REPORT TO:

ASHTON COAL MINE

Subsidence Assessment for Extension of Development Consent Area at Ashton Coal Mine

ASH3476

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SUBJECT Subsidence Assessment for Extension to Development Consent Area at Ashton Coal Mine

REPORT NO ASH3476

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SUMMARY

Ashton Coal Operations Pty Ltd (Ashton) is applying to extend the area of their existing Development Consent approximately 140m west to include an area that is proposed to be mined by Longwall 9 and Miniwall 9. Ashton commissioned SCT Operations Pty Ltd to undertake a subsidence assessment for this Development Consent Extension Application Area based on the mining geometry currently proposed in the Pikes Gully Seam. This report presents the results of our assessment of the subsidence impacts that would be expected for the surface area above Longwall 9 and Miniwall 9.

Our assessment indicates that the mining proposed in the Application Area is likely to cause surface subsidence impacts that are similar to the impacts that have already been observed and are expected to occur within the area for which there is an existing Development Consent. The surface area in the Application Area is only partly owned by Ashton and most subsidence impacts will occur in an area that is owned by Macquarie Generation.

The Application Area is located below and to the west of Bowmans Creek. The mine layout in the Pikes Gully Seam has been designed specifically to limit the subsidence on Bowmans Creek and the associated alluvium by narrowing the section of panel that is located directly below them.

Surface subsidence is expected to be limited to less than 200mm within the southern part of the Application Area and is considered unlikely to be perceptible for most practical purposes. Maximum strains are expected to remain less than 4mm/m and maximum tilts less than 11mm/m.

At the northern end of the Application Area, maximum subsidence above the centre of Longwall 9 is expected to range up to 1.2m, but is most likely to be in the range 0.5-1.0m. Maximum strains are expected to range up to 20mm/m and maximum tilts to 50mm/m. Mining subsidence is expected to be perceptible in this area as cracking and grade changes on hard surfaces such as the tarseal surface of Brunkers Lane.

The proposed mining is expected to cause low levels of subsidence along Bowmans Creek with maximum subsidence of less than 200mm at the two crossing points above Miniwall 9. There is a flow gauging station located directly over Longwall 9. The V-notch weir is likely to be lowered along with the creek and may sustain minor cracking as a result of possible differential subsidence.

Brunkers Lane may experience surface cracking and surface buckling during mining of Longwall 9, but is expected to remain serviceable with suitable management. The unsealed road in the Macquarie Generation land is expected to experience similar levels of subsidence movement but is likely to be more tolerant of any movement and more easily rehabilitated. We recommend that a management plan for Brunkers Lane and the Macquarie

Generation access road is developed in consultation with the relevant stakeholders and should also address any future road works that are planned in the area.

Mining of Longwall 9 is expected to cause subsidence of up to 1.2m below sedimentation ponds located on Macquarie Generation land. There is potential for surface cracking and tilting of these structures that may require some remediation. Such remediation is likely to be relatively easily accomplished once subsidence movements are complete. We recommend that the ponds are kept empty during the period of mining to reduce the potential for erosion of dispersive clay walls along subsidence cracks.

A buried, polyethylene water supply pipe from Narama Dam to Mt Owen Mine crosses the surface above Longwall 9 and then crosses back again. Mining subsidence is not expected to significantly impact on this pipeline.

A buried, copper wire, Telstra line crosses Longwall 9. It is understood that this line previously serviced the Bowmans Creek gauging station and provides future connection for subdivided blocks that form part of the southern extent of the Ravensworth lease. Mining subsidence movements are not expected to impact significantly on this line although some interruption may be possible depending on the condition of the line.

A 32kV power line supported on single concrete poles crosses the surface above Longwall 9. Mining subsidence may cause tilting and horizontal movement of individual poles, but such structures are typically able to withstand the 300mm of horizontal movement expected at conductor level if the conductors are placed in sheaves.

The proposed mining is not expected to have any impact on the New England Highway road reserve or any of the power lines or buried fibre optic cables located in the road reserve.

Although all of Miniwall 9 and the southern part of Longwall 9 is located within the Dam Safety Notification Area for Narama Dam, mining subsidence movements are not expected to have any perceptible impact on the dam wall or any associated infrastructure.

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1. INTRODUCTION

Ashton Coal Operations Pty Ltd (Ashton) is applying to extend the area of their existing Development Consent approximately 140m west to include an area that is proposed to be mined by Longwall 9 and Miniwall 9. Ashton commissioned SCT Operations Pty Ltd to undertake a subsidence assessment for this Development Consent Extension Application Area based on the mining geometry currently proposed in the Pikes Gully Seam. This report presents the results of our assessment of the subsidence impacts that would be expected for the surface area above Longwall 9 and Miniwall 9.

The report is structured to provide:

1. A description of the general area including the proposed mining geometry, the area for which development consent is sought, the land ownership, lease boundary, 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. Subsidence estimates based on the previous subsidence monitoring at the mine and for panels elsewhere of similar panel width to overburden depth ratios.

4. Specific assessments of the likely subsidence impacts on the surface features identified.

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

2. SITE DESCRIPTION

Figure 1 shows a plan of the area for which development consent is being sought, the area where there is existing Development Consent, the Ashton lease boundary, and the location of surface features superimposed onto a 1:25,000 topographic series map of the area (updated to reflect changes since the map was produced in 1982). Figure 2 shows similar detail superimposed onto a more recent aerial photograph.

2.1 Surface Features and Improvements

The area for which development consent is being sought comprises cattle grazing land on either side of Bowmans Creek and a rehabilitated out-of-pit spoil dump associated with the adjacent Ravensworth Open Cut. The area is located between the current mining area to the east and the original alignment of Brunkers Lane to the west, the New England Highway to the north and the Hunter River to the south. Approximately half of the surface area is owned by Ashton. The remainder at the northern end of Longwall 9 is owned by Macquarie Generation.

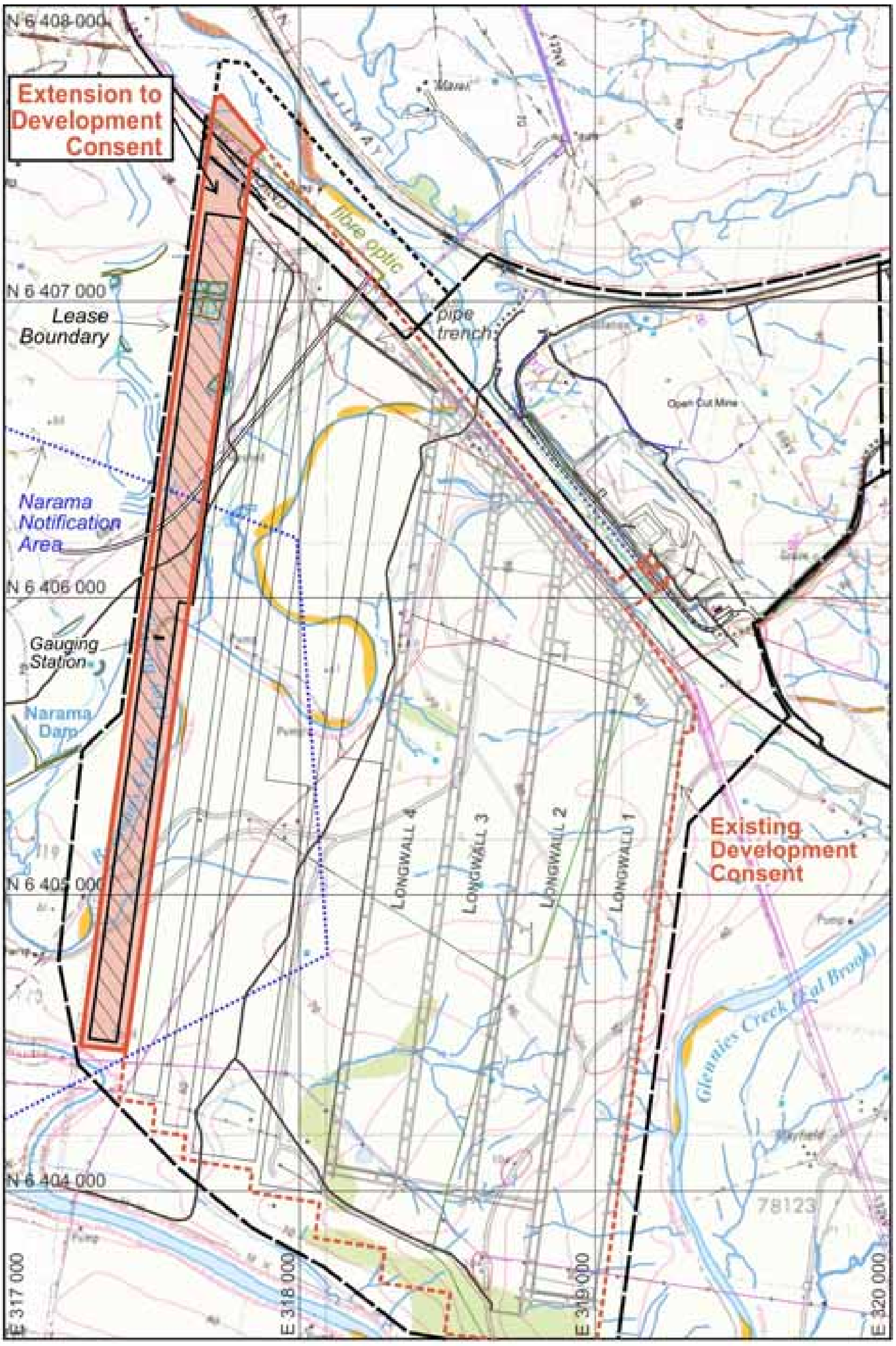

Figure 1 Site plan superimposed onto 1:25,000 topographic series map.

Figure 2 Longwall layout superimposed onto aerial photograph.

The major natural feature within the area is Bowmans Creek. The mine layout in the vicinity of Bowmans Creek has been specifically designed to limit the impacts of subsidence on the creek and its associated alluvium by reducing the width of individual panels in the areas directly below these features.

Other non-mining related infrastructure includes a local area electricity line, a buried Telstra copper wire lines, and a river gauging station on Bowmans Creek.

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

The Dam Safety Committee (DSC) Notification area for Narama Dam overlaps the Application Area, although the dam itself is located outside the Application Area, some 270m at its nearest point from Longwall 9. A second water storage dam is planned west of the north-western corner of Longwall 9 within the timeframe of mining Longwall 9. This dam will also be located outside the mining area, but the DSC Notification Area will overlap with the area of proposed mining.

Ashton owned infrastructure located within the proposed mining area includes a minor access road, fences, and four polyethylene pipelines that pass under the New England Highway below the bridge over Bowmans Creek.

2.2 Mining Geometry

Miniwall 9 is designed to limit hydraulic connection between the mine and Bowmans Creek and its associated alluvium. The panel is narrowed directly under the creek and alluvium but is mined full width to the north in areas remote from the creek. The width of Longwall 9 is limited by proximity to the lease boundary.

The chain pillars between Longwalls 8 and 9 are 35m wide measured centre to centre with cut-throughs at 100m centres. The maingate chain pillar of Longwall 9 is at 25m centres.

Table 1: Summary of Panel Widths for Proposed Longwalls

Longwall	Panel Width (m)	Overburden Depth (m)	W/D (Max)
MW9	93	160-190	0.5-0.6
LW9	141	140-180	0.8-1.0

Figure 3 shows a plan of the mine layout with surface infrastructure, overburden depth and thickness of the proposed mining section in the Pikes Gully Seam. The seam ranges in height from 2.3m in the central part of Miniwall 9 to 3.1m at the north-western corner of Longwall 9 due to thickening of inter-seam plys. The seam section to be extracted is nominally 2.3-2.4m. The seam dips to the south-west at a grade of up to about 1 in 10.

The overburden depth ranges from 140m at the northern end of Longwall 9 to 190m above Miniwall 9 principally as a result of seam dip.

Miniwall 9 is designed to limit subsidence below Bowmans Creek. The maximum panel width to overburden depth directly below Bowmans Creek and associated alluvium is designed to be 0.6. The panel width is designed so that the maximum subsidence is less than 10% of the seam thickness extracted.

3. DESCRIPTION OF NATURAL FEATURES AND SURFACE IMPROVEMENTS

The natural features and surface improvements in the proposed mining 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 Natural Features

The main natural features of interest in and adjacent to the proposed mining area are Bowmans Creek, its associated alluvial flats, and the Hunter River. The area in the north has been significantly modified by nearby open cut mining activity and subsequently rehabilitated.

3.1.1 Bowmans Creek

Bowmans Creek meanders from north to south crossing Miniwall 9 in two locations. 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 countryside.

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. There are two ponded sections of a previous stream channel that have become disconnected from the main channel and several tributaries draining off the surrounding countryside.

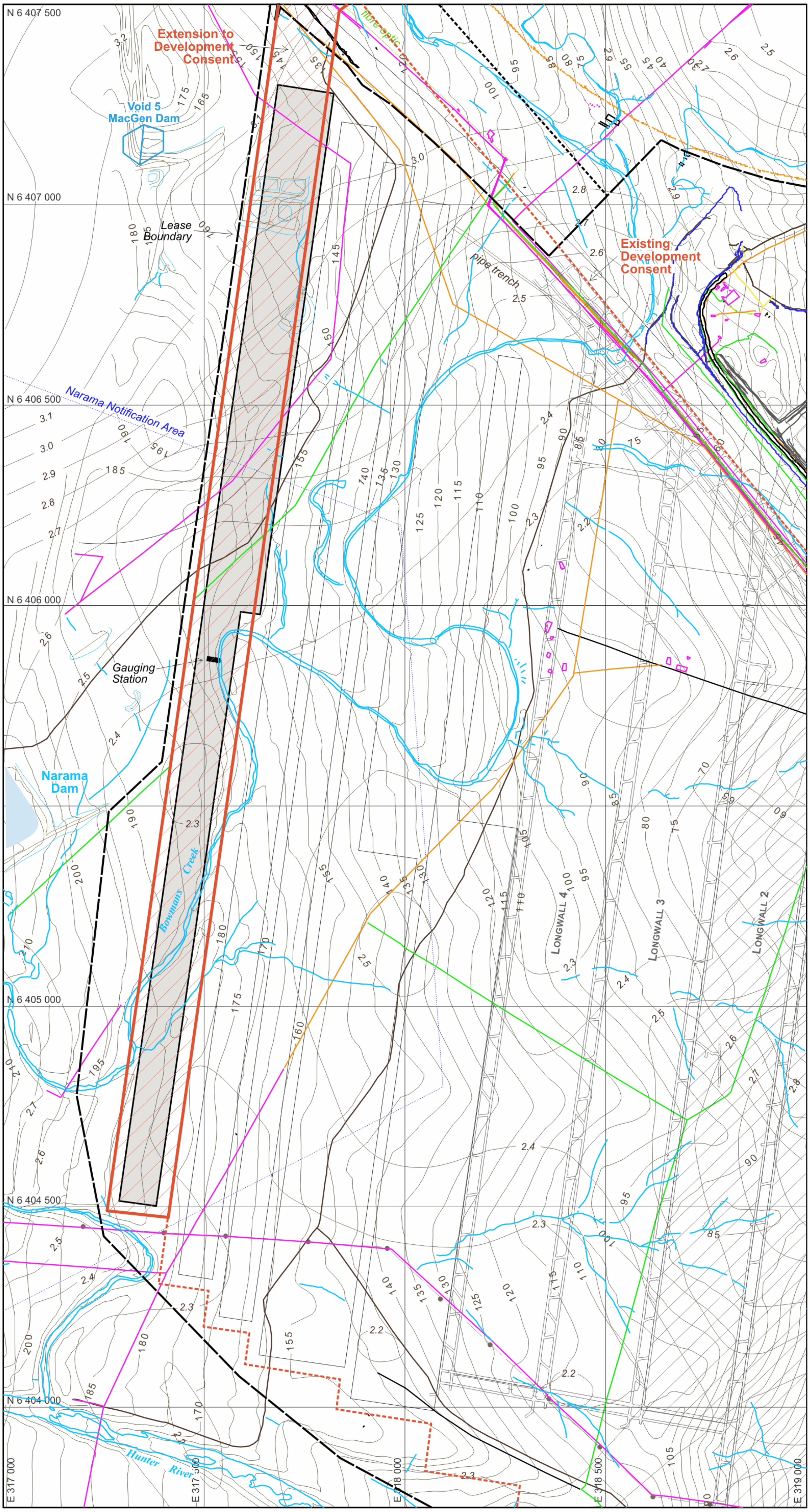

Figure 3 Plan showing overburden depth and seam thickness isopachs together with the location of surface infrastructure.

Figure 4 shows a selection of photographs of Bowmans Creek illustrating the nature of the stream channel. The photographs were taken shortly after a period of heavy rain when the flow in the river was still several hundred megalitres per day. In extended dry periods, the stream channel is reduced to a series of ponds with surface flow reduced to only a few megalitres per day.

3.1.2 Hunter River

The Hunter River is located to the south of, and well beyond the Application Area. The closest point of Miniwall 9 is approximately 520m from the Hunter River. The overburden depth at this point is approximately 185m, so the river is protected by a barrier approaching three times the overburden depth.

3.2 Surface Improvements

The various items of surface infrastructure located within the vicinity of Miniwall 9 and Longwall 9 are described in detail in this section.

3.2.1 New England Highway

The southern edge of the New England Highway road reserve is located some 100m from the northern end of Longwall 9. Mine roadways pass directly under the highway at a depth of greater than 130m.

3.2.2 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 up to the intersection with the realigned Brunkers Lane where it crosses under the highway and is located on the northern side of the highway from there on. The fibre optic cable is approximately 170m from the corner of Longwall 9 at its closest point.

3.2.3 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. Both cross the highway near the intersection with Brunkers Lane. The poles are supported with multiple stays in this area.

An 11kV line also supported on the poles of the southern 66kV line continues along the southern side of the highway and is approximately 80m from the corner of Longwall 9 at its closest point.

A second 132kV electricity line crosses the southern end of all the longwall panels but is approximately 60m south of the end of Miniwall 9 at its closest point.

Figure 4 Photographs of Bowmans Creek.

3.2.4 Local Area Electricity Lines

There is an electricity line located on the Macquarie Generation land that skirts the edge of the spoil dump and crosses Longwall 9 at two locations. The single pole structures on this line are shown in Figure 5. The line is stayed at changes in direction, but the stays are mainly over the earlier panels.

3.2.5 Buried Telstra Lines

A buried, copper wire, Telstra line crosses Longwall 9. It is understood that this line previously serviced the Bowmans Creek gauging station and provides future connection for subdivided blocks that form part of the southern extent of the Ravensworth lease.

3.2.6 Bowmans Creek Flow Gauging Station

A flow gauging station is located on Bowmans Creek above the centre of Miniwall 9. Figure 6 shows photographs of this installation. We understand that the station was previously used for the Hunter Salinity Trading Scheme.

3.2.7 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 Ashton's lease to its current location during open cut mining operations on the site now owned by Macquarie Generation. Figure 7 shows a photograph of the section of road located over Longwall 9.

Although the road is accessible to the public along the section above Longwall 9, we understand that the road is not actually a public road. Macquarie Generation maintains this roadway as a private roadway as far as the Void 4 access gate as an 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 4 dam. The road has recently been upgraded including the highway intersection.

Ravensworth Open Cut makes use of this road as a rear access to their site through a locked gate but we understand they have no legal right of way.

The overburden depth ranges from 160m to 170m where Brunkers Lane crosses Longwall 9.

3.2.8 Macquarie Generation Access Road

The alternative access to Macquarie Generation land continues from Brunkers Lane on a gravel road as shown in Figure 8. This road crosses the northern end of Longwall 9. The overburden depth in this area is approximately 145m.

Figure 5 Photographs of single pole structures on 66kV power lines.

Figure 6 Flow gauging station on Bowmans Creek.

Figure 7 Sealed section of Brunkers Lane.

Figure 8 Unsealed access road on Macquarie Generation lease.

3.2.9 Macquarie Generation Sedimentation Ponds

Figure 9 shows a panorama of the surface above the out-of-pit spoil pile. The surface has been substantially rehabilitated and revegetated. There are four clay lined sedimentation ponds and a fifth downstream dam that are still used. All five dams are located over Longwall 9 and the overburden depth is approximately 150m.

3.2.10 Polyethylene Water Pipes

A polyethylene pipeline from Narama Dam to Mt Owen Mine is buried for most of its length including the two sections that cross Longwall 9 but comes to the surface where it passes through a culvert under Brunkers Lane (Figure 10a).

Figure 9 Panorama of surface above out of pit spoil pile.


a)


b)

Figure 10 Polyethylene pipelines

A separate group of pipes associated with Ashton tailings transfer and water reclamation from Void 4 cross Longwall 9 in an open trench (Figure 10b). The diameters of these pipes range from 110mm to 315mm.

All the lines except the Narama Dam line carry mine water.

3.2.11 Narama Dam

Narama Dam is a 1,000Ml capacity earth dam located outside the Ashton Lease west of Miniwall 9. Figure 11a shows the dam wall and downstream structures. Figure 11b shows the dam wall looking from the nearest point above Miniwall 9.

We understand that Narama Dam provides water for Mt Owen Mine and other Xstrata mining operations. The toe of the dam is 270m from the nearest goaf edge of Miniwall 9. A concrete structure downstream of the dam on the original watercourse and associated steel pipes are located approximately 400m from the nearest goaf edge of Miniwall 9. The overburden depth at this location ranges 190-200m.

The Dam Safety Notification Zone for Narama Dam extends over the area for which development consent is being sought.

3.2.12 Proposed Water Storage Dam

A second water storage dam is planned to be constructed west of the north-western corner of Longwall 9 before Longwall 9 is mined. This dam will also be located outside the mining area, but the DSC Notification Area will extend over Longwall 9.

3.2.13 Ashton Infrastructure

There is no Ashton owned infrastructure located within the Application Area apart from the polyethylene pipelines referred to in Section 3.2.10 and fences and an access track.

4. SUBSIDENCE ESTIMATES

The subsidence predictions used for assessment purposes at Ashton are based on the empirical experience elsewhere in NSW at similar panel width and overburden depth, and previous subsidence monitoring over Longwalls 1, 2 and 3 as an indication of the likely range.

Subsidence monitoring at Ashton is most relevant to the subsidence behaviour over full width panels. However centreline subsidence lines located over the start of Longwalls 1, 2 and 3 provide an indication of the bridging characteristics of the overburden strata for narrow width longwall panels. As the longwall face moves away from the starting rib, the effective width of the void increases. The subsidence characteristics for a range of panel widths can thus be measured, albeit as dynamic subsidence profiles.

a) b)

Figure 11 Namara Dam.

The results of monitoring above the start line of Longwall 1 show bridging characteristics that are not consistent with bridging behaviour indicated at other sites including the starts of Longwall 2 and 3. While, the mechanics of the process that caused this greater bridging at the start of Longwall 1 are not fully understood, this result is considered to be an aberration and has been disregarded for estimating subsidence over the narrow panels within the Application Area.

Profiles of subsidence for Ashton are based on the subsidence profiles measured over Longwalls 1 and 2 with allowance for differences in overburden depth and panel geometries. Estimates of strains and tilts are based on guidelines developed in the Western Coalfield and the results of previous monitoring over Longwalls 1 and 2. The Western Coalfield guidelines have been chosen because the database of experience is for similar overburden depths and panel geometries as those at Ashton.

An upper limit approach to estimating subsidence and subsidence parameters has been used. There is considered to be no potential for vertical subsidence of greater than 1.6m and actual subsidence is expected to be in the range 70-80% of this maximum.

At the low levels of subsidence predicted over Miniwall 9, there is some potential for natural variations in overburden behaviour to cause predicted subsidence to be exceeded because of the low levels involved, but the approach adopted is nevertheless considered to be conservative.

In the wider section of Longwall 9, the panel width to depth ratio ranges 0.8-1.0, so the panel is of sub-critical width, but too wide for effective bridging. The maximum subsidence in this situation is likely to be sensitive to small changes in overburden behaviour. A conservative approach has been adopted for estimating maximum subsidence.

For practical purposes, the subsidence profiles developed over each goaf edge are expected to be essentially similar. The dynamic profile developed over the longwall panel as it retreats may be flatter than the final goaf edge profiles developed over the start, finish and sides of each panel, but any differences are not expected to alter the impacts significantly and will tend to be temporary in nature.

Permanent strains and tilts are expected to develop over each of the longwall goaf edges. Transient tilts and strains up to near maximum values are expected above the retreating longwall face.

4.1 Miniwall 9

Miniwall 9 is located in the southern part of the Application Area and is remote from previous panels so subsidence will be almost entirely a result of sag subsidence. For panel width to depth ratios of 0.6, maximum sag subsidence is expected to be less than 10% of the seam thickness extracted and may be as low as 2% depending on the overburden strata behaviour. For 2.4m extraction height, the maximum sag subsidence is expected to be in the range 0.05-0.24m. Given the remoteness of Miniwall 9 from previous panels, it is considered likely that maximum subsidence will be less than 200mm and barely perceptible for most practical purposes.

Table 3 summarises the maximum subsidence parameters that are expected over the various narrow panels based on the sag subsidence of 240mm. Values of K_1 = 2000, K_2 = 2600 and K_3 = 7000 have been used because these better fit the actual measured results over Longwall 1 and are more conservative to use than the generic Western Coalfield data based on maximum subsidence of 65% of seam thickness extracted.

Table 3: Summary of Predicted Maximum Strains & Tilts for Miniwall 9

Site	Maximum Subsidence (mm)	Maximum Tensile Strain (mm/m)	Maximum Compressive Strain (mm/m)	Maximum Tilt (mm/m)
Miniwall 9	200	3.2	4.2	11

Goaf edge subsidence over Longwall 9 is expected to be less than 40-50mm and the angle of draw to 20mm is likely to be less than 10°.

The radius of ground curvature is expected to be less than 2.5km based on experience in the Western Coalfield.

Horizontal subsidence movements of up to 200mm are considered possible, but they are likely to be generally less than 50mm.

Surface cracking is unlikely to be perceptible given the alluvial nature of most of the surface area above Miniwall 9.

4.2 Longwall 9

Longwall 9 is constrained to be less than full width by the lease boundary. The width to depth ratio of the panel is approximately 1.0 which makes the prediction of maximum subsidence difficult because small differences in overburden behaviour can result in large differences in maximum subsidence.

Full subsidence of 50-55% of seam thickness develops when the panel width to depth ratio reaches 1.2. Monitoring at the start of Longwall 2 showed maximum dynamic subsidence of approximately 20% of seam thickness when the width to depth ratio was 1.0, but measurements from other sites in the Hunter Valley have shown maximum subsidence up to 40% of seam thickness for width to depth ratios of 1.0. For impact assessment purposes, the maximum subsidence over Longwall 9 is estimated using 50% of seam thickness recognising that the actual maximum ground subsidence is likely to be in the range 0.5-1.0m based on previous monitoring. The surface subsidence may be greater in the area of the spoil pile. The strain and tilt values are calculated using K values of 1500, 2000 and 5000.

Table 4: Predicted Maximum Strains & Tilts for Longwall 9

Site	Maximum Subsidence (mm)	Maximum Tensile Strain (mm/m)	Maximum Compressive Strain (mm/m)	Maximum Tilt (mm/m)
Longwall 9	1200	15	20	50

Much of the surface above Longwall 9 is part of an out-of-pit spoil dump. Whittaker and Reddish (1989) provide a method for estimating the additional subsidence that can be expected when a spoil dump is subsided. This method is summarised in Figure 12. Assuming the average height of the spoil pile is 15m, and the average overburden depth is 150m, the Whittaker and Reddish approach indicates that most likely subsidence of 0.8m at the ground surface has the potential to cause an additional 0.2m of surface subsidence at the top of the spoil pile. This extra subsidence is within the upper bound estimate of 1.2m.

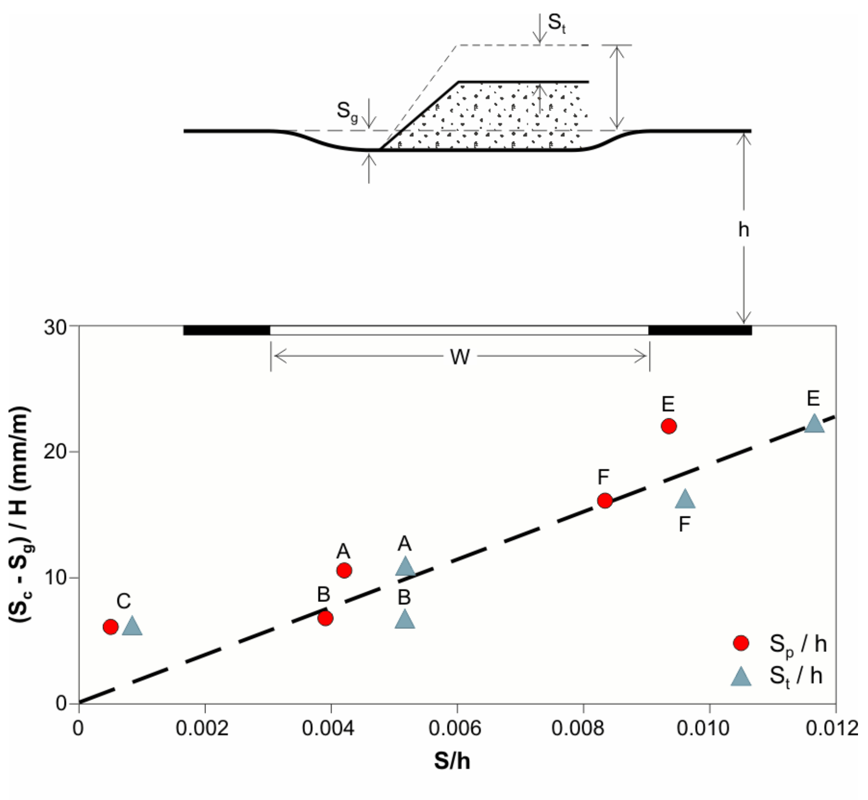

Figure 12 Summary of subsidence estimate technique
(after Whittaker and Reddish.)

On natural surfaces, goaf edge subsidence is expected to be less than 100mm and the angle of draw to 20mm less than 17°, however these may increase in spoil pile areas depending on the thickness of spoil and how well it has consolidated since placement.

Systematic horizontal movements of 0.3-0.5m are expected, with the ground initially moving in a direction toward the approaching longwall panel and then, once the longwall face is approximately 0.2-0.3 times depth (30-45m) past, the direction of movement reverses and is toward the retreating longwall face, typically leaving a permanent offset of up to 0.2m in the direction of mining.

In the spoil dump area, movement in a downslope direction of up to about 0.5m are considered possible. These movements would be superimposed onto any systematic horizontal movement.

Surface cracking of up to about 200mm is expected in the vicinity of the longwall goaf edges. Permanent tension cracks are expected to develop over all the goaf edges in a direction parallel to the goaf edge. Surface cracking is expected to occur from just outside the goaf edge and increase in magnitude with distance over the goaf reaching a peak at the largest crack located approximately 25-40m from the goaf edge. Cracks are also expected to develop in an arcuate shape around the corners of the longwall panel to become parallel with the longwall face in the centre of each panel.

4.3 Profiles and Contours of Final Subsidence

Figure 13 shows a summary of the range of goaf edge subsidence profiles that have been measured previously at Ashton and over longwall panels at similar overburden depth in the Western Coalfield. These profiles are used to predict the subsidence profiles at Ashton. The ground surface at Ashton is expected to drape over the solid goaf edges with subsidence profiles within the limits shown in Figure 13. The measured results show the range of natural variability that can be expected.

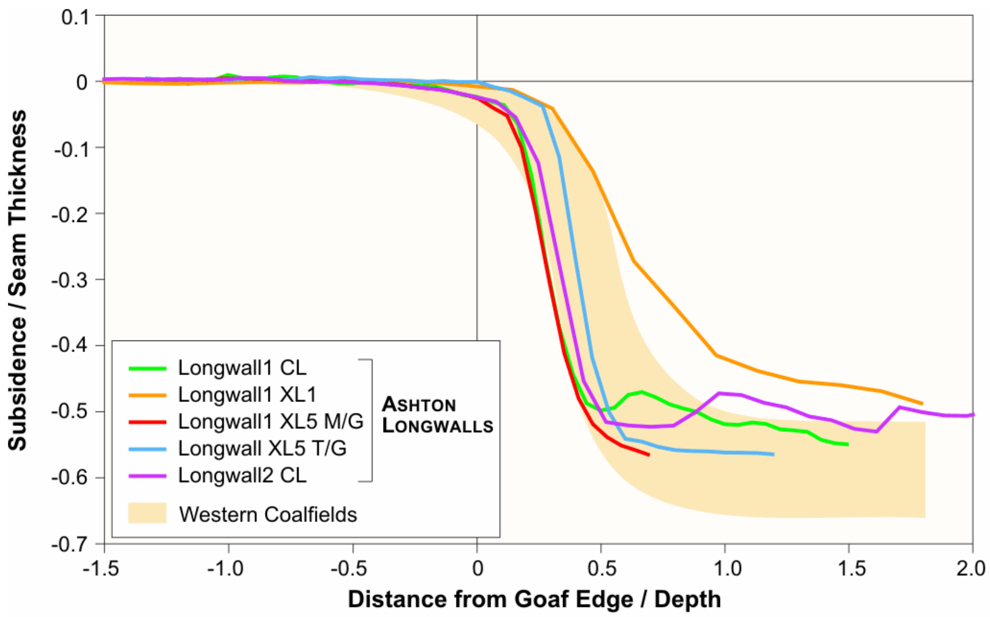

Figure 13 Summary of the goaf edge subsidence profiles from western coalfields and Longwalls 1-3 at Ashton.

Figure 14 shows a cross-section of the final subsidence profile that is expected to develop within the Application Area at the southern end of the panel above Miniwall 9 and at the northern end above Longwall 9.

Figure 15 shows contours of the final subsidence that is expected at the completion of mining.

5. ASSESSMENT OF SUBSIDENCE IMPACTS

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

5.1 Natural Features

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

5.1.1 Bowmans Creek

The mine layout has been designed specifically to control the hydraulic interaction between the surface water in Bowmans Creek and adjacent alluvium and the underground mine. Numerical modelling (reported elsewhere) has indicated that by narrowing the individual panels to approximately 0.6 times overburden depth, the hydraulic interaction between the mine and Bowmans Creek can be controlled to acceptable levels.

The proposed mine layout is expected to cause vertical subsidence along Bowmans Creek of up to approximately 200mm. The sections of the creek channel subject to the peak subsidence are likely to be only 5-10m long with subsidence decreasing back to less than 50mm over the panel edges.

While there is some potential for localised ponding within the creek channel, the level of ponding is considered unlikely to be outside the variability that is currently evident within the channel or that occurs naturally during flood scouring.

Strains of less than 3-4mm/m are unlikely to be evident in the floor of the creek channel.

Local tilting of the surface may cause the stream channel to move sideways within the creek bed, but for the low tilt levels expected and the short distances over which tilting is occurring, the changes are expected to be within the natural variation that is evident naturally in the creek.

5.1.2 Hunter River

The Hunter River is located more than 500m outside the Application Area, consistent with the 200m offset from the Hunter Alluvium specified in the existing Development Consent. There is considered to be no potential for subsidence to impact on the Hunter River itself.

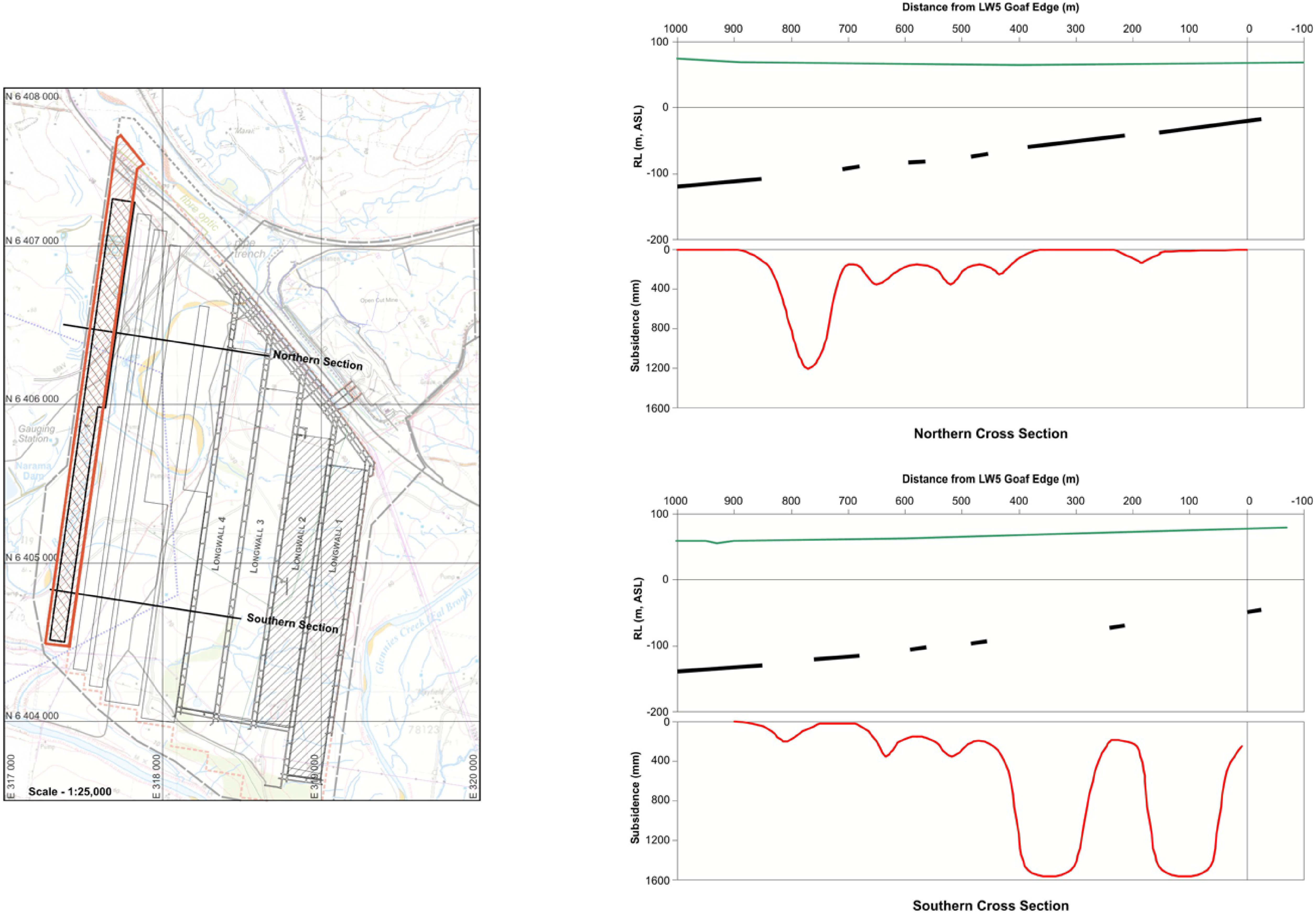

Figure 14 Cross section of final subsidence profiles expected on two cross sections.

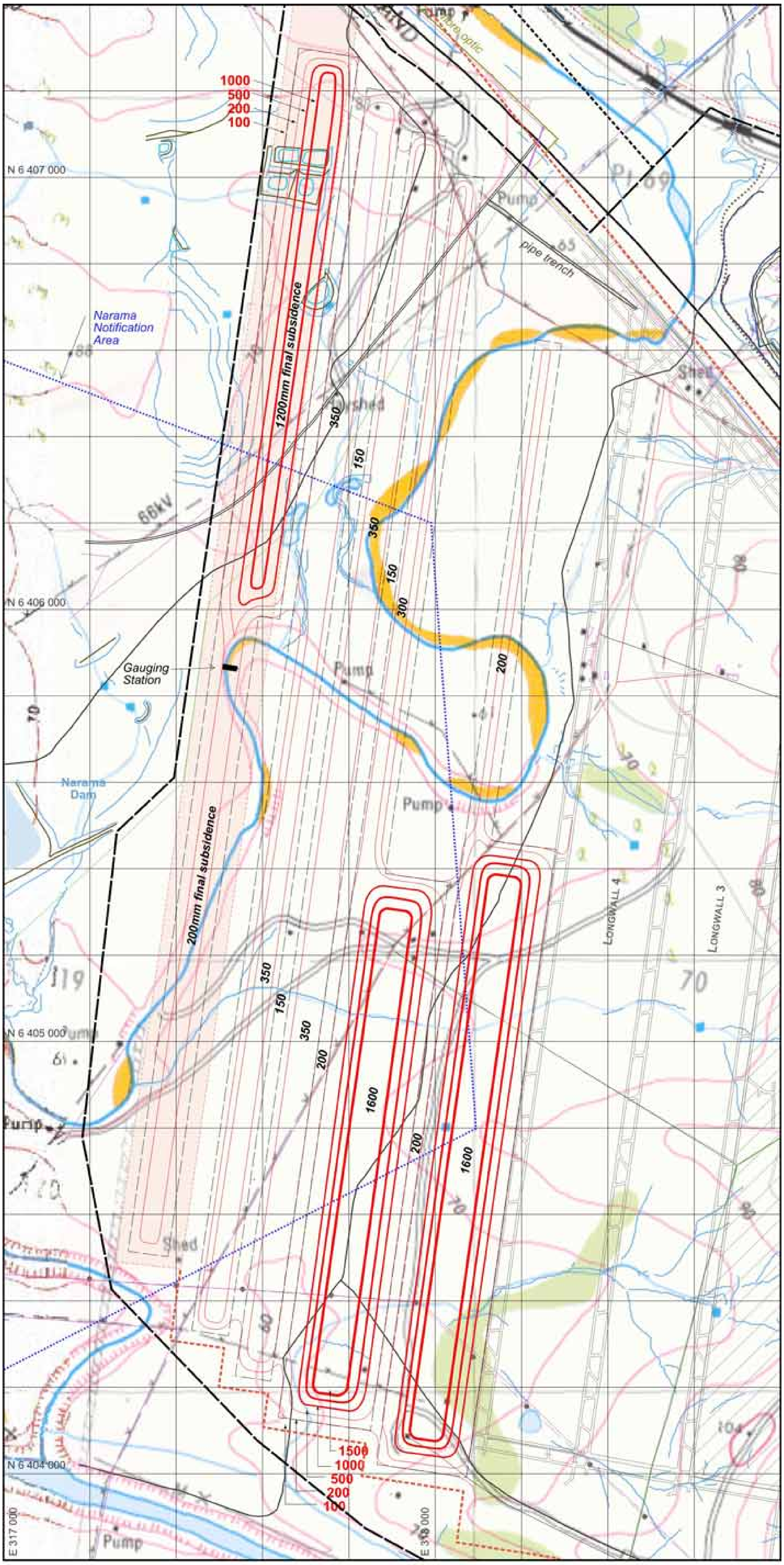

Figure 15 Contours of final subsidence expected at the completion of mining.

5.1.3 General Surface Cracking

The surface cracking that is expected to develop over the goaf edges of Longwall 9 as a result of mining subsidence is likely to require minor remediation to prevent ingress of surface water, injury to livestock, or entrapment of small animals. This process has been successfully undertaken over Longwalls 1 and 2 and there does not appear to be any impediment to similar treatment within the Application Area, assuming that access to Macquarie Generation land can be gained for the purpose.

5.2 Surface Improvements

The impacts of mining subsidence on the various items of surface infrastructure located within the Application Area are assessed in this section.

5.2.1 New England Highway

The southern edge of the road reserve is located some 100m from the northern end of Longwall 9. Mine roadways pass directly under the highway at a depth of greater than 130m.

Vertical subsidence is expected to be less than 20mm at a distance of less than 20m from the goaf corner and horizontal subsidence movements are expected to be imperceptible beyond about 40m from the goaf corner. No impacts on the New England Highway road reserve are expected.

5.2.2 Buried Fibre Optic Cable

The Powertel fibre optic cable is approximately 170m from the corner of Longwall 9 at its closest point in an area where the overburden depth is approximately 140m, so the cable is protected by an angle of draw of greater than 45°. It is not expected to be impacted by mining subsidence from Longwall 9.

5.2.3 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. Both lines cross the highway near the intersection with Brunkers Lane. The poles are supported with multiple stays in this area. This geometry and the low level of subsidence are expected to be sufficient to provide a high level of protection to these lines.

5.2.4 Local Area Electricity Line

A local area electricity line crosses Longwall 9 twice within the Macquarie Generation land. This line is supported on single pole structures. Single pole structures are typically capable of accommodating subsidence movements.

Tilts of up to 50mm/m are considered possible so horizontal movements at conductor level of up to approximately 300mm are expected at an elevation of 6m. Suspension of individual conductors in sheaves may be necessary to protect the cross-arms from becoming overloaded.

5.2.5 Buried Telstra Line

Typically buried copper lines in good repair are likely to remain serviceable where ground strains do not exceed 20mm/m. Maximum ground strains over Longwalls 1 and 2 reached 40mm/m in some areas where the Telstra line is buried but the line remained serviceable throughout. Predicted maximum ground strains above Longwall 9 are 20mm/m so the buried Telstra line is expected to remain serviceable. We understand that the line is currently unused so some checking and possible remediation may be necessary if it is damaged by mining subsidence.

5.2.6 Bowmans Creek Flow Gauging Station

A flow gauging station is located on Bowmans Creek above the centre of Miniwall 9. Subsidence at the location of the weir is expected to reach a maximum of 200mm at the western end and 140mm at the eastern end. The gauging house is expected to subside approximately 200mm.

The section of the channel where the weir is located will also subside by a similar amount, so there is not expected to be more than a few centimetres of relative movement once mining has finished, but there will be a transient effect when mining is proceeding directly under the site.

Tilting of the weir and possible structural cracking of the concrete may affect the accuracy of the flow gauging station, so it is possible that some remedial work may be required to bring the weir back into operation.

The detail of the cables connecting the weir to the gauging house have not been investigated, but at the low levels of strain expected, damage to the cabling is not anticipated. The radio communication link used for regional data transfer from this station is not expected to be impacted by mining subsidence.

5.2.7 Brunkers Lane (Private Road)

The tarsealed section of Brunkers Lane is expected to subside up to 1.2m above Longwall 9 (between the gate to Macquarie Generation and the gate to Ravensworth) with horizontal strains of up to 20mm/m and maximum tilts of 50mm/m across the road and 25mm/m in a direction along the road).

These levels of vertical subsidence, strains and tilts are expected to cause perceptible cracking and buckling of the pavement surface starting soon after Longwall 9 mines under the road continuing until it is approximately 100m past. Gradual subsidence of 100-200mm may continue for some months before it stabilises at a final level expected to be less than 1.2m and most likely in the range 0.5-1.0m.

We understand that Ravensworth is planning to upgrade the road and return it to public ownership within the next decade. We recommend that a management plan for the road is developed in consultation with the relevant stakeholders so that access can be maintained to Macquarie Generation land and to Ravensworth Open Cut when required and that road construction can be coordinated to reduce the potential for later subsidence impacts. Some filling, regrading and resealing of the road is likely to be required once subsidence is complete, particularly along the section south of the Macquarie Generation gate.

5.2.8 Macquarie Generation Access Road

The alternative access to Macquarie Generation land continues from Brunkers Lane as a gravel road. This road crosses the northern end of Longwall 9. The overburden depth in this area is approximately 145m.

Subsidence movements are expected to cause perceptible cracking and grade changes on this road, but remediation is likely to be much simpler than along the tarsealed section of Brunkers Lane. Regrading and filling of cracks as required is expected to be an effective control measure.

5.2.9 Macquarie Generation Sedimentation Ponds

The four clay lined sedimentation ponds and a fifth downstream dam located over Longwall 9 at an overburden depth of approximately 150m are expected to experience the full range of subsidence movements.

Mining subsidence movements are expected to cause temporary and permanent tensile cracking in the ponds with up to about 1.0m of differential settlement across the two western ponds and the downstream dam. The two eastern ponds are likely to experience mainly transitory subsidence.

Some remedial work is likely to be required to restore the overflow levels to their pre-mining condition. Some resealing of cracks may also be necessary to ensure the integrity of the dams. We would 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.

5.2.10 Polyethylene Water Pipes

The polyethylene pipes located in open trenches or laying on the surface are not expected to be impacted by mining subsidence.

The buried polyethylene pipe that crosses over Longwall 9 and back is expected to experience the full range of subsidence movements including tensile strains of up to 20mm/m and compressive strains of up to 27mm/m. These 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.

A failsafe strategy 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. However this measure is considered likely to be unnecessary.

A separate group of pipes associated with Ashton tailings transfer and water reclamation from Void 4 cross Longwall 9. These pipes are located in an open trench and are unlikely to be significantly impacted by mining subsidence.

5.2.11 Narama Dam

Narama Dam is an earth dam located outside the Application Area west of Miniwall 9. The toe of the dam is 270m from the nearest goaf edge of Miniwall 9 and the maximum subsidence anticipated above Miniwall 9 is 200mm. Subsidence movement at Narama Dam are expected to be imperceptible. We recommend that the existing network of survey pegs around Narama Dam is monitored at the completion of each of the approaching miniwall panels including Miniwall 9 to confirm the low levels of movement expected.

5.2.12 Proposed Water Storage Dam

A second water storage dam is planned west of the north-western corner of the Application Area within the timeframe of mining Longwalls 5-9. This dam will also be located outside the mining area, but the DSC Notification Area will overlap with the Application Area. The nearest toe of the proposed dam wall is approximately 260m from the nearest goaf edge of Longwall 9. The average overburden depth is approximately 160m, so the dam is protected by an angle of draw of 26.5° plus 180m. No subsidence impacts would be expected with a barrier of this size.

5.2.13 Ashton Infrastructure

Ashton owned infrastructure located within the Application Area is limited comprising some fences, a farm access track and tailings pipelines referred to in Section 5.2.10.

Some temporary electric fencing may be necessary to control livestock during the period that fences are impacted by mining. The fences may need to retensioned at the completion of mining. The access track is unlikely to be significantly impacted.

6. RECOMMENDATIONS FOR SUBSIDENCE MONITORING

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

A cross-line with pegs spaced at 5m centres and measured in three dimensions is recommended across the middle of Miniwall 9 as an extension of the cross-line across all the southern panels. A second line across the middle of Longwall 9 is also recommended as an extension of the cross-line across all the northern panels.

Three dimensional monitoring of pegs is considered appropriate for monitoring over the longwall panels where the strain levels are expected to be generally higher. Peg to peg strain measurement would be appropriate above the miniwalls where low magnitude strains are anticipated. It is recommended to survey the lines for each panel once the longwall has mined at least 150m past.

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

7. CONCLUSIONS

Approximately half the surface area above Longwall 9 is owned by Ashton, the remainder is owned by Macquarie Generation. This latter area comprises Brunkers Lane and a rehabilitated out-of-pit spoil pile associated with the adjacent Ravensworth Open Cut. Most of the subsidence impacts expected within the Application Area will occur on the land owned by Macquarie Generation.

Surface subsidence is expected to be limited to less than 200mm within the southern part of the Application Area and is unlikely to be perceptible for most practical purposes. Maximum strains are expected to remain less than 4mm/m and maximum tilts less than 11mm/m.

At the northern end of the Application Area, maximum subsidence above the centre of Longwall 9 is expected to range up to 1.2m, but is most likely to be in the range 0.5-1.0m. Maximum strains are expected to range up to 20mm/m and maximum tilts to 50mm/m. Mining subsidence is expected to be perceptible in this area as cracking and grade changes on hard surfaces such as the tarseal surface of Brunkers Lane.

The proposed mining is expected to cause low levels of subsidence along Bowmans Creek with maximum subsidence of less than 200mm at the two crossing points above Miniwall 9. There is a flow gauging station located directly over Longwall 9. The V-notch weir is likely to be lowered along with the creek and may sustain minor cracking as a result of possible differential subsidence.

Brunkers Lane may experience surface cracking and surface buckling during mining of Longwall 9, but is expected to remain serviceable with suitable management. The unsealed road in the Macquarie Generation land is expected to experience similar levels of subsidence movement but is likely to be more tolerant of any movement and more easily rehabilitated. We recommend that a management plan for Brunkers Lane and the Macquarie Generation access road is developed in consultation with the relevant stakeholders and should also address any future road works that are planned in the area.

Mining of Longwall 9 is expected to cause subsidence of up to 1.2m below sedimentation ponds located on Macquarie Generation land. There is potential for surface cracking and tilting of these structures that may require some remediation. Such remediation is likely to be relatively easily accomplished once subsidence movements are complete. We recommend that the ponds are kept empty during the period of mining to reduce the potential for erosion of dispersive clay walls along subsidence cracks.

A buried, polyethylene water supply pipe from Narama Dam to Mt Owen Mine crosses the surface above Longwall 9 and then crosses back again. Mining subsidence is not expected to significantly impact on this pipeline.

A buried, copper wire, Telstra line crosses Longwall 9. It is understood that this line previously serviced the Bowmans Creek gauging station and provides future connection for subdivided blocks that form part of the southern extent of the Ravensworth lease. Mining subsidence movements are not expected to impact significantly on this line although some interruption may be possible depending on the condition of the line.

A 32kV power line supported on single concrete poles crosses the surface above Longwall 9. Mining subsidence may cause tilting and horizontal movement of individual poles, but such structures are typically able to withstand the 300mm of horizontal movement expected at conductor level if the conductors are placed in sheaves.

The proposed mining is not expected to have any impact on the New England Highway road reserve or any of the power lines or buried fibre optic cables located in the road reserve.

Although all of Miniwall 9 and the southern part of Longwall 9 is located within the Dam Safety Notification Area for Narama Dam, mining subsidence movements are not expected to have any perceptible impact on the dam wall or any associated infrastructure.