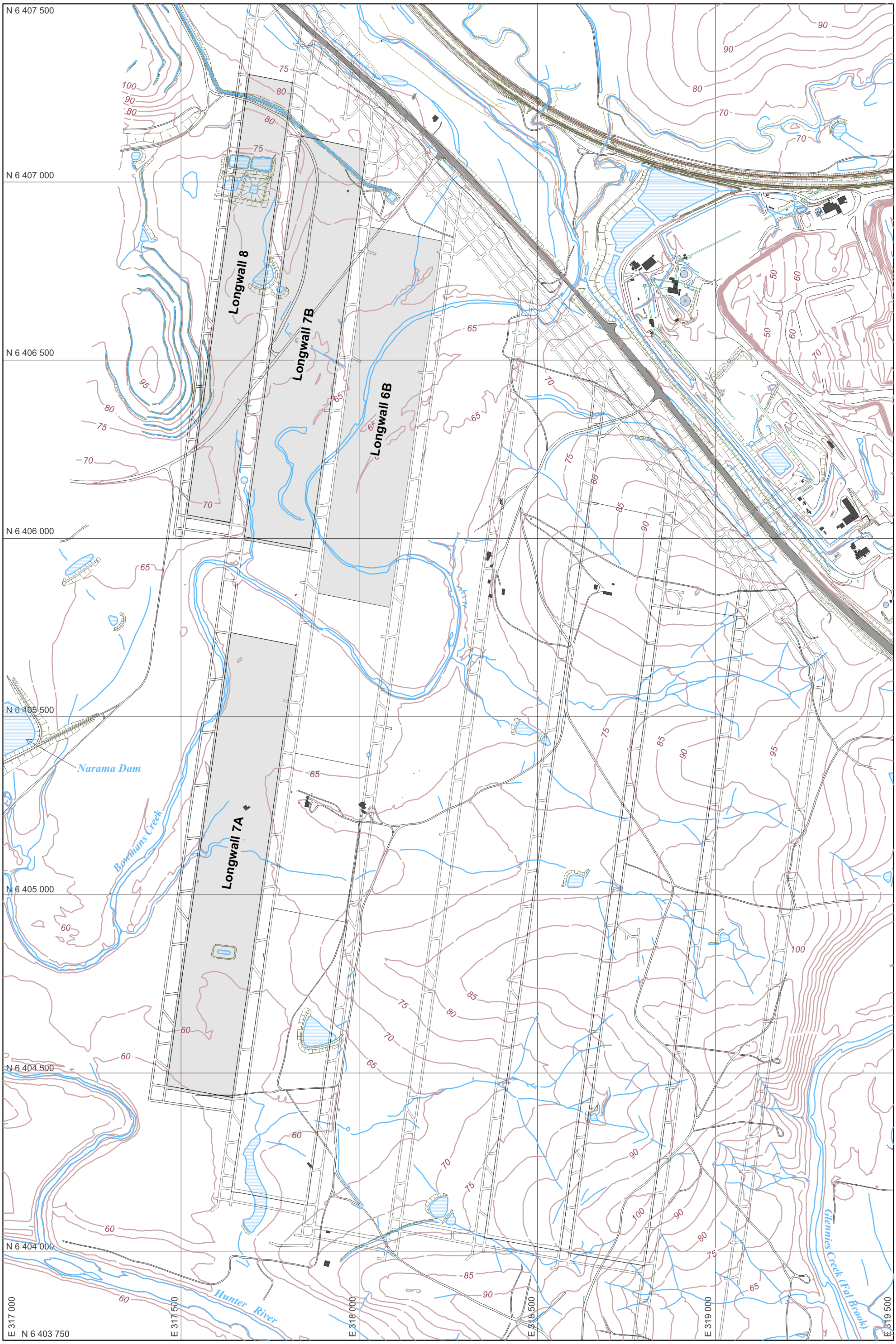
In this section, previous subsidence monitoring results from LW1-5 are presented to illustrate the subsidence behaviour that can be expected over LW6B-8 and the variability in subsidence behaviour that occurs. Subsidence estimates are then presented based on this previous experience and general experience of subsidence monitoring in New South Wales and elsewhere.

3.1 Summary of Previous Subsidence Monitoring

Subsidence monitoring has been undertaken at the Ashton Coal Project since the commencement of longwall operations in early 2007. The subsidence behaviour observed is consistent with supercritical width subsidence and with the subsidence behaviour expected.

Figure 4 shows the locations of subsidence lines that have been monitored over LW1-5. The maximum subsidence parameters are summarised in Table 2. Figure 5 summarises the subsidence measured on the main cross line XL5 at the completion of each of the first five longwall panels.

The vertical subsidence profiles shown in Figure 5 are consistent with supercritical width subsidence behaviour where full subsidence occurs in the central part of each panel and relatively low levels of subsidence are observed over the chain pillars between panels. The maximum vertical subsidence measured is less than the 1.6-1.8m predicted in the SMP. Measured tilt and strain values are generally within the range predicted in the SMP although there are several locations where locally higher strains and tilts have been observed. These anomalies are a consequence of ground movements, particularly horizontal ground movements that are not possible to predict by conventional subsidence estimation techniques.



Proposed Mining Area

Figure 1: Site plan showing location of proposed mining area and contours of surface RL.

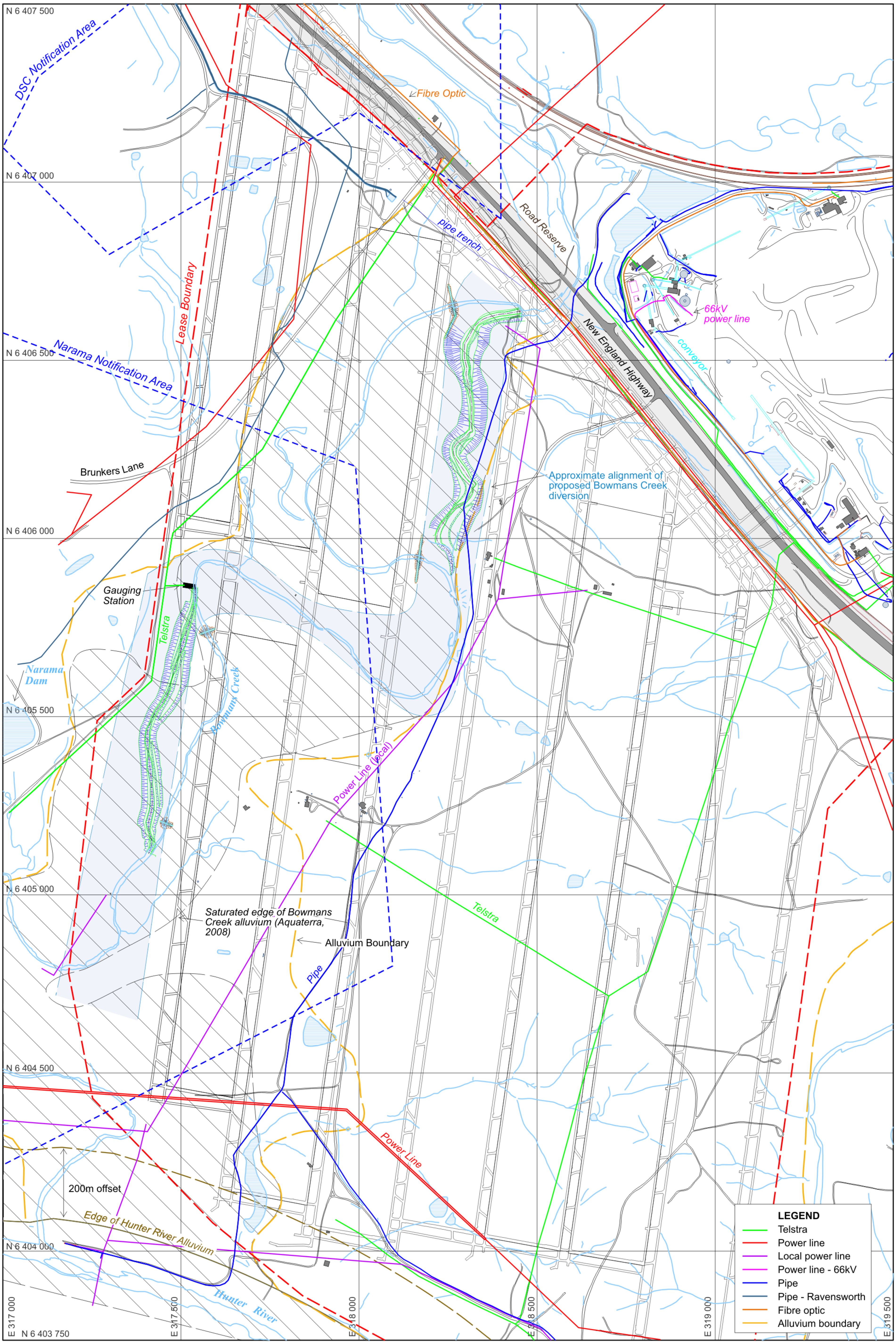


Figure 2: Site plan showing mine plan and location of surface infrastructure, natural features and proposed developments.

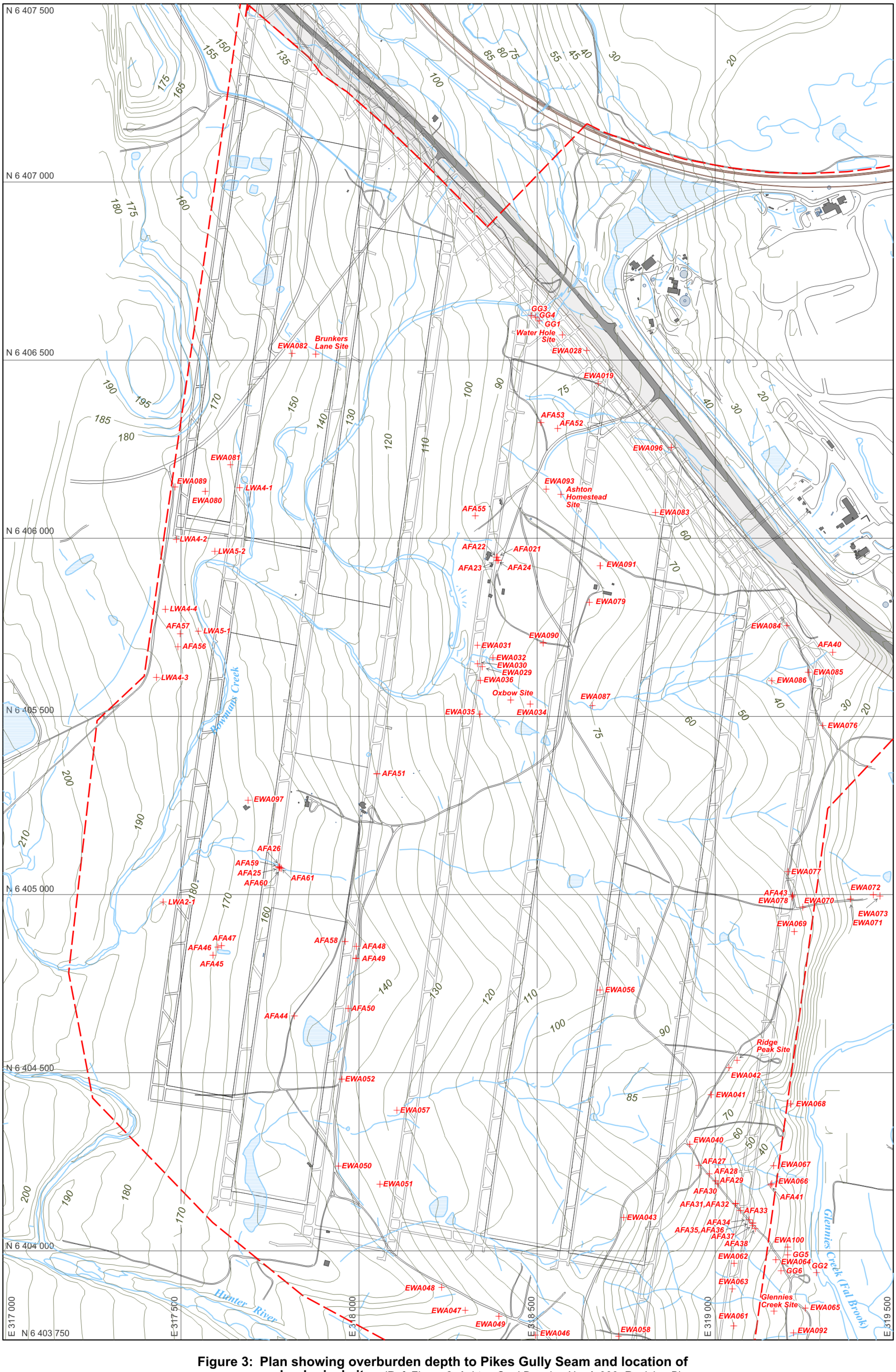


Figure 3: Plan showing overburden depth to Pikes Gully Seam and location of archeological sites *(Ref. Figure 2, Ashton Coal Drawing No. A-000, Revision B)*.

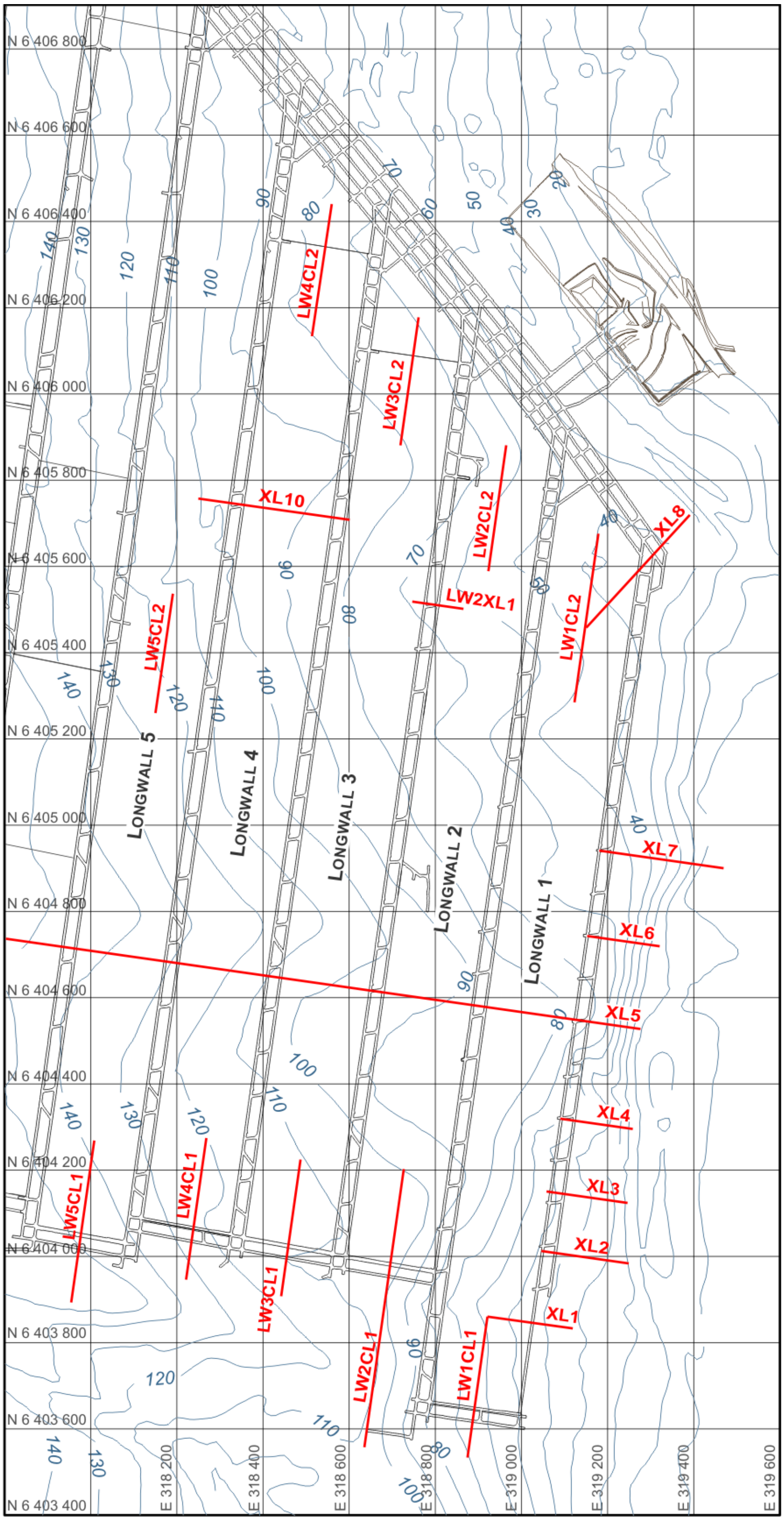


Figure 4: Overburden depth to the Pikes Gully Seam and location of subsidence lines.

Table 2: Measured Subsidence Over Longwalls 1 to 5

	Maximum Measured			
North End of LW1	**CL2**	**XL8**		
Subsidence (mm)	1528	1500		
Tilt (mm/m)	100	103		
Horizontal Movement (mm)	476	500		
Tensile Strain (mm/m)	40	15		
Compressive Strain (mm/m)	28	27		
Remainder of LW1	**CL1**	**XL5**		
Subsidence (mm)	1318	1436		
Tilt (mm/m)	60	75		
Horizontal Movement (mm)	480	503		
Tensile Strain (mm/m)	49	17		
Compressive Strain (mm/m)	23	24		
Longwall 2	**CL1**	**CL2**	**XL5**	
Subsidence (mm)	1296	1513	1266	
Tilt (mm/m)	40	82	78	
Horizontal Movement (mm)	440	298	390	
Tensile Strain (mm/m)	17	16	11	
Compressive Strain (mm/m)	16	32	28	
Longwall 3	**CL1**	**CL2**	**XL5**	
Subsidence (mm)	1420	1354	1429	
Tilt (mm/m)	41	48	97	
Horizontal Movement (mm)	463	345	394	
Tensile Strain (mm/m)	10	17	22	
Compressive Strain (mm/m)	7	18	24	
Longwall 4	**CL1**	**CL2**	**XL5**	**XL10**
Subsidence (mm)	1397	1194	1546	1263
Tilt (mm/m)	36	40	53	33
Horizontal Movement (mm)	230	560	360	258[1]
Tensile Strain (mm/m)	10	18	9	6
Compressive Strain (mm/m)	9	67	9	10
Longwall 5	**CL1**	**CL2**	**XL5**	
Subsidence (mm)	1266	1326	1376	
Tilt (mm/m)	23	29	35	
Horizontal Movement (mm)	399	339[2]	360	
Tensile Strain (mm/m)	21	6	5	
Compressive Strain (mm/m)	9	8	17	

[1] XL10 was installed after some horizontal movement associated with the previous longwall may already have occurred so not all horizontal movements were measured.
[2] Measured at end of line so maximum expected to be greater.

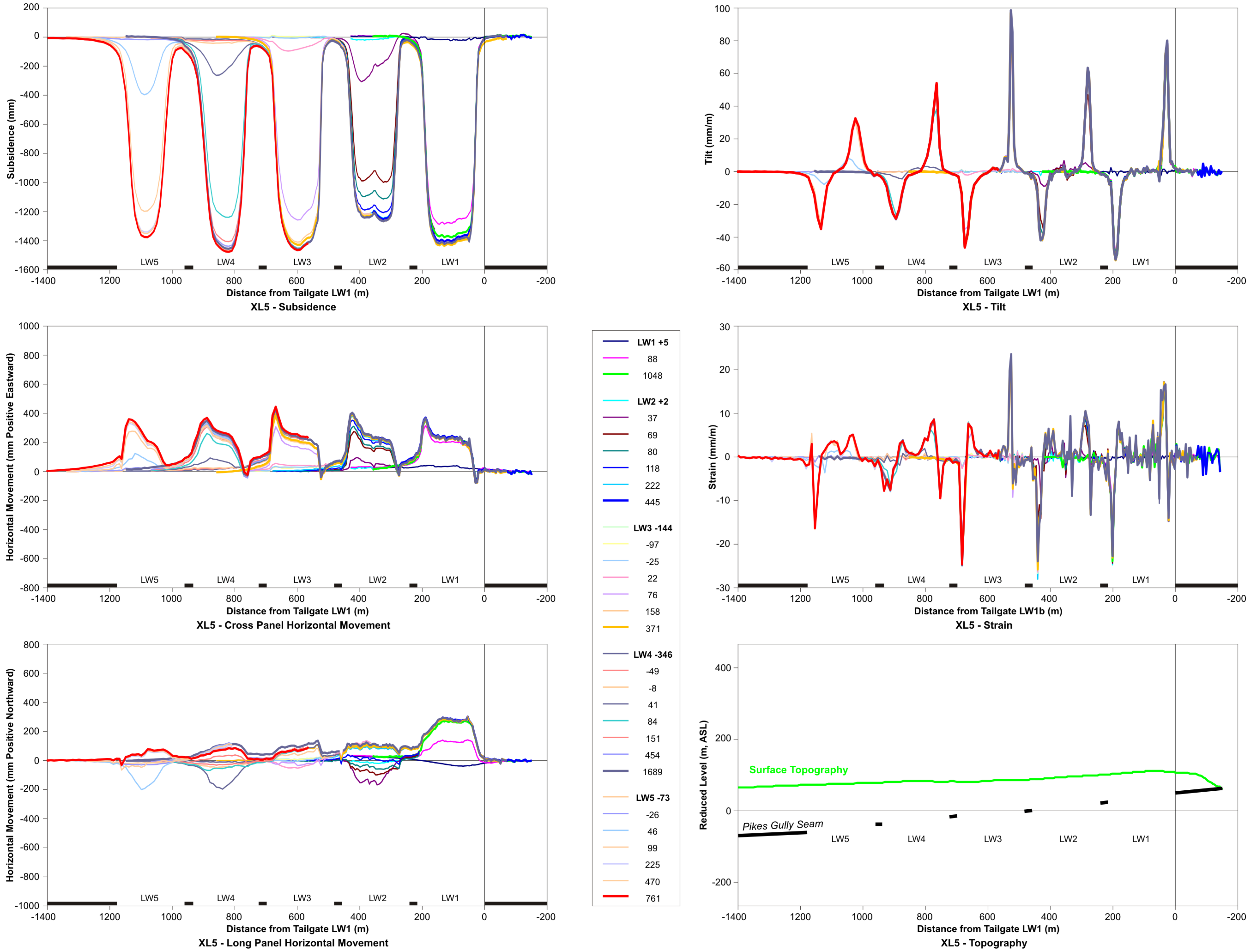


Figure 5: XL5 subsidence - Longwall 4, Ashton Mine.

Approximately 200-250mm of eastward or upslope horizontal movement has been observed over all the previous longwall panels. The mechanics of the processes causing horizontal movement at the ACP are thought to be the same as elsewhere except that they are modified by the general dip of the strata to the west. Dilation of subsiding strata toward a free surface is recognised to cause the downslope movement commonly observed in horizontally bedded strata (Mills 2001). When the strata is dipping, the process is effectively rotated so that horizontal movement caused by movement toward a free surface, usually seen as downslope movement, actually occurs toward the free surface in an upslope direction against the strata dip.

Horizontal movements outside the longwall panels have been generally less than 100mm and decreasing with distance from the goaf edge. Over the sides of each panel, horizontal movements are perceptible to a distance of up to 200m from the goaf edge. At the start of each of the panels, horizontal movements are observed to a distance of approximately 100m beyond the start line. At the finish of each panel, most of the horizontal movements occur within 50m of the goaf edge.

Maximum tilt measured to date has been 103mm/m and although there is a trend of generally decreasing tilt as the overburden depth increases, maximum tilt of 97mm/m was observed above Longwall 3 at an overburden depth of approximately 100m. In general, maximum tilts are more typically less than 70mm/m at overburden depths above about 70m.

Maximum strains also show a generally decreasing trend with increasing overburden depth and are generally less than 40mm/m at overburden depths greater than 70m, but a peak value of 67mm/m was observed over the finish of Longwall 4 at an overburden depth of approximately 80m and there is a high variability in maximum strain values.

Dynamic overburden bridging at the start of each panel shows that vertical subsidence starts to increase when the goaf width to overburden depth ratio increases above about 0.8. Long term, static subsidence is expected to be greater than dynamic subsidence.

Subsidence measurements at ACP show that the angle of draw increases with overburden depth. A 0° angle of draw is observed at about 60m overburden depth. The maximum angle of draw measured to date has been 29° over the maingate goaf edge of Longwall 5 where the overburden depth is approximately 145m.

3.2 Subsidence Estimates

In this section, the subsidence estimates are presented in the form of subsidence contours, and in terms of maximum subsidence estimated for each panel. Indicative maximum strain and tilt estimates are also provided.

Figure 6 shows the subsidence contours that are expected at the completion of mining the PG Seam. Point measurements of the maximum and minimum subsidence in the centre of each panel and over the chain pillars are also shown. The contour intervals are variable for clarity, and simplicity of presentation. It should be recognised that the maximum vertical subsidence is naturally variable by about 15% for any given panel geometry and overburden depth so the subsidence contours shown should be regarded as indicative of the level of subsidence that can be expected rather than as providing a high level of precision of the subsidence value at a point.

Table 2 summarises the average maximum subsidence that is expected at the completion of mining each panel. These values are expected over the central part of the full width panels. In general, the tilts and strains are likely to be greater in Longwall 6 where the overburden depth is less and decrease in magnitude as the overburden depth increases toward Longwall 8 and toward the centre of each panel. However, the unconsolidated material on the surface in the land owned by Macquarie Generation is expected to cause locally higher levels of subsidence, strain and tilt.

Table 3: Summary of Expected Subsidence Movements from Proposed Mining in Pikes Gully Seam

SEAM	MAXIMUM SUBSIDENCE (M)	MAXIMUM TILT (MM/M)	MAXIMUM STRAIN (MM/M)
LONGWALL 6B	1.6	70	30
LONGWALL 7A	1.6	70	30
LONGWALL 7B	1.6	70	30
LONGWALL 8	0.7	40	20

Surface cracks associated with mining in the PG Seam are expected to be generally less than 100mm wide, but may increase locally up to 200mm wide at the top of unconsolidated slopes such as those associated with overburden spoil dumps.

Although surface infrastructure is unlikely to remain serviceable at these strains and tilt levels, relocation or temporary mitigation measures are possible for some infrastructure. Natural features such as trees, creek channels, and flat areas are likely to be disturbed to a level consistent with experience over Longwalls 1 to 5.

An angle of draw of 26.5° or half depth provides a reasonable indication of the limit of subsidence impacts for most practical purposes in a single seam mining environment. The angle of draw is expected to be of the order of 26.5° once mining in the PG Seam is complete.

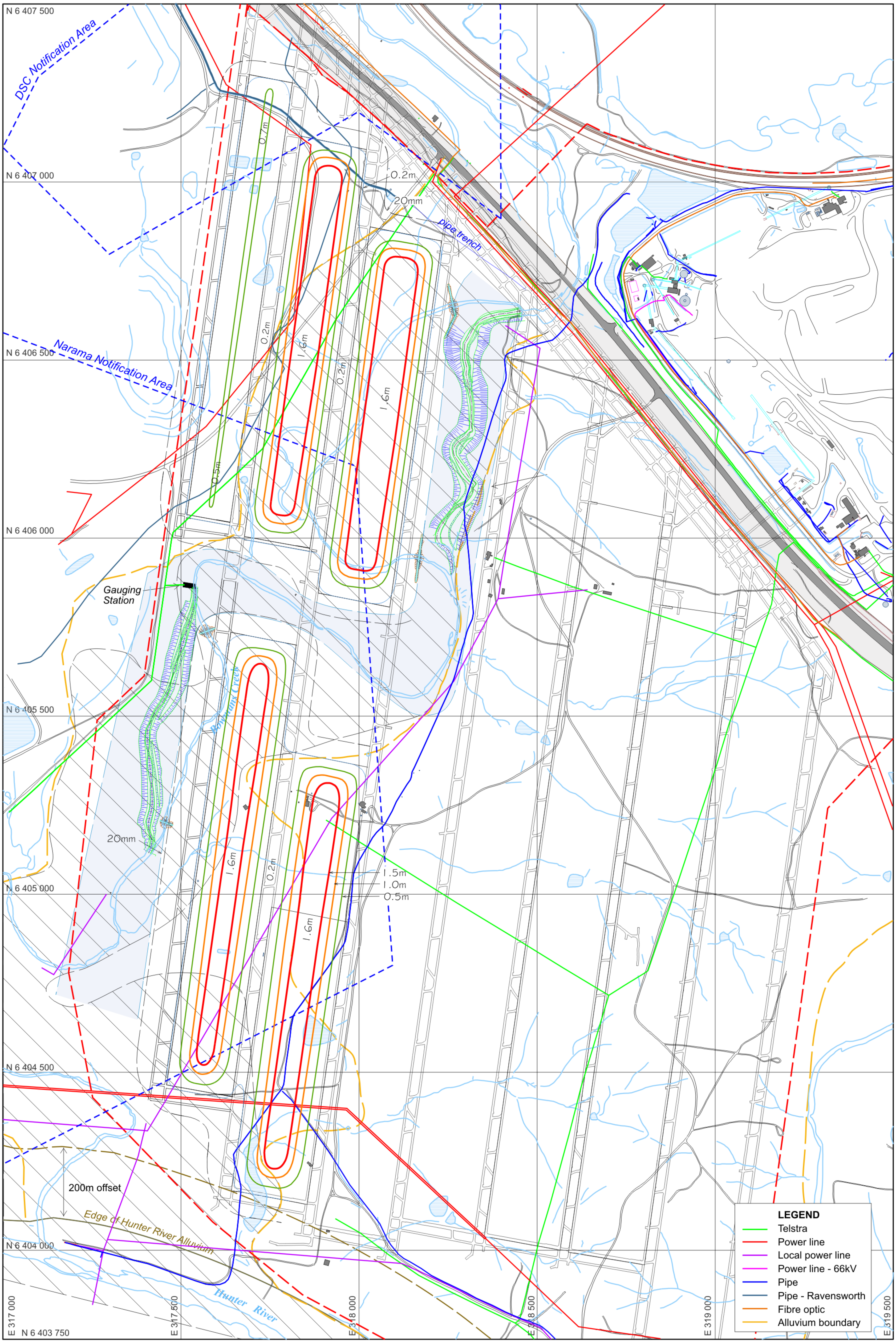


Figure 6: Subsidence contours at completion of mining in Pikes Gully Seam.

3.3 Factors Influencing Reliability of Subsidence Estimates and Assumptions

In this section, the factors that influence the subsidence and the assumptions that have been made to arrive at the subsidence estimates are presented and discussed.

Subsidence estimates for the longwall panels in the PG Seam are considered to be reliable because of the previous experience of monitoring the PG Seam at ACP, and because the PG Seam is the first seam mined in undisturbed ground.

Longwalls 6 and 7 are of supercritical width for mining in the PG Seam. In supercritical width panels, the central part of the surface above each panel is resting fully on the goaf, so the magnitude of maximum subsidence is a function of the seam thickness mined and the bulking characteristics of the overburden strata. Maximum subsidence is typically in the range 55-65% of seam thickness mined. For a 2.4m mining section, maximum subsidence is therefore estimated to be 1.6m.

Longwall 8 is 134m wide because of lease boundary constraints. The width to depth ratio of this panel varies along the panel but is approximately 0.89 at the northern end. At this width to depth ratio, the panel is of subcritical width, but the overburden stratum is no longer able to substantially bridge across the panel. Full subsidence is not reached in the centre of this panel for mining in the PG Seam. Estimates of maximum subsidence in subcritical width panels tend to be sensitive to the nature of the overburden strata and in situ stress conditions, and so are difficult to predict with a high level of certainty.

Subsidence over the chain pillars is controlled by the elastic compression of the strata above and below the chain pillar as well as a small amount of compression of the coal in the chain pillar itself. At 150m deep, the elastic compression usually causes less than 200mm of surface subsidence in total when both adjacent panels have been mined. The chain pillars are typically large enough to prevent pillar instability that might cause additional subsidence and the 25-35m wide pillars (measured rib to rib) proposed are expected to remain stable in the long term.

4. ASSESSMENT OF SUBSIDENCE IMPACTS

The natural features and surface improvements in the proposed mining area have been identified on the basis of several site walk-overs, discussion with mine personnel, and discussion with other specialist groups working for the mine. In this section, these features and improvements are described and the impacts of the expected subsidence movements are assessed and described.

4.1 Natural Features

The main natural features of interest in and adjacent to the proposed mining area are Bowmans Creek and its associated alluvial flats, and the Hunter River.

4.1.1 Bowmans Creek

Bowmans Creek meanders from north to south across the proposed mining area. In the north, the stream channel is cut into the surrounding countryside to a depth of several metres. In the south, near the confluence with the Hunter River, the channel is deeply incised to a depth of 10-15m below the surrounding alluvial floodplain.

The stream channel comprises a series of pools retained behind gravel bars. There are conglomerate rock exposures in the banks at several locations, typically near sharp changes in direction, but along most of its length, the channel is cut into the alluvium and the banks comprise sand, silt, and clay material.

Figure 7 shows a selection of photographs of Bowmans Creek illustrating the nature of various sections of the stream channel. The photographs were taken shortly after a period of heavy rain when the flow in the creek was estimated at several hundred megalitres per day. In extended dry periods, the stream channel is reduced to a series of ponds with surface flow estimated to be only a few megalitres per day.

ACOL propose to divert Bowmans Creek so that it runs along the northern, unmined section of Longwall 5, crosses to the west within its natural channel in an area where the panels are of narrow width to reduce surface subsidence, and then down the unmined section adjacent to Longwall 8. The location of this diversion is shown in Figure 2.

The proposed mining geometry is expected to maintain subsidence at less than 0.1m below the alignment of the proposed diversion of Bowmans Creek. However, nearby subsidence from mining in the PG Seam is expected to leave the creek diversion elevated above the original creek by up to 1.6m. The subsided channel and floodplain may pool during flood events as surface runoff or overtopping flow from the diversion channel accumulates in the subsided section of the original channel.

4.1.2 Hunter River

The Hunter River is located to the south and outside of the proposed mining area. Figure 8 shows a photograph of the Hunter River.

The closest point of longwall mining to the edge of the Hunter River channel is at the start corner of Longwall 6. The horizontal distance between the goaf edge and the Hunter River channel is approximately 300m. SCT understand that the longwall start positions are based on an offset of 200m from the edge of Hunter River alluvium where the edge of the alluvium has

Figure 7: Photographs of Bowmans Creek.

been determined by Aquaterra (2008). A distance of 200m is equivalent to 26.5° plus 120m offset to this point for the PG Seam. The offset distance is therefore greater than the 26.5° plus 40m typically used for determining offsets from creeks and rivers and their associated alluvium.

There is not expected to be any subsidence impacts on the Hunter River channel. SCT understand that hydrogeological impacts associated with flow from the Hunter River channel and the associated alluvium have been assessed by Aquaterra (2008).

Figure 8: Photograph of the Hunter River south of the proposed mining area.

4.1.3 Pooling in Subsidence Troughs and Mine Inflows

Water falling as rain on the floodplain, water flowing as runoff from adjacent areas, and water that overtops Bowmans Creek during a flood event is expected to flow to the lowest point in the landform and may pool in subsidence troughs. The disturbance to the overburden strata caused by subsidence is expected to increase the hydraulic connection between the surface and the mine.

At the completion of mining in the PG Seam, some proportion of the water that pools in subsidence troughs and water stored in the Bowmans Creek alluvium above the longwall panels is expected to drain downward into the mine. Filling subsidence troughs with suitably compacted material of low hydraulic conductivity after each panel is mined is expected to reduce both the storage volume available on the surface in topographic low points and access of runoff water to the fracture network in the overburden strata. Such a filling operation is likely to involve large volumes of material and cause significant disturbance to the land surface and surface infrastructure. The impacts associated with such an operation are beyond the scope of this report. Nevertheless, the approach is recommended as a means to control rainfall and surface run-off from pooling on the surface and eventually entering the mine. SCT understands that this issue is discussed in Evans and Peck (2009).

4.1.4 General Surface Cracking

The surface cracking that is expected to develop over the goaf edges of the proposed longwall panels is likely to be similar to that which has occurred previously above LW1-5. Some remediation may be necessary to reduce ingress of surface water, injury to livestock, and entrapment of small animals.

Surface cracks of generally less than 100mm wide and possibly up to 200mm wide are expected in isolated locations along goaf edges at the completion of mining in the PG Seam.

4.2 Surface Improvements

The various items of surface infrastructure located within the proposed mining area are described in detail in this section, along with potential subsidence impacts, including:

- major and minor non-mining infrastructure
- mining infrastructure associated with operations
- ACOL owned infrastructure.

4.2.1 New England Highway

Figure 9 shows a photograph looking east along the edge of the New England Highway road reserve in an area where a buried fibre optic cable and two high voltage electricity lines are located.

The southern edge of the New England Highway road reserve is located some 80m to 100m from the northern ends of LW6B-8. The main headings pass directly under the highway. The depth of overburden in this area ranges from 90-130m to the PG Seam. The road reserve lies outside 26.5° angle of draw for the proposed mining in the PG Seam.

Figure 9: Photograph looking east along New England Highway road reserve.

4.2.2 Buried Fibre Optic Cable

The Powertel fibre optic cable follows the alignment of the 132kV power lines on the southern side of the New England Highway as shown in Figure 10 up to the intersection with the realigned Brunkers Lane. The cable crosses under the highway and is located on the northern side of the highway from there on.

Available plans indicate that the fibre optic cable comes within 90m of the end of Longwall 6 before it passes under the highway and follows the northern side of the highway further west. The overburden depth at this location is approximately 120m to the PG Seam. Subsidence movements at the location of the fibre optic cable associated with mining in the PG Seam are expected to be small in magnitude and of a general body nature that is not expected to impact on the fibre optic cable.

4.2.3 132kV & 66kV Electricity Lines

Two electricity lines (one 132kV and one 66kV) supported on single poles are located along the southern side of the New England Highway as shown in Figures 9 and 10. Both cross the highway near the intersection with Brunkers Lane. The poles are supported with multiple stays in this area.

Figure 10: Photograph of Powertel cable and high voltage power lines in New England Highway road reserve.

An 11kV line also supported on the poles of the southern 66kV line continues along the southern side of the highway.

The corner poles are located approximately 100m from the end of Longwall 6. The overburden depth at this location is approximately 120m to the Pikes Gully Seam.

Single pole structures are relatively tolerant to subsidence movements, but these structures are not expected to experience significant subsidence movements because of their location beyond the northern ends of the panel where the tilts and strains are likely to be negligible. Monitoring of the tension in the stay wires at the change in direction is recommended as the longwalls in this area reach their finish line.

A second 132kV electricity line crosses the southern end of all the longwall panels. This line is supported on a two pole structure for the straight sections as shown in Figure 11a and three stayed poles at changes in direction as shown in Figure 11b.

Figure 11: Photographs of 132kV line at the southern end of the proposed mining area.

Power lines traversing the surface above the proposed mining area are likely to experience subsidence movements of a magnitude that depends on their location relative to the individual longwall panels. The line is expected to be able to remain serviceable during mining in the Pikes Gully Seam based on the experience of mining Longwall 1. Some mitigation works may be necessary at changes in direction where the conductors are fixed to the poles for tensioning purposes.

4.2.4 Local Area Electricity Lines

Several local area electricity lines cross the proposed mining area. These are supported on single pole structures, some with the conductor suspended from insulators and others fixed directly to cross-arms. The 11kV line supported on the 66kV poles at the northern end of the panels has already been noted in Section 4.2.3 (Figure 9).

There is a line located on the Macquarie Generation land that skirts the edge of the spoil dump. The single pole structures on this line are shown in Figures 12a and 12b. They are stayed at changes in direction.

There is a line that extends north to south across the Application Area that services the ACOL owned properties and continues south across the Hunter River after passing under the 132kV line. The line branches at the southern edge of the Application Area to service ACP's submersible pump and other customers west of Bowmans Creek. Figure 13 shows a selection of photographs of this line. The line is supported on single pole structures.

The impacts of mining subsidence are expected to be managed without undue difficulty using the approaches that have been developed and successfully deployed over previous longwall panels at the mine.

4.2.5 Buried Telstra Lines

Three buried, copper wire, Telstra lines cross the proposed mining area. The western line crosses LW6B-8. This line previously serviced the gauging station and provides future connection for subdivided blocks that form part of the southern extent of the Ravensworth lease.

The other two lines are branches off the line located over LW1-3 that service the house located over Longwall 6 and another ACOL owned building located over Longwall 5. These lines are understood to be currently active.

Typically buried copper lines in good repair are likely to remain serviceable where ground strains are less than about 20mm/m. Alternative communication provisions for residents and adjoining private property tenants are recommended. SCT understand that these are addressed in accordance with ACOL's existing Subsidence Management Plans and these plans have been effective in managing the subsidence impacts of previous longwalls.

Figure 12: Photographs of single pole structures on 66kV power lines.

Figure 13: Photographs of single pole structures on local electricity lines.

4.2.6 Bowmans Creek Flow Gauging Station

A flow gauging station is located on Bowmans Creek outside the proposed mining area to the west of Longwall 7. Figure 14 shows photographs of this installation. The sections of Bowmans Creek that are planned to be diverted are located either side of the gauging station so the gauging station will be able to continue to operate, although it may need to be recalibrated given changes to the flood plain landform.

If the gauging station were to be left in its current location, it would be approximately 140m to the nearest longwall goaf. The overburden depth to the PG Seam is approximately 180m in this area so it is unlikely that significant changes would be observed at the flow gauging station.

The radio communication link and underground cabling between the weir and the communication structure is not expected to be impacted by mining subsidence. The power supply infrastructure and any buried telecommunications that the station uses may be impacted by subsidence. This infrastructure is discussed in other sections of this report.

4.2.7 Brunkers Lane (Private Road)

Brunkers Lane is the name given to a tarsealed section of road that was realigned from its location on the western edge of ACOL's lease to its current location during open cut mining on the site owned by Macquarie Generation. Figure 15 shows a photograph of the section of road located over LW6B-8.

Although the road is accessible to the public along the section that is within the proposed mining area, SCT understand that the road is not used as a public road. Macquarie Generation maintains this roadway as a private roadway as far as the Void 5 access gate. This road provides alternate access for heavy vehicle traffic to the mine when access via the normal route becomes restricted. The road is also planned to be used for heavy vehicle movements associated with construction of the Void 5 dam. The road has recently been upgraded including the highway intersection.

Ravensworth Open Cut uses this road as a rear access to their site through a locked gate. SCT understand that there are proposed plans to upgrade this section of the road and possibly transfer it to public ownership to:

1. replace Lemington Road should future open cut operations expand through the area where Lemington Road is currently located

2. provide access to a number of subdivided blocks that form part of the southern extent of the Ravensworth lease.

The timing of any implementation of these plans is currently unknown, but it is anticipated that they would not be undertaken prior to completion of mining in the PG Seam.

Figure 14: Flow gauging station on Bowmans Creek.

Figure 15: Sealed section of Brunkers Lane.

The sealed section of Brunkers Lane and any proposed upgrades are likely to require significant remedial work to maintain them in a serviceable condition during mining of LW7- 8. If the road becomes a public road, temporary diversions and/or continuous supervision of the site is likely to be necessary during the period of active mining. Filling, regrading, and resealing of the road surface is likely to be required at the completion of Longwalls 6, 7 and 8. The road crosses a minor tributary of Bowman's Creek. This tributary passes under the road through circular steel pipes. Replacement and re-levelling of this structure and the surrounding landform is likely to be required at the completion of each longwall panel.

4.2.8 Macquarie Generation Access Road

The alternative access to Macquarie Generation land continues from Brunkers Lane on a gravel road as shown in Figure 16. This road is located over the northern end of Longwall 7. The overburden depth in this area is approximately 145m to the PG Seam.

Unsealed access roads are unlikely to remain serviceable during the period of active mining in the second and subsequent seams, but once subsidence is complete, it is anticipated that they could be re-established by regrading without particular difficulty.

Figure 16: Unsealed access road on Macquarie Generation lease.

4.2.9 Macquarie Generation Sedimentation Ponds

Figure 17 shows a panorama of the surface above the out of pit spoil pile in the northwest corner of the proposed mining area. The surface has been substantially rehabilitated and revegetated having been previously open cut mined. There are four clay lined sedimentation ponds and a fifth downstream dam that are still in use. All five dams are located over Longwall 8 and the overburden depth is approximately 150m to the PG Seam.

The four clay lined sedimentation ponds and a fifth downstream dam are expected to experience the subsidence movements of up to 1.6m of vertical subsidence, 70mm/m of tilt and 40mm/m of horizontal strain.

Figure 17: Panorama of surface above out of pit spoil pile.

Mining subsidence movements are expected to cause temporary and permanent tensile cracking in the ponds with differential settlement across the two western ponds and the downstream dam. Remedial work will be required to restore the dam volumes and overflow levels to their pre-mining condition. Resealing of cracks is also likely to be necessary to ensure the integrity of the dams. SCT recommend that the dams are pumped down during the few weeks of mining under them as a precaution against cracks that may allow uncontrolled discharge and possible erosion of the dam wall.

4.2.10 Polyethylene Pipes

A polyethylene water supply pipeline from Narama to Mt Owen crosses Longwalls 7 and 8. The pipeline is buried for most of its length, but is exposed where it passes through a culvert below Brunkers Lane (Figure 18) above Longwall 7.

A separate group of pipes associated with ACOL tailings transfer and water reclamation from Void 4 are laid in an open trench across Macquarie Generation's lease (Figure 18b). To the north of Longwalls 6 and 7, these pipes are buried in a shallow trench. They pass under Brunkers Lane, alongside Bowmans Creek and under the New England Highway at the Bowmans Creek Bridge (Figure 18c).

The diameters of the pipes range from 110mm to 315mm. All the lines carry mine waste water, except the fresh water line from the Hunter River.

The polyethylene pipes located in open trenches or laying on the surface are not expected to be impacted by mining subsidence except in terms of grade changes that may affect sediment accumulation in the pipes.

The buried polyethylene pipes located over longwall panels are expected to experience the full range of subsidence movements. The predicted strains are expected to exceed the 5-10mm/m working strains of polyethylene if they are concentrated at a point and there is tight contact between the fill material and the pipe. However, the contact between the ground and the pipe is not expected to be sufficiently tight for all the ground strains to be transferred to the pipe. SCT understand that similar buried pipes located over Longwalls 4 and 5 have not been adversely affected by mining subsidence.

Mining of panels in the PG Seam is not expected to cause the buried polyethylene pipes to become overstressed, but there is potential for damage if there is good contact between the backfill and the pipe and the subsidence movements become concentrated at large cracks or compression humps. A potential solution would involve exposing the buried pipeline so that shear could not be generated between the soil and the pipe or bypassing sections across the surface with a temporary pipe and reconnecting back to the buried pipe once it is confirmed that the buried section remains serviceable.

a)

b)

c)

Figure 18: Polyethylene pipelines

4.2.11 Narama Dam

Narama Dam is a 1,000ML capacity earth dam located outside the proposed mining area to the west of Longwall 8. Figure 19a shows the dam wall and downstream structures. Figure 19b shows the dam wall looking from the east.

SCT understand that Narama Dam provides water for Mt Owen Mine and other Xstrata mining operations. Although the toe of the dam is outside the Ashton Coal Mining Lease, the DSC Notification Area for Narama Dam falls within the proposed mining area.

The toe of the dam is approximately 430m from the nearest goaf edge of Longwall 8. The overburden depth at this location ranges 190-200m, so there is not expected to be any impact from mining on this infrastructure.

A concrete structure downstream of the dam on the original watercourse and associated steel pipes are located approximately 550m from the nearest goaf edge of Longwall 8. There is not expected to be any impact from mining on this infrastructure.

Subsidence movement at Narama Dam are expected to be imperceptible for all practical purposes, but SCT recommend that the existing network of survey pegs around Narama Dam is monitored at the completion of Longwalls 7 and 8 in each of the seams to confirm the low levels of movement expected.

4.2.12 Ravensworth Void 5 Ash Dam

A second water storage dam known as the Ravensworth Void 5 Ash Dam is planned west of the north-western corner of the proposed mining area within the timeframe of mining LW6B-8 in the PG Seam. This dam will also be located outside the mining area, but the DSC Notification Area will overlap with the proposed mining area.

The details of this dam remain uncertain, but SCT understand that the toe of the dam will be approximately 260m from the goaf edge of Longwall 8 based on drawings provided by ACOL. The overburden depth to the PG Seam in this area is approximately 155m, so mining in the PG Seam is not expected to have any perceptible impact on the dam.

SCT understand that the dam will be designed to accommodate the potential for low level subsidence movements that may occur as a result of subsidence from Longwall 8. A program of subsidence monitoring based on an array of pegs located around the dam wall is recommended. SCT recommend that surveys be conducted at the completion of Longwalls 7 and 8 and more frequently if significant movements are observed or expected based on other subsidence monitoring.

a)

b)

Figure 19: Namara Dam.

4.2.13 Ravensworth Underground Mine

Ravensworth Underground Mine (RUM) owned by Xstrata is planning a multi-seam underground longwall operation that shares a lease boundary with the ACOL lease. Although, the two mines are required by law to be separated by a 40m wide barrier, 20m either side of the lease boundary, there is nevertheless some potential for interaction.

The proposed mining in the PG Seam is not expected to have a significant impact on any proposed main heading developments in RUM in the vicinity of the lease boundary. If longwall panels are proposed in RUM alongside the lease boundary with the ACP, some consideration should be given to the potential for cumulative stress effects.

The ACOL lease is up dip of the RUM so there is potential for mine water that may collect against the barrier in the ACP Underground Mine to flow down into RUM through the coal seam.

4.2.14 ACOL Owned Infrastructure

ACOL owned infrastructure located within the proposed mining area includes several farm buildings and houses, three farm dams, farm roads, fences, a fresh water polyethylene pipe from the Hunter River, and the mine pump out polyethylene pipe from the southern end of the panels. These pipes traverse the surface above Longwalls 5 and 6 in shallow trenches.

Figure 20 shows panoramas that include most of the surface infrastructure within the proposed mining area that is owned by ACOL.

Building structures are considered unlikely to remain fully serviceable and will need to be either relocated or monitored to determine if they can be repaired or require demolition. We understand that two domestic structures above Longwalls 4 and 6 have been previously subsided with only minor impacts.

Unsealed access roads are likely to be serviceable for most of the time during the period of active mining, but once subsidence is complete some regrading may be necessary as per previous panels. Sections of road affected by surface pooling or possible filling operations may need to be re-established on a new alignment.

Buried pipelines are likely to remain serviceable based on experience over previous longwall panels.

4.2.15 Disused and Dilapidated Infrastructure

There are two disused pump stations located along Bowmans Creek within the proposed mining area. Figure 21 shows a photograph of the northern one of these. All that remains is a small tin shed which is in an advanced state of disrepair. The power supply and pump out line have been disconnected and all the machinery has been removed.

Figure 20: Panoramas looking northwest and southwest across proposed mining area.

Figure 21: Disused pump shed adjacent to Bowmans Creek.

Figure 22 shows a photograph of a shed that Macquarie Generation has advised is not occupied and is in an advanced state of disrepair.

The two disused pump stations located along Bowmans Creek are likely to be demolished during works associated with the diversion of Bowmans Creek. The dilapidated shed located on the Macquarie Generation land beyond the northern end of Longwall 8 is currently in an advanced state of disrepair. Any mining subsidence movements are not likely to significantly change this status.

5. SUMMARY OF RECOMMENDATIONS FOR SUBSIDENCE MONITORING AND MANAGEMENT

A program of subsidence monitoring is recommended to confirm that the subsidence behaviour is developing as expected.

A cross-line with pegs spaced at 1/20th depth (6m to 9m) centres and measured in three dimensions is recommended across the middle of all the southern panels and a second line across the middle of all the northern panels. Peg to peg strain measurement is not required given the high strain levels anticipated. It is recommended to survey this line for each panel once the longwall has mined at least 150m past. Additional surveys as the longwall face approaches and passes would provide useful information on the development of vertical and horizontal subsidence movements over ACP longwall panels and provide measurement of time related subsidence movements.

Figure 22: Disused shed beyond the northern end of Longwall 8.

A longitudinal subsidence line at the start of each longwall panel is recommended to continue to provide early confirmation of the overburden strata bridging behaviour at the ACP.

Monitoring of individual items of infrastructure is recommended on an as required basis.

Specifically SCT recommend that:

- The sediment dams described in Section 4.2.9 are pumped down during the few weeks of mining under them as a precaution against cracks that may allow uncontrolled discharge and possible erosion of the dam wall.

- The existing network of survey pegs around Narama Dam described in Section 4.2.10 is monitored at the completion of Longwalls 7 and 8 in each of the seams to confirm the low levels of movement expected.

- Subsidence is monitored on an array of pegs located around the wall of the Void 5 Ash Dam described in Section 4.2.12 at the completion of Longwalls 7 and 8 and more frequently if significant movements are observed or expected based on other subsidence monitoring.

6. CONCLUSIONS

Maximum subsidence over the centre of each longwall panel is expected to be less than 1.6m. Maximum tilt of 70mm/m and horizontal strain up to 40mm/m are also expected.

The maximum total subsidence below the alignment of the proposed diversion of Bowmans Creek is likely to be sensitive to the overburden bridging characteristics across the narrow panels directly below the creek alignment particularly over the long term.

Notwithstanding the low levels of subsidence expected along the diversion of Bowmans Creek, nearby subsidence is expected to leave the creek diversion elevated above parts of the original channel. Water falling as rain on the original channel, water flowing as runoff from adjacent areas, and water that overtops Bowmans Creek during a flood event is expected to flow to the lowest point in the landform and pool there. The disturbance to the overburden strata caused by 1.6m of subsidence is expected to provide sufficient hydraulic connection between the surface and the mine for some vertical flow to occur, although not at a rate that presents a safety hazard for the underground operation. The potential for inflow is addressed by Aquaterra (2009) in their Bowmans Creek Diversion: Groundwater Impact Assessment Report.

SCT understand that filling of subsidence troughs and reshaping of the subsided landform is to be undertaken in some areas to obviate the potential for pooling of water on the surface. This approach is expected to be effective for reducing the potential for surface pooling and inflow into the mine.

The ground disturbance caused by the subsidence from mining the PG Seam and any associated filling operations is expected to significantly impact any surface infrastructure located directly over the panels. It is noted that the majority of the surface area affected by mining subsidence is owned by ACOL, but there is a section in the northwest of the lease owned by Macquarie Generation.

Subsidence impacts on power lines traversing the surface above the mining area are likely to be manageable. Building structures are considered unlikely to remain fully serviceable and will need to be either relocated or monitored to determine if they can be repaired or require demolition. We understand that two domestic structures above Longwalls 4 and 6 have been previously subsided with only minor impacts.

Unsealed access roads are likely to remain serviceable most of the time during the period they are actively mined. Once subsidence is complete, these roads can be re-established by regrading without undue difficulty. The sealed section of Brunkers Lane is likely to require significant remedial work to maintain it in a serviceable condition, particularly if, as SCT understand is planned, a proposal is put forward to re-align this section of the road, designate it a public road, and provide an alternative route to replace Lemington Road. Buried water pipes and Telstra Lines are expected to remain serviceable based on experience over previous longwall panels.

RUM owned by Xstrata is planning a multi-seam underground longwall operation that shares a lease boundary with the ACOL lease. There is unlikely to be any significant interaction between the two mines for mining operations in the PG Seam. ACP Underground Mine is located up dip of RUM, so there is some potential for mine water that may pond in the ACP Underground Mine to flow through the barrier into RUM either during operations at the ACP or subsequently.

The angle of draw is expected to be generally of the order of 26.5° for mining in the PG Seam. Infrastructure located outside the mining area is expected to be substantially protected from the impacts of mining subsidence. The protection barriers provided to the Narama Dam, the New England Highway and bridge over Bowmans Creek, buried fibre optic cable, and power transmission lines outside the mining area are expected to be sufficient to provide a high level of protection.

7. REFERENCES

Aquaterra 2008 "Aston Underground Mine - Bowmans Creek Alluvium Investigations" Report for ACOL dated October 2008

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Evans and Peck (2009) "Bowmans Creek Diversion Environmental Assessment" Newcastle.

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