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CENTENNIAL MANNERING PTY LTD

SECTION 75W ASSESSMENT

GREAT NORTHERN AND FASSIFERN SEAMS

Mannering 65.docx AUGUST 2011

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Wednesday, 31 August 2011

REF: Mannering 65.docx

Mr A Klein
Manager of Mining Engineering
Centennial Mannering Pty Ltd
PO Box 1000
Toronto NSW

Dear Alan,

Re: Section 75 – Immediate Great Northern and Fassifern options

We are pleased to submit the following report on the subsidence deformations that are predicted to develop above the first workings in the Fassifern and Great Northern Seam

Please contact the undersigned if you require further information.

Yours sincerely,

Ross Seedsman

EXECUTIVE SUMMARY

This report addresses the subsidence deformations that are predicted to develop above the first working of the Fassifern and Great Northern Seams in areas you have identified for a 75W submission.

The Fassifern mine layout continues with the same pillar and roadway dimensions used in the last 5 years at Mannering. The same subsidence outcome are predicted – a maximum vertical subsidence of 12mm.

The Great Northern Seam has been mined at Mannering in the past, albeit with different mining systems – pillar extraction and longwall. The roof of the Great Northern Seam is a conglomerate and the floor consists of either conglomerates/sandstones or tuff. The tuff can have a low strength layer at the interface with the Great Northern coal. Where this thin layer is less than 0.5m, the predicted subsidence associated with the proposed first workings is less than 8mm.

The combined subsidence of the proposed mining in both seams where the workings will overlap is predicted to be less than 20mm.

Coring of the floor of the Great Northern Seam at nominal 500m centres during mining is recommended to confirm the model for the thickness and strength of the thin low strength layer.

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1 INTRODUCTION

In addition to continuing mining in the Fassifern Seam (Figure 1), it is understood that you are planning to recommence mining in the Great Northern Seam (Figure 2) and will be seeking a Section 75 variation to the current mine plan on the basis that the combined subsidence of first workings in the Great Northern and Fassifern Seams will not exceed 20mm. For both seams the pillars are to be formed on 30m centres in panels of 5 headings with inter- panel pillars of 54.5m. Figure 3 combines the proposed working for both seams and Figures 4 and 5 focus on the overlapping workings in the proposed access roadways.

This report is provided to complement a more detailed submission on the environmental impacts being prepared by Centennial Coal. The report provides a justification for the mine plan from a subsidence deformation perspective and should be considered as a necessary but not sufficient treatment of all the requirements for a Section 75 variation.

Figure 1 Proposed Fassifern Seam with respect to earlier mining in the same seam (green – proposed, grey – existing)

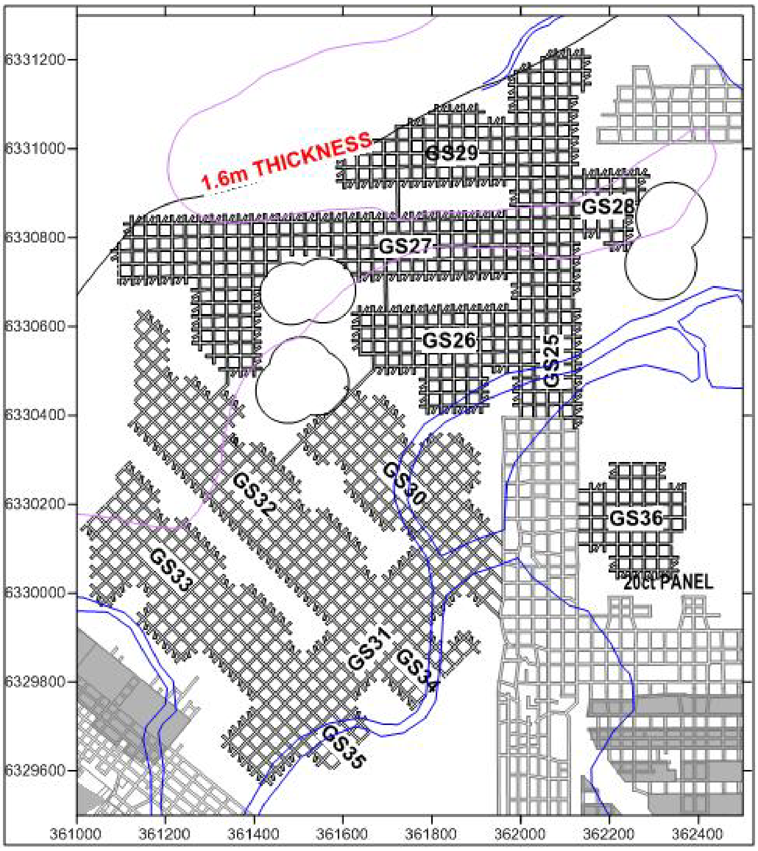


Figure 2 Majority of the proposed Great Northern layout with respect to earlier mining in the same seam (black – proposed, grey – existing)

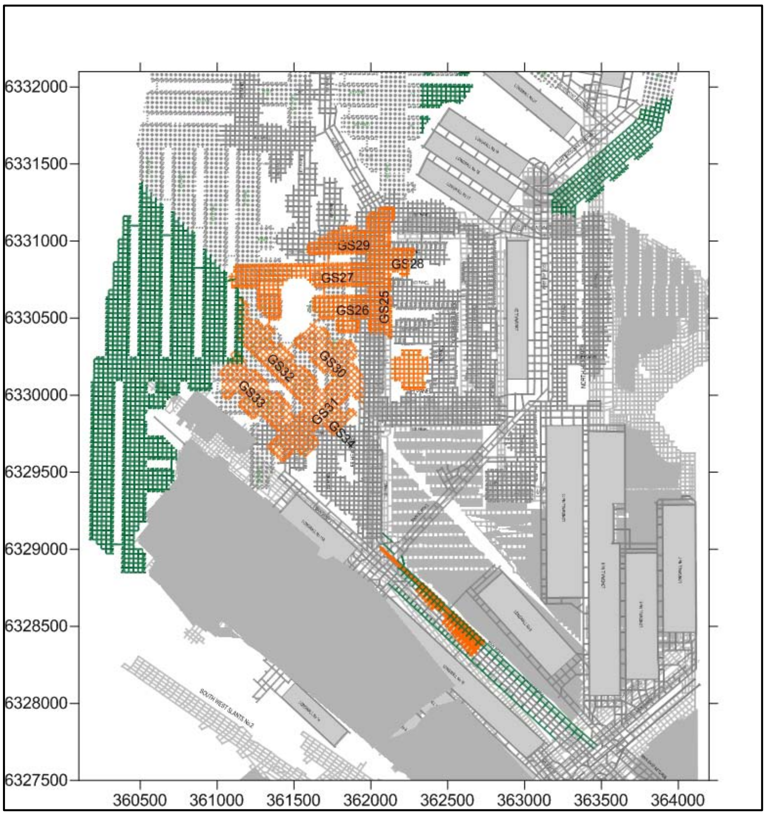
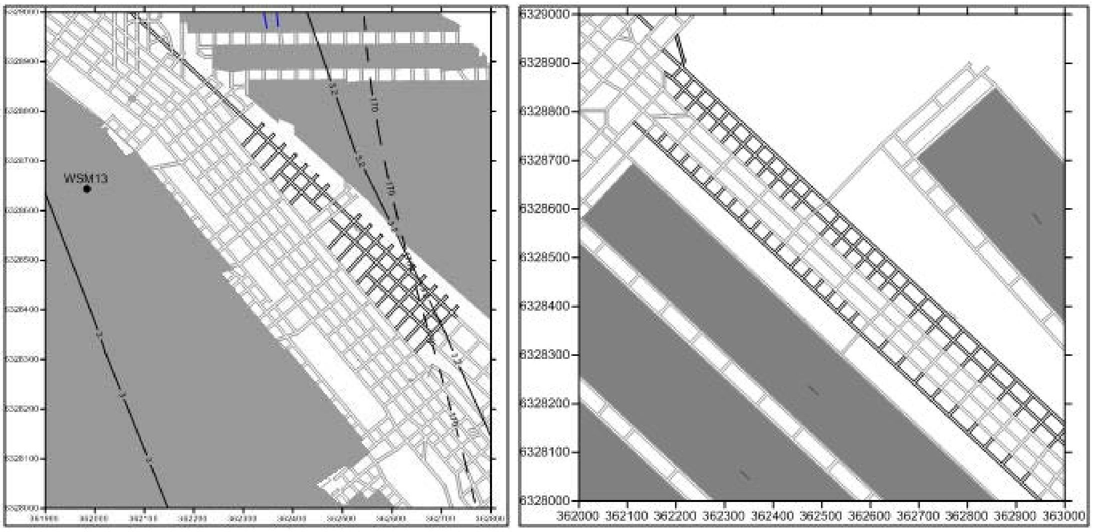


Figure 3 Combination of the 2 proposed seams (Fassifern – green, Great Northern –orange)



(a) Great Northern (b) Fassifern

Figure 4 Detail of main headings to access the area (proposed – black, grey – existing)

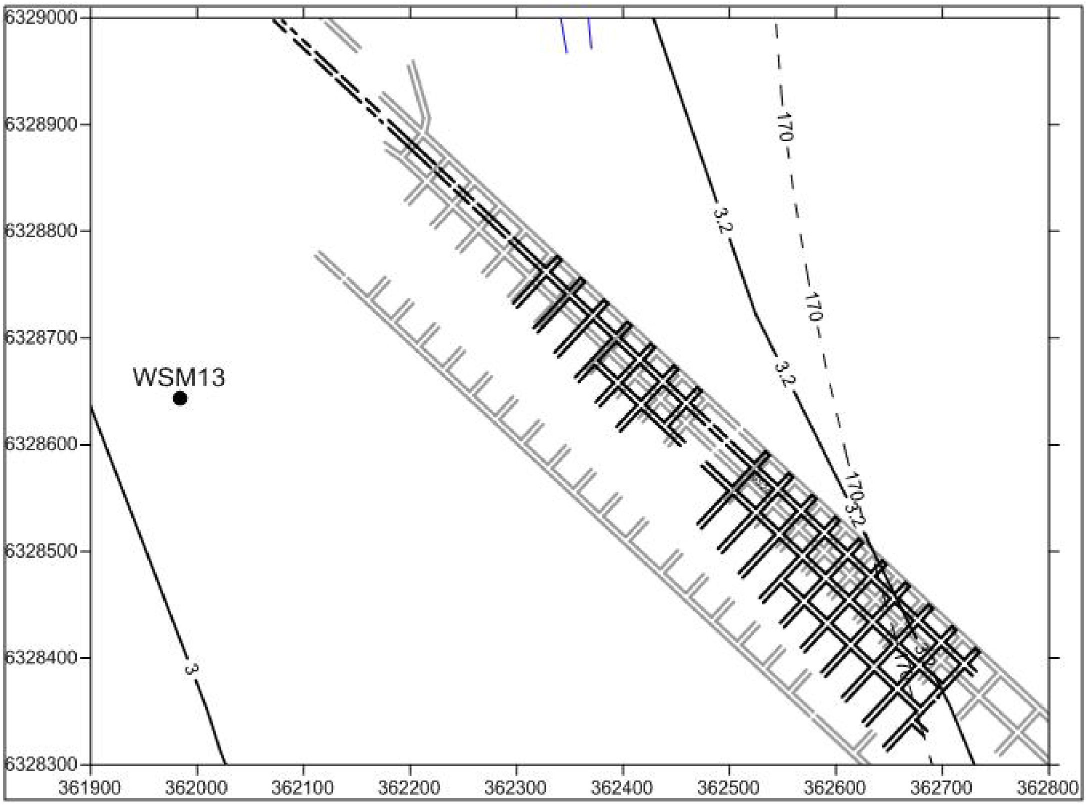


Figure 5 Overlapping of proposed driveages in the access headings (Depth of cover and seam thickness shown for Great Northern Seam)

The original SMP guidelines defined subsidence as vertical movements in excess of 20mm. If adopted as the maximum vertical movement in a subsidence bowl, this 20mm threshold does not represent the onset of any adverse consequence. It is important to note that the subsidence movements under consideration in this report approach the limits of precision of the survey methods (circa 5mm) and are well within the usual shrink/swell range for the district. Delaney et al (2005)[1] state:

"The observed reactive soil ground surface movements in open ground areas across the region range between 7 mm and 58 mm with an average of 29 mm. Using the approach suggested by AS2870, on average these movements can be reasonably reliably predicted, although the average error between predictions and observations is up to 11 mm and in individual cases the errors may be as large as 30 mm."

The implication of these anticipated soil movements is it will be very difficult if not impossible to resolve the predicted mining induced movements from those naturally occurring ones that occur on a seasonal basis.

2 SEAM GEOMETRY

The depth of cover to the Great Northern Seam is between 140m and 155m (Figure 6) and the typical seam thickness is 2.5m. The Fassifern Seam is approximately 30m below the Great Northern Seam (Figure 7) and in some locations has already been mined in the area of interest. Only the proposed GS36 and GS30 panels lie fully above unmined Fassifern Seam.

Mining in the Fassifern Seam is based on a 3.2m section of coal beneath the B ply – about 1.0-1.2m of inferior coal is left in the roof.

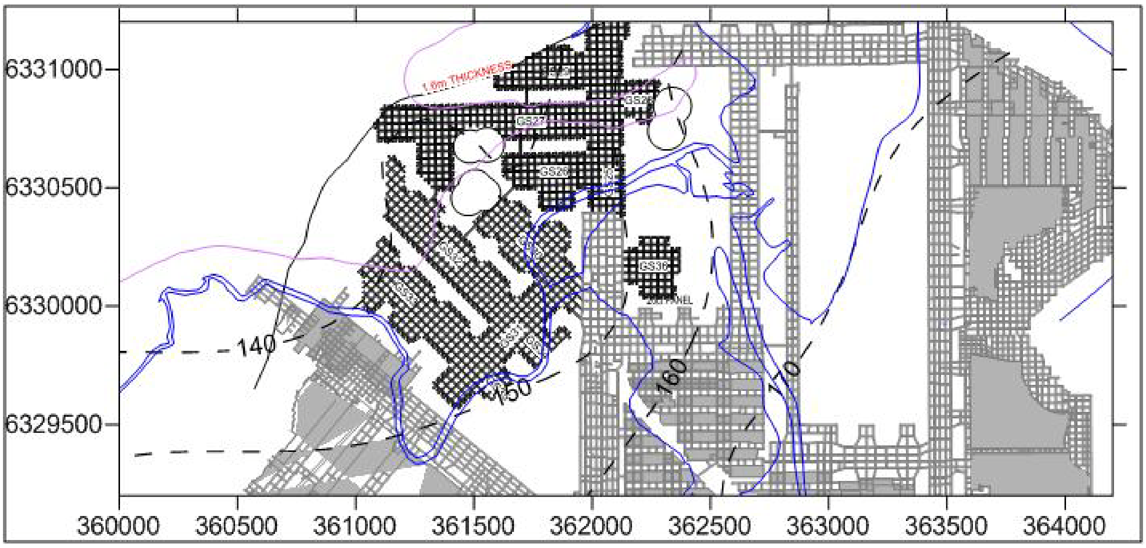


Figure 6 Proposed Great Northern seam workings (black), existing Great Northern Seam workings (grey) and depth of cover contours.

3 SUBSIDENCE INDUCED BY RECENT FASSIFERN MINING

Since mining recommenced in the Fassifern Seam at Mannering in 2004 there has been no failure of pillars. There is some slowly developing outbye floor heave but this is not associated with damage to the pillar ribs and hence does not impact on pillar stability. The pillars are on 30m centres with width to height ratios in excess of 8:1.

[1] Field monitoring of expansive soil behaviour in the Newcastle-Hunter Region. Australian Geomechanics, 40, 2, 3-14.

Subsidence surveys have been conducted along the conveyor, Vales Road, Rutleys Road and at some of the transmission towers. The patterns of greater movements above the pillar panels as compared to the inter-panel pillars indicate that there are certainly mining-induced movements at the surface, albeit of small magnitude. Table 1 lists the maximum subsidence values along the various lines as of early 2010. Along the Rutleys Road survey line in particular there is evidence of shrink/swell movements of in excess of 40mm.

Table 1 indicates the maximum subsidence induced by the recent Fassifern Seam first workings is between 8mm and 15mm, with an average of 11mm.

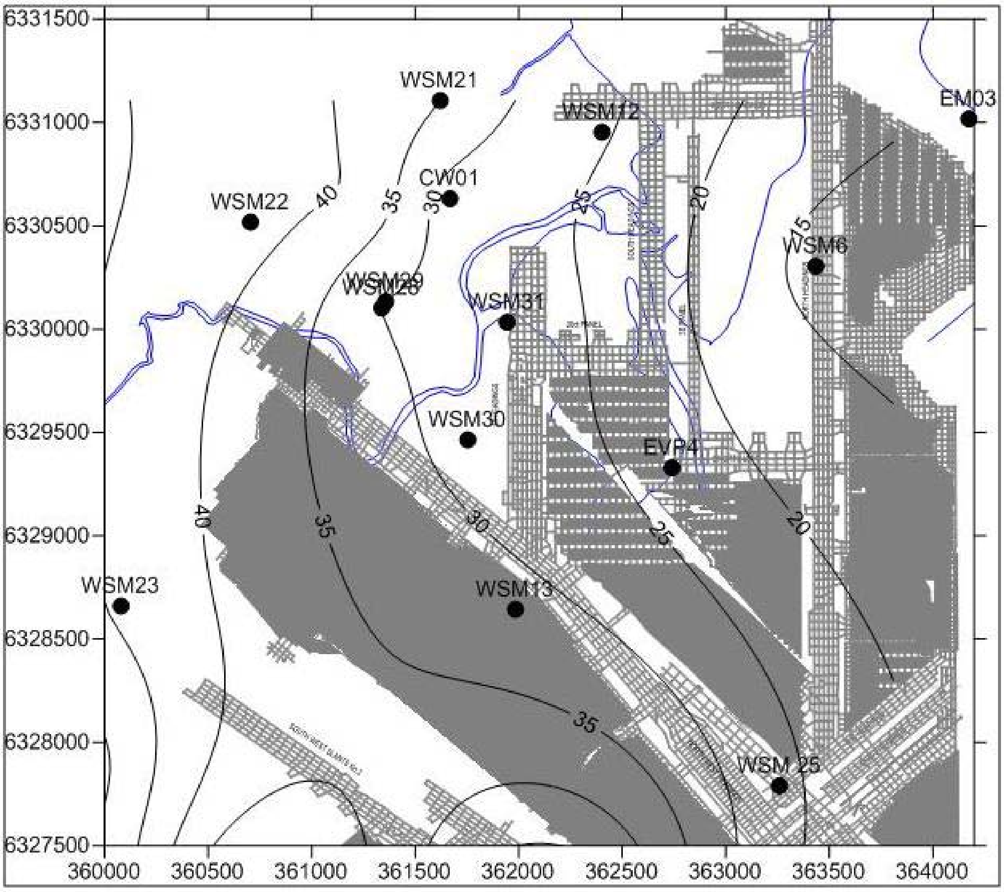


Figure 7 The Fassifern to Great Northern isopach and borehole locations overlain on Great Northern Seam workings

Table 1 Summary of maximum vertical subsidence recorded above the Fassifern workings at Mannering

Survey line	SubsidencePeg	Subsidence (mm)	Precision Peg	Precision (mm)	Mining induced (mm)
Vales Road	V11	3	V6	3	
Vales Road	V12	4	V6	3	
Towers	TG/26/92/9	19	VP50002-A	7	12
Towers	VP50000-a	15	VP50002-A	7	8
Towers	95TL62-a	4	estimate	4	
Conveyor	FC10	12	estimate	3	9
Rutleys Road	RR20	20	estimate	5	15

From what is known of the Fassifern Seam, there is no reason to indicate these subsidence outcomes will not continue – the depths are similar, the seam is similar and the pillar and roadway dimensions are the same.

Based on the precedent practice summarised above, the subsidence associated with the proposed Fassifern mining will be 12 mm.

4 GEOTECHNICAL ENVIRONMENT OF THE GREAT NORTHERN SEAM

In this report the vertical subsidence that will develop at the surface is determined by estimating the compression of the roof/coal/floor system at the Great Northern Seam level using the methods applied at Mandalong Mine[2]. The methods require knowledge of the geometry and strength/deformation properties of the various near-seam strata.

Figure 8 presents the lithological log for CW01 (see Figure 7 for location). The roof of the Great Northern Seam is Teralba Conglomerate, and the floor is dominantly conglomerate and coarse grained sandstone. The Awaba Tuff is present as the roof of the Fassifern Seam. By contrast, in hole EVP04 there is no conglomerate present and the full interburden is Awaba Tuff (Figure 9).

Drawing MG1497 (attached) summarises the immediate roof and floor geology of the Great Northern Seam. Most of the holes report a hard mudstone floor, with only holes WSM06, EVP04 WSM13 and CW01 having either claystone or tuff/tuffite logged. Where claystone or tuff is logged, terms such as waxy and soft are sometimes used. The WSM series holes have strength information using an undefined terminology. In this assessment any strength logged as soft or lower is of concern (Table 2).

Table 2 Assignment of strength and deformation properties to WSM logging terms

Term	Uniaxial compressive strength (MPa)	Undrained modular ratio	Drained modular ratio
Friable	0.5 MPa	170	34
Very soft	1 MPa	170	34
Soft	2.5 MPa	170	34
Moderately soft	5 MPa	170	34
Hard	>5 MPa	300	NR

2 Seedsman, R.W. 2010. Calibrated parameters for the prediction of subsidence at Mandalong Mine. 2010 Coal Operators Conference, AusIMM Illawarra Branch.

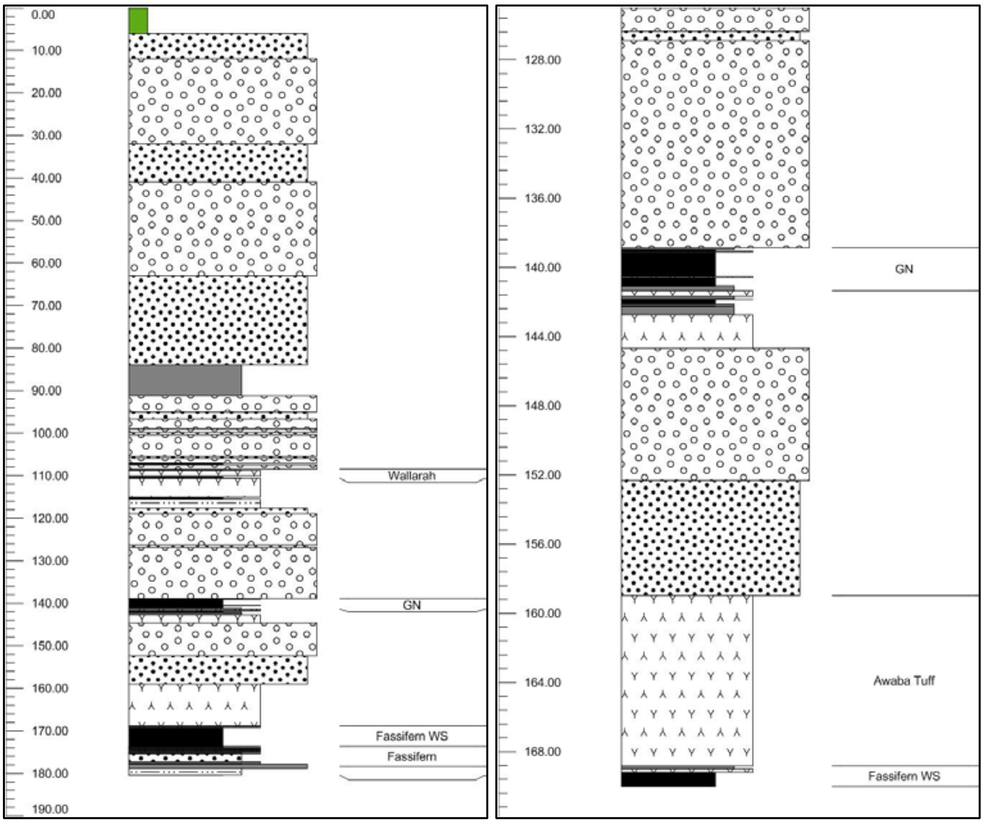


Figure 8 Lithologies in CW01

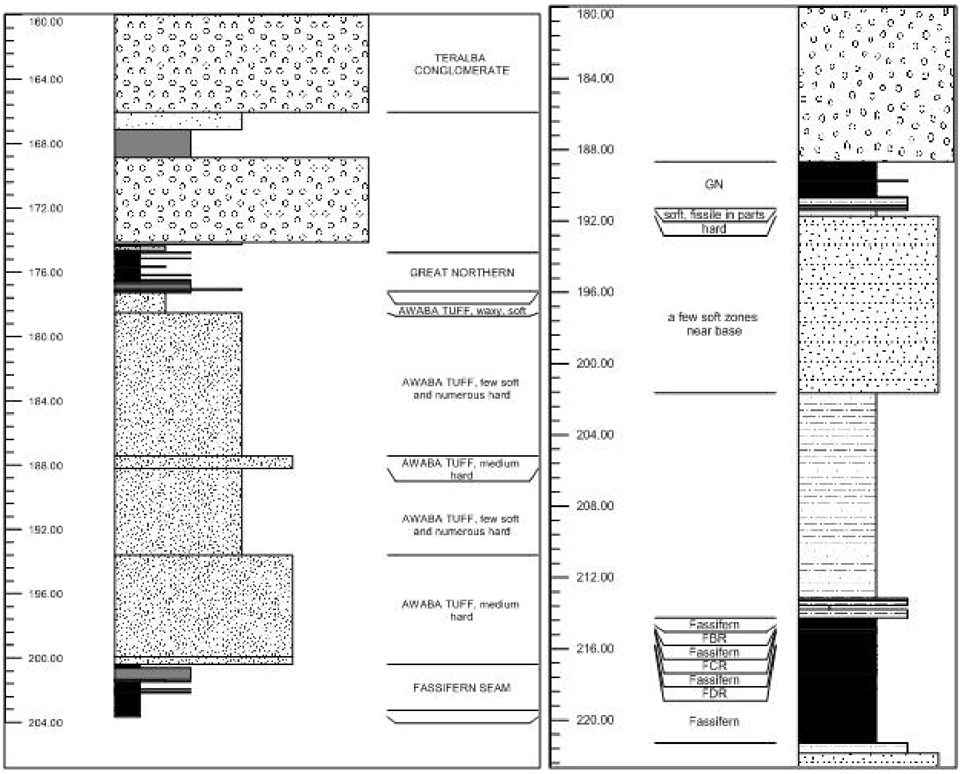


Figure 9 Great Northern to Fassifern interval in EVP04

Figure 10 presents the thickness of the Great Northern Seam floor logged as soft or weaker (Table 3). Note the trend of increasing thickness of lower strength floor towards the east which corresponds to a decreasing Great Northern to Fassifern Interval (Figure 7). A diagrammatic representation of the relationship is shown in Figure 11.

Table 3 Thickness of layers logged as "soft"

Hole	EAST	NORTH	Thickness of "soft" in immediate floor of GN seam
WSM6	363435	6330304	0.37
WSM12	362402	6330953	0
WSM13	361983.9	6328643	0.322
WSM21	361621	6331106	0.15
WSM22	360704.5	6330518	0.8
WSM23	360079	6328660	0
WSM 25	363260	6327790	0
WSM28	361338	6330102	1.28
WSM29	361358	6330133	0
WSM30	361754	6329464	0
WSM31	361944	6330033	0
EM03	364174.5	6331017	3.1
EVP4	362740	6329329	1.24

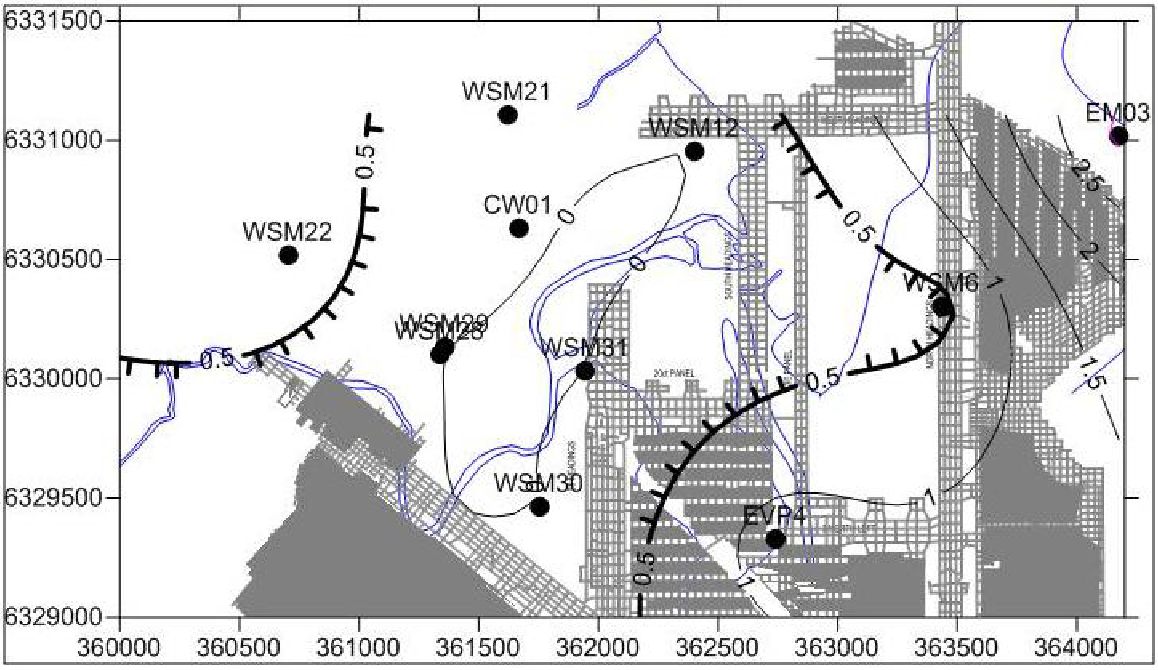


Figure 10 Thickness of low strength floor

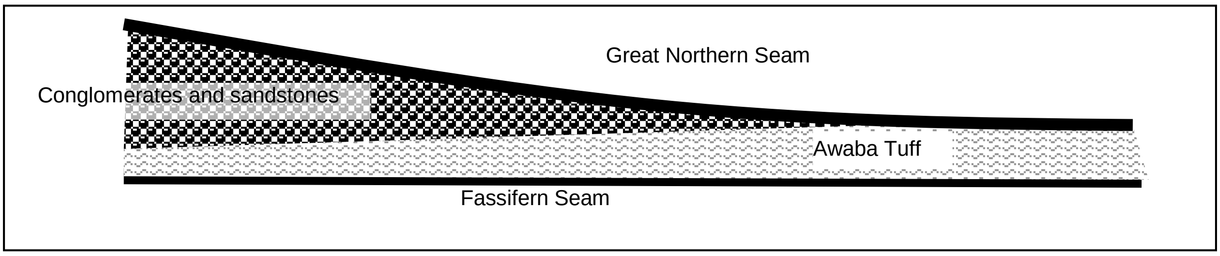


Figure 11 Schematic of possible variations in the floor of the Great Northern Seam

5 SUBSIDENCE INDUCED BY PREVIOUS MINING IN THE GREAT NORTHERN SEAM

Subsidence data are available from the Ash Dam wall (Figure 12 and 13) which is located close to EVP04 (Figure 9). Mining was conducted in 1981 using 23m wide pillars and 47m wide panels. Subsidence data is available up to 1990. The north-west trending coal block recorded 58mm of vertical subsidence along its centreline, the subsidence above the inter-panel pillars was between 142m and 175mm, and above the extraction panels the subsidence was between 220mm and 204mm. Tilts are less than 1.5mm/m, and the strains are less than 1 mm/m. There have been no adverse impacts on the serviceability of the dam.

Figure 12 Key subsidence values projected onto the extraction plan (grey areas show extraction)

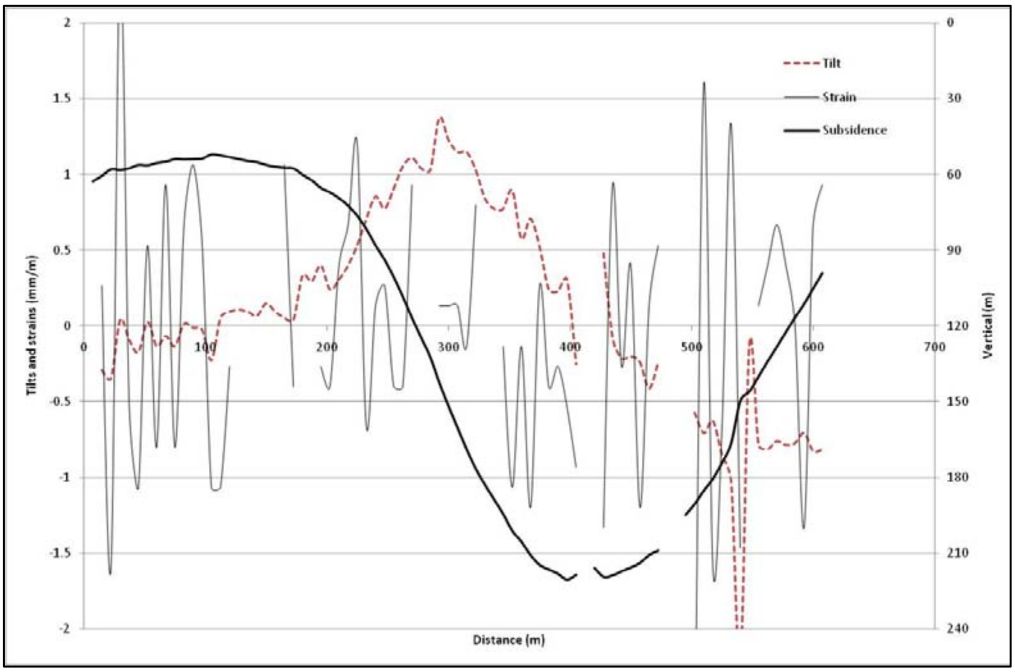


Figure 13 Ash Dam subsidence line – 1990.

The early subsidence along this line was discussed in a paper by Mattes[3] . Mattes reported 68mm at the berm and 87mm at the crest of the wall in 1982, and noted that the crest value had increased to over 200mm by 1986 (it is now about 220m). At that time the surface above the central coal block had subsided by about 50mm.

The following section of the report discusses the likely origin of this subsidence and uses it to calibrate a prediction for first workings.

There was no survey monitoring over first workings of the Great Northern Seam because at that time it was correctly assumed that the deformations would be less than 20mm.

6 PREDICTION OF GREAT NORTHERN SEAM SUBSIDENCE

6.1 STABILITY

For 2.5m pillar heights in the Great Northern Seam, the width to height ratios of pillars on 30m centres would be 9.8. These are well in excess of the width to height ratios of any failed pillar in the international pillar performance data bases (e.g van der Merwe[4], Galvin et al[5]) where failure is known to have developed within the coal pillar itself. It is noted that the proposed Great Northern Seam pillars have the same plan dimensions and a lower height as those used in the deeper Fassifern Seam – on this basis they must be more stable than those approved previously and which have not failed.

Table 4 assesses the possible bearing capacity failure of the thin layer using the thin layer bearing strength equation of Mandel and Salencon[6] for the undrained condition, a UCS of 2.5 MPa, and thickness from Figure 10. The safety factors are adequately high to indicate that pillar collapse due to the failure of the floor is unlikely for pillars on 30m centres.

Table 4 Stability of Great Northern pillars and immediate floor

	Ash Dam	30m centres	30m centres
DEPTH (m)	174	145	175
ROCK DENSITY (t/m^3)	2.5	2.5	2.5
ROADWAY WIDTH (m)	5.5	5.5	5.5
PILLAR WIDTH (m)	27.5	24.5	24.5
PILLAR LENGTH (m)	27.5	24.5	24.5
PANEL WIDTH (m)	46.2	5.5	5.5
PILLAR HEIGHT (m)	1.8	2.5	2.5
SEAM THICKNESS (m)	1.8	2.5	2.5
THIN LAYER STRENGTH (mpa)	2.5	2.5	2.5
THIN LAYER THICKNESS (m)	1.4	0.5	2
Width/height	15.3	9.8	9.8
PILLAR STRESS (mpa)	13.7	5.3	6.42
Floor Bearing capacity (MPa)	17.46	35.80	12.83
Floor Bearing factor	1.27 (possible failure ?)	6.72	2.00

[3] Mattes, N.S. 1988. Effects of Mining Subsidence on Mannering Creek Ash Dam. Proceedings of the 1st Conference on Buildings and Structures Subject to Ground Movements, Mine Subsidence Technological Society, August 1988.
[4] Van der Merwe, J.N. 2006. South African coal pillar database. J. Sth. Afr. Inst. Min. Metal., 106, 115-128.
[5] Galvin, J.M., Hebblewhite, B.K., Salamon, M.D.G. and Lin. B.B. 1998. Establishing the strength of rectangular and irregular pillar. ACARP Research Project No C5024.
[6] Mandel and Salencon. 1969. Force portante d'un sol sur une assise rigide. Proc 7th Int Conf. Soil Mech. Found. Eng., Vol 2, 157-164.

It is interesting to note that the bearing factor for the ash dam pillars is low – it is possible that the high subsidence levels were due to yield in the floor – if this is the case, the back analysed deformation for the thin layer may not be valid as it assumes elastic deformations only.

6.2 DEFORMATION

Subsidence above the pillars has been estimated using the method of Seedsman (op cit). Table 5 presents details of the analysis, with the column labelled "ash dam" representing a calibration/validation with the survey data discussed above. The drained analysis assumes that the floor under the ash dam pillars did not fail. Based on Ives[7], the strength of the conglomerates is assumed to be 67 MPa, and for the Awaba Tuff a value of 66 MPa is used. The method of Hoek and Hutchinson[8] allows an estimation of the large scale deformation properties. The method requires an estimate of the Youngs Modulus/uniaxial compressive strength ratio (modular ratio) and the GSI (Geological Strength Index). The GSI chart is shown in Figure 14.

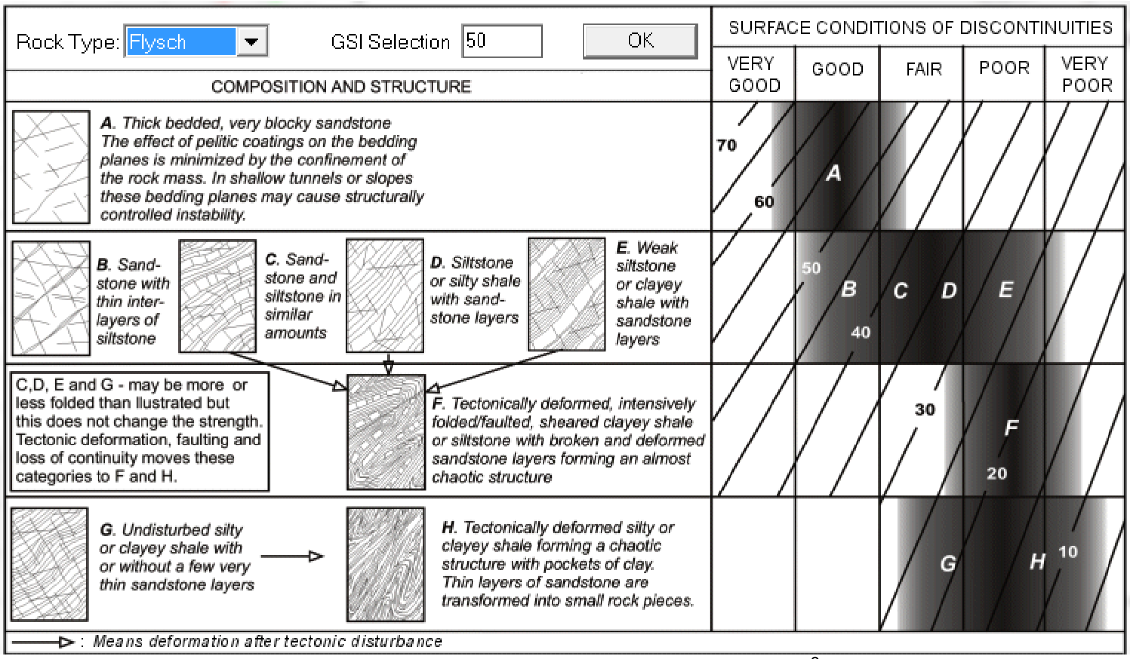


Figure 14 GSI for a sedimentary rock mass[9]

Table 5 shows the subsidence above Great Northern pillars for 2 general areas as well as the ash dam. To the west, the subsidence is predicted to be 8mm, while to the east the subsidence may be greater due to the greater thickness of low strength floor. Because of the low floor bearing factor, it is assessed the floor failed under the ash dam pillars and the drained/long term values are not valid.

[7] Ives M.J. Stratigraphy and engineering properties of the Newcastle and Tomago Coal Measures. In Engineering Geology of the Newcastle-Gosford region.

[8] Hoek E and Diederichs M.S. 2006. Empirical estimation of rock mass modulus. In J Rock Mechanics Mining Sciences, 43, 203-215.

[9] www.rocscience.com

Table 5 Deformation of the coal, roof, and floor

	Ash Dam	Western area (0.5m soft floor)	Eastern area (2m soft floor)
DEPTH (m)	174	145	175
ROCK DENSITY (t/m^3)	2.5	2.5	2.5
ROADWAY WIDTH (m)	5.5	5.5	5.5
PILLAR WIDTH (m)	27.5	24.5	24.5
PILLAR LENGTH (m)	27.5	24.5	24.5
PANEL WIDTH (m)	46.2	5.5	5.5
PILLAR HEIGHT (m)	1.8	2.5	2.5
SEAM THICKNESS (m)	1.8	2.5	2.5
THIN LAYER STRENGTH (MPa)	2.5	2.5	2.5
THIN LAYER THICKNESS (m)	1.4	0.5	2
ROOF STRENGTH (MPa)	67	67	67
ROOF GSI	90	90	90
FLOOR STRENGTH (MPa)	80	80	80
FLOOR GSI	60	60	60
COAL MODULUS (MPa)	1500	1500	1500
ROOF REDUCTION	0.96	0.96	0.96
FLOOR REDUCTION	0.52	0.52	0.52
ROOF MODULUS (MPa)	22480	22480	22480
FLOOR MODULUS (MPa)	14560	14560	14560
THIN LAYER MODULUS (MPa)	425	425	425
DRAINED MODULUS (MPa)	85	85	85
Stress change	9.5	1.8	2.1
Thin layer deformation (mm)	31	2	10
Thin layer drained deformation (mm) [10]	~~125~~	8	40
Pillar deformation (mm)	11	3	4
Roof deformation (mm)	8	1	2
Floor deformation (mm)	12	2	3
SUBSIDENCE short term (mm)	63	8	18
SUBSIDENCE long term (mm)	~~188~~	17	58

ASSESSMENT

The Fassifern Seam has induced an average of 11mm of maximum subsidence and it is predicted that this level will continue.

In areas where the low strength floor is less than 0.5m thick, the proposed Great Northern workings will induce an additional 8mm. Therefore, for the proposed pillars on 30m centres it is assessed there is little likelihood that surface deformations will exceed 20mm for the combined Fassifern and Great Northern Seams. This includes most of the Great Northern Seam including the main access roadways (Figure 5) but not the GS36 panel.

The panel referred to as GS36 is in an area where the Fassifern Seam has not been mined and hence there will have been no surface subsidence. Given the thickness of low strength floor present in this area (0.7m), the likely vertical subsidence associated with the proposed Great Northern extraction is 10mm.

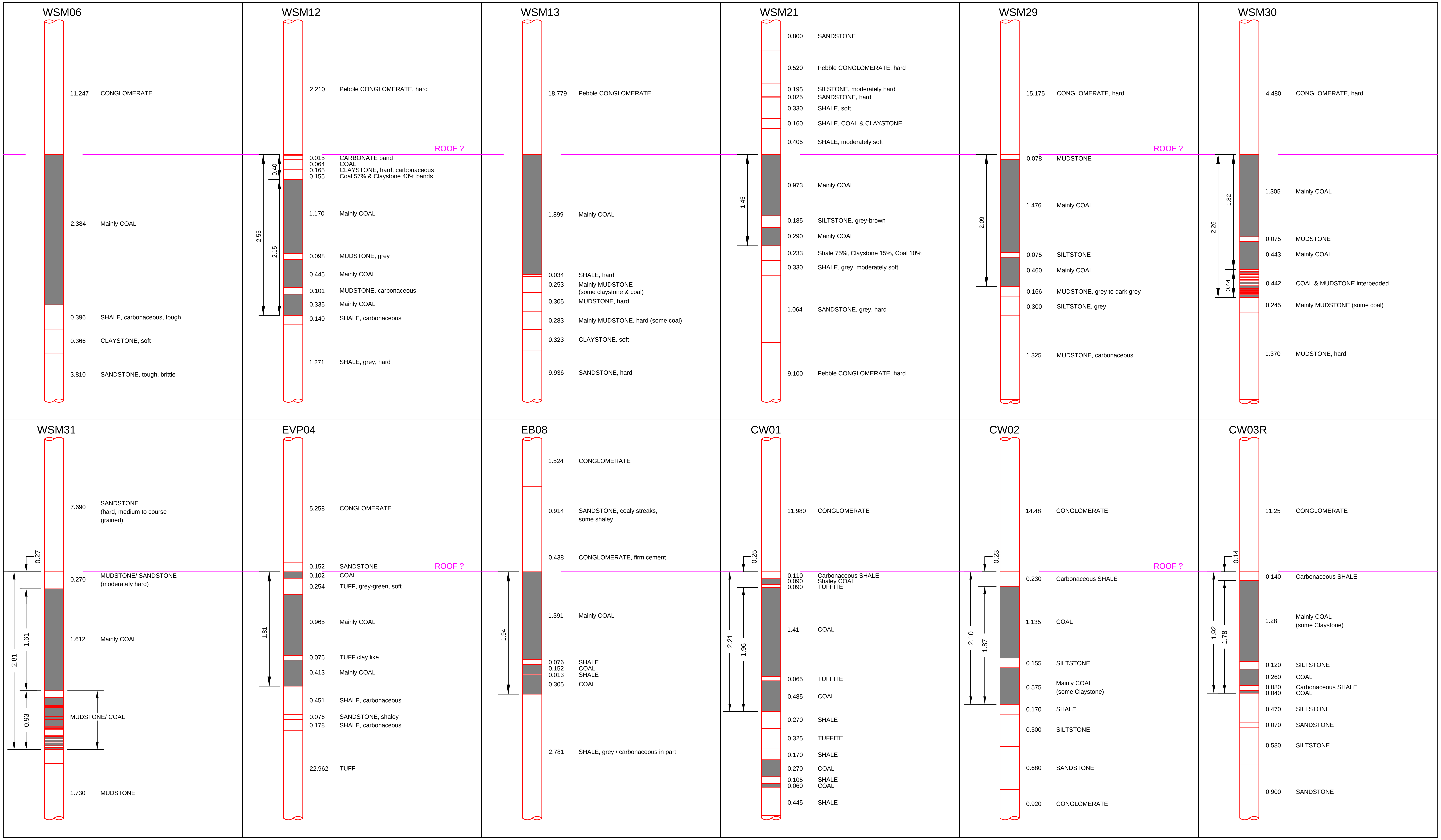
For maximum vertical subsidence of less than 20mm, any associated maximum tilts or strains are predicted to be in the order of 0.5 mm/m.

[10] Not applicable as more likely the floor failed

7 RECOMMENDATION

The mine plan as discussed should be adopted with a high level of confidence that the vertical subsidence induced will not exceed 20mm. It is noted that even if the maximum vertical subsidence does exceed 20mm, it would only be by a few millimetres and there would be no adverse environmental consequences. Maximum tilts and strains should be less than 0.5mm/m.

The prediction of the Great Northern subsidence depends on the validity of the model for the thickness and strength of the low strength tuff layer. This should be checked during mining. The processes used at Awaba Colliery in the Great Northern Seam could be used: coring under the pillars, geotechnical logging, and geotechnical assessment of the results in terms of bearing capacity and deformation.



No logs for WSM11 & WSM15 as they were drilled down from the GNS floor; and log for SW3 not in our files.

Centennial Mannering

LOCATION -	MANNERING
SEAM -	Great Northern
DRAWN -	Geoff Nowland
APPROVED -	
DATE -	7-02-2011
SCALE -	1:40 @ A2

MANNERING COLLIERY
GREAT NORTHERN SEAM
"NORTHERN AREA"
SEAM SECTIONS

PDF FILE MG 1497

PLAN No. MG 1497